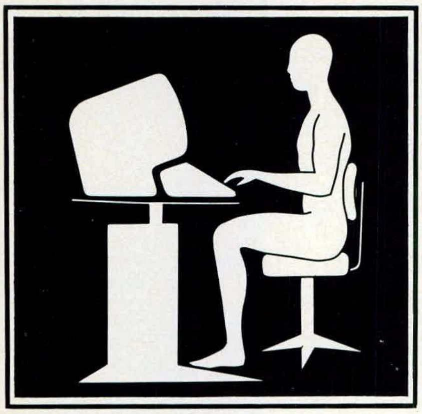

Working With Video Display Terminals*

Abrégé

L'usage des écrans cathodiques a soulevé la possibilité d'un lien entre ces appareils et certains problèmes de santé. Au début on soupçonnait que ces écrans étaient source de radiations nocives. Plus récemment on les juge sources de symptômes visuels et psychosomatiques.

Aucune enquête à date soutient que les écrans cathodiques sont intrinsèquement nocifs à la santé. Il semble que les problèmes de santé ne proviennent pas d'irradiation mais d'une mauvaise installation physique de l'appareil, une conception fautive de construction ainsi que des conditions latentes de santé qui se manifestent par suite des exigences visuelles de l'écran ou d'une mauvaise posture maintenue trop longtemps.

Une attention plus soignée à l'état de santé et l'application judicieuse de principes ergonomiques peuvent obvier ou diminuer les plaintes.

Les recherches à date indiquent que les radiations provenant des écrans sont de basse teneur et ne constituent pas un risque, selon les normes actuelles. Toutefois, les autorités sont inquietes des effets à long terme des radiations à basse teneur provenant de divers sources y inclus les écrans cathodiques. Il y a lieu de continuer les recherches dans ce domaine jusqu'a l'établissement d'un consensus dans le monde scientifique.

Puisque ces écrans bouleversent profondément le status quo du monde travailleur tant du côté des employés que des patrons il est important de maintenir une bonne communication entre ces groupes afin que les craintes de l'opérateur soient mises à jour et solutionnées.

Introduction

Video display terminals (VDTs), or visual display units (VDUs) as they are sometimes called, are comprised of a typewriter keyboard and a television-like display screen. Information is fed into a computer or memory system via the keyboard, and the image appearing on the display screen is generated by a cathode ray tube. The broadest application of this equipment is in graphic, data- and word-processing systems.

Display Screen

The method of image generation in a VDT is identical to the method used in a conventional TV set; the cathode ray tube (CRT) used in both instances is a glass vacuum tube with an electron gun at one end and a phosphor-coated screen at the other. When high electrical voltage is supplied to the gun, a stream of electrons is produced. This stream of electrons resembles a slender beam, and can be directed to any desired position on the face of the screen. The electron beam interacts with the phosphor-coated screen to emit a bright spot of light.

Scanning control sweeps the beam across the surface of the screen in a series of regularly spaced horizontal lines called raster-scan lines. The method most commonly used to form the letters or characters that appear on a VDT screen is dot-matrix generation. This means that each character is defined by a set of dots selected from a rectangular matrix (or source) of dots by the scanning control. The resolution of the matrix is defined by the number of horizontal and vertical dots used to determine the maximum extent of the character image; e.g., five dots by seven dots, or seven dots by nine dots. In general, a five by seven matrix is adequate for displaying capital letters and numerals, but seven by nine and above are the ones most commonly used in the processing of text for display.

Because the light emitted by the phosphor coating of a cathode ray tube decays rapidly, the image on the screen must be continually refreshed in order to present a stable, flicker-free image. The characteristics of the phosphor and the resolution of the character shapes together determine the time required to display a single line of text.

Health Aspects

The widespread use of video display terminals, since their development a little more than a decade ago, has been accompanied by varying degrees of uncertainty as to their possible health hazard. Initially, particular attention was directed to their potential as a radiation hazard but more recently this concern has been enlarged to include possible visual and musculoskeletal problems. The following section outlines psychological, radiation, fatigue and visual factors involved in VDT operation. It is not intended as a comprehensive text on these health aspects, but it is hoped that it will be

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By the Occupational Environment Branch of the Ministry of Labour with the assistance of Ulrika Wallersteiner — Occupational Health Consultant

Dr. Craig L.T. Galbraith — Assistant Director, Division of Occupational Health, Ministry of Health

Dr. M. Wayne Greene — Director, Radiation Protection Service, Ministry of Health

of some practical help to those individuals with concerns in this area.

1. *Psychological*

One of the most effective precautions that can be taken to safeguard against future dissatisfaction, discomfort, and health problems among operators of video display terminals is to involve the operators from the beginning in how to use these sophisticated machines with assurance. In practice, the successful introduction of VDTs depends principally on the attitude of those involved. When this has not been achieved, the costs of poorly designed work change are eventually paid for by the community as a whole. Worker alienation can be prevented if the potential VDT users understand their role in the overall work process, if they have a sense of control over their tasks, if they understand the importance of their jobs, and if they do not feel isolated within the working environment.

Individuals differ in their response to change, the difference depending on whether change is perceived in a positive or a negative light. If the perception is negative, then the potential for health problems would probably increase if VDTs were introduced in a manner that failed to meet the needs of both the job and the users.

To cope with a negative perception, supervisors must be prepared to recognize that the individual may regard the introduction of VDTs as a nuisance, because it requires a change in job description; as disturbing, because it demands the rejection of old skills and the acquisition of new ones; as unsettling, because quality of work may henceforth be measured in terms of quantity; and as a threat to security, because of the possibility of redundancy. Singly or in combination, these responses can generate an anxiety that may cause the individual to exhibit symptoms of both psychological and physiological stress that can lead to illness.

2. *Radiation*

Considerable attention has been focussed on the possibility that harmful electromagnetic energy radiates from VDTs. Electromagnetic radiation is of two major types, ionizing and non-ionizing.

Ionizing radiation occurs normally in nature, emanating from radioactive materials in rocks, soils, building materials, space, and is commonly used in diagnostic and therapeutic medicine. The average Canadian receives approximately 200 mrem* of this type of radiation annually, approximately half of which is from natural background. Federal and international standards, recognizing the harmful effects of excessive ionizing radiation, recommend that members of the public not receive whole-body doses of more than 500 mrem in a year, exclusive of medical and dental radiation exposure.

The only ionizing radiation that a VDT is capable of producing are X-rays of low energy, (produced inside the cathode ray tube). These X-rays are of low penetrating energy when compared to medical and dental X-rays. X-rays which are generated inside the cathode ray tube are totally, or almost totally absorbed by the material of the screen or tube housing, (i.e. glass enclosure and other shielding materials). The maximum allowable limit of ionizing radiation from VDTs is set at 0.5 mR** per hour measured at 5 cm from any accessible external surface of the VDT. (Reference: Radiation Emitting Devices Regulations made under the Radiation Emitting Devices Act of Canada).

Measurements of thousands of VDTs for X-rays, indicate emission levels of at least 10 to 20 times lower than the allowable limit of 0.5 mR/hour. Generally, radiation surveys of VDTs have failed to detect any ionizing radiation coming from the machines.

To assess the validity of claims that VDTs might be emitting X-rays at low level, (below background levels), 60 different models were tested in Health and Welfare Canada — Radiation Protection Bureau's low level counting facility. This facility can detect low energy X-rays at emission levels of 500,000 times lower than the mandatory standard for VDTs (0.5 mR/hour). No X-ray emission was detected during the tests.

Non-ionizing radiation has a much lower potential for causing adverse health effects that does ionizing radiation. Non-ionizing radiation includes ultraviolet, visible, infrared, microwave, and radiofrequency, which includes, very low frequency (VLF), and extremely low frequency (ELF)). Non-ionizing radiation surveys of VDTs indicate that these types of radiation are either undetectable or hundreds to thousands of times lower than the applicable radiation standards. (Table 1 summarizes the maximum radiation exposure levels allowable for each frequency range of non-ionizing radiation.)

Table 1

Non-Ionizing Radiation Maximum Radiation Exposure Standards

Type of Radiation	Standard
Ultraviolet (UVA)[1]	1 milliwatt/cm^2
Infrared[1]	10 milliwatt/cm^2
Microwave[2]	1 milliwatt/cm^2
Radiofrequency[2] (above 10 MHz)	1 milliwatt/cm^2

Some VDTs produce measurable quantities of very low frequency (VLF) electromagnetic fields. Typical measurements in the operator's position show results of less than 1

**mrem (millirem)* — provides a measure of the amount of ionizing energy actually absorbed by a person, (i.e. dosage).

***mR (milliroentgen* — provides a measure of ionizing radiation emission. (1 mR is equivalent to approximately 1 mrem for X-rays).

[1]Threshold Limit Values for Chemical Substances & Physical Agents in the Work Environment, ACGIH, 1982.

[2]Safety Code 6, Recommended Safety Procedures for the Installation & Use of Radiofrequency & Microwave Devices in the Frequency Range 10 MHz - 300 GHz, Health & Welfare Canada, 1979.

mW/cm². These emissions, technically not radiation, are associated with the beam scanning circuitry and have a frequency range from 15 kiloHertz to 300 kiloHertz. Many common electrical appliances, e.g., electric can openers, electric kettles, etc., emit VLF and ELF with intensities equal to or greater than VDTs. There is no evidence of detrimental biological effects from the levels of VLF and ELF generated by VDTs.

Health and Welfare Canada in its booklet *Safety Guide for Video-Display Terminals* concludes:

> "It can be stated unequivocally that Video Display Terminals do not emit levels of any electromagnetic radiation of any wavelength that could possibly be hazardous to any person, male or female, young or old, pregnant or not, and therefore do not present an occupational radiation hazard".

Non-ionizing radiation surveys for ultraviolet, visible, infra-red, microwave and radio frequency emissions indicate that these are well below recognized radiation standards. Although it is recognized that exposure to high-intensity microwave radiation can cause cataracts and other damage associated with heating of soft tissues, no VDT in Canada has to date been shown to produce cataracts.

Although published studies indicate that radiation emissions from VDTs are low and do not constitute a health hazard based on current radiation standards, concerns still exist over the possible long-term effects of low-level radiation from many sources including VDTs. More research is required in this area to obtain a consensus among the scientific community.

3. *Fatigue*

Fatigue is a broad term for which there is no unequivocal definition. VDT operators may experience it as psychological, physiological or general body fatigue, just as would any other worker — the extent depending on their work tasks, and on such individual characteristics as general health and lifestyle.

VDT operators who enjoy good health may become fatigued, and experience both visual and postural discomfort in the absence of any visual or postural problems. Although pre-existing problems of this nature predispose a person to fatigue, the condition is thought to be due largely to a sustained effort to see clearly and maintain a static posture.

Prolonged attention to visual detail with reduced eye movement in a restricted visual VDT field, when coupled with the absence of auditory stimulation, can give rise to fatigue and symptoms of eyestrain. The latter is experienced in the form of irritated, heavy, dry, burning eyes, and is sometimes associated with headache and focusing difficulties. Indeed, eyestrain symptoms may indicate the presence of a more generalized fatigue. Similarly, postural-fatigue symptoms can arise from prolonged stationary postures. Because the body is designed for movement, a fixed posture is much more tiring than a dynamic one, as can readily be appreciated by comparing an individual's tolerance to standing and to walking.

In the case of VDT operators, it is important to realize that, for practical purposes, the visual and musculoskeletal systems behave as a single functioning unit. Shortcomings in vision, for example, are commonly compensated for by faulty work postures that may give rise to symptoms of muscle fatigue. The converse holds true for postural shortcomings. In both instances, however, the symptoms that arise may not indicate the source of the problem, because visual and musculoskeletal deficiencies may co-exist.

To avoid fatigue, discomfort and health problems, the VDT operation should be designed to accommodate reasonable rest pauses. These pauses should not be defined in terms of apparent work-station inactivity, as in the case of waiting time that occurs during normal VDT use; nor should they be selected in an unpredictable fashion based on work convenience. Preferably, the operator should be permitted to rest in an area removed from the VDT station, and prior to the onset of noticeable fatigue. The rest pauses should be scheduled regularly. Their scheduling and duration should be based on the visual demands of the task and the total work time at the VDT — e.g., 15 minutes after every two hours for those working under moderate visual demands.

Rest pauses are a means of overcoming or avoiding occupationally induced fatigue, and it is therefore the recovery value, not the nominal duration of a rest pause, that is important. Frequent pauses taken before the onset of a high level of fatigue are judged to be more effective than longer but less frequent pauses after fatigue has set in.

Job rotation or substitution of a less demanding activity can also provide a means of recovery from fatigue.

Some work settings have had their usual informal communications significantly altered by the introduction of VDTs, so where possible, the location for rest pauses should take this factor into account.

4. *Visual*

(a) Normal Vision

The normal eye is a fluid-containing sphere with a transparent cornea, admitting light to the lens, which focuses it onto the fovea and the retina, the image sensitive parts of the eye. For viewing distances of less than 20 feet, one third of the focussing ability, the active or "accommodating" aspect, is carried out by the internal muscles of the eye and by the malleability and elasticity of the lens. The remaining two thirds of focussing ability, the passive or "non-accommodating" aspect, is carried out by the cornea and the internal fluids of the eye.

The capacity of both the internal muscles, which vary the size and shape of the lens, and the external muscles, which control eye movement and depth perception, is so great that they do not normally become fatigued or exhausted. Current medical opinion holds that it is not possible to damage the eyes through use. One may, however, develop eye fatigue and discomfort symptoms from a prolonged effort to see clearly, because visual acuity is not a fixed property of the eye, but rather a function that depends on visual capacity, as well as on the quality of such optical stimuli as level of illumination, glare, contrast, character size, and colour.

(b) Impaired Vision

Between the ages of 20 and 60 it is common for the focusing capacity of a normally sighted individual to be reduced by about 25 percent, as the lens becomes less flexible. As one ages, this slow but progressive process results in a slower rate of accommodation to distances, diminished ability to detect small differences in light levels, and increased sensitivity to glare.

These changes tend to become the rule rather than the exception after the age of 40. Owing to the added visual demands inherent in VDT operation, these age-related impairments, together with other common visual problems that affect 20 to 30 percent of the work force, must be taken into account when the visual aspects of VDT operation are being considered.

(c) Visual Disabilities

The defective eye is usually characterized by an abnormality in one or more of the eye structures which comprise the image forming mechanism, such as an abnormal eyeball size (short-sightedness — myopia and long-sightedness — hyperopia), an unusual shape to the cornea (astigmatism), an altered lens structure (aging change — presbyopia) and cataracts, a change in the volume or viscosity of the eye liquids (glaucoma and aging), and impairment of the muscle balance controlling eye movements (squints, strabismis and phorias).

Most eye disabilities can be compensated for by the use of appropriate spectacles or corneal contact lenses. However, it is essential that the eyeglasses chosen provide a range of focus adequate for viewing such varied items as equipment and documents, each of which may require different visual capabilities. For example, glasses prescribed for reading may not match the viewing distance of either the VDT screen or keyboard. It may therefore be necessary for an operator to use bi- or multi-focal lenses, for without a sufficient range of focus, a person may unconsciously resort to dysfunctional postural positions in order to secure the optimal viewing distance.

(d) Vision Testing

According to the majority of published expert opinion, there is little likelihood that VDTs produce damaging or disabling eye conditions. What research documents have indicated, however, is that failure to accommodate the operator in VDT design, implementation, and use may result in health complaints.

Although these complaints may not be individually disabling, their combined effect on a continuing basis may prove debilitating. It is therefore important that vision testing not be treated as a substitute for normal health and eye care. In the absence of generally accepted guidelines on visual testing, it is recommended that eye examinations be conducted on the principle of early detection and correction of defective vision. Any ongoing visual complaint should serve to indicate the need for a prompt and complete optometric or ophthalmological examination, including refraction, acuity, accommodation, colour vision, corneal, lens, and retinal testing.

Operators should undergo regular vision testing prior to and during their working with a VDT if there is an existing eye complaint, a corrected visual defect that has not been examined for two years, or a marked concern about the safety of VDT viewing — especially if the work involves a high visual demand and the potential operator is over 40 years of age.

If large numbers of employees require vision testing, employers, union, and occupational health and safety personnel may want to consider establishing a formal visual-test program. Like other health-surveillance programs, it should take into account the need for confidentiality, and the setting up of a central system for recording results, in order to ensure detection of an abnormal incidence of visual defects. Program organizers should also consider the need to educate employees on the health aspects of VDTs, to regularly assess employees with defective vision, and to evaluate existing rehabilitation resources and employee benefit packages to determine how they might be adapted to provide retraining and alternate job placement of employees.

5. *Other Medical Conditions*

It has been estimated that between one and three percent of the epileptic population is subject to visual-reflex epilepsy — i.e., epileptic seizures induced by visual stimulation. Despite the rarity of this condition, it would seem a wise precaution to have

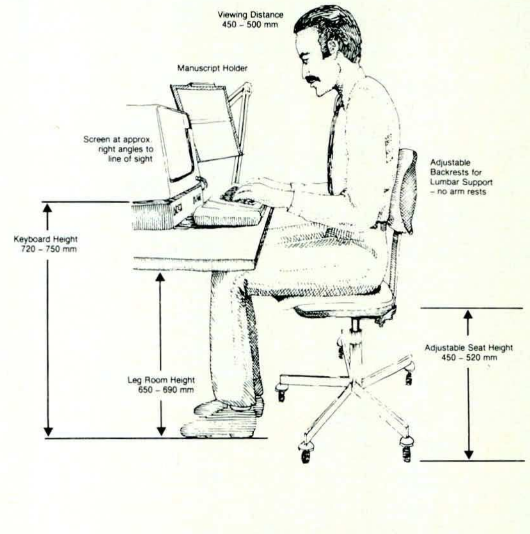

FIGURE 1 — WORK STATION DIMENSIONS

known photosensitive epileptics undergo an appropriate medical examination before using VDTs, especially if the employee has a history of being adversely affected by watching TV.

Ergonomics

Ergonomics is the planning and adapting of equipment or tasks to promote the comfort and efficiency of workers.

By applying sound human engineering principles to the design of the VDT work environment, the incidence of visual and musculoskeletal-induced discomfort and fatigue can be significantly reduced. The following sections identify visual, postural and environmental problems normally present in the VDT work environment, and offer proven ergonomic principles for their control.

1. *Vision-Related*

As discussed in the preceding sections of this text, working at a VDT places special visual demands on the operator. Because of this, the following factors merit special attention:

(a) The Quality of the VDT Display Image

Display-image resolution is determined by *character size* and *inter-character spacing*. If the characters are too small or too close to one another, legibility is diminished. If the characters are too large, then the phosphor dots appear to dissociate. At times, VDTs may suffer from distracting *flicker* (the characters seem to "jitter" or "shimmer"). This is due to the decay of the phosphor image before it is refreshed by the electron scan. Maintaining a minimum refresh rate of 60 Hertz (cycles per second) should prevent flicker. *"Swim"* is the term used when the whole screen image wavers or moves. This is caused by power supply instabilities, or power supply voltage consistently below the nominal voltage rating of the VDT. The signal strength may be insufficient to ensure a static image. In such a case, it may be necessary to consider the installation of what is termed a "dedicated power line" or constant-voltage device. The *resolution* (clarity) and *luminance* (brightness) of the VDT characters may be degraded by grime on the screen or deteriorating cathode ray tubes. Periodic cleaning of the screen, and replacement of an expiring CRT will enhance the resolution and luminance of screen characters.

(b) Presence of Glare

Glare results when bright sources of light — e.g., light fixtures, windows, or their reflected images — fall within the operator's field of vision. Once the processes of visual adaptation are disturbed, visual discomfort may result. The operator may adopt a poor body posture to minimize the glare, possibly leading to neck and back pains.

VDTs should not be placed against a bright background such as windows or white walls, because the eyes adjust to the total light entering them, and the images on the screen become more difficult to see. Walls should be textured (matte finished) in neutral tones to reduce reflections. Windows should be furnished with pattern-free curtains or roll blinds (venetian blinds can cause a pattern of light stripes). The VDT should be located so that the operator's line of viewing is parallel to the windows, hence avoiding VDT screen reflections. Similarly, light fixtures should be located along the sides of the VDT. Light fixtures located in front of the VDT operator cause direct glare, and those located directly overhead or behind the operator cause reflected glare. To control glare, light fixtures should be shielded with prismatic diffusing lenses or, preferably, cube-parabolic louvres.

Another means of reducing glare is to install filters on the front of the VDT screen. Different types of filters are currently available. However, reducing reflections by this means occurs at the expense of resolution and image brightness. A roughened screen panel (fine grain etch) or a coating of VDT screens provide the best methods of controlling reflections without too much compromise of brightness and clarity. The screen should not have been too coarsely etched, or the character image will diffuse and seem unclear. From the point of view of reducing reflections alone, micromesh filters have been judged to be equally effective, but they greatly reduce brightness, contribute to blurring, and produce a flat display that may be difficult to read. Polarization (tinting) of filters with an anti-glare coating is the second-best method. Because filters have some disadvantages, the best method for preventing reflections is to position the VDT correctly in relation to light sources. An adjustable screen angle will also help.

(c) Other Sources of Glare

Shiny key tops and source documents can be distracting to VDT operators. The shape of the key top can act as a mirror. For this reason, keys should have a matte surface, and be a neutral colour — for example, gray.

Source documents may be over-illuminated or wrongly positioned, thus creating difficulties in reading. If possible, the source document should be provided on other than white, glossy paper, so that strain caused by frequent adjustment — from the dark screen to the bright paper and back — is avoided or reduced.

(d) Lighting for the VDT Environment

Discerning text on a VDT screen is greatly enhanced by reduced ambient or environmental illumination: light characters on a dark screen require less light for reading than do dark characters on a light background. The average brightness in the total visual field should be matched with the brightness of the immediate visual objects, in order to reduce constant readjustment of the eyes to the varying lighting conditions.

When the user's task involves both VDT and paper, a compromise light level is required; one bright enough for the paperwork without reducing screen contrast.

Ambient light levels:

— 500 - 700 lux* is an acceptable compromise for tasks requiring

continuous use of source documents;
— 300 - 500 lux* is an acceptable compromise for tasks requiring occasional use of source documents.

2. *Posture-Related*

Four basic conditions must be satisfied in order to make the work area operational.

VDT users should be able to:
— reach and operate all controls;
— see and read the displays;
— adopt a comfortable posture by adjusting chairs and the VDT; and
— have easy access in and out of the work place.

Back problems are mainly caused by incorrect work place design leading to poor posture and muscle tension. Figure 1 identifies preferable work-station dimensions. Numerous factors contribute to poor posture.

(a) Seating

A suitable chair is an important part of a VDT work station. Failure to have proper seating and good posture can cause fatigue in calf, thigh, back and neck muscles. For the VDT user, a suitable chair will have the following characteristics:
— total adjustability, which can be regulated from a seated position;
— good stability (preferably on five legs and castors);
— no arm rests to interfere with arm movements;
— adjustable backrest to support the lower spine and lumbar region;
— a backrest that is adjustable in two directions — forward and up;
— rounded front seat edge to prevent cutting into the thigh;
— flexible, upholstered material that helps to distribute the pressure of sitting more evenly, thus eliminating pressure spots and blood pooling; and
— woven chair coverings to prevent sliding, body heat buildup, prespiration and chafing.

Other requirements that must be met if the chair is to satisfy the foregoing conditions are as follows:
— chair should be adjustable in height between 450 and 520 mm;
— correct sitting height is obtained with feet flat on the floor, and the thighs in a horizontal position on the chair seat;
— depth of the chair should be about 380 mm;
— seat depth, while sitting, should be less than the distance from the back of the buttock to the inside of the calf, to allow sufficient space to prevent the edge of the seat from pressing into the back of the calf;
— backrest should be adjustable in height between 125 and 200 mm from the seat;
— backrest must be sufficiently high to give direct support to the small of the back;
— angle between seat and backrest should be between 95 and 100 degrees; and
— seat should be horizontal or sloping back by up to 5 degrees.

(b) Foot Rests

For smaller operators, when the desk height is fixed, correct leg posture (thighs horizontally on the seat and feet flat on the floor) can be achieved with a foot rest, having these characteristics:
— adjustable both in height (from 0 to 50 mm) and inclination (10 to 15 degrees); and
— large enough to cover the entire usable leg area to avoid movement restrictions.

(c) Desks and Work Surfaces

Desk space should be adequate and not cluttered. Too small a desk makes the work place unpleasant and cramped, and inhibits proper working posture. Desks should provide:
— enough space for document holders, incoming and outgoing document trays, calculators, pencils, etc.;
— an area for handbags and briefcases, to prevent tripping;
— adequate leg room; and
— desk tops should not be too thick, otherwise correct arm position cannot be maintained.

Measurements required for desks to satisfy the above conditions are as follows:
— desks should have a suitable height to accommodate a keyboard height of 720 to 750 mm above the floor; VDT screen height and keyboard height should be independently adjustable; ideal arrangement is a VDT with a keyboard detached from the display screen, and a fully adjustable machine stand;
— minimum leg-room height should vary between 650 and 690 mm; and
— leg-clearance space between thigh and desk should range between 170 and 200 mm for easy access in and out of the work place.

(d) Keyboard and Screen

If the keyboard is attached to the screen casing, it is impossible for all operators to sit comfortably while keying and reading the screen. Hence a detachable keyboard is strongly recommended, also:
— optimum height of keyboard should permit forearms and hands to be held approximately horizontally;
— wrists should not need to be cocked-up in order to reach the keyboard, as this may produce wrist problems; hence keyboard should be of minimum thickness to ensure correct elevation;
— keyboard should not be placed too far from the desk edge, as this subjects wrists and forearms to cutting action;
— screen height should be such that the viewing angle is approximately 20 degrees below the horizontal, thereby allowing for a slightly downward gaze in accordance with the natural curvature of the spine; and
— viewing distance between the screen and the eyes should not be greater than 700 mm (450 to 500 mm recommended).

(e) Document Holders

Placing documents flat on the desk results in awkward twisting and bending, which leads to neck and shoulder tension. Using adjustable document holders, and placing them

*lux — unit of illumination level — 500 lux is equivalent to approximately 50 footcandles.

next to the VDT screen at a similar angle, distance and height, provides the following advantages:

— minimizes bending and twisting of the head and neck;
— minimizes eye adjustments, as the viewing distance between the source and screen is decreased; and
— minimizes reflected glare from the source document.

(f) Posture

Holding any set of muscles in a fixed position for a long time is tiring, but some positions are less fatiguing than others. Special attention must be paid to the arms, head, spine, pelvis, abdomen and thighs of the seated operator.

Optimum VDT work-station design will enable the operator to assume the following favourable posture:

— arms should be held horizontally at a 90 degree angle from the elbow; raising them higher for an extended period requires more energy, and results in earlier onset of fatigue;
— wrists should be in line with the forearm, as cocking the wrists up may result in wrist problems;
— head should be slightly inclined forward to follow the natural curve of the spine; if the head is bent down too far, the support will shift from the spine to the shoulder and neck muscles, thereby inducing fatigue and headaches;
— spine should be kept fairly straight, with the backrest supporting the lower back and pelvis, enhancing the lumbar curvature of the spine, and preventing rotation of the pelvis and consequent fatigue and strain in the back muscles;
— abdomen will be naturally tucked in with a straight upright spine, thereby aiding in the support of the spine and back muscles;
— thighs should be resting horizontally at a 90 degree angle from the pelvis; and
— feet should be placed flat on the floor and not wrapped around one another, as this compresses the soft tissue of the thighs and calves, diminishing blood flow; a foot rest is necessary for smaller operators.

Employing good posture is essential if the VDT operator is to avoid unnecessary discomfort, fatigue, aches and pain.

Even when the operator is provided with a properly designed workplace, problems may occur. Maintaining a fixed static posture (even an apparently good one) is fatiguing. A certain amount of movement is necessary and is encouraged. Doing simple body and eye exercises during rest breaks can be helpful in avoiding strains in the back muscles, fatigue of the eye muscles, and the long-term consequences of blood pooling. It is in the area of posture that the VDT operator has the most control over his/her work environment, health and well-being. Appendix "A" describes some simple exercises the VDT operator can do at the workplace.

3. *Environment-Related*

General working conditions are also important. The visual environment has already been discussed in some detail. However, several additional points deserve mention:

— the opportunity to rest the eyes by viewing relatively distant objects is important; visual relief areas that are visible from the VDT work place are desirable; backgrounds with distracting patterns, a lot of free movement, and in sharp contrast to the work station, however, should be avoided; and
— optimally, all large surface areas should be in soft pastels or warm gray, and devoid of point sources of light.

Other environment issues of importance are temperature and humidity.

— all VDTs and related equipment emit heat, often as much as 400 watts from a single VDT; this may place considerable demands on the existing ventilation system;
— concentration often leads to a reduction in eye-blink rate; the lack of humidity tends to dry out the secretions on the surface of the eye and may cause irritation; and these symptoms may be intensified in contact-lens wearers.

Static electricity can also cause problems for VDT operation:

— discharge between operators and VDTs can cause data loss, program changes and operating difficulties; static charges can attract dust and dirt to the screen face; and static electricity can cause skin irritation for operators.

Providing draft-free ventilation, avoiding overcrowding of VDTs in the work place, and maintaining a constant relative-humidity level (preferably 50 to 70 percent) should minimize or eliminate these problems. Periodic cleaning of the VDT screen with anti-static solutions will control dust accumulation, and anti-static floor mats can reduce static-electricity problems in low-humidity work places.

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Editor's Note

Copies of a booklet which includes the foregoing text, as well as illustrations of a) the structure of the eye; b) a work station layout; c) examples of good and poor posture; and Appendices: a) simple exercises for the VDT operator; b) an employee referral form re: vision testing; c) an examiner's form re: vision testing and d) investing in a VDT — Equipment selection; can be obtained by writing:

Mr. Ken R. Martin
Director & Chief Inspector
Occupational Environment Branch
Ministry of Labour
Room 220, 4946 Canada Way
Burnaby, B.C. V5G 4J6