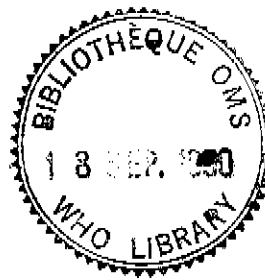




WORLD HEALTH ORGANIZATION  
ORGANISATION MONDIALE DE LA SANTE



32809

DISTR.: GENERAL(E)

WHO/OCH/90.3

ENGLISH ONLY

## UPDATE ON VISUAL DISPLAY TERMINALS AND WORKERS' HEALTH

### INTRODUCTION

In December 1985, a WHO Working Group met in Geneva to discuss the occupational health aspects in the use of visual display terminals. When its report was finalized in 1986, it managed to incorporate also the findings presented in the First Conference on "Work with Display Units" held in Stockholm in May 1986. The WHO report was published in 1987 as Offset Publication No. 99 - "Visual Display Terminals and Workers' Health".

In September 1989, during the Second Conference on "Work with Display Units" held in Montreal, some members of the working group started to look into the possibility of producing an update of the conclusions and recommendations in the WHO report. This was prompted by the expressed desire for such an update from many researchers of various countries, including the developing world.

In January 1990, the WHO Office of Occupational Health made a request to Professor Bengt Knave and Dr Ulf Bergqvist of the National Institute of Occupational Health in Sweden to provide a "statement accounting for the major recent development in the field of health protection of VDT workers".

After some discussion, it was agreed to restrict the update to the executive summary (Chapter 1) and the guidelines for work with visual display terminals (Chapter 3) of the 1987 WHO publication. The statements in this update have been prepared by Professor Bengt Knave and ~~Dr Ulf Bergqvist and circulated to other members of the 1985 working group for review~~ (Annex 1). Their contributions to this update are herewith duly acknowledged.

### EXECUTIVE SUMMARY - HEALTH AND VDT WORK (Chapter 1)

A World Health Organization Working Group on Aspects of Occupational Health in the Use of Visual Display Terminals (VDTs) studied in December 1985 the considerable literature available from research that is pertinent to the health implications of work on VDTs.

The conclusions made then have been re-examined in the light of research results appearing in 1986-1989. The revised conclusions are set out below in some details. It is apparent that the executive summary provided in 1985-1986 by the working group is still basically valid. Our understanding of the underlying issues have not changed substantially, but rather increased in depth.

#### 1.1 Eye and Visual Problems

Numerous reports have testified to the rather high occurrence of eye discomfort problems of VDT operators, necessitating a discussion on specific causes and remedies in VDT work situations. Concern about the possibility of damage to the visual system due to VDT work has also been expressed.

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Various symptoms of visual discomfort are reported to a higher degree by VDT operators than by office workers doing comparable jobs without VDTs. (Moreover, experimental studies have generally found a lower reading performance for people reading texts shown on VDTs compared to texts printed on good quality papers.) Causal factors for these observations are to be found in the design of the equipment (especially the visual display quality of the screen), the workplace (e.g. placement of VDT equipment and lighting conditions) and the work task. Preventive attention should thus be given to all of these. In addition, attending to the visual health needs of workers using VDTs is essential to an effective preventive approach.

In contrast, there is no evidence of damage or permanent impairment to the visual system of persons working with VDTs and, thus, the possibility of direct eye damage due to any emission from VDTs has been generally dismissed.

### 1.2 Musculoskeletal Disorders

Reports of occurrences of musculoskeletal problems are frequent among users of VDTs. The possibility of long-term effects resulting from such problems has also been discussed.

In several studies, the occurrence of discomfort in various upper body locations is higher among VDT operators than in workers doing similar types of work without VDTs. In other studies, however, no such difference was observed. On the whole, musculoskeletal discomfort appears to be common in VDT work situations.

Injury from repeated stress to the musculoskeletal system is possible; such effects have been observed in other jobs, and outbreaks of musculoskeletal injuries have been witnessed in recent years. The causation of these injuries, however, is not clear, and appears to encompass ergonomic, work organization, and social or cultural factors. Thus, further research on the potential for musculoskeletal injury among VDT users and on the causal factors is warranted. However, these statements should not be interpreted to mean that musculoskeletal discomfort inevitably leads to injury or is necessarily a sign of injury.

Musculoskeletal problems in work associated with VDTs are largely preventable and appropriate control measures should be introduced. These include the application of ergonomic principles to the design of the workplace equipment, the work station and to the organization of work. Occupational health services play a key role in the early recognition and prevention of musculoskeletal problems in persons using VDTs.

### 1.3 Stress-related Problems

Stress factors and stress-related disorders have been repeatedly discussed in relation to work with VDTs. Arguments have been put forward for a role of the VDT system itself, as compared to the role of other factors such as job design and work organization.

There is little consistent evidence of abnormal levels of stress-related disorders (either physical, psychological or behavioural) among workers using VDTs compared to workers with non-VDT jobs.

Many aspects of working conditions can lead to stress-related disorders; these are referred to as stress factors and many of them can be found in both VDT and non-VDT work. However, the design of certain types of VDT work may lead to a higher prevalence of some of these stress factors, examples being work overload or a reduced variety of postures, as found in the monotonous routine data entry work with a high quantitative work load. Some specific stress factors do also exist in VDT work, such as prolonged response times, system malfunction and the inappropriate design of the human-computer interaction.

In all, there is considerable evidence that stress factors such as those mentioned above may create health problems. Consequently, additional research is warranted to investigate stress-related disorders among workers in VDT work situations. It should also be recognized that certain intervention and control strategies could improve working conditions with respect to stress factors and these should be implemented.

#### 1.4 Skin Problems

Indications of skin problems in connection with VDT use have appeared in a few countries.

Reports primarily from Scandinavia suggest that certain skin reactions such as rashes and itching may be related to some factors present in VDT work situations. In contrast, an increase in diagnosed skin diseases due to VDT work has not been shown.

The skin reactions reported can, in many instances, be explained by indoor climate factors such as temperature and low humidity or by stress situations. Other possible explanations for these observations include bias (excessive reporting by VDT operators) or presence of contact allergens in the environment. The roles played by electrostatic or low frequency magnetic fields from VDTs on the occurrence of these skin problems have, by and large, been dismissed. In addition, speculations as to the involvement of electric fields, expectation reactions or secondary reactions to eye fatigue have been made, so far unsupported by VDT-specific research results.

In summary, certain skin reactions in connection with VDT work have been noticed in a few countries. Currently, the primary explanations are based on indoor climate factors and/or stress.

#### 1.5 Risk of Adverse Reproductive Outcomes

There is a widespread concern in several countries regarding the possibility of a relationship between work with VDTs and certain adverse pregnancy outcomes, especially with respect to spontaneous abortions and serious malformations.

A number of factors in VDT work situations have been suggested to influence the outcomes of pregnancies, but most of them have however been dismissed. The two current contenders for such a role are stress (and worry) and low frequency magnetic fields from VDTs.

The results of experimental studies performed on the reproductive effects of VDT-like low frequency magnetic fields on various animals and in vitro systems have been equivocal and, generally, have failed to confirm the existence of an effect of these fields on reproduction. Epidemiological studies to date have, on the whole, failed to indicate an excess of adverse reproductive outcomes among women working with VDTs. In some studies, however, some indications were found of an association between certain adverse pregnancy outcomes and certain work characteristics such as type of work or reported stress.

In conclusion, it can be said that the considerable amount of research performed hitherto have failed to provide evidence of a link between adverse effects on pregnancy and the use of VDTs per se. The possibility of an effect due to certain other work conditions cannot, however, be similarly dismissed. Measures to avoid excessive discomfort, fatigue, stress and worry for a pregnant woman who is using the VDT are thus advisable.

#### 1.6 Existence of Electric and Magnetic Fields around VDTs

In connection with some health issues, such as adverse reproductive outcomes and skin problems, the question whether certain electromagnetic phenomena due to the VDTs play a role as risk factors has been raised. The availability and advisability of "low-radiation" VDTs is also pertinent to this discussion.

There is an increasing scientific concern regarding the possibility in general of adverse health effects of low frequency, low magnitude electric and magnetic fields, because of some recent indications of an association between leukemia and certain measures of magnetic field exposures. With respect to VDT work, no positive results have appeared in attempts by researchers to correlate adverse health effects and exposure to VDTs or VDT-like fields.

In Sweden, some organizations have issued statements as to the advisability and practicality of VDT field reduction. (There are no regulatory limits of emission or exposure to these VDT fields in Sweden.) Data have been published relating to the levels of electrostatic and low frequency magnetic fields that are technically attainable without reducing the visual quality of the screen. Such voluntary statements have been made on the premise that any unnecessary exposure should be reduced. They are based on technical rather than medical or biological considerations. In terms of reduction of exposure, the application of these voluntary statements by several buyers of equipment in Sweden has been rather successful. In terms of reducing the amount of adverse health effects, especially skin reactions, this has yet to be demonstrated.

### 1.7 Concluding Comments

The 1989 Montreal Conference on "Work with Display Units" emphasized that the central issues concerning 'Health and VDT' are on visual and other ergonomic factors as well as job design and work organization. With the exception of the visual ergonomic impact on (primarily) eye discomfort, the issue of whether VDT work is more prone to cause discomfort than (similar) office work is less clear. Basically, many factors causing various types of ill-health (muscle problems, stress reactions and possibly also skin problems) are likely to be found both in VDT and non-VDT work situations. The degree by which VDT work differs from non-VDT work may then be due to the variation of these general ergonomic and organizational factors found in these different types of jobs. Obviously, comparisons would differ in different settings, accounting for the differences found in several studies from various countries.

Some of the concerns which are frequently aimed towards health and VDT work may well be extended to other types of office work. Irrespective whether it is VDT work or non-VDT work, a high prevalence of problems (e.g. neck or other muscle disorders) in the workplace is clearly an indication of the need for corrective and preventive actions.

## GUIDELINES FOR WORK WITH VISUAL DISPLAY TERMINALS (Chapter 3)

In the 1987 WHO Publication, guidelines were given for work with VDTs. These guidelines have been revised, the results of which appear below.

### 3.1 Introduction

The increased use of visual display terminals in many types of workplace has drawn attention to a number of adverse health effects which are, or are alleged to be, caused by working with VDTs. Research has confirmed that certain kinds of discomfort are related to the use of VDTs, while other health effects have not been shown to be so related. The main emphasis of relevant corrective and preventive activities are towards various ergonomic and organizational conditions.

Various international and national organizations, among them the International Organization for Standardization (ISO) and the Commission of European Communities (CEC), are developing standards, recommendations and directives aimed at or relevant to health and VDT work.

## 3.2 Intent and Applicability of these Recommendations

### 3.2.1 Intent of these recommendations

These recommendations are intended to ensure (as far as possible) that visual display terminals, and work performed with these terminals, should be so designed that no individual should develop adverse health effects as a result of VDT work.

### 3.2.2 Applicability of these recommendations - The visual display terminal

These recommendations concern work being performed using a visual display terminal - a device for the visual presentation of electronically stored information. They do not concern work with oscilloscopes, radar or with displays of measuring instruments, etc., although certain sections may also serve as a guide for work with these devices.

Most of the knowledge upon which these recommendations are based, is derived from situations where monochromatic VDTs based on cathode ray tubes (CRTs) were used. The use of multicolour CRT-based VDTs, or VDTs based on other techniques such as plasma, liquid crystal or electroluminescent displays may present different situations, with both specific advantages and disadvantages. Nevertheless, these recommendations should, at present, also be considered applicable to all other VDT techniques.

### 3.2.3 Applicability of these recommendations - The work performed

The recommendations are applicable to work situations where the use of visual display terminals forms a significant part of the work.

### 3.2.4 Applicability of these recommendations - The effects

The recommendations are intended as protection against those adverse health effects that are associated with the use of VDTs.

## 3.3 Recommendations Concerning the Operator

### 3.3.1 General recommendations

It is intended that no individual should be excluded from working on VDTs, except on the basis of insurmountable disabilities.

There are at present no indications that work with VDTs causes photosensitive epileptic seizures. Nevertheless, persons known to be susceptible to photosensitive epileptic seizures should consult a physician before commencing VDT work.

Should a pregnant woman show great concern and worry about working with a VDT, this worry must by itself be taken seriously, although it may be explicitly stated that the worry is not justified on the basis of scientific evidence. Decisions - on an individual basis - for alternative non-VDT work or work on a VDT with low field emissions because of this worry may, however, be advisable.

### 3.3.2 Eye examination

Certain eye conditions such as presbyopia and astigmatism may contribute to the development of eye and musculoskeletal discomfort during VDT work. Therefore, operators should undergo an eye examination before starting to work with a VDT. Subsequently, further examinations after the age of 40 years should be available and a system should be instigated by the employer, by which VDT workers with eye discomforts, headaches or neck muscle problems would be the subjects of such eye examinations. These examinations should be performed by qualified personnel (trained in visual ergonomics) and should include refraction, visual acuity

and, when necessary, prescription for new glasses required for the semi-near work distance of that operator's specific working conditions. VDT workers should be made aware of the fact that these examinations are not a substitute for complete visual health care.

Unless specifically required by the work situation, bifocal, multifocal or progressive lenses should be avoided. Tinted lenses should also be avoided.

### 3.4 Recommendations Concerning the Visual Display Terminal

#### 3.4.1 Visual ergonomics

Display quality and readability are important factors for visual comfort and productivity. The display quality is affected by a number of specifications concerning the structure, the luminance and the time appearance of the picture elements (dots/strokes) and the formed characters.

The International Organization for Standardization (ISO) is currently developing standards for visual ergonomic characteristics of VDTs. The draft ISO International Standard 9241/3 is based on the principle that the display should present a clear, stable and legible image to allow it to be read quickly, accurately and comfortably.

The advantages of a flicker-free positive polarity (dark character on bright background) presentation is primarily dependent on actual work and lighting conditions. More information on this issue will appear in the following sections.

Available alternatives to monochromatic CRT-based VDTs, such as multicolour CRT screens or VDTs based on other techniques, may provide both advantages and disadvantages to the operator. Among advantages are the possibility of colour-based information (colour CRT) and a smaller size (non-CRT), while disadvantages consist mainly of additional visual ergonomic problems such as reduced resolution or reduced contrasts when the operator is not sitting in a specific position. High quality monochromatic CRT-based VDTs appear to offer, at present, the best choice for routine office work, unless the advantages of the other types of VDTs are specifically required in the work situation. Further technical development of these alternatives may, however, change this cautionary approach to new technologies.

#### 3.4.2 Physical factors

Noise emitted from VDTs and auxiliary equipment such as hard disk drives and printers should be minimized. Young operators may be sensitive to certain high frequency noise from VDTs. The heat generated from VDTs must be considered in relation to that of other objects, room size, ventilations, etc.

The current trend in making reduction of electric or magnetic fields from VDTs is not motivated on the basis of any shown risk increase. There are, however, other reasons for reduction of these fields, such as specific worry among the operators in a workplace, or a general decision to reduce excessive exposure. In doing so, care must be taken that the visual quality of the screen display is not adversely affected.

#### 3.4.3 System design and operations

Particular attention must be given to the operational aspects of the VDT system, including software, as these can play a role as stress factors. The optimum design of user interface for maximum efficiency and minimum discomfort is, however, far from clear. It constitutes a major field both of actual development and of standardization efforts. Examples include a decreased dependence on exact formulation of command words (e.g. by mouse and window techniques), which is particularly relevant for the dyslectics, and various measures for aiding physically disabled persons in doing VDT-centered work.

Breakdowns of system operation and delayed responses are problematic in many routine tasks and should be minimized - especially in combination with certain job conditions. The combination of electronic monitoring, incentive pay based on quantity of work and a system prone to breakdown is a very serious one. Even the combination of any two of these three factors should be avoided. Customer relation (e.g. in ticket sales) and a system prone to breakdown is another potent stress factor combination. In such cases, an independent back-up system should, whenever feasible, be available.

In general, the use of electronic monitoring should be discouraged, based on both stress and integrity reasons.

### 3.5 Recommendations Concerning the Workplace

#### 3.5.1 Design of the work station

The design of the work station is important in order to avoid muscle discomfort. The primary objectives are to ensure that the positions of keyboard, screen, manuscript holder, etc., are fully adjustable to the requirements and preferences of the individual operators.

Adjustability of the workplace may be achieved in various ways, e.g. by using adjustable furniture, using adjustable equipment, or preferably by a combination of the two. One important example is that keyboard should be thin and detachable.

While a good and adjustable design of the work station is imperative, it must also be emphasized that it is not a substitute for a good work task structure. Both aspects should be fully considered.

#### 3.5.2 Lighting conditions of the workplace

Lighting affects visual ergonomics. The introduction of a VDT into a workplace may necessitate several lighting adjustments. The workplace should be arranged in such a way that glare and reflection do not occur, particularly on the screen and work surfaces, including the keyboard and the keys. Screens with dark characters on a light background (positive polarity) require less modification of the workplace lighting than screens with light characters on a dark background (negative polarity). The use of antireflection devices should not interfere with the display image quality. Thus, the use of additional and external filters is not advisable - unless reflections cannot be prevented or eliminated in any other way.

The ambient lighting level must be appropriate to the task, the readability of both the VDT display and the manuscript, as well as to the individual's sensitivity. To read manuscripts easily, some situations may require a separate adjustable task light. Large differences in luminance in the field of vision, and between different areas of visual work, should be avoided. As an example, the use of a positive polarity screen precludes, in general, the appearance of large luminance differences between the screen and the manuscripts.

Flicker from light sources (e.g. from fluorescent tubes) should be avoided.

#### 3.5.3 Work environment

Too high or too low temperatures in VDT workplaces may cause discomfort problems and should be controlled. In the workplace design, the total number of heat-emitting devices - and people - should be considered, and appropriate measures taken.

Fairly high electrostatic charges on the operator may sometimes occur in situations of low relative humidity. This is primarily a discomfort problem, but its possible contribution to some skin reactions has not been ruled out. It may also cause problems with the function of some VDT equipment. If these conditions cannot be remedied by increasing the relative humidity, other appropriate measures must be considered.

### 3.6 Recommendations Concerning the Organization of Work

#### 3.6.1 Time restrictions for work with visual display terminals

The types of work performed at VDTs differ in many ergonomically important respects, among them the length of time actually spent looking at the screen: this clearly affects the importance of the quality of the display in relation to other aspects of the visual work conditions. In consequence, it does not appear feasible to assign general rules as to the length of time spent working with a VDT. It should, however, be emphasized that it may be possible - and beneficial - to establish time limits for VDT work in particular situations.

Work breaks are important in order to avoid discomfort - especially in jobs where no diversity is possible. The types of breaks can be varied, however, both long breaks and short pauses being important. The frequency of breaks should be adjusted to the type and intensity of the work performed. There is considerable evidence that for tasks that are highly repetitive, hourly breaks of at least several minutes in duration benefit both performance and comfort.

#### 3.6.2 Intensive use of visual display terminals

Adverse effects are most commonly associated with strictly regimented, constrained, and monotonous routine work. Measures should be taken to improve such jobs. One important method for improvement is to diversify the job content, i.e. by providing an opportunity to do other tasks (e.g. without a VDT, without a constrained posture or repetitive motions, etc.). Where such remedies are unavailable, improvement should be achieved by ensuring sufficient breaks in the work routine.

#### 3.6.3 Introduction of visual display terminals

The reaction of the staff to the introduction of VDTs is partly dependent on the provision of information and the participation of the staff in the planning, design and implementation stages. Adequate training is also essential - including follow-up periods after the commencement of actual work on these devices and systems. This training should - apart from operation of equipment - also include ergonomic aspects of the equipment and workstation.

### 3.7 Recommendations Concerning the Incidence of Adverse Health Effects

Normally, the first step should be to examine whether the VDT, the workplace, and the work organization are in accordance with the recommendations given and to ensure that appropriate adjustments are carried out. It should be noted that an early step to take when a VDT worker develops headache, eye or neck discomfort is an eye examination in order to ensure that the individual has adequate and correct vision.

Should problems initially require, or persist after such adjustments, the individual should be referred for an appropriate medical consultation.

ANNEX

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IN THE USE OF VISUAL DISPLAY TERMINALS**

Geneva, 2-6 December 1985

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