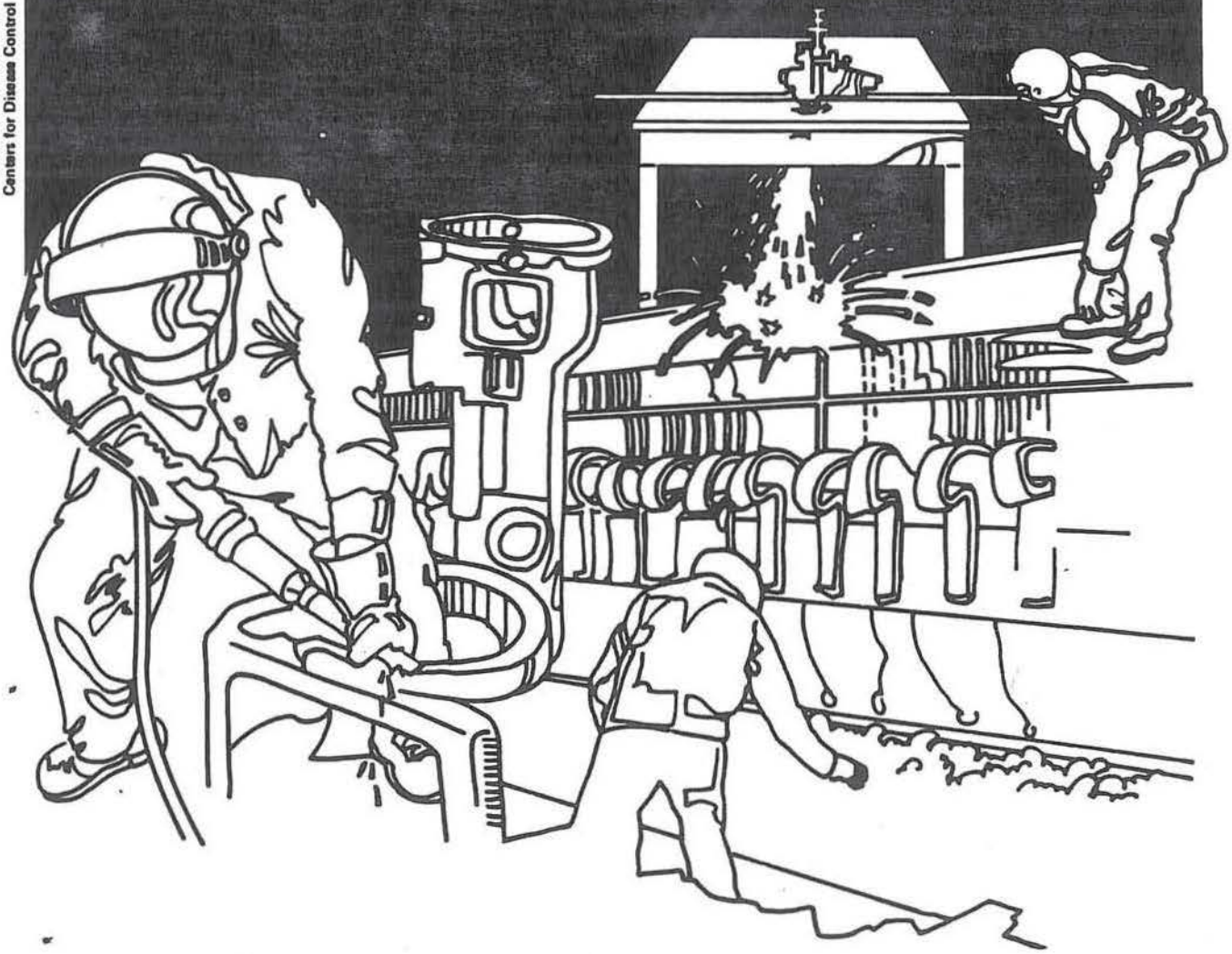
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Pub... ...alth Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 82-329-1246
SOCIAL SECURITY ADMINISTRATION
BALTIMORE, MARYLAND

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 82-329-1246
January 1983
Social Security Administration
Baltimore, Maryland

NIOSH INVESTIGATORS:
Michael J. Smith, Ph.D.
Marvin J. Dainoff, Ph.D.
Barbara G.F. Cohen
Donna S. Bierbaum

I. SUMMARY

On June 28, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Social Security Administration (SSA) to evaluate symptoms of blurry vision, headache, dizziness, neck and back pain, and nausea in approximately 300 office workers who utilize video display terminals (VDTs) in their work.

From July 13 through 16, 1982, a NIOSH evaluation team conducted an ergonomic evaluation, visual examinations and a health questionnaire survey of these workers. The results of this investigation indicated that ergonomic conditions were suboptimal. In particular, illumination levels at keyboard and document areas for reading of hard copy at the VDT were either too high or too low at over 60 percent of the workstations, keyboard heights were too high or too low for more than 30 percent of the workstations, character contrast on the VDT screen was too low for 53 percent of the VDTs, all VDTs had significant glare problems and none of the chairs evaluated met minimal adjustment requirements.

Visual and muscular complaints reported by VDT operators were comparable to those found in the literature. Specific health complaints were cold or sore throats, sinus trouble, headaches, tearing or itching eyes, burning eyes, eye strain, painful or stiff neck or shoulders, back pains, emotional complaints and stomach disorders. Thirty-eight percent of the VDT operators who were given a visual examination had a visual defect.

Based on the results of this evaluation, it has been concluded that potential health concerns due to VDT use are evident. Recommendations are made in Secion V for improving ergonomic conditions.

KEYWORDS: SIC 9190 (Federal Government), video display terminal, VDT, health complaints, job stress, visual disorders.

INTRODUCTION/BACKGROUND

On June 28, 1982 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Social Security Administration (SSA) to evaluate symptoms of blurry vision, headaches, dizziness, neck and back pain, and nausea in approximately 300 office workers, who utilize VDTs in their work at the Woodlawn Building in Baltimore, Maryland. On July 13 through 16, 1982 an evaluation team from the Division of Biomedical and Behavioral Science, NIOSH conducted ergonomic and visual examinations and a questionnaire survey of employee health status at the Woodlawn Building. This work was done with the technical assistance of the Division of Employee Health and Occupational Safety, SSA.

The Woodlawn Building houses approximately 300 employees of the Office of Data Services (ODS); 234 of these employees work at VDTs. The ODS is comprised of 5 Divisions which are broken into 9 Branches. The Divisions are: (1) Specialized Software, (2) Administrative Support, (3) Specialized Services, (4) Technical Support, and (5) Program Statistics.

For the most part, VDT users are computer software programmers. Their use of VDTs is limited to one hour segments of work at the terminal followed by work with hard copy. Programmers are limited to one hour work segments at the VDT, as the demand for VDT use far exceeds the supply of VDTs, and thus, VDTs must be shared. In addition to the programmers, there were also a small number of VDT operators who use the VDTs for wordprocessing and statistical purposes. These persons had greater access to VDTs and thus, spent more time working on them.

The literature acknowledges a variety of health concerns related to VDT use (see Dainoff, 1982; Smith, 1982). These include acute visual dysfunction and irritation, musculoskeletal aches and pains and emotional disturbances. In addition, recent reports of reproductive problems in VDT operators have been noted, although most have not been verified and no research has been carried-out in this regard.

Visual health concerns have dominated the VDT literature, and have been the primary concern of the workers using VDTs. The evidence from these studies indicates that VDT operators, as a group, suffer from a high incidence of visual disturbances including visual fatigue, visual irritation and headache (Cakir et al, 1978, 1979; Gunnarsson and Ostberg, 1977; Laubli et al, 1980; Dainoff et al, 1980; Smith et al, 1980; Sauter et al, 1982). In addition, it is clear that the type of VDT work activity, i.e., data entry versus word processing, and the specific visual demands imposed by that activity influence the incidence of visual complaints (see Smith, 1982). VDT workers at visually demanding jobs have a much higher rate of visual complaints. Finally, most types of VDT work produce higher levels of visual complaints than traditional office work that is also visually demanding.

Some studies have shown that the acute visual disturbances do not dissipate within a short time after leaving work, and may, in fact, still be present at the start of the next work day (Gunnarsson and Ostberg, 1977; Laubli et al, 1980). In particular, symptoms of eye irritation, soreness and tiredness seem to carry-over. While those that relate to visual

performance, such as blurred vision, seem to recover after a short period of time (15 to 30 minutes) (Haider et al, 1975, 1980). In essence, the eyes are able to perform properly but asthenopic symptoms persist.

There is some evidence that the process of visual accommodation and/or convergence are influenced by VDT work. Haider et al (1975, 1980) found slight shifts in acuity (1/8 to 1/4 diopter) after working at a VDT in a visually demanding task for 3 hours. Gunnarsson and Ostberg (1977) and Gunnarsson and Solderberg (1980) have demonstrated a recession in the near point (both accommodative and covergence shifts) during the course of a work day for young VDT workers, but not for older VDT workers. Ostberg et al (1980) observed shifts in dark focus between air traffic control radar operators and clerical workers. However, the evidence for functional changes in vision in not convincing based on these studies and the results of other research indicating no such changes (Dainoff et al, 1980; Kintz and Bowker, 1980).

There is also some evidence concerning the relationship between VDT work and the use of corrective eye wear. Ostberg (1976) indicated that bifocal wearers should have more problems than other VDT workers. Cakir et al (1978) and Smith et al (1982) found that this was not true for the VDT operators in their studies. However, VDT operators who wore reading glasses did report more visual health complaints (Cakir et al, 1978). Sauter et al (1982) confirmed that VDT operators who wear glasses have a greater frequency of visual complaints. Thus, it seems that wearing glasses may have a relationship to visual health complaints of VDT operators.

A second major health concern shown by the results of the various VDT studies is a high incidence of musculoskeletal health complaints in VDT operators (Cakir et al, 1978; Hunting et al, 1980; Smith et al, 1981; Sauter et al, 1982). As with the visual complaints, musculoskeletal complaints vary with the type of VDT work (see Smith, 1982). Most types of VDT work generally produce more muscular complaints than other types of traditional office work, including working on a typewriter. The increased muscular complaints for VDT typists, versus traditional typists, is probably due to the increased postural demands imposed by the viewing requirements of the VDT. The musculoskeletal complaints are of a diverse naturel affecting the neck, shoulders, back, arms, hands and fingers, possibly demonstrating a systemic influence.

The third area of health complaints reported by VDT operators concerns emotional disturbances (Smith et al, 1980; Ghiringhelli; 1980; Elias et al, 1980). These fell into two categories: (1) those that reflect mood states, and (2) those that reflect psychosomatic symptoms. Only a few studies of VDT operators have evaluated emotional factors. Smith et al (1980) and Elias et al (1980) indicated that both mood disturbances and psychosomatic symptoms demonstrate the same pattern as the visual and muscular complaints. That is, they vary by the type of VDT work activity, and VDT operators, as a group, report more such health complaints than other office workers.

The mood type disturbances observed are typical of neurotic behavior demonstrating anger, frustration, irritability, anxiety and depression. The psychosomatic disorders reflect a typical distress syndrome, with

gastrointestinal disturbances, muscle and psychic tension, heart palpitations and frequent sweating.

The fourth major VDT operator complaint that has a health implication relates to psychosocial disturbances (Cakir et al, 1978; Smith et al, 1980; Gunnarsson and Ostberg, 1977). In particular, VDT operators in many of the studies complained about specific job demands, such as workload, workpace and supervision, which can produce health complaints, physical and mental disorders, general job dissatisfaction and reduced efficiency and performance (Smith et al, 1980; Smith et al, 1982). As with the other types of health complaints, the psychosocial problems also varied by the type of job activity.

III. DESCRIPTION OF METHODS

A. Ergonomic Evaluation

The first stage of the ergonomic evalution was a walk-thru of VDT work areas to characterize general environmental conditions, and to define specific VDT tasks. The next step of the ergonomic evaluation was to take detailed measurements on workstations (Appendix 1). The measurements included ambient lighting, glare, workstation dimensions and workplace layout.

All lighting measurements were made using a Photo-Research Litemate III Photometer. These included the ambient illuminance incident upon the VDT screen and any other permanently established reading surfaces.

All luminance and glare measurements were made using the Spotmate attachment to the Litemate. The luminance of a variety of surfaces in the immediate visual field of the VDT operator was measured for each workstation. Glare reflected on the VDT screen was determined by measuring shielded and unshielded luminance fields on the VDT screen with the display turned off. The character/background contrast ratios were computed from measurements of screen luminance taken using the Spotmate.

A variety of other workstation design features were noted, including availability and type of controls for adjusting brightness and contrast on the VDT screen, positioning of the keyboard and screen, glare filters, copy holders, and footrests.

Keyboard height and screen height were measured using a metric tape measure. The adjustable features of the workstation and chair were also noted, as well as the range of the possible adjustments.

B. Health Complaints and Psychological Status Evaluation

The purpose of this phase of the investigation was to determine health risk to VDT operators based on self-reported complaints and measures of psychological status. A questionnaire survey was used to collect information about job stressors, stress level, working conditions, disease state, health complaints and current psychological state. Information about job stress level and specific stressors was obtained from scales developed by Caplan et al. (1975) and Insel and Moos (1974) for comparing stress over

a number of different occupations. Questions about working conditions, disease states and health complaints were taken from prior NIOSH studies (Smith et al., 1979). In addition, special questions were developed primarily for the evaluation of video display operations (Dodson et al., 1979). Psychological mood state was evaluated using the Profile of Mood States (McNair et al., 1971).

Prior to conducting the questionnaire survey, agreement was obtained to survey all available VDT operators. Questionnares were distributed to VDT operators either individually or in small groups during working hours at their regular work areas. All participants were referred to the instructions contained in the questionnaire and asked to fill out the questionnaire at home. Questions about the purpose of the study were briefly addressed. The majority of questionnaires were collected at the worksite on the day after distribution. A few were returned in a postage-paid envelope which was provided with all questionnaires. A total of 234 VDT operators were given questionnaires and 198 returned completed questionnaires for a response rate of 84 percent.

C. Visual Function Testing

A Titmus Vision Tester was used to screen 32 employees. Acuity for both eyes together, and lateral phoria were assessed at three different optical distances; 20 feet, 14 inches, and 31.9 inches. The latter distance was achieved by inserting a -1.25 diopter lens into the apparatus at the 20 ft. distance setting. In addition, an experimental astigmatism test was used at the 20 ft. distance.

As part of the procedure, participants were asked to estimate the number of hours they spent per week using the VDT.

IV. RESULTS AND DISCUSSION

A. Environmental Factors

General Comments: The interior of the Woodlawn Building represents an open office design with enclosed offices around the perimeters. The open office areas have been divided into work cubicles and work spaces using six foot high standard office partitions. A computer room is located in the center of the building and is an independent, separate work area from the rest of the office.

Lighting and Illumination: Illumination levels were measured at various locations in the Woodlawn building. As shown by the measurements reported below, there was a great deal of variability in the level of illumination from one area to another, and in some cases within a particular area.

Area	Illumination Levels (foot candles)
Room 1314	75 - 80
Room 1224	62 -112
Room 1216	46 - 65
G-4	18 - 36
G-5	30 - 35
F3 / F4	52 - 61
D-2	42 - 46
Computer Room	58 -135

Generally, lighting levels should be between 30 and 70 foot candles. The lighting level necessary will vary with the work activity and the visual demands imposed by that activity. For jobs that require that the operators spend a significant amount of time reading hardcopy, the lighting levels should be at least 50 foot candles, but should not exceed 70 foot candles. In particular, those employees who have to read computer print-outs should have lighting levels around 70 foot candles. For jobs that require that the operators spend most of the time looking at the VDT screen, then the lighting levels should be lower; approximately 30 to 50 foot candles.

It is clear that some adjustment in lighting levels is necessary at the Woodlawn Building to bring the levels within suggested limits. In particular, the computer room area has a very high illumination level, except for a few dark spots. This room also has very reflective walls, floor and ceiling which increase the amount of environmental glare and bright contrast sources.

Illumination was also measured at a plane vertical to the VDT screen at the center of the keyboard for each workstation. As shown below, 44% of the workstations had illumination levels between 10-30 foot candles, 25% between 31-50 foot candles, 12% between 51-70 foot candles, and 19% over 70 foot candles.

Illumination Range (fc)	Number of Workstations	Percentage of Total
10 - 15	4	15
16 - 20	3	11
21 - 25	3	11
26 - 30	2	7
31 - 35	2	7
36 - 40	2	7
41 - 45	1	4
46 - 50	2	7
51 - 55	1	4
56 - 60	1	4
61 - 65	1	4
66 - 70	0	0
over 70	5	19
	27	100

In order to improve the illumination at the workstation, it may be necessary to provide individual supplemental lighting at those workstations which are

below the recommended levels. This should be done only after adjustments in the general office lighting fail to provide adequate illumination.

Climatic Factors: No measurements were taken of temperature or humidity. However, during the walk-thru there was a great variability in perceived temperature from one part of the building to another. Discussions with the SSA industrial hygiene team indicated that the current ventilation system was "out-of-balance", and therefore, produced this situation of uneven building temperatures. This situation needs further evaluation by a ventilation engineering specialist.

C. Workstation Factors

General Comments: In general, VDTs were situated at any available desk or table. Such placement almost always puts the keyboard at an improper height for the majority of users, thus, imposing undue biomechanical loads on the arms and wrists. Very few of the workstations provided adequate space for source documents and reference materials.

Desk Heights: As shown by the following measurements, the majority of desk heights were generally within the range for standard desk height (700-735 mm). All workstations were set at a fixed height, with no height adjustability.

Desk Height (mm)	Number of Workstations	Percentage of Total
675	2	8
680	2	8
700	11	44
710	1	4
735	3	12
750	3	12
800	3	12
	25	100

Typically, installing VDTs on a standard height desk will make the keyboard height too high for most operators. This will be discussed in the section on keyboard height.

Viewing Distances: Generally, viewing distances were beyond 500 mm; however, none exceeded 700 mm. Thus, all were within allowable limits.

Viewing Distance (mm)	Number of Workstations	Percentage of Total
450 - 500	1	4
501 - 550	12	50
551 - 600	6	25
601 - 700	5	21
	24	100

Chairs: Chairs were typical of those found in government offices with the majority having cloth upholstery, non-adjustable height, non-adjustable seat pan angle or depth, non-adjustable back support and a 4 point base.

Chair Feature	Percentage Chairs Having Feature
5 point base	0
Adjustable seat pan height	7
Adjustable seat pan depth	0
Adjustable seat pan angle	0
Adjustable backrest	0
Arm rests	22
Foot rests	9

It is recommended that these chairs be replaced with chairs that allow for height adjustment and back-rest adjustment to the lumbar region of the back. It is also adviseable for chairs to have adjustable seat pan depth and seat pan angle. A five point base is preferred.

D. Video Display Terminal Factors

Keyboard Characteristics: Only 29% of the video display terminals had detachable keyboards. Keyboard heights measured from the floor to the center of the home row are shown below. As can be seen, 73% of the keyboards were more than 750 mm high, which exceeds the height requirements of the German DIN Standard (750 mm maximum keyboard height), and the recommendations of Cakir et al, 1979. The best solution for ensuring proper keyboard height is to provide adjustable workstations that enable the keyboard to be adjusted to the proper height for each operator. Standard desks and tables are typically between 700 and 735 mm in height. Adjustable workstations vary the keyboard height between 630 and 870 mm depending on the make and model, so that adjustments can be made for each operator. If adjustable workstations are not feasible, then the current desks and tables should be lowered by cutting down the legs. As the need to raise keyboards arises, then platforms can be added to these lowered desks to heighten the keyboard.

Keyboard Height (mm)	Number of Workstations	Percentage of Total
0 - 720	2	6
721 - 750	7	21
751 - 790	16	48
greater than 790	8	25
	33	100

Screen Characteristics: Screen height was measured from the floor to the center of the screen. As shown below, 85 percent of the screens were between 85 and 100 cm high.

Screen Height (cm)	Number of Workstations	Percentage of Total
85 - 90	4	19
91 - 95	7	33
96 -100	7	33
101 -105	1	5
106 -110	1	5
greater than 110	1	5
	21	100

Character to screen background contrast was measured for 28 workstations. As shown below, 53 percent of the workstations had a contrast ratio less than 3:1, and therefore failed to meet the minimum acceptable level of contrast (ANSI, 1973). In the majority of cases, the contrast insufficiency can be reversed through glare control which will be discussed in the next section.

Contrast Ratio	Number of Workstations	Percentage of Total
less than 3:1	15	53
3:1 to 5:1	5	18
5:1 to 7:1	2	7
7:1 to 10:1	3	11
greater than 10:1	3	11
	28	100

Glare was evident on all of the VDT screens examined. Luminance from the screen, with glare and shielded from glare using a hood, was measured. From these measurements, the percentage of luminance from the screen due to glare was determined. As shown below, for more than three-fourths of the VDTs, the glare percentage was greater than 80 percent of the luminance from the screen, which demonstrates a significant glare problem.

Glare is the single most detrimental environmental factor for VDT operators, because it reduces contrast and increases the amount of visual effort. Glare is best controlled by eliminating its sources, or modifying the source. Glare sources consist of: luminaries, windows, and reflective surfaces in the environment. Proper placement of the video display screen, so as to eliminate reflections from glare sources, is the most effective means of glare control. Therefore, positioning VDT screens parallel to windows, as well as parallel and between luminaries, will eliminate or reduce the amount of screen glare considerably.

When positioning is not feasible, then modifications must be made to the glare source. In the case of windows; curtains, blinds or shades can be installed and drawn to block out the incoming light. However, use of very dark curtains or shades and the complete elimination of all window light or view of the outdoors, can have an adverse psychological impact on employees, which may override any positive effects from the glare control. The purpose of shades is not to make the work area into a dungeon, but to reduce a major light source sufficiently to control glare.

For luminaries, it is possible to install fixtures that focus the light downward such as parabolic wedge reflectors. These act to reduce the amount of light dispersion, and hence, the amount of reflected glare.

If glare persists, some modifications must be made to the VDT. The most effective method is to use a filter over the screen, which provides for the absorption of incoming light rays and reduces the amount of reflections from the screen surface. Such filters can be put on the screen during the original manufacturing process, or they can be added at a later date. It should be pointed out that some filters reduce contrast, and hence, degrade the character images on the screen. Most filters also cut down the

luminance of the characters on the screen, requiring the operator to increase the brightness level.

Another method of glare control is to install a hood over the screen, to block the screen from all angular reflections. Thus, all glare sources, except those directly behind the screen, are not accessible to the screen. Some problems with such hoods include: difficulty looking between the screen and source documents due to a tunnel vision effect, and problems of excessive contrast variations. Because the operator is forced to focus solely on the screen due to the hood, when the operator looks away from the screen, the difference in contrast between the screen and the lighter room surfaces is accentuated.

Screen Glare %	Number of Workstations	Percentage of Total Workstations
95 and greater	3	13
90 to 94	4	17
85 to 89	7	31
80 to 84	4	17
75 to 79	4	17
under 75	1	5
	23	100

The quality of characters was evaluated and 25% of the VDTs had blurred characters, 30% screen flicker, 15% sparkling or moving characters, 25% edge distortion of characters and 25% brightness variations. Routine VDT servicing should eliminate this problem.

Character size was measured and all VDTs met the minimum requirements for height and width of characters. However, the VYDEC 1400 characters, when used in the fine print mode, are too small.

In terms of contrast problems, most VDTs provide sufficient contrast between the characters and background (3:1 minimum) for adequate character recognition. As VDTs age, however, the ability to maintain adequate contrast is reduced. This could pose some problems. For this reason, it is recommended that VDTs be serviced on a routine basis to ensure proper working order. When operators observe that a VDT is losing some contrast capability, repairs should be made, so that each VDT always meets the minimum contrast requirements.

Other contrast problems relate to environmental sources of reflected glare or luminance that are much higher than the VDT screen. Most experts feel that these contrasts should not exceed 10:1 (ANSI, 1973). As a working approach, any environmental glare source or luminance source that is bright enough to be uncomfortable to view is probably too bright and should be controlled. This can be done by covering the source or redirecting the luminance.

E. Health Complaints

Table 1 lists the percentage of employees reporting the occurrence of a health complaint in the previous year. For the purpose of making judgments about the seriousness of a particular health complaint in relation to VDT use, any complaint that was reported by at least fifty percent of the operator was considered a potential health problem (NIOSH, 1981). Thus, the following health complaints could be considered a potential health problem: frequent colds or sore throats (71%), hay fever or sinus trouble (56%), headaches (81%), tearing or itching eyes (77%), burning eyes (71%), eye strain or sore eyes (69%), pain or stiffness in neck or shoulders (60%), back pain (59%), occasions of easy irritability (71%), difficulty sleeping (62%), periods of depression (61%), high levels of tension (59%), severe fatigue or exhaustion (57%), gas or gas pains (58%), bloated or full feeling in stomach (58%), and indigestion, heart burn or acid stomach (51%).

These potential health problems can be classified into five general categories: (1) respiratory difficulties, (2) visual disorders, (3) musculoskeletal disorders, (4) psychological problems, and (5) stomach disorders. Such findings are consistent with the types of health complaints reported by VDT operators (Smith et al, 1981; Dainoff, 1982; Smith, 1982).

F. Disease States

Table 2 lists the percentage of employees reporting a physician's diagnosis or treatment of a chronic health condition. Two conditions demonstrate an elevated prevalence when compared to VDT operators previously studied (NIOSH, 1981). These are high blood pressure (26%) and gastritis (16%).

G. Psychological Mood States

Table 3 lists the mean scores of employees on standardized psychological mood state scales. When compared to VDT operators and control subjects from previous research (Smith et al, 1981), psychological fatigue and confusion demonstrate elevated levels as compared to the clerical controls, with levels similar to the VDT operators. However, the levels of reported anxiety, depression, and anger were lower than levels found for VDT operators in prior research (Smith et al, 1981).

H. Job Stress Factors

Table 4 lists the mean scores for employees on the WES stress scales (see Insel and Moos, 1974). In comparing the reported levels to normative data and other VDT operators from previous research (Smith et al, 1981), the VDT operators reported low job clarity and involvement, low task orientation, low supervisory control, and low work pressure. Thus, the general pattern demonstrates that the operators as a group, did not perceive their jobs as overly taxing or stimulating. Table 5 lists the mean scores for employees

on job demands stress scales (see Caplan et al, 1975). Comparing the reported levels to norms, the VDT operators reported moderate levels of workload, role ambiguity and conflict, boredom and job future ambiguity. As with the previous stress scales, the reported levels do not indicate stressful working conditions as perceived by the VDT operators as a group.

I. Visual Examinations Findings

Thirty-two employee volunteers selected randomly from each work area were evaluated by means of the Titmus Clerical and Administrative Job Standards overlay. (There are no published Titmus standards for astigmatism). By these criteria, 20 of the individuals had no defects at all, and 12 had at least one defect. Thus, 38.7% of the sample was found to have a visual deficit.

There were a total of 13 separate deficits obtained--not including astigmatism. These were distributed as follows:

Acuity - 14 inches	6 employees
Acuity - 31.9 inches	4 employees
Phoria - 14 inches	1 employee
Phoria - 20 feet	1 employee

In addition, one employee had no detectable phoria measurement.

In the above distribution, for only 2 of the 13 persons, the acuity deficits at 14 inches were accompanied by acuity deficits at 31.9 inches.

Since there is not a standard to judge astigmatism, the following simply describes what was observed. Seventy-five percent of those tested reported that at least one pair of the lines on the fans appeared darker. However, when participants were asked to estimate the apparent darkness of the lines (none/some/a lot), none of those reporting astigmatism in the employees without visual defects used the highest darkness judgment, while three with visual defects did so (33.3%).

Finally, it appears that the average amount of time spent per week at the VDT was higher for the defect group (12.62 hours/week), than for the no-defect group (8.75 hours/week).

J. Conclusions on Health and Stress Findings

The incidence and type of visual complaints reported by VDT operators is similar with other studies (for a review see Dainoff, 1982). This indicates visual strain related to visual fatigue. The most likely cause is unfavorable environmental conditions (lighting and glare), but could also be due to task demands which require heavy visual concentration on the screen when using the VDT.

The musculoskeletal problems are indicative of postural demands of the work which puts high loads on the back, shoulders and neck. These loads are likely due to poor workstation design and improper chairs.

The results on psychological effects are consistent, in general, with other VDT stress research (Smith, 1982). Basically, acute psychological distress is evident by reports of psychic tension, sleep problems and stomach disorders. However, employees reported lower levels of anxiety and depression using standardized measures (than for VDT operators in previous studies (Smith et al, 1981).

The job stress due to task demand that was reported by employees was lower than for previous VDT stress studies (Smith et al, 1981) and studies of other occupations (Caplan et al, 1975).

Except for the reported prevalence of high blood pressure, the reported levels of other disease states is consistent with findings from other VDT workers in prior studies (NIOSH, 1981). However, this blood pressure prevalence rate approximates national norms.

K. A significant number of employees given visual examinations (38%) showed a visual deficit.

V. RECOMMENDATIONS

The following recommendations are made in their order of importance for reducing the physical stress imposed by VDT work at the Woodlawn Building.

1. Glare on the VDT screens should be eliminated or substantially reduced. Given the lighting system at the Woodlawn Building, this can best be accomplished by the use of glare reduction filters on the face of the VDT.

2. Current chairs should be replaced with chairs that provide adequate lumbar support, and provide adjustment for seat pan height, angle and depth, as well as adjustment of back-rest height. A five point base is preferred to reduce tipping.

3. Keyboard height should be adjusted for the majority of operators so that the arm angle is between 90 - 100 with the floor. In most cases, this will require that table heights be lowered. In addition, wrist rests should be provided at all workstations to reduce biomechanical loading on the wrist.

4. Lighting levels, both general illumination and workstation illumination, should be brought within recommended levels. For job tasks requiring screen intensive activities and little hard copy viewing, lighting levels should be between 30-50 foot candles. For job tasks requiring the reading of a good deal of hard copy, the lighting levels should be between 50-70 foot candles.

5. VDTs should be serviced on a routine basis to ensure good character quality. Those VDTs that currently have character quality problems should be serviced immediately; these are:

Data Point 8200	#471450
Data Point 6600	#305376
Hewlett Packard 2621B	#2146V00128
Computer Optics	#6100957
Computer Optics	#TRM047C3
OMRON	#5047
OMRON	#5229
OMRON	#5251
Lanier	#4179

6. New purchases of VDTs should require detachable keyboards.

7. Since 38 percent of the VDT operators who were given visual examinations had uncorrected visual defects, it is reasonable that some type of visual testing program be initiated for SSA VDT operators. See pages 71 and 72 of the NIOSH report "Potential Health Hazards of Video Display Terminals" for recommendations on visual testing for VDT operators (NIOSH, 1981).

8. We understand that there is a proposal to move the employees in the Woodlawn Building to a different facility. We suggest that if such a move is made, that NIOSH can provide technical assistance in the design of the work environment to minimize the types of problems which have been identified in this report. Further, a follow-up evaluation of the employees should be conducted once they are moved to ascertain the benefits of the new work area on employee health and productivity.

VI. REFERENCES

1. ANSI. "American national standard practice for office lighting". The Journal of IES, 1973.

2. Cakir, A., Reuter, H., VonSchmude, L., and Armbruster, A. Unterschung Zur Anpassung Von Biloschirmarbeitsplatew an dic Physche und Physchische Function Bundeminiter fur Arbeit und Sozialordund, 1978.

3. Cakir, A., Hart, D.J., and Stewart, T.F.M. The VDT Manual. (Darmstadt: FRG: Ince-Giej Research Association (IFRA), 1979.

4. Caplan, R., Cobb, S., French, J.R.P., Van Harrison, R. and Pinneau, R. Job Demands and Worker Health. (Washington, D.C.: National Institute for Occupational Safety and Health), Publication No. 75-160, 1975.

5. Dainoff, M. Visual Fatigue in VDT Operators. In E. Grandjean and E. Vigliani (Eds.) Ergonomic Aspects of Visual Display Terminals, London: Taylor and Drancis, Ltd., 1980, 95-100.

6. Dainoff, M.J. Occupational stress factors in visual display terminal (VDT) operation: A review of empirical research. Behaviour and Information Technology, 1982 1(2), 141-176.

7. Din. Deutshes Institut fur Normungen. Display screen workplaces. (Berlin, Germany: Deutsches Institut fur Normungen), DIN 66234, 1980.

8. Dodson, V.N., Sauter, S., Gottlieb, M. and Smith, M. Job demands and office work study supporting statement. (Cincinnati, Ohio: National Institute for Occupational Safety and Health), 1979.

9. Elias, R., Cail, F., Tisserand, M. and Christman, M. Investigations in Operators Working With CRT Display: Relationships Between Task Content and Psychophysiological Alterations. In E. Grandjean and E. Vigliani (Eds.) Ergonomic Aspects of Visual Display Terminals, London: Taylor and Francis, Ltd., 1980, 211-218.

10. Ghiringhelli, L. Collection of Subjective Opinions on Use of VDUs. In E. Grandjean and E. Vigliani (Eds.). Ergonomic Aspects of Visual Display Terminals. London: Taylor and Francis, Ltd., 1980, 227-232.

11. Gunnarsson, E. and Ostberg, O. The Physical and Psychological Working Environment in a Terminal-based Computer Storage and Retrieval System. (Stockholm, Sweden: National Board of Occupational Safety and Health Report 35), 1977.

12. Gunnarsson, E. and Soderberg, I. Eye-strain Resulting from VDT Work at the Swedish Telecommunications Administration. (Stockholm, Sweden: National Board of Occupational Safety and Health), 1980.

13. Haider, M., Hollar, J., Kundi, M., Schmid, H., Thaler, A. and Winter, N. Stress and Strain on the Eyes Produced by Work with Display Screens: Report on a Work-Physiological Study Performed for the Union of Employees in the Private Sector. (Vienna, Austria: Austrian Trade Union Assoc.), 19

14. Haider, M., Hundi, M. and Weissenbock, M. Worker Strain Related to VDUs wi Differently Colored Characters. In E. Grandjean and E. Vigliani (Eds.) Ergonomic Aspects of Visual Display Terminals, London: Taylor and Francis Ltd., 1980, 53-64.

15. Hunting, W., Laubli, T. and Grandjean, E. Constrained Postures of VDU Operators. In E. Grandjean and E. Vigliani (Eds.) Ergonomics Aspects of Visual Display Terminals, London: Taylor and Francis, Ltd., 1980, 175-1

16. Insel, P. and Moos, R. Work environment scale - Form S. Pal Alto, California: Consulting Psychologist Press, Inc., 1974.

17. Kintz, R.T. and Bowker, D.O. Accommodation response during a prolonged visual search task. Paper presented at Ergonomic Aspects of Visual Display Units Workshop, Milan, Italy, March 1980.

18. Laubli, T., Hunting, W. and Grandjean, E. Visual Impairments Related to Environmental Conditions in VDU Operators. In E. Grandjean and E. Vigliani (Eds.) Ergonomic Aspects of Visual Display Terminals, London: Taylor and Francis Ltd., 1980, 85-94.

19. McNair, D., Lorr, M. and Droppleman, L. Profile of mood states. San Diego, California: Educational and Industrial Testing Service, 1971.

20. NIOSH. National Institute for Occupational Safety and Health. Potential Health Hazards of Video Display Terminals. (Washington, D.C.: National Institute for Occupational Safety and Health) DHHS (NIOSH) Publication No. 81-129, 1981.

21. Ostberg, O. Office computerization in Sweden: Worker participation, work place design considerations, and the reduction of visual strain. Paper presented to the NATO Advanced Study Institute on Man-Computer Interaction, September, 1976.

22. Östberg, O., Powell, J. and Blomkvist, A. Laser Optometry in Assessment of Visual Fatigue. (Lulea, Sweden: Department of Human Work Sciences, University of Lulea Report 1980: 1 T), 1980.

23. Sauter, S.L., Gottlieb, M.S. and Jones, K.C. A general systems analysis of stress-strain in VDT operations. Paper presented at the Conference on Human Factors in Computer Systems, Gaithersburg, Maryland, 1982. Copies available from S. Sauter at Dept. of Preventive Medicine, University of Wisconsin, Madison, Wisconsin 53706.

24. Smith, M.J., Colligan, M.J., and Hurrell, J.J. A review of the psychological stress research carried-out by NIOSH, 1971 to 1976. In R. Schwartz (Ed.) New Developments in Occupational Stress. Los Angeles, California: Institute of Industrial Relations, University of California at Los Angeles, 1979.

25. Smith, M.J., Cohen, B.G.F., Stammerjohn, L. and Happ, A. An investigation of health complaints and job stress in video display operations. Human Factors, 1981, 23, 387-400.

26. Smith, M.J. Health Issues in VDT Work. In Sandelin, J., Bennett, J. and Smith, M.J. (Eds.) Windows into the Electronic Workplace. Stanford, California: Stanford University, 1982.

27. Smith, A.B., Tanaka, S., Halperin, W. and Richards, R.D. Cross-Sectional Survey of VDT Users at the Baltimore Sun, Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1982.

VII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. Local 1923 American Federation of Government Employees.
2. The American Federation of Government Employees.
3. The Social Security Administration.
4. U.S. Department of Labor (OSHA), Region III
5. NIOSH, Region III

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation conducted by and report prepared by:

Michael J. Smith, Ph.D.
Marvin J. Dainoff, Ph.D.
Barbara G.F. Cohen
Donna S. Bierbaum

Applied Psychology and Ergonomics Branch, Division of Biomedical and Behavioral Science.

Table 1

Percentage of VDT Operators Reporting a Health Complaint

Health Complaint	VDT Operators %
a. Shortness of breath or trouble breathing	49
b. Frequent colds of sore throats	71
c. Persistent cough and spitting up sputum	37
d. Coughing up blood	3
e. Fever, chills, and aching all over	47
f. Hay fever or sinus trouble	56
g. Wheezing in your chest	22
h. Respiratory infections	35
i. Jaundice, yellow eyes or skin	1
j. Skin rash, itching skins, allergic skin reactions	48
k. Swollen or painful muscles or joints	44
l. Back pain	59
m. Pain or stiffness in your arms or legs	48
n. Pain of stiffness in your neck or shoulders	60
o. Change in your ability to see colors	5
p. Tearing ot itching eyes	77
q. Persistent numbness or tingling in any part of your body	25
r. Burning eyes	71
s. Occasions of easy irritability	71
t. Difficulty sleeping	62
u. Periods of depression	61
v. Ringing or buzzing in ears	35
w. Headaches	81
x. Fainting spells or dizziness	19
y. Nervous or shaking inside	38
z. Times when you feel sweaty or trembly	38
aa. Increased urination	39
bb. Painful urination	6
cc. Bloody urine	3
dd. Alarming pain or pressure in your chest	23
ee. Pain down your arms	12
ff. "Racing" or pounding heart	35
gg. Leg cramps	38
hh. Times of severe fatigue or exhaustion	57

Health Complaint	VDT Operators %
ii. Acid indigestion, heartburn, or acid stomach	51
jj. Diarrhea for more than a few days	12
kk. Gas or gas pains	58
ll. Nausea or vomiting	24
mm. Blood in your bowel movement	11
nn. Constipation	38
oo. Tight feeling in stomach	33
pp. Bloated or full feeling	58
qq. Feeling of pressure in the neck	39
rr. Hemorrhoids or piles	26
ss. Periods of extreme anxiety	43
tt. Trouble digesting food	29
uu. Blurred vision	39
vv. Dryness in the mouth	43
ww. Stomach pains	39
xx. Belching	47
yy. High levels of tension	59
zz. Difficulty with feet and legs when standing for long periods	41
aaa. Shoulder soreness	38
bbb. Loss of feeling in the fingers or wrists	15
ccc. Neck pain that radiates into shoulder, arm or hand	20
ddd. Cramps in hands and fingers relieved only when not working	10
eee. Loss of strength in arms or hands	10
fff. Eye strain or sore eyes	69
ggg. Stiff or sore wrists	15

Table 2

Percentage of VDT Operators Reporting Diagnosis or Treatment of a Disease State by Their Physician Within the Previous 5 Years

Disease State	VDT Operators %
Diabetes	3
Cancer	3
Hernia or Rupture	4
Tuberculosis	2
Asthma	4
High Blood Pressure	26
Heart Disease	3
Arthritis or Rheumatism	11
Epilepsy (Convulsions of Fits)	2
Glaucoma of the Eyes	2
Paralysis, Tremor, or Shaking	2
Kidney or Bladder Trouble	13
Lung or Breathing Problems	10
Stroke	2
Anemia	8
Gall Bladder, Liver	6
Thyroid Trouble or Goiter	4
Insomnia	7
Gastristis	16
Colitis	6
Stomach Ulcer	4
Cataracts	3
Mental or Psychological Problems	7

Table 3

Mean Scale Values for Psychological Mood States

Mood Scale	Scale Means (VDT Operators)	Scale Means for Clerical VDT Operators from Smith et al (1981)	Scale Means for Clerical Control Group from Smith et al (1981)
Anxiety	8.4	10.2	7.9
Depression	7.2	9.7	7.6
Anger	6.7	8.0	7.2
Vigor	15.9	16.0	17.2
Fatigue	8.1	9.0	5.9
Confusion	5.8	6.2	4.4

Table 4

Mean Responses for VDT Operators for WES[1]

Stress Scales

WES Scale	Scale Means (VDT Operators)	Norms[2]
Involvement	1.79	2.80
Peer Cohesion	2.48	2.73
Staff Support	2.97	2.94
Autonomy	3.23	2.69
Task Orientation	1.53	2.51
Work Pressure	1.21	1.77
Clarity	1.71	2.33
Supervisory Control	1.08	2.32
Innovation	2.02	2.40
Physical Comfort	1.38	2.04

[1]Work Environment Scale (Insel and Moos, 1974) Form S.

[2]Scale norms derived by Insel and Moos (1974) in studying various occupations.

Table 5

Mean Responses for VDT Operators for Job Demands[1] Stress Scales

Stress Scale	Scale Means (VDT Operators)	Norms[2]
Workload Dissatisfaction	2.05	2.13
Boredom	2.29	1.83
Role Ambiguity	2.12	2.06
Quantitative Workload (Quinn)	3.00	--
Quantitative Workload (Caplan)	3.35	3.51
Role Conflict	1.77	1.75
Workload Variance	2.76	2.81
Job Future Ambiguity	2.72	2.71

[1]Scales taken from Job Demands and Worker Health (Caplan et al, 1975).

[2]Median scale scores for the 23 occupations studied by Caplan et al (1975).