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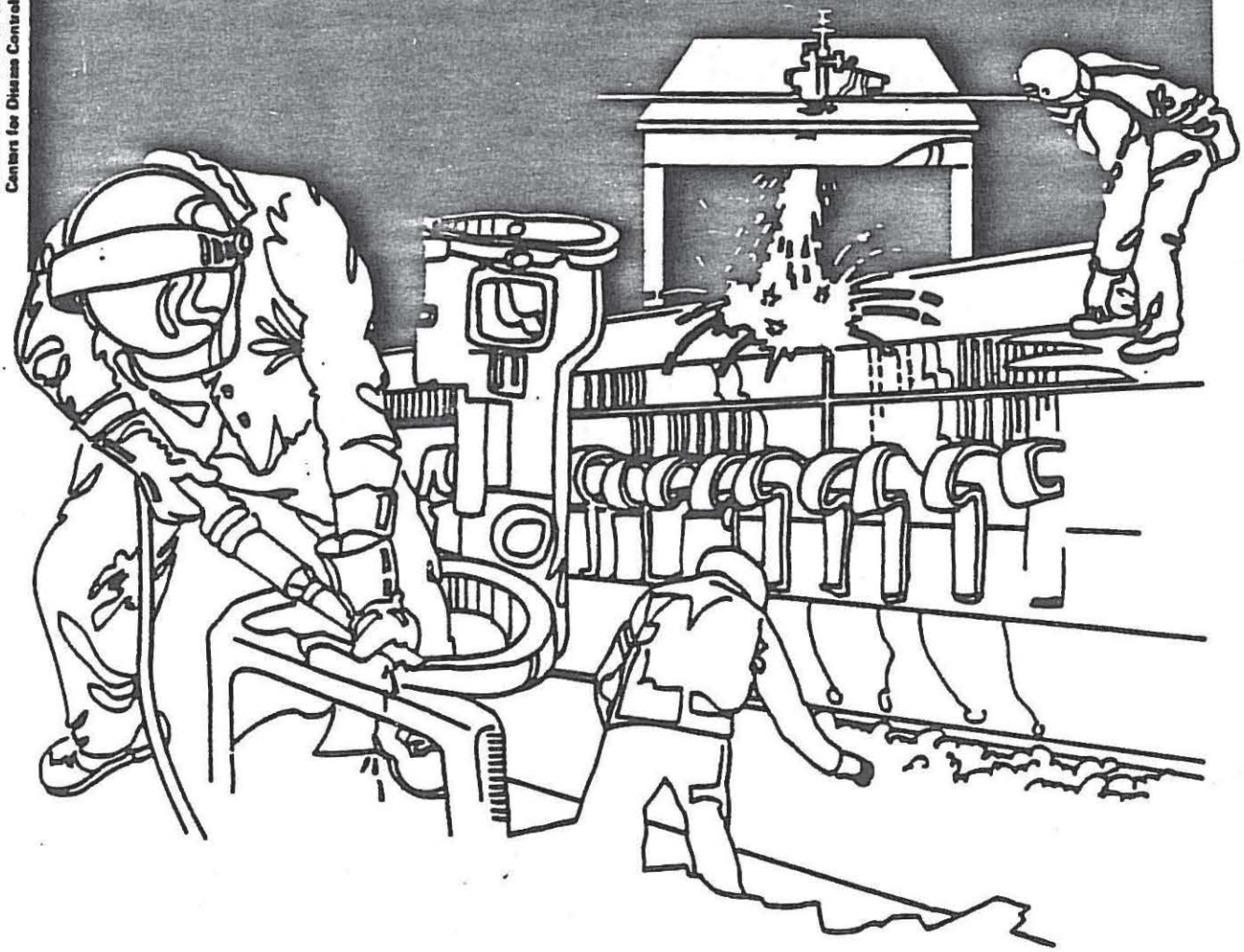

Health Hazard Evaluation Report

HETA 83-463-1642
E P A
CINCINNATI, OHIO

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.

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NIOSH INVESTIGATORS:
Linda M. Cahill, M.S.
B.G.F. Cohen, M.A.
M.J. Smith, Ph.D.

I. SUMMARY

On September 26, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Environmental Protection Agency (EPA) to evaluate complaints of blurred vision, headaches, and neck and back pain reported by office workers using video display terminal (VDT) units in their jobs. The office sites were located in the Andrew W. Breidenbach Environmental Research Center in Cincinnati, Ohio.

In October, 1983, a NIOSH investigating team analyzed the physical characteristics of the work environment and the VDT workstations and conducted a questionnaire survey of the office workers to gain information about the apparent problems and their underlying causes. Individual interviews with a small sample of workers were also held to augment the latter data.

The worksite observations revealed certain workstation characteristics that were at variance with recommendations in the literature aimed at meeting health and comfort criteria. Specifically, 73% of the illumination levels measured at the keyboards in use exceeded recommended values as did 43% at the copy holder, and 75% at the desk surface. Furthermore, 36% of the workstations showed keyboard height above the recommended range. The presence of screen glare and chairs lacking in minimal adjustment features was also notable.

The questionnaire findings indicated significant visual and musculoskeletal difficulties consistent with those found in previous surveys of VDT operators. Exemplifying such problems, more than 75% of the surveyed workers indicated the following kinds of health complaints: tearing and burning eyes; eye strain; headaches; back, shoulder, and neck pain, and fatigue. The combination of worksite observations and questionnaire data suggest that benefits could accrue from improving the VDT working conditions, and recommendations for doing so are made herein. Initial impressions and recommendations were verbally conveyed following the original site visit.

A subsequent survey of the same EPA office facility was made by NIOSH during June 1985 to check on the nature of worksite changes introduced since the first survey. The most notable evidence of improvement was the presence of adjustable chairs. Glare screens were in use though major glare problems remained. Other workstation design aids to relieve further the musculoskeletal problems were beginning to be introduced. Such features included: wrist and foot rests; adjustable copy holders and work surfaces; detachable keyboards, and adjustable tilt screens. Reinforcement of these and other efforts to relieve workstation problems is in order.

The results of this evaluation indicate that certain worker health complaints are attributable to problematic features in VDT workstation conditions and recommendations are offered for improvements, some of which are already being introduced.

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

II. INTRODUCTION/BACKGROUND

On Sept. 26, 1983 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Environmental Protection Agency (EPA) to investigate symptoms of blurred vision, headaches, and neck and back pain in approximately 150 workers who utilize VDT units in their work at the Andrew W. Breidenbach Environmental Research Center in Cincinnati, Ohio.

In October of 1983, a NIOSH team investigated the aforementioned health complaints and verbal recommendations were supplied at that time. A subsequent evaluation was performed in June of 1985 to supplement previous information and note any changes occurring since the original study.

Video display terminal users at the EPA site are generally comprised of four job categories: secretaries, clerk-typists, information processors, and "other" users. Clerk-typists include statistical, accounting, payroll, file, and miscellaneous clerks. Information processors consist of data entry and processing clerks, and clerks who process bills, questions and complaints, or update records and files. "Other" users are comprised chiefly of librarians. The majority of the VDT operators spend at least 50% of their working day in VDT usage. Clerk typists spend at least 75% of their time at the VDTs.

The literature acknowledges a variety of health concerns related to VDT use (Dainoff, 1982; Smith, 1982) (From Smith et al, SSA, 1983). These include acute visual discomfort and irritation, musculoskeletal aches and pains and emotional disturbances. In addition, there have been reports of reproduction problems in VDT operators, but these remain to be verified through more vigorous research.

Visual complaints have dominated the VDT research literature and have been the primary concern of workers using VDTs. The evidence from these studies indicates that VDT operators, as a group, experience a variety 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). The specific visual demands imposed by a given VDT job task influence the incidence of visual complaints (see Smith, 1982), with those workers engaged in the most visually demanding VDT work displaying the greatest signs of visual discomfort. Though most effects recede after brief periods of rest, they can persist in some cases. However, there is as yet no strong indication of permanent visual damage in VDT workers.

There has been a rising concern regarding the relationship between VDT work and the use of corrective eye wear. Although the research has been mixed (Ostberg, 1976; Cakir et al, 1978; Smith et al, 1982; Sauter et al, 1982), it is common to find that people who wear glasses report more visual health complaints. As a preventive approach to

the difficulties arising from VDT workers wearing glasses which do not permit the proper focus, it is normally recommended that glasses be re-refracted to accommodate the video viewing task.

A second major problem 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; Sauter et al, 1982). These are probably due to the increased postural demands imposed by the viewing requirements of the VDT, as well as the constrained postures and repetitive keystroking associated with the VDT task. The musculoskeletal complaints are of a diverse nature, affecting primarily the neck, shoulders, back, arms, wrists, hands, and fingers.

The third area of health complaints reported by VDT operators concerns emotional disturbances (Smith et al, 1980; Ghiringhelli; 1980; Elias et al, 1980). These fall into two categories: (1) those that reflect mood states, including anger, frustration, irritability, anxiety and depression, and (2) those that reflect psychosomatic symptoms, including gastrointestinal disturbances, muscle and psychic tension, heart palpitations, and frequent sweating. Only a few studies have evaluated emotional factors. The basis for emotional problems are not entirely clear. They may arise from the presence of stress factors in the work situation that extend beyond issues of VDT equipment and VDT use per se.

III. DESCRIPTION OF METHODS

A. Ergonomic Evaluation

Prior to a detailed study of the Research Center, a walk-through of the areas to be evaluated was performed. The purposes of this walk-through included task definition, characterization of overall environmental conditions, and recording the layout of the work area.

The detailed ergonomic phase of the investigation involved the evaluation of (1) environmental factors, (2) workstation design and layout, and (3) VDT design features. Measurements were compared with recommended levels designed to meet health and comfort criteria. Such criteria serve as guidelines in the design of the working environment, enabling an optimal interface between the worker and his or her task to be achieved.

During the ergonomic evaluation, measurements of screen and copyholder illuminance were obtained using the Photo-Research Litemate III Photometer. In addition, various workstation dimensions were measured with a metric tape. These included the

heights of the seat pan, screen, desk, and keyboard. Several design features were also noted, including keyboard detachability, availability of contrast and brightness adjustments, and the presence of adjustable chairs and work surfaces, glare filters, footrests, and adjustable copy holders.

A walk-through was also performed prior to the follow-on evaluation in June, 1985 for familiarization purposes.

During the detailed portion of the follow-up study, attention was given to quantifying screen glare and inventorying workstation and VDT design features. Measurements of screen glare were obtained using a Photo-Research Litemate III photometer, with the Spotmate attachment. Glare determinations were accomplished by measuring shielded and unshielded luminance fields on the VDT screen while the display was turned off.

B. Health Complaints and Psychological Status Evaluation

A questionnaire survey was utilized to ascertain potential health risks to VDT operators during the first survey in 1983. Permission was not obtained for re-administering the questionnaire in 1985. This self-reported information included health data, perceived working conditions, and demographics.

Questionnaires were completed by employees during their regular working hours and returned immediately to the investigator. As a result, every worker receiving a questionnaire returned it, yielding a 100 percent response rate.

IV. EVALUATION CRITERIA

NIOSH (Millar, 1984) recommends the following general guidelines regarding the design and use of video display terminal workstations:

1. Workstation design: Maximum flexibility should be designed into VDT units, supporting tables, and operator chairs. VDTs should have detachable keyboards, work tables should be height adjustable, and chairs should be height adjustable and provide proper back support.

   Design criteria meeting these requirements are cited throughout the report text (e.g., Grandjean, 1980, recommended adjustability for chair features - Table 12).

2. Illumination: Sources of glare should be controlled through VDT placement (i.e., parallel to windows as well as parallel and between lights), proper lighting, and the use of glare control devices on the VDT screen surface. Illumination levels should be lower for VDT tasks requiring screen-intensive work and increased

as the need to use hard copy increases. In some cases, hard copy material my require local lighting in addition to the normal office lighting.

Appropriate levels for illumination of the VDT workstation were taken from Smith et al (1983), Sauter (1985), and Grandjean (1980). These values are delineated within the report text.

3. Work regimens: Continuous work with VDTs should be interrupted periodically by rest breaks or other work activities that do not produce visual fatigue or muscular tension. As a minimum, a break should be taken after 2 hours of continuous VDT work and breaks should be more frequent as visual, mental and muscular burdens increase.

4. Vision testing: VDT workers should have visual testing before beginning VDT work and periodically thereafter to ensure that they have adequately corrected vision to handle such work.

Ongoing research efforts will continue to advance the state of knowledge regarding issues in VDT work leading to additions and refinements with respect to the aforementioned recommendations.

V. DISCUSSION AND RESULTS

General Comments:

The interior of the EPA building is composed primarily of two-person offices with access and entry through corridors. Most offices in which VDTs are used are on the outside of the corridor and thus have either one or two windows. VDTs are also located throughout the library in enclosed offices and in large open space areas.

A. Environmental Factors

Screen Glare:

As indicated in Table 1, 73% of the questionnaire respondents in the 1983 evaluation reported a problem with glare at the workstation. During the 1985 follow-up study, reflective glare was observed on all 60 VDT screens examined. Luminance screen values were obtained with glare present and while shielding the screen from glare using a hood. The percentage of luminance due

to glare was then determined. As seen in Table 2, for nearly 70% of all VDT screens surveyed, the glare percentage was greater than 80 percent of the luminance from the screen. Thus, a significant glare problem still exists at this site.

At the time of the follow-up study, glare shields were in use at 20% of the VDT's. Of these, 35% were of the mesh type and 65% were of the polarized light type. It was noted that existing screen glare filters were able to reduce glare, on the average, by 80%. The mesh type filters were found to be somewhat more effective (reduction of 86%) than the polarized light type (reduction of 75%). It was also observed that the polarized light type filters produced reflections of their own, while the mesh filters did not.

Glare, according to Smith et al (SSA, 1983), is the single most detrimental environmental factor for VDT operators, because it reduces contrast and increases the amount of visual effort. At present glare is best controlled by eliminating its sources, or modifying the source. Glare sources consist of: lights, 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 to and between luminaries, should eliminate or reduce the amount of screen glare considerably.

When positioning is not feasible, then modifications should 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 lights, 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 should 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 surface is accentuated.

The above discussion outlines several strategies regarding glare control. At the EPA site, the majority of VDTs are positioned correctly with respect to windows and overhead lighting. Repositioning appears to be infeasible for the remaining terminals due to severe space constraints. Heavy draperies are in place in most perimeter offices. The use of sheer panels or vertical blinds should be considered as an alternative. Lighting fixtures of the parabolic wedge type should be installed wherever possible. All VDT screens should be outfitted with glare reduction filters, preferably mesh type.

Lighting And Illumination:

Illumination levels were measured at each of the 51 workstations in the 1983 evaluation. These measurements were taken at the keyboard and desk for all 51 workstations and for a smaller sample measurements were obtained at the screen and hard copy holder.

Generally, lighting levels at the work surface 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. As Table 3 indicates, illumination levels at 73% of the keyboards in use were in excess of this limit. A similar pattern is illustrated in Table 4 with 75% of the illumination levels at the desk exceeding recommended levels. Levels taken at the screen (Table 5) and the copy holder (Table 6) were closer to the recommended illumination levels (88% and 57%, respectively).

The situation in which some measures are within recommended levels while others are not, may be due to the light colored, highly

reflective walls in the offices surveyed. This suggests that reducing the general ambient level of office illumination may not provide an acceptable solution to the excessive illumination levels at keyboards and desks because the reduction would negatively alter the currently acceptable illumination levels at the screen and copy holder. Therefore it may be necessary to reposition workstations to take advantage of illumination in a specific office quadrant when ambient room illumination is reduced. It may also be necessary to add individual task lighting in some cases to provide adequate hard copy illumination. Finally, reflections could be reduced significantly by painting office walls a darker color with a matte finish.

Table 1 presents the 1983 summary results of selected questionnaire items relating to issues of lighting at the individual workstations. Over one-third of the workers indicated that existing lighting hindered their work. It was noted that 80% of the respondents were unable to adjust lighting at their work area. Furthermore, nearly half of those surveyed indicated an inability to obtain additional lighting if needed. The questionnaire results were consistent with the ergonomic measurements concerning lighting. To remedy the aforementioned situation one might consider the use of adjustable task lighting, allowing adaptation to individual needs.

Other Environmental Factors:

Measurements of temperature, humidity, air quality, and noise were not taken at this EPA worksite during either the 1983 or 1985 surveys. However, employees in the examined areas were asked in 1983 about their perception of climate conditions. These results appear in Tables 7, 8, and 9. Table 7 indicates that workers are satisfied with humidity levels and summer temperature controls. However, the majority of employees feel that winter temperature settings are too low. Concerning air quality (Table 8), employees are generally not bothered by dust, odors or smoke. However, 31% report a lack of fresh air. With regard to noise levels (Table 9), the majority of those surveyed are at least sometimes bothered by machine noise and worker conversations, but rarely by steady background noise. Furthermore, 68% believe the noise level at work to be acceptable.

B. Workstation Factors

Chairs:

Results of the original study showed that the majority of chairs in use were not of the adjustable type. Workers were asked in the 1983 questionnaire to assess chair comfort. As seen in Table 10, nearly a third of those surveyed did not find the chair at their workstation to be comfortable.

Table 11 lists the features of chairs found on follow-up. As seen in the table, the majority of chairs now incorporate the two most important features, that of adjustable seat pan height (80%) and adjustable backrest (77%). Other advisable features, adjustable seat pan depth and adjustable seat pan angle, were found with less frequency, 50% and 10%, respectively. A five point base is preferred for stability. Only 25% of the chairs in use had such a base. Table 12 presents recommended ranges of adjustable chair features (Grandjean, 1980).

Desk Heights:

In the original 1983 evaluation, workstations were found set at a fixed height with no provision for height adjustability. Measurements (Table 13) indicate that the desk heights (84%) were lower than the range of standard desk height (700-735 mm, Smith et. al., 1983). The lower desk heights allow for better keyboard heights for most operators. (Keyboard heights are discussed in the next section). As part of the questionnaire administered to the VDT operators, workers were asked to assess the comfort of their desk heights; 79% of the 76 respondents believed the desk height to be comfortable.

Other Workstation Features:

Table 14 lists the percentage of current workstations possessing the indicated features based on the follow-up observations. Of the 60 workstations surveyed, only 2% incorporated wrist rests, adjustable work surface heights, or screens with adjustable tilt; 13% were now utilizing footrests, and 18% of the workstations included an adjustable jointed-arm type copy holder. Detachable keyboards were found at 23% of the stations. While the aforementioned recommended features were virtually non-existent during the previous investigation, and while such features are beginning to be incorporated into the workstations, they exist only in small numbers.

C. Video Display Terminal Factors

Keyboard Characteristics:

The majority of VDT units in 1983 had non-detachable keyboards. Keyboard heights, as measured from the floor to the center of the home row are displayed in Table 15. As seen in this table, 36% of the keyboards exceed the 750 mm maximum keyboard height, (German DIN standard, 1980, and Cakir et. al., 1979). The remaining 64% achieve the required height largely due to the fact that, as stated previously, 84% of the desks fell below the range of standard desk height.

Adjustable workstations provide the best means for ensuring proper keyboard height. This allows adjustability to proper working height for each operator, regardless of individual differences. Such workstations are typically capable of varying keyboard height between 630 and 870 mm. Standard, static height, desks tend to range from 700 to 735 mm. If procurement of adjustable workstations is not feasible, then existing desk heights may be altered through the addition of platforms or by cutting the length of the desk legs.

D. Health Complaints:

In the original 1983 survey, respondents were asked to indicate the frequency with which they experienced various health complaints within the past year. They were asked to respond with never, occasionally, frequently, or constantly. For the purpose of making judgements regarding the seriousness of a particular health complaint relative to VDT usage, any complaint that was reported as at least occasional by at least 50% of the operators was considered a potential health problem (NIOSH, 1981). The results are enumerated in Table 16. Special attention should be given to: burning eyes, watering eyes, eye strain, back pain, pain in neck/shoulders, pain in arms/legs, colds, difficulty sleeping, headaches, fatigue, acid stomach, and gas pain. These reported health problems may be classified into five general categories: (1) visual disorders, (2) musculoskeletal disorders, (3) respiratory difficulty, (4) psychological problems, and (5) stomach disorders. These findings are consistent with the types of complaints reported by clerical workers in previous studies, (Smith et. al., 1981; Dainoff, 1982; Smith 1982). Of the reported complaints the most salient are those of a visual and musculoskeletal nature.

Underlying causes of visual problems are most likely suboptimal environmental conditions -- lighting and glare. However, visual strain may also be due to task demands requiring a high level of visual concentration when using the VDT screen.

The musculoskeletal difficulties are most likely a result of postural factors in VDT work which impose static-type loads on the back, shoulders, and neck. Workstation and chair designs to alleviate this stress need careful consideration.

E. Self-Reported Disease States:

Survey respondents were asked to report physician diagnosis or treatment of chronic health conditions experienced within the past five years. Table 17 lists the percentages of employees indicating such states. These percentages are consistent with previous studies (NIOSH, 1981; NIOSH, SSA, 1982).

F. Job Stress Factors:

Table 18 lists the mean scores for EPA employees on the job demands stress scales (Caplan et al., 1975), along with scores of VDT user and non-user groups from previous studies. Scale norms are also provided.

As a group EPA secretaries demonstrated less job future ambiguity than all other groups, except miscellaneous (other) workers, with whom they were comparable. In addition, they perceived themselves as having greater workloads than clerk-typists in their organization as well as all previously studied groups with the exception of information processors. EPA clerk-typists reported lower workload variability than all other groups, and higher role ambiguity. EPA information processors felt that they experienced less role conflict, yet assumed a greater workload than clerk typists, as well as all previously studied groups. Their amount of role ambiguity is comparable with that of programmers, but lower than all remaining groups. Miscellaneous (other) workers showed higher role conflict than all groups, and a greater workload that the clerk-typists, as well as all previously studied groups. Comparisons of the EPA worker data with the norms and other group responses on the job stress scales do not yield deviant indications suggestive of unusual stress-producing conditions for this workforce.

VI. CONCLUSIONS

Health complaints reported by VDT operators at the EPA are generally consistent with those found in previous studies (Dainoff, 1982, NIOSH, 1981; and NIOSH, 1982). Stress findings in 1983 are also consistent with previous research (Smith et. al., 1981, and Smith et. al., 1983).

Visual complaints may be linked to suboptimal levels of lighting and glare. Musculoskeletal difficulties most likely arise from postural factors in VDT work which impose static-type loads on the back, shoulders, and neck. Absence of flexibility features in the VDT workstation heights and adjustments and supports in operator chairs can aggravate such problems.

VII. RECOMMENDATIONS

The following recommendations are made for further improving the environmental and workstation conditions for VDT work at the Breidenback Environmental Research Center in Cincinnati, Ohio.

A. Glare on VDT screens should be eliminated or substantially reduced. This can best be accomplished at this site by the installation of mesh type glare reduction filters on the face of the VDT's. It should be noted that these filters should cover the entire screen. Additional glare control may be realized by the use of window shading, matte finish wall covering, and selective banking for overhead lights in conjunction with individual task lighting.

B. Lighting levels, both general 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 and 50 foot candles. For job tasks requiring the reading of a good deal of hard copy, the lighting levels should be between 50 and 70 foot candles. Recommended levels may be achieved by the use of adjustable overhead lighting, individual task lighting, window shading, and matte finish wall covering.

C. Current chairs should continue to be replaced by those providing adequate lumbar support, as well as adjustability of seat pan height, angle, and depth. New purchases should also possess adjustable backrest height and a five point base.

D. Wrist rests should be provided at workstations as desired to reduce biomechanical loading on the wrist.

E. New purchase of VDT's should continue to require detachable keyboards and, where possible, should incorporate an adjustable tilt screen to accommodate a wide range of viewing angles.

F. Keyboard heights should be adjusted to bring all workstations within acceptable height limits. It is recommended that keyboard heights be adjusted so that the arm angle is between 90 and 100 degrees when the hands are positioned on the home row keys.

G. A visual testing program is recommended. Initial testing will allow detection of uncorrected visual defects. Visual defects should be remedied with corrective eyewear prior to assignments to VDT work. Periodic testing will aid in the detection of visual degradation.

H. A work regimen is recommended which would minimally include a restbreak for each two hours of continuous VDT use.

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and Report Prepared by:	Linda M. Cahill, M.S. Barbara G.F. Cohen, M.A. Michael J. Smith, Ph.D. Applied Psychology and Ergonomics Branch Division of Biomedical and Behavioral Science
Technical Assistance:	Olov Ostberg, Ph.D. Marvin Dainoff, Ph.D. Kathy Hicks Division of Biomedical and Behavioral Science
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies
Report Typed By:	Connie L. Kidd Secretary Applied Psychology and Ergonomics Branch Mary Orr Clerk-Typist Experimental Toxicology Branch

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1. U.S. EPA 26 West St. Clair, Cincinnati, Ohio 45268
2. NIOSH, Region V
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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

EPA QUESTIONNAIRE SUMMARY

RESPONSES CONCERNING LIGHTING AND GLARE
HETA 83-463
SEPTEMBER, 1983

Attribute	Job Category	Number Responding	% Responding Yes	% Responding No
1. Lighting is Extremely Good	Secretary	41	44	56
	Clerk Typist	20	55	45
	Info Proc.	4	50	50
	Other	11	27	73
	Total	71	45	55
			Helps	Hinders
2. How does the Lighting Affect your work	Secretary	39	56	44
	Clerk Typist	20	75	25
	Info. Proc.	2	100	0
	Other	10	70	30
	Total	71	65	35
			Too Bright	Just Right	Too Dark
3. Rate the Brightness at your Workstation	Secretary	41	20	58	22
	Clerk Typist	20	10	70	20
	Info. Proc.	3	0	100	0
	Other	11	18	55	27
	Total	75	16	63	21
			Lot	Some	None
4. How Is the Glare at Your Workstation	Secretary	41	24	51	24
	Clerk Typist	20	15	50	35
	Info. Proc.	4	0	100	0
	Other	11	9	64	27
	Total	76	18	55	26

continued

TABLE 1 (continued)

EPA QUESTIONNAIRE SUMMARY

RESPONSES CONCERNING LIGHTING AND GLARE
HETA 83-463
SEPTEMBER, 1983

	Attribute	Job Category	Number Responding	% Responding Yes	No
5.	How Many Shadows At Workstation	Secretary	41	51	49
		Clerk Typist	20	30	70
		Info. Proc.	3	0	100
		Other	10	20	80
		Total	74	39	61
				Yes	No
6.	Able to Adjust Light In Work Area	Secretary	41	12	88
		Clerk Typist	20	30	70
		Info. Proc.	4	25	75
		Other	11	27	73
		Total	76	20	80
				Yes	No
7.	Able to Get Additional Light When Needed	Secretary	40	50	50
		Clerk Typist	20	55	45
		Info Proc	4	75	25
		Other	10	70	30
		Total	74	55	45

TABLE 2

SCREEN GLARE
HETA 83-463
JUNE, 1985

Screen Glare %	Number of Workstations	Percentage of Total Workstations*
95 and greater	8	13%
90 to 94	14	23%
85 to 89	9	15%
80 to 84	11	18%
75 to 79	3	5%
70 to 74	7	12%
65 to 69	3	5%
Less than 65	5	8%

*Total percentage not equal to 100 due to round off error.

TABLE 3

KEYBOARD ILLUMINATION
HETA 83-463
SEPTEMBER, 1983

Illumination Range (fc)	Number of Workstations
10 - 30	1
31 - 50	1
51 - 70	12
71 - 80	14
81 - 90	10
91 - 100	5
>100	8

fc - footcandles

TABLE 4

DESK ILLUMINATION (fc)
HETA 83-463
SEPTEMBER, 1983

Illumination Range (fc)	Number of Workstations
10 - 50	0
51 - 70	12
71 - 80	4
81 - 90	11
91 - 100	12
>100	9

fc - footcandles

TABLE 5

SCREEN ILLUMINATION (fc)
HETA 83-463
SEPTEMBER, 1983

Illumination Range (fc)	Number of Workstation
10 - 30	2
31 - 50	12
51 - 70	1
71 - 90	1

fc - footcandles

TABLE 6

COPY HOLDER ILLUMINATION (fc)
HETA 83-463
SEPTEMBER, 1983

Illumination Range (fc)	Number of Workstation
10 - 30	1
31 - 50	3
51 - 70	5
71 - 90	5

fc - footcandles

TABLE 7

EPA QUESTIONNAIRE SUMMARY

RESPONSES CONCERNING TEMPERATURE AND HUMIDITY
HETA 83-463
SEPTEMBER, 1983

Attribute	Job Category	Number Responding	% Responding Too High	Correct	Too Low
1. How is Summer Temperature at Work	Secretary	41	22	63	15
	Clerk Typist	20	15	70	15
	Info. Proc.	4	0	50	50
	Other	11	27	27	46
	Total	76	20	59	21
2. How is Winter Temperature at Work	Secretary	41	7	44	49
	Clerk Typist	20	5	45	50
	Info. Proc.	4	0	25	75
	Other	11	9	18	73
	Total	76	7	39	54
3. How is the Humidity At Work	Secretary	38	11	63	26
	Clerk Typist	20	15	70	15
	Info. Proc.	3	0	67	33
	Other	11	18	64	18
	Total	72	13	65	22

TABLE 8

EPA QUESTIONNAIRE SUMMARY

RESPONSES CONCERNING AIR QUALITY
HETA 83-463
SEPTEMBER, 1983

	Attribute	Job Category	Number Responding	% Responding Rarely	Sometimes	Often
1.	How Often Is There a Lack of Fresh Air	Secretary	41	20	46	34
		Clerk Typist	20	15	60	25
		Info. Proc.	4	50	25	25
		Other	11	18	45	36
		Total	76	20	49	31
2.	How often Does Smoke at work Bother You	Secretary	41	41	41	17
		Clerk Typist	20	50	25	25
		Info. Proc.	4	50	25	25
		Other	11	73	18	9
		Total	76	49	33	18
3.	How often Do Odors at Work Bother You	Secretary	41	36	54	10
		Clerk Typist	20	35	60	5
		Info. Proc.	4	25	75	0
		Other	11	27	45	27
		Total	76	34	55	11
4.	How Often Does Dust at Work Bother You	Secretary	41	54	32	14
		Clerk Typist	20	40	50	10
		Info. Proc.	4	25	75	0
		Other	11	36	45	18
		Total	76	46	41	13

TABLE 9

EPA QUESTIONNAIRE SUMMARY

RESPONSES CONCERNING NOISE
HETA 83-463
SEPTEMBER, 1983

Attribute	Job Category	Number Responding	% Responding Rarely	Sometimes	Often
1. Bothered by Office Machine Noise	Secretary	41	22	46	32
	Clerk Typist	20	35	40	25
	Info. Proc.	4	50	50	0
	Other	11	18	73	9
	Total	76	26	49	25
2. Bothered by Steady Background Noise	Secretary	41	51	32	17
	Clerk Typist	20	60	25	15
	Info. Proc.	4	75	25	0
	Other	11	73	27	0
	Total	76	58	29	13
3. Bothered by Workers Conversations	Secretary	41	24	61	15
	Clerk Typist	20	45	40	15
	Info. Proc.	4	75	25	0
	Other	11	27	64	9
	Total	76	33	54	13
			Too High	Correct	Too Low
4. How is the Noise Level at Work	Secretary	41	37	61	2
	Clerk Typist	20	25	75	0
	Info. Proc.	4	25	75	0
	Other	11	18	82	0
	Total	76	30	68	2

TABLE 10

EPA QUESTIONNAIRE SUMMARY
RESPONSES CONCERNING CHAIR COMFORT
HETA 83-463
SEPTEMBER,1983

Attribute	Job Category	Number Responding	% Responding Yes	% Responding No
Is your chair at work comfortable	Secretary	41	73	27
	Clerk-typist	20	70	30
	Info. Proc.	4	75	25
	Other	11	55	45
	Total	76	70	30

TABLE 11
CHAIR FEATURES
HETA 83-463
JUNE, 1985

Chair Feature	Percent of Chairs Having Feature*
5 Point Base	25%
Adjustable Seat Pan Height	80%
Adjustable Seat Pan Depth	50%
Adjustable Backrest	77%
Adjustable Seat Pan Angle	10%

*60 VDT workstations were surveyed.

TABLE 12

RECOMMENDED ADJUSTABILITY
FOR CHAIR FEATURES
HETA 83-463

Feature	Range of Adjustability*
Seat Pan Height	38-53 cm
Seat Pan Width	40-45 cm
Seat Pan Depth.	38-42 cm
Seat Pan Angle	4^{o}-6^{o} from Horizontal
Backrest Height (Top)	48-50 cm
Backrest Length	10-20 cm
Backrest Width	32-36 cm
Backrest Horizontal Radius	40-50 cm
Backrest Vertical Radius	80 cm
Points at Base	5
Base Diameter	40-45 cm

*From Grandjean, 1980.

TABLE 13

DESK HEIGHT MEASUREMENTS
HETA 83-463
SEPTEMBER, 1983

Desk Height (mm)	Number of Workstations	Percentage of Total
Below 650	4	8
650	3	6
660	10	20
670	20	40
680	2	4
690	2	4
700	2	4
Over 700	8	16
	51	*

*(Percentages total more than 100% due to rounding off of figures)

TABLE 14
WORKSTATION FEATURES
HETA 83-463
JUNE, 1985

Feature		Percent of Workstations Having Feature*
Wrist Rest		2%
Foot Rest		13%
Adjustable Copy Holder		18%
Adjustable Work Surface		2%
Detachable Keyboard		23%
Screen Tilt Adjustability		2%
Glare Shield -		
Mesh Type	7%	
Polarized Light Type	13%	20%

* 60 VDT Workstations were surveyed.

TABLE 15

Keyboard Height Measurements
HETA 83-463
September, 1983

Keyboard Height (mm)	Number of Workstations	Percentage of Total
Under 720	2	4.0
721 - 750	30	60.0
751 - 790	11	22.0
Over 790	7	14.0
Total	50	

TABLE 16

WORKER HEALTH COMPLAINTS
HETA 83-463
SEPTEMBER, 1983

HEALTH COMPLAINT	Percentage Reporting Health Complaints N=76
Short Breath	41
Colds	78
Cough	32
Cough up Blood	3
Fever	
Hayfever	60
Wheezing	15
Respiratory Infection	24
Ability to see colors	13
Eyes Water	78
Burning Eyes	76
Blurred Vision	56
Eye Strain	81
Headache	86
Back pain	72
Neck pressure	49
Pain in Neck/Shoulders	74
Leg Cramps	52
Leg pain when standing	63
Swollen Muscles	48
Numbness or Tingling	37
Pain in arms/legs	63
Loss strength arms/hands	24
Stiff or sore wrists	28
Difficulty sleeping	59
Fainting	35
Nervous	49
Sweaty	37
Ringing in Ears	35
Fatigue	78
Dry Mouth	41
Chest pains	26
Pain down arms	16
Pounding Heart	28
Acid Stomach	58
Stomach Pains	47
Digestive trouble	34
Belching	50
Gas Pain	62
Nausea	33
Diarrhea	21
Hemorrhoids	25
Increase Urination	55
Painful Urination	13
Blood in Urine	3

TABLE 17

PERCENTAGE OF VDT OPERATORS REPORTING DIAGNOSIS
OR TREATMENT OF A DISEASE STATE BY THEIR PHYSICIAN
WITHIN THE PREVIOUS 5 YEARS
HETA 83-463
SEPTEMBER, 1985

Disease State	EPA VDT Operators %
Diabetes	3
Cancer	1
Hernia or Rupture	4
Tuberculosis	0
Asthma	4
High Blood Pressure	18
Heart Disease	3
Arthritis or Rheumatism	21
Epilepsy (Convulsions of Fits)	1
Glaucoma of the Eyes	1
Paralysis, Tremor, or Shaking	4
Kidney or Bladder Trouble	20
Lung or Breathing Problems	9
Stroke	1
Anemia	8
Gall Bladder, Liver	7
Thyroid Trouble or Goiter	12
Insomnia	7
Gastritis	14
Colitis	12
Stomach Ulcer	8
Cataracts	4
Mental or Psychological Problems	7

TABLE 18
MEAN RESPONSES FOR JOB STRESSORS
HETA 83-463
SEPTEMBER, 1983

STRESSOR	VDT USERS (This Study)				VDT USERS (Previous Studies)				Non-Users		
	Secretary	Clerk Typist	Info Processor	Other	Programmers (1)	Professional(2)	Clerical (2)	Clerical (3)	Clerical (2)	Clerical (3)	Job Demands and worker Health Study Median Scores (Norms) (4)
Workload variability	2.85	2.65	2.93	3.03	2.76	2.74	3.02	2.97	2.87	3.05	2.81
Role Conflict	1.97	1.87	1.40	2.10	1.77	1.82	1.71	1.73	1.92	1.96	1.75
Job Future Ambiguity	2.52	2.94	3.05	2.46	2.72	3.04	3.50	3.16	3.10	2.94	2.70
Underutilization	3.65	3.42	3.67	3.77							
Workload (Quinn)	4.15	3.64	4.25	4.13	2.76	3.55	4.04	3.62	3.61	3.68	—
Role Ambiguity	1.80	2.16	2.10	1.50	2.12	1.55	1.79	1.96	1.73	1.89	2.06

1. From Smith et al (1983)
2. From Smith et al (1981)
3. From Sauter et al (1984)
4. Scales taken from Job Demands and Worker Health (Caplan et al., 1975).

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