Scand J Work Environ Health 1985;11(6):467-474

<https://doi.org/10.5271/sjweh.2199>

Issue date: Dec 1985

**Work with video display terminals among office employees. II.
Physical exposure factors.**

by [Knave BG](#), [Wibom RI](#), [Bergqvist UO](#), [Carlsson LL](#), [Levin MI](#), [Nylen PR](#)

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/4095525

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Work with video display terminals among office employees

II. Physical exposure factors

by Bengt G Knave, MD, Roger I Wibom, Ulf OV Bergqvist, MScTech, Lars LW Carlsson, Mats IB Levin, Per R Nylen, BSc¹

KNAVE BG, WIBOM RI, BERGQVIST UOV, CARLSSON LLW, LEVIN MIB, NYLEN PR. Work with video display terminals among office employees: II Physical exposure factors. *Scand J Work Environ Health* 11 (1985) 467-474. This is the second report in a major epidemiologic health investigation on work with a video display terminal (VDT). The first study showed that VDT operators reported more eye discomfort than a reference group not employed in VDT work and that women reported more eye discomfort, musculoskeletal complaints, headache, and skin disorders than men, regardless of whether they worked with a VDT or not. The present report contains the results of the occupational hygiene measurements (indoor climate, lighting and electrostatic conditions). Considerable differences were found between VDT operators and referents and also between sexes. Indications were obtained of a possible relationship between eye discomfort and luminance ratios in the working field of vision. Otherwise, no association could be established between occupational exposure factors and subjective eye discomfort, musculoskeletal complaints, headache, or skin disorders.

Key terms: electrostatic charging, electrostatic fields, epidemiologic study, floor resistance, indoor climate, light air ions, lighting, ultraviolet radiation.

In the literature, no specific visual display or work environment factor has been fully identified as causally relating to, eg, eye discomfort. A number of suggestions have been made, however, for a relationship between eye discomfort and workroom lighting, glare, dry air, screen or character brightness, readability, flicker, reflections, or phosphor characteristics (3, 5, 10, 11, 12, 15, 16, 17). Most of these studies used comparison between subjective data (from the examinee) only.

The present epidemiologic health investigation involved about 400 video display terminal (VDT) operators and, as a reference group, 150 office employees without any VDT work. In a first report (9), it was shown that the VDT operators reported more eye discomfort and skin disorders than the referents. Furthermore, the women consistently reported more discomfort than the men, regardless of whether they were employed in VDT work or not.

In this second report of the epidemiologic study, various indoor climate factors (dimensions of premises, temperature, air velocity, humidity, and pressure) were studied and measured at the workplaces of each individual operator and referent in the investigation; lighting and ultraviolet radiation were also measured. The extent of certain electrical phenomena (electrostatic fields from the VDT screen, electrostatic charging of operators and referents, light air ions) were also

measured. The objective measurement results obtained were related to various forms of subjective discomfort and symptoms as reported in the health status questionnaire of the first report (9).

Subjects and methods

Subjects

Tables 1 and 2 in our first report (9) show the material in terms of "exposed" (VDT operators) and "unexposed" (reference group) subjects. For the present report it has in most cases been possible to use a material comprising 539 persons (391 exposed and 148 reference subjects) or 516 persons (374 exposed/142 referents) having almost the same sex and age structure as was presented previously (9).

Methods

The overall structure and various stages of the epidemiologic study have already been described, as have, in greater detail, the questionnaire, the documentation underlying the calculation of the discomfort indices, the duration of the workhours, and the statistical methods used (9). A description will now be given of the methods used in measuring and assessing the various physical exposure factors investigated.

Indoor climate. Room size (volume), globe temperature, air velocity, air humidity, and air pressure were measured at the various enterprises on the days when the questionnaires were completed and the eye examinations performed. Temperature and relative air humidity

¹ National Board of Occupational Safety and Health, Research Department, Solna, Sweden.

Reprint requests to: Professor BG Knave, Department of Occupational Neuromedicine, National Board of Occupational Safety and Health, S-171 84 Solna, Sweden.

were recorded with a Lambrecht thermohygraph. Air pressure was determined by means of a Lambrecht registering barometer. Air velocity measurements were taken using a Wallace GGA 23 S hot wire anemometer. The mean radiated temperature was measured with a globe thermometer with a standard 15-cm diameter globe.

Lighting. Illuminance and luminance were measured against horizontal and vertical surfaces at the workstations (manuscript, screen, keyboard) and horizontally in the offices (general lighting) using a Hagner universal light meter (model S2). Luminance was also measured in the paracentral part (referred to as "surround" in the figures and as "close surroundings" in the text) and periphery of the visual fields for each subject in a normal work position. The luminance measurements were recorded with the normal measuring angle (1°) of the instrument and also as luminance averages for a visual field restricted by a cone having an apex angle of 60° . The luminance on 0.5 cm^2 of the screen surface was measured with a measuring angle of 1° and with the instrument positioned 0.5 m away from the screen. A measuring angle of 60° gave a corresponding measuring field of 0.25 m^2 , which included the whole of the VDT screen and part of the workstation. These measurements were conducted while work was in progress.

Contrast reduction on the manuscript and keyboard was measured with a Brüel & Kjær contrast meter (type 1100). Contrast (C), which is the relative difference in luminance between surfaces (L_1 and L_2), can be defined as $C = 100 \cdot (L_2 - L_1) / L_1$ (percent).

Contrast reduction (CR) expresses the relation between the observed contrast and the best possible contrast, $CR = 100 \cdot (1 - C/C_{\max})$ (percent). The visual distance of the individual employee from the manuscript, the keyboard, and the screen was measured at every workstation.

Ultraviolet radiation. Ultraviolet (UV) radiation within the UV_A wavelength band (315–400 nm) was measured with a UVM-8 Airam instrument. The detectors were positioned with the sensitive surface facing the ceiling and, where relevant, the VDT screen. In the latter case the detectors were kept in the operators' normal facial position, about 60 cm in front of the screen.

Electrostatic fields from the screen. The electrostatic field was measured with an Eltex Q 475 C "field mill." The electrostatic field strength was recorded every 10th cm between 10 and 70 cm in front of the screen with the field mill positioned centrally in front of the screen. The casing of the mill was grounded for the measurements, and the person taking the measurements was grounded via the casing. The employee was

not sitting at the workstation when these measurements were performed.

This procedure agrees with that used by Cato Olsen (4). Since then, and subsequent to the commencement of our measurements, a different procedure has been proposed by Harvey (6) and by Paulsson et al at the Swedish National Institute for Radiation Protection (SSI) (13). In this procedure a large metal disc or foil sheet is positioned parallel to the screen. The field mill sensor is placed in a hole in this disc, and the grounded casing of the field mill is also connected to the disc. This procedure has two advantages. First, a more homogeneous field is obtained, which means that the potential on the surface of the screen can be estimated more accurately, and, second, measurements are less prone to interference from other charged objects.

We have investigated the relation between these two methods with 14 screens (though not the same screens as were included in our study). The results showed that the values obtained at a distance of 10 cm with the method of measurement we used are about 2–2.5 times greater than those obtained with the methods used by SSI and others. This ratio increases with increasing distance. Thus the measurements obtained by these various methods are not directly comparable. However, the measurements obtained in this study are real in the sense of showing the fields occurring in a certain, realistic measuring situation. In addition, our results are consistent insofar as comparisons can be made within the study.

Electrostatic charging. Static charges of the employees were roughly estimated using the aforementioned field mill. The fields corresponding to these charges were measured with the employee seated normally at the workstation and also after the employee had been moving about on the premises for a minute or so. The measurement procedure for the employee was to hold the ungrounded field mill and point it towards a grounded metal disc, the distance between the disc and field mill being about 1 cm, whereupon the electrostatic field in this measuring situation was recorded.

Another method, based on the same measurement principle, has been presented, eg, by Ancker et al (1). For reasons resembling those already stated concerning the electrostatic fields from the VDT screen, however, our measurements are not comparable with those reported by Ancker et al (1). They can, however, be used for purposes of comparison within this study.

Estimate of the electrostatic field between the screen and the operator. A rough estimate of the electrostatic field occurring in a typical VDT work situation has been obtained by treating the observed fields as homogeneous, the field being calculated as $E = (EF_{10} \cdot 0.1 - STEL \cdot 0.01) / VD_{SCR}$, where E = the (estimated) field between the screen and the operator in kilovolts per meter, EF_{10} = the observed field from the screen

at a distance of 0.1 m (in kV/m), STEL = the observed field from the operator at a distance of 0.01 m (in kV/m), and VD_{SCR} = the distance in meters between operator and the VDT. (This rough estimate has only been used for comparison purposes within the present study.)

Floor resistance. Floor resistance was measured by the method specified by the Swedish Planning and Rationalization Institute for the Health and Social Services (SPRI) (14). The measuring instrument used was a Norma Isolationsmesser 1806.

Light air ions. Charged particles will be affected by electrostatic fields, as determined by the field and the ion mobility, given in square meters per volts times seconds, ie, meters per second divided by volts per meter. So-called light air ions are small (about 0.001–0.003 μm), short-lived, and highly mobile (mobility of some 10^{-5} – $3 \cdot 10^{-4} \text{ m}^2/\text{V} \cdot \text{s}$). Larger ions (Langevin ions, approximately 0.003–0.03 μm) have a mobility of about $5 \cdot 10^{-7}$ – $10^{-5} \text{ m}^2/\text{V} \cdot \text{s}$, while charged particles (Aitken nuclei, $>0.03 \mu\text{m}$) have a mobility of 10^{-9} – $5 \cdot 10^{-7} \text{ m}^2/\text{V} \cdot \text{s}$ (4, 7).

The content of small air ions in the air was measured with an Allen Weston A 7893 instrument, the threshold mobility of which was $5 \cdot 10^{-5} \text{ m}^2/\text{V} \cdot \text{s}$. (Thus these measurements only include the small, highly mobile, and short-lived ions.) This instrument alternately measures the average content of positive and negative

air ions at 5-min intervals. Ion content was measured close to the employee and in the middle of the room or about 2 m away from the employee.

Results

Both the entire material and the exposed women only have been used for the correlation analyses in the present work. This procedure was used because the exposed women were the largest homogeneous “discomfort group” in the material. As was shown in the first report, the exposed employees stated significantly more discomfort (eg, eye discomfort) than the reference subjects, just as the women reported more discomfort than the men.

Indoor climate

As can be seen from figure 1, several significant differences were observed in the climate, both between the exposed and reference groups and between the sexes. The VDT operators’ workstations were located in larger rooms (figure 1A), with lower temperatures (figure 1B) and higher air velocities (figure 1C) than the referents’. Women were found to be working in larger rooms with higher temperatures and air humidities but with lower air velocities (figures 1A–D) than men.

A correlation analysis showed several significant ($p < 0.001$) correlation coefficients between the different climate factors. With the exception of a negative correlation between the musculoskeletal discomfort

Figure 1. Room volume (A), globe temperature (B), air velocity (C), relative air humidity (D), and air pressure (E) for the exposed and reference groups and for the men (♂) and women (♀) in the two groups combined. (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

Figure 2. General room illuminance (A), manuscript illuminance (B) and luminance (C), luminance in the close surroundings (surround) (D), the ratio between the luminance on the manuscript and in the close surroundings (E), and the contrast reduction on the manuscript (F) for the exposed (diagonally striped columns) and reference (unstriped columns) groups and for the men (σ) and women (φ) in the two groups combined (horizontally striped columns). (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

Figure 3. Relationship between the luminance ratios and eye discomfort for the women in the exposed group. (surround = close surroundings)

scores and air pressure ($p < 0.001$), there were no associations with the different subjective complaints.

Lighting

As regards the lighting factors investigated, there were clear differences between the exposed and reference groups (figure 2). The VDT operators had both lower room illuminances and lower illuminances on the manuscript (figures 2A and B). Luminances were lower on the manuscripts (figure 2C) and in the close surroundings (figure 2D). The luminance ratios between the manuscript and the close surroundings and the contrast reduction on the manuscript were considerably higher among the exposed subjects than among the referents (figures 2E and F).

There were also differences in lighting between the men's and women's workstations, although these differences were less conspicuous than those between the exposed and reference subjects. Statistically significant differences were only found with regard to manuscript illuminance and luminance; lower values were recorded for the women.

There were high correlation coefficients between the various lighting factors, but no such associations could be established between the lighting factors and the reported subjective discomfort.

It is a well known fact that large luminance ratios between adjoining areas within the working field of vision can generate what is termed contrast glare. [See

Hopkinson & Collins (8).] Luminance ratios in the region of 3 : 1 have been stated as guidelines for a good visual environment. The diagram in figure 3 has been made to include (for the female VDT operators) eye discomfort scores versus luminance ratios for manuscript : screen (solid line), manuscript : close surroundings (broken line), and for close surroundings : periphery (dotted line). The data, as presented in the figure, suggest that eye discomfort increases with larger luminance ratios. This finding applies particularly to the manuscript : screen luminance ratio (solid line). The eye discomfort score for a luminance ratio of 20 : 1 differs from the other values in that curve ($p < 0.05$). It is also worth noting that screen luminance was significantly negatively correlated with the various luminance ratios. This fact indicates that the cause of the large luminance ratios may be found in the low-luminance, dark VDT screens.

Visual distance

Measured distances between the eyes and various visual objects showed that female VDT operators worked at closer distances than their male colleagues in relation to the screen, the keyboard, and the manuscript (figure 4A). Furthermore, exposed women were found to be working with the manuscript farther away (mean about 8 cm) than women in the reference group (figure 4B). There was a clear correlation between the various visual distances, but no relation could be established with relevant subjective discomfort (eye discomfort, musculoskeletal complaints, headache).

Ultraviolet radiation

When the UV instrument was aimed at the ceiling, lower radiation intensity was observed among the VDT operators than among the referents (figure 5A). No differences were established between the sexes (figures 5A–B), whether the instrument was aimed at the screen or the ceiling. There was no association between UV radiation and eye discomfort or skin disorders.

Electrostatic conditions

Electrostatic field from the screen. The electrostatic field was measured at a distance of 10, 20, 30, 40, 50, 60, and 70 cm from the screen for all worksites of the exposed group. The measured field strength diminished with increasing measuring distance (as expected) and was 2–4 kV/m when measured at normal work distances for the group as whole (figure 6). There were considerable differences, however, between individual makes and models of screen. Some models displayed a strong electrostatic field, others displayed a weaker one, and some models did not display any quantifiable field at all. Field strength at a measuring distance of 10 cm varied from 0 to 200 kV/m between screens. The estimated average potential of these screens is about 3 kV (range 0–9 kV). These potentials agree with other reported values of 0–10 kV (2, 4, 19).

Figure 4. Visual distance to the screen, the keyboard, and the manuscript for the men (♂) and women (♀) in the exposed group (A) and the visual distance to the manuscript for the women in the exposed (diagonally striped column) and reference (unstriped column) groups (B). (** $p < 0.01$, *** $p < 0.001$)

Figure 5. Ultraviolet (UV) radiation ($\text{UV}_A = 315\text{--}400$ nm wavelength band) measured towards the ceiling for the exposed (diagonally striped columns) and the reference (unstriped columns) groups (A) and for the men (♂) and women (♀) in the two groups combined (horizontally striped columns) and measured towards the screen of the video display terminal (VDT) for the exposed group (B). (** $p < 0.01$, *** $p < 0.001$)

Figure 6. Electrostatic field strength between the screen and sensor at measuring distances between 10 and 70 cm.

Figure 7. Electrostatic charging (measured as field strength at a measuring distance of 1 cm — note negative sign (A), floor resistance (B), and the percentage of wall-to-wall carpeting (C) for the exposed (diagonally striped columns) and reference (unstriped columns) groups and for the men (♂) and women (♀) in the two groups combined (horizontally striped columns). (** $p < 0.01$, *** $p < 0.001$)

Figure 8. Positive (A and C) and negative (B and D) light air ions near the face (A and B) and in the room (C and D) for the exposed (diagonally striped columns) and reference (unstriped columns) groups and for the men (♂) and women (♀) in the two groups combined (horizontally striped columns). (*** $p < 0.001$)

The statistical analyses yielded no relation between observed electrostatic fields and subjective disorders (eye discomfort, musculoskeletal complaints, headache, or skin rash).

Electrostatic charging and resistance. Figures 7A and B show the results of measurements of static charges and floor resistance. Figure 7C shows the relative incidence of wall-to-wall carpeting in the offices, since the type of floor has a bearing on electrostatic charges and resistance. Both the exposed and reference subjects had wall-to-wall carpeting in their offices in about 80 % of all cases, while the remainder had linoleum flooring. Significant relations were observed between certain electrostatic conditions and the type of flooring. On the other hand we did not find any correlations in this material between electrostatic charges and indoor climate factors.

There were certain differences between the VDT operators and the referents in terms of electrostatic charges and resistance, just as there were between the men and women as regards resistance and type of flooring. For example the VDT operators displayed a significantly lower electrostatic charge than the referents (measured as field strength to ground).

Higher headache scores were recorded for persons in workrooms with wall-to-wall carpeting, for both the material as a whole and for the exposed women as a group ($p < 0.001$). Otherwise no associations were found between subjective complaints and electrostatic charges and resistance.

Electrostatic fields between the screen and the operator

The estimated fields in work situations varied from 0 to about 15 kV/m. The particle migration speed (particles measuring approximately $0.03\text{--}1\text{ }\mu\text{m}$, moderate charge) was therefore between 0 and 7.5 mm/s. These calculated migration speeds were considerably lower than recorded air velocities at the VDT workstations (figure 1C). (Light air ions have much higher migration speeds.)

We did not find any relation between the field thus estimated and alleged skin disorders.

Light air ions

For both positive and negative ions measured close to the face (figures 8A and B) and in the middle of the room (figures 8C and D) there were clear differences between the exposed and reference groups. Higher ion contents were generally observed for the VDT operators. This increase was particularly noticeable when the referents were compared to the VDT operators sitting at a VDT without an electrostatic field. There were also clear differences between the sexes in that the men had consistently lower ion values.

Significant correlation coefficients could be noted between several of the electrostatic conditions and indoor climate factors. Thus there were negative correlations between ion contents and the electrostatic field from the VDT screen, while there were positive correlations between ion content and room volume and humidity. Rooms with wall-to-wall carpeting had higher ion contents than other rooms.

As regards subjective disorders, eye discomfort correlated with ions in the room for the material as a whole but not for the group of exposed women. Otherwise no correlations were observed between light air ions and subjective disorders.

Questionnaire concerning eye discomfort and headache on the days when the occupational hygiene measurements were taken

On the days when the occupational hygiene measurements were made at the workplaces, the employees concerned were asked to complete simple questionnaires concerning the occurrence of discomfort, namely, eye discomfort and headache. Thus the data collected in this way were related solely to the observation date. The questions in the larger questionnaire (9) were worded in such a way as to cover a larger current period and not just the observation date. The results of the simpler questionnaire were no different, however, from the results of the larger one, even as regards analyses of relations with the physical exposure factors included in the present study.

Duration of workhours

In the first report on subjective disorders and symptoms, the importance of duration (number of years) and intensity (number of hours per week or day) of VDT work was evaluated by various methods, both questionnaires, and special workhour measurements (9). The physical exposure factors dealt with in the present work have also been investigated and assessed with reference to duration and intensity. There were no clear indications that the impact of these physical factors on the discomfort and symptoms was reinforced by a longer duration and intensification of VDT work.

Discussion

The results of the present report show that there were clear differences between the VDT operator groups and the reference group as regards various exposure factors in the indoor climate, lighting, and electrostatic conditions. The analyses undertaken of relations between exposure factors and subjective disorders and symptoms as registered in the standardized questionnaires did not, however, indicate any correlations. There was one exception, that of the effect of luminance ratios on the occurrence of eye discomfort. (See the following discussion.) The reason for exposure factors and discomfort otherwise not being correlated may be that there was no actual relationship between them or that the methods we used were insufficiently sensitive or inappropriate.

This latter explanation is contradicted to some extent by the fact that no relations could be established with subjective disorders registered on the very day when the physical factors were measured. Epidemiologic, retrospective studies generally suffer the shortcoming that exposure measurements refer to one point in time, while assessment of the degree of health/illness requires a somewhat longer period of time, at all events when the employees are required to complete a questionnaire.

Some of the physical factors are, no doubt, fairly constant; this statement applies, eg, to the size of room, visual distance, type of flooring, and resistance. Some factors, eg, atmospheric pressure, vary from one day to the next. Furthermore, seasonal fluctuations do a great deal to influence variations in many of the observed exposure factors, eg, indoor lighting, electrostatic charges, temperature, and air humidity. It is worth emphasizing, however, that the results from our study indicate differences in exposure between the VDT operators and the referents, and also between the men and the women, irrespective of whether measurements were taken on one day only or on a couple of days. Thus the VDT screens have changed the occupational environment, even though we were unable in the present study to relate such changes to discomfort or other undesirable effects.

There does, however, seem to be one exception. The greater the luminance ratios in the working field of vision, the greater the eye discomfort experienced by the subjects. This finding makes it worth emphasizing once again that the large luminance ratios are partly attributable to the dark screens. The introduction of bright screens, therefore, might possibly improve the situation, ie, reduce the occurrence of eye discomfort.

An increased deposition of atmospheric particles on the operators and the screens, due to the electrostatic fields between the screens and the operators, has recently been shown (4, 18). (It should be observed that these deposits comprised particles in the 0.03–1- μm size range.) After these measurements, Cato Olsen (4) put forward the hypothesis that certain skin disorders

observed in Bergen were related to an increase in exposure to ambient atmospheric contaminants due to these electrostatic fields. Air humidity is an important factor in this hypothesis; the alleged skin disorders appear to occur only in conjunction with low air humidity. Analysis of the data presented by Cato Olsen (4) revealed a correlation between the estimated electrostatic field between the screen and operator and the observed increases in particle depositions (2). Ungethüm (18) suggested that the migration velocities of charged particles which can occur in the fields appearing between the screen and the operator are negligible compared with normal air velocities in the office environment. This suggestion was confirmed by our findings. According to Ungethüm (18) facial deposition ought therefore to be mainly dependent on conditions in the immediate proximity of the operator's face. According to this hypothesis, therefore, electrostatic charging of the operator is probably the most relevant parameter.

This assumption makes it worth noting that we did not find any correlation between electrostatic fields from the screen or electrostatic charges of the operator and reported skin disorders. Furthermore, our study did not reveal any correlation between the estimated screen-operator field (as already explained) and alleged skin disorders. Thus our study does not corroborate the hypothesis put forward by Cato Olsen (4).

There are several possible reasons for this discrepancy. The air contaminants occurring in Bergen differ in several respects from those in Stockholm. Therefore the increased exposure suggested by Cato Olsen (4) and Ungethüm (18) differs in real terms between these geographic localities. Furthermore, about 30 % of the groups investigated by us reported skin disorders, while the cases discussed by Cato Olsen appeared to be relatively unusual. The explanation put forward by Cato Olsen, therefore, should not be expected to correlate with the skin disorders reported in our study.

References

1. Ancker K, Bjurström R, Göthe C-J, Holm S, Langworth S. Electrostatic charge in office environments. In: Proceedings of the 3rd International Conference on Indoor Air Quality and Climate, Stockholm August 20–24, 1984. Volume 3. Swedish Council for Building Research, Stockholm 1984, pp 157–162.
2. Bergqvist UOV. Video display terminals and health: A technical and medical appraisal of the state of the art. Scand J Work Environ Health 10 (1984): suppl 2, 87 p.
3. Canadian Labour Congress, Labour Education and Studies Centre. Towards a more humanized technology; exploring the impact of video display terminals on the health and working conditions of Canadian office workers. Ottawa, Quebec 1982.
4. Cato Olsen W. Electric field enhanced aerosol exposure in visual display unit environments. Chr Michelsen Institute, Bergen 1981. (CMI 803604-1).
5. Dainoff MJ. Visual fatigue in VDT operators. In: Grandjean E, Vigliani E, ed. Ergonomic aspects of visual display terminals. Taylor & Francis, London 1982, pp 95–99.
6. Harvey SM. Characteristics of low frequency electrostatic and electromagnetic fields produced by video display terminals. Ontario Hydro Research Division, Toronto, Ontario 1982. (Report 82-528-K).
7. Hedge A, Eleftherakis E. Air ionization: An evaluation of its physiological and psychological effects. Ann Occup Hyg 25 (1982) 409–419.
8. Hopkinson RG, Collins JB. The ergonomics of lighting. MacDonald & Co, London 1970.
9. Knave BG, Wibom RI, Voss M, Hedström LD, Bergqvist UOV. Work with video display terminals among office employees: I Subjective symptoms and discomfort. Scand J Work Environ Health 11 (1985) 457–466.
10. Läubli T, Hünting W, Grandjean E. Postural and visual loads at VDT workplaces: II Lighting conditions and visual impairments. Ergonomics 24 (1981) 933–944.
11. Mellner M, Moberg I. Belastnings- och synbesvär vid arbete med dataterminal. Oxens Företagshälsövärd, Stockholm 1983.
12. Nishiyama K, Bräuninger U, De Boer H, Gierer R, Grandjean E. Physiological effects of oscillating luminances in reversed display of VDTs. Ergonomics 25 (1982) 555–556.
13. Paulsson L-E, Kristiansson I, Malmström I. Strålning från dataskärmar, arbetsdokument a 84-08. Statens Strålskyddsinstitut, Stockholm 1984.
14. Sjukvårdens planerings- och rationaliseringsinstitut. Elektriskt halvledande golv: Mätning av resistans. Gränsvärden. Stockholm 1979. (SPRI specifikation 108 01).
15. Smith AB, Tanaka S, Halperin W, Richards RD. Report of a cross-sectional survey of video display terminal (VDT) users at the Baltimore Sun. National Institute for Occupational Safety and Health, Cincinnati, OH 1982.
16. Smith MJ, Cohen BGF, Stammerjohn LW. An investigation of health complaints and job stress in video display operations. Hum Factors 23 (1981) 387–400.
17. Stammerjohn LW, Smith MJ, Cohen BGF. Evaluation of work station design factors in VDT operations. Hum Factors 23 (1981) 401–412.
18. Ungethüm E. Elektrostatiska fält i närheten av dataskärmar och dess betydelse för transport av luftburen förorening: Resumé, 33. Nordiske yrkeshygieniske møte. Yrkeshygienisk institutt, Oslo 1984, p 17.

Received for publication: 19 March 1985