ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

– VISUAL DISPLAYS – HEALTH ASPECTS

ECMA
TECHNICAL REPORT TR 33
ON
THE STATE OF SCIENTIFIC
KNOWLEDGE AND RESEARCH

December 1985

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1. SCOPE

This ECMA Technical Report states the position of the Association with regard to health aspects of visual displays.

From time to time there have been suggestions that various health risks may be associated with the use of visual display units (VDUs or VDTs) using cathode ray tubes. Naturally, people called upon to use VDUs in the course of their employment are concerned by these allegations and are anxious to know the truth. Equally concerned are the Member Companies of the European Computer Manufacturers Association and their employees who are among the heaviest users of VDUs.

To ascertain the facts, ECMA set up a study team to review current knowledge on potential health hazards that might be attributable to VDUs and to relate their findings to the allegations which have been made. This report presents the results of that study for the benefit of members and the general public.

On the basis of information currently available, it is concluded that VDUs do not cause damage to health. However, research on this subject is continuing and should be encouraged. New evidence will be reviewed by ECMA as it becomes available.

The environment and the way in which VDUs are used can have a considerable bearing on health and it is important that problems attributable to the workplace or the workflow should be avoided. For instance low air humidity, reflections from the screen, seating which gives inadequate support, a keyboard position which causes the user to stretch, can all cause discomfort which may, over a period, adversely affect health. In addition, VDU tasks should be designed to incorporate some element of variety, operator control over the process and naturally occurring changes in the routine.
Ergonomic and organisational matters such as these have been the subject of many studies and several manuals exist which give good advice [1], [2], [3], [4], [23].

2. COULD A VDU BE A HEALTH HAZARD?

— **Radiation**

— **Electrostatic fields**

— **Sound emissions**

— **Flicker**

2.1 RADIATION

Quote:

"The radiation surveys demonstrated that exposure to X-rays, radio frequency, ultraviolet and visible radiation was well below current occupational exposure standards, and, in many cases, below the detection capability of the survey instruments". [5]

VDUs are designed to emit visible light from the screen. They can however, like all electrical appliances, emit electromagnetic radiation of other wavelengths in small quantities. In most cases the radiation received from a VDU is much less than that received from the sun or constantly present as a result of radio and television transmissions, fluorescent lighting and other electrical apparatus. It is always below the safety levels specified by the world's recognised authorities.

The electromagnetic spectrum is divided into two major regions, ionising radiation and non-ionising radiation. Non-ionising radiation can be sub-divided into optical, microwave and radio frequency radiation.

2.1.1 Ionising Radiation

Ionising radiation is radiation sufficiently energetic to dislodge electrons from molecules thus creating charged ions. The term includes X-rays and ionising ultraviolet radiation but the latter does not constitute a hazard as it cannot pass through air to reach the operator. A potential source of ionising radiation in a VDU is the inside of the viewing screen where it is struck by the beam of electrons. The maximum possible frequency of ionising radiation from this source is limited by the velocity of electrons in the beam to about 6×10^{18} Hz (soft X-Rays). Emissions thus produced are effectively shielded by the glass of the tube face and further reduced by the distance between the screen and the operator. The amount of ionising radiation emitted by VDUs has been measured and when detected has been so low as to be insignificant as a health hazard.

Quotes:

"It can be concluded that the VDU does not present a radiation hazard to employees working at or near a terminal". [5]

"Measurements of VDUs for X-ray emissions have repeatedly shown non-detectable above natural background levels. The Radiation Protection Bureau has carried out X-ray measurements on over 250 VDUs, comprising 150 different models. No X-radiation above background was detected". [6]

"The maximum X-ray radiation from any surface of the VDUs surveyed was less then 10 microrems per hour. This is fifty times less than the permitted maximum exposure rate for household electronic apparatus of 0,5 millirems per hour at 5 centimetres". [7]

"There was no ionising radiation detected from any of the (50 different) VDTs". [22]

2.1.2 Optical Radiation

Quote:

"The American Academy of Ophthalmology considers video display terminals (VDTs) to be safe for normal use and to present no hazard to vision". [8]

This range of radiation covers the non-ionising ultraviolet, visible and infrared spectrum.

The only potential source of the ultraviolet, visible and near infrared components is the face of the display tube. The production of visible light in the form of characters and symbols is the purpose of the display tube and the intensity is adjustable by the user for comfortable viewing. The phosphors which coat the inside of the tube are chosen for their efficiency in converting electron beam energy into visible light. There is negligible output at other wavelengths and therefore no health hazard.

Radiation in the far infrared is what is commonly known as radiant heat and is manifestly at a low level.

2.1.3 Microwave and Radio Frequency Radiation

Quote:

"Microwave emission was found to be at least 100 times below the maximum standard of 61-610 V/m set by the American National Standards Institute". [9]

There are three major cyclical operations within a VDU which are potential sources of electromagnetic radiation.

— The frame scan, typically in the frequency range 50 kHz to 100 Hz.
— The line scan, typically in the frequency range 15 kHz to 50 kHz.
— The pixel modulation, typically in the frequency range 5 kHz to 10 MHz.

The only obvious way in which microwaves might be generated is as harmonics of the modulation frequency. But the harmonics would be of a very high order (say 1000) and therefore of very low power compared with the fundamental frequency which is itself of low power. Microwaves, if they are generated at all, are therefore of very low intensity.

The electric and magnetic components of electromagnetic fields in all frequency bands from ELF (Extremely Low Frequency) to HRF (High Radio Frequency) have been measured and found to be well within nationally accepted standards where they exist.

Quotes:

"VDTs are not a source of harmful intensities of electromagnetic radiation in the X-Ray, ultraviolet, visible, infrared, microwave or high radio frequency parts of the spectrum". [10]

"Low radio frequency radiation (less than 3 MHz) and Very Low Frequencies (less than 3 kHz) are not considered to be harmful at intensities emitted by VDTs". [10]

"However, major sources of such fields of far greater strength than those from VDUs have been around for a long time, such as TVs, fluorescent lights and many domestic devices, without apparent harm. Government Research Authorities cannot see any reason for concern at this time". [11]

"In the analysis discussed in this report the author has found no valid evidence that would indicate any health hazards associated with non-ionizing electromagnetic field exposure of persons operating VDTs". [20]

2.2 ELECTROSTATIC FIELDS

Like the screens of domestic television sets, the screen surfaces of VDUs may accumulate an electrostatic charge as a result of the cathode ray tube's operation. One possible effect of this, in conditions of low humidity, is discussed in the section on skin rashes.

It has been suggested that charged ions in association with an electrostatic field may influence operators in a variety of ways. No plausible scientific evidence has been found.

2.3 SOUND EMISSIONS

There are strict regulations governing the permissible level of sound intensity at the workplace in many countries. Sound pressures in the audible range measured at the operator's position are at least a factor of 4 below the most rigorous occupational standards set by the health authorities in Europe and usually a factor of 100 below.

The acoustic radiation from VDUs is dominated by that from the flyback transformer in the horizontal sweep circuit. The sound waves produced are typically in the range 15 kHz to 50 kHz and hence above the audible range of most adults.

2.4 FLICKER

Characters on a VDU screen are composed of illuminated dots which have their intensity refreshed at frequencies of typically 50 Hz to 100 Hz by the scanning beam of electrons. The rate at which the light output of the dots decreases depends on the phosphor used. With the types of phosphor currently in use and the refresh rates quoted above, the eye performs an integrating action and most people see a steady character, not a flickering one. There is no pathology or disease associated with flicker although those few people who detect it on a display sometimes find it annoying. It should be noted that flicker at similar frequencies is a characteristic of all domestic television sets.

3. HEALTH QUESTIONS ANSWERED

— **Can VDUs affect Pregnancy and Birth?**

— **Can VDUs cause Cataracts or Eye Diseases?**

— **Can VDUs cause Epilepsy?**

— **Are VDUs likely to cause Skin Rashes?**

3.1 Can VDUs affect Pregnancy and Birth?

Investigations of reports that display operators were having miscarriages and babies with birth defects, have not shown the VDUs to be the cause.

The incidents which provoked investigation were a number of reports that groups of women working with VDUs had experienced very high proportions of spontaneous abortions and birth defects. Bergqvist, [10] and Purdham [21] analysed six studies of groups (or clusters) of women with reported high rates of spontaneous abortion that occurred during 1979 and 1980. The groups ranged in size from 7 to 19 and the rates of spontaneous abortion reported ranged from 43% to 58%. They concluded that these occurrences were within the range that could plausibly be explained by pure statistical probability. It is not widely appreciated that the average rate of spontaneous abortion amongst all pregnant women is approximately 18%. When this is coupled with the fact that there are more than 15 million VDU operators worldwide, chance clusters are sure to occur.

> *Quote:*
>
> *"A plausible explanation of these recorded clusters is the combination of chance (random) accumulation of a number of spontaneous abortion cases in a few of the many groups of pregnant women working with VDUs, together with the selective identification of only these groups". [10]*

An epidemiological study was performed in Montreal by McDonald *et al.* [18, 19] covering all women (14708) attending 11 hospitals for childbirth or after a spontaneous abortion. The preliminary results suggested that rates of spontaneous abortion among VDU workers were marginally higher at 21,5% than the average (18,1%) but the authors were cautious about the statistical validity of the figures. A re-examination of the data by Bergqvist [10, App 3] led to the conclusion that the apparent increase was fully explicable by reference to other factors.

3.2 Can VDUs cause Cataracts or Eye Diseases?

Visual displays do not cause cataracts, deterioration of vision or other eye pathology.

Evidence:

"We find no scientifically valid evidence that occupational use of VDUs is associated with increased risk of occular diseases or abnormalities, including cataracts. We find no scientifically valid evidence that use of VDTs causes harm, in the sense of anatomical or physiological damage, to the visual system". [13]

"The ten anecdotal reported cases of cataracts among VDU workers do not suggest an unusual pattern attributable to VDT work: six of the cases appear to be common, minor opacities not interfering with vision, and each of the remaining four cases had known pre-existing pathology or exposure to cataractogenic agents". [13]

3.3 Can VDU use cause Epilepsy?

VDUs do not cause epilepsy, but a few people who suffer from epilepsy may have attacks induced by the light patterns on a cathode ray tube screen; either at home whilst watching television or at work from a VDU.

This type of epilepsy is known as photo-sensitive epilepsy and is very uncommon (0,5% of the population suffer from epilepsy and of this number perhaps 2% will be photo-sensitive giving a combined incidence of 1 in 10000).

First attacks are unlikely to be found among VDU operators, as they will probably be fully aware of lighting effects which trigger the condition.

> *Quote:*
>
> *"Persons who are sensitive to epileptogenic seizures caused by flickering displays have induced seizures only when the display refresh rate is extremely low, typically in the 8-14 Hz region... There appears to be no significant problem of this nature induced by most existing displays". [13]*

3.4 Are VDUs likely to cause Skin Rashes?

There have been a few reported cases of facial skin rashes occurring among VDU operators. These reports have come mainly from Norway [14] but also from Sweden [15] and the UK [16].

The number of cases is very small compared with the number of VDU operators so any direct causal relationship is difficult to establish. One consistent observation in many reports has been the coincidence of facial rash with periods of dry weather, all the reported cases in Norway occurred during winter when the relative humidity is very low. Another observation was that floor carpets in offices where face rashes had occurred were often of the type prone to electrostatic charging.

A postulated cause of the rashes is migration of charged aerosol particles in electric fields caused by electrostatic charges of opposite polarity on the VDU tube and the body of the operator.

Increasing the air humidity has reduced rash reactions markedly when they have occurred [10]. Elimination of carpets prone to static electricity in combination with increased humidity, resulted in the disappearance of the facial rashes [17].

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