Recommendation T/SF 40 E (Nice 1985)
concerning the human factor aspects of visual display terminals for telecommunication services

Recommendation proposed by Working Group T/WG 7 "services and facilities" (SF)

Text of the Recommendation adopted by Commission "Telecommunications":

"The European Conference of Posts and Telecommunications Administrations,

Considering

— that display terminals may or may not be provided to customers by the Administrations;

— that the provision of different types of visual means e.g. display screen, small digit display, lamps, etc., for a variety of telecommunications purposes are now technically possible;

— that the provision of such means and services provided by them are becoming cheaper and stimulate demand;

— that even though the use of e.g. optical fibres is becoming widespread, the cost of wideband services long distance transmission may remain high in the near future;

— that various forms of visual services are likely to be introduced in the PABX and office environment initially, and will subsequently need to be switched via the public networks and will also subsequently be used by customers in the public networks;

— that the capability for interworking between all versions of the visual services is desirable;

— that the evolving IDN/ISDN networks provide a future possibility to integrate these services into the same network, into the same customer access/line and into the same functionally integrated terminal(s) where the display screen module can be common for a number of visual services;

— that it would be advantageous for both customers and the Administration to have common standards for terminals and their modules providing visual services;

— that guidance should be given regarding the operational parameters, services, features and interworking requirements so as to avoid Administrations introducing unnecessarily widely diverging types of visual service and displays providing them.

Recommends

that therefore visual display terminals should be developed on the basis of the user requirements and operational characteristics given in Annex A."

Annex A. Contents

1. INTRODUCTION

This Recommendation concerns human factor aspects of visual display terminals used in telecommunications applications. Chapters 1-3 of the Draft Recommendation are intended to cover all services while chapter 4 includes Additional requirements for specific telecommunication services.

Visual display terminals for telecommunications will be employed for both professional, continuous usage and domestic, casual usage. Generally all of the appropriate Recommendations of this document apply to both situations. An indication is given where it is considered that a particular recommendation is not appropriate to the Domestic environment.

2. TERMINAL CATEGORIZATION

Visual display terminals can be divided into:

1. Supplementary services telephone terminals with displays which are able to indicate the status of supplementary telephone services and simple data services (alpha-numerical) and present system responses and guidance messages.
2. Multifunction terminals which are intended to provide a variety of voice and non-voice services, including supplementary services, and where display screen provides visual means for, in addition to those services mentioned in point one above the following services:
   — teletex and word processing;
   — videotex;
   — directory enquiry;
   — local computing;
   — drawing, graphics transmission;
   — text telephone (for deaf/speech retarded persons);
   — videoservices for
      — videophone,
      — teleconferencing.

   Recommendations given in the following chapter 3 are valid for terminals and services mentioned above, although some aspects may not be relevant for all terminals and services.

   In addition recommendations which are specific to one type of telecommunication service are included in chapter 4.

3. GENERAL REQUIREMENTS FOR VISUAL DISPLAY TERMINALS

3.1. Display requirements

In this section consideration is given to the physical requirements of the screen unit of visual display terminals, including character requirements and presentation of information.

3.1.1. *Physical requirements of the screen*

3.1.1.1. Screen size and number of characters per line Screen size (number of horizontal and vertical character lines) is specifically related with the task to be performed. For terminals with one or two line display a minimum of 16-20 characters should be used. For tasks in which alternatives have to be chosen or forms have to be filled in, a screen size of 12-16 lines of 40 characters each is suitable. With other tasks such as textprocessing, programming, etc., the numbers of characters and lines should be greater (e.g. 24 lines of 80 characters each).

3.1.1.2. Aspect ratio

The aspect ratio i.e. the ratio between the height and width of the viewing area of the VDT screen should be 3:4 for visual display terminals in which the screen is horizontally mounted. For terminals in which the screen is vertically mounted, the ratio should be 4:3, which corresponds approximately to the proportions of an A4 sheet of paper.

This recommendation only holds for rectangular viewing areas.

3.1.1.3. Screen angle (tilt)

Ideally the screen should be positioned such that the focus of the user's attention is at right angles to the line of sight. As the point of focus can vary with the task between the top and the bottom of the screen, it is desirable for the screen angle to be adjustable. Adjustment controls should be easy and positive in operation.

3.1.1.4. Viewing height of the screen

Correct screen height is important in the prevention of potential postural problems. It may be defined in several ways, of which the specification of the visual down angle seems functionally the most appropriate. Adjustment of screen height can be provided in the terminal or furniture. In the case of intensive utilization of the terminal the centre of the screen should be adjustable between 905 and 1148 mm from the floor. Using e.g. a 720 mm high desk, this leads to a range of 185 and 482 mm for the height of the centre of the screen above the working surface. Adjustment controls should be easy and positive in operation.

3.1.1.5. Screen swivel

This is a desirable facility when it is necessary to frequently rotate the screen around its vertical axis. The adjustment controls must be easily accessible and the operation should be simple, positive and safe.

3.1.1.6. Screen manœuvrability

To enable the user to place the screen unit in the optimum position, the unit should be easily manœuvred, yet stable when positioned. The weight of the screen unit and the frictional characteristics of its base should fulfil this requirement.

3.1.1.7. Screen finish

The finish of the housing material of the screen unit is important in determining possible sources of visual discomfort and distraction in the user's field of view. The reflection factor of the housing material should be 20-50% and the surface should be matt finished. Adjacent surfaces within the field of view should preferably have luminance ratios no greater than 3:1.

3.1.1.8. Screen homogeneity

The screen unit should be such that no perceivable distorsion of the characters is present at the screen edges. Lines should give the impression of running straight.

3.1.1.9. Screen reflectance

Bright reflections from the screen should be avoided as much as possible. They can be reduced by (a) coating or (better) frosting the screen (b) lowering the luminance of objects in the environment (c) limiting the sideward radiation from ambient lighting by application of parabolic reflectors. Screen reflectance should be maximally 0.2 times character luminance. In this respect it is important to have a careful position of the screen unit in relation to lights, windows, etc.

3.1.1.10. Display resolution

Generally speaking, the more scan lines (in CRT technology), the finer the resolution of the character shapes and the more readable the information is for the user. The minimum number of scan lines depends upon the number of text lines including line spacings and the number of vertical dots of the character matrix, the requirements of which depend largely on the task requirements and kind of service.

For professional and frequent terminal use, a greater number of scan lines might be required.

Note: Similar requirements will apply for non-CRT technology displays.

3.1.1.11. Screen refresh rates

In order to keep the image visible on the screen, the screen must be continually regenerated or refreshed. This frequency or refresh rate is technology dependent. Using short to medium persistance phosphor it is recommended to be 80 Hz minimally. However, a frequency of 50 or 60 Hz is often used for economic reasons.

3.1.2. *Character requirements*

3.1.2.1. Character set

It should be possible to display the following types of characters:
— numeric, alphanumeric;
— lower case, upper case;
— special graphics, symbols.

A full range of characters is not necessary for all applications. In addition, possibilities for different character styles (e.g. inverse display, italics, underlining, double character dimensions) are desirable.

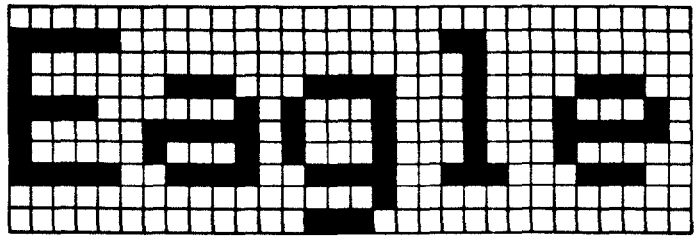
3.1.2.2. Colour

The normal light adapted eye is maximally sensitive to 550 nm: the green/yellow part of the spectrum. Although colour choice is a matter of personal choice largely, the green/yellow colours are recommended by most sources. However, adequate luminance and colour contrast are considered to be of greater importance for readability.

As regards character and background colour, there are no uniform recommendations. Dark symbols on light background (e.g. black or blue on white) or similar character and background colour (yellow/green) seem the most acceptable ones. Different shades of the same colour for characters and background are also acceptable.

3.1.2.3. Character display

Dot matrix character generation is the technique which is commonly used for visual display terminals. At first, a 5×7 dot matrix seemed to be sufficient for displaying letters and numerals. However, to generate both upper and lower case with true ascenders and descenders, a 5×9 dot matrix is considered to be a minimal requirement. Because there should be a separation between characters and lines of characters, it is necessary to reserve a 6×10 dot matrix for each character. The next figure should clarify this



It is recognized that other types of generation techniques exist e.g. seven or sixteen segment display for alpha numerics.

3.1.2.4. Character size

Character dimensions are important for good legibility and readability and are derived from considerations of viewing distance and the visual acuity of the eye.

3.1.2.4.1. Character height

Character height should subtend a visual angle of 16 to 22 minutes of arc. A height of 3 mm is considered to be the minimum. Preferred viewing distances for naive users are 550 to 690 mm. The angular dimensions given above lead to a character height of 2.6 to 3.5 mm at a viewing distance of 550 mm and 3.2 to 4.4 mm at a viewing distance of 690 mm.

3.1.2.4.2. Character width

Character width (capital letter) should be 60-80% of the character height. Stroke width (the thickness of a line segment) should be 10-17% of character height.

3.1.2.5. Character spacing

The horizontal (inter character) spacing should be 0.25-0.5 times the character width (capital letter).

The horizontal spacing between words should be 1.5-2.0 times the character width (capital letter).

The vertical spacing between lines should be such that the descenders should not interfere with any part of the character below. The recommendations vary from 10% of the character height to 150% of the character height.

3.1.2.6. Character differentiation

Confusion between characters primarily occurs because of similarity of shape and construction. The following characters are most frequently confused and should therefore be examined for mis-identification.

MUTUAL	ONE WAY
O, O, Q	C called G
T, Y	D called B
S, 5	H called M, N
I, L	J, T called I
X, K	K called R
I, l	2 called Z
	B called R, S, 8

3.1.2.7. Cursor

A cursor directs the user's attention to the appropriate position on the screen. It should be easily located at any random position in the display, easily tracked as it is moved, not interfere with the reading of the symbol, not be distracting and be unique. The two most common cursor types are underscore and a box with inverse display. Preference depends on the task to be performed but is merely a personal matter. A blinking facility can be added to both types, with recommended blink rate of 3 Hz. The possibility to switch off the blinking is recommended.

3.1.2.8. Luminance

Luminance is the physical attribute of light which produces the sensation of brightness. It is measured in terms of light emitted per unit area: candelas per square meter (cd/m^2). The following recommendations should be considered in relation with the lighting conditions of the workplace (see chapter 4).

3.1.2.8.1. Background luminance

Background is defined here as the area of screen luminance with no character information. It is important for both the resistance of the screen to reflections and the clarity of the characters. A background luminance of 10-20 cd/m² is recommended, when light characters on a dark background are used.

3.1.2.8.2. Character luminance (brightness)

A minimum character luminance of 45 cd/m² is given for light characters on a dark background. Luminances of 80-160 cd/m² are preferred.

3.1.2.8.3. Brightness and contrast

Brightness and contrast controls enable the user to adjust both luminances when CRT technology is used. A contrast control accentuates the difference between the character and background luminance, whereas a brightness control adjusts the luminance of the character and background. At least one is considered essential. The character to background luminance ratio should be minimally 3:1 and maximally 15:1 with 8:1 to 10:1 as optimum values.

3.1.2.9. Character stability

The main type of image instability is often referred to as 'flicker': the periodic dimming and brightening of the display due to refreshing of the images in the display. The perceptibility of flicker depends a.o. upon brightness, size and density of the display, wavelength of the light and the sensitivity of the user as well as the technology in use. To reduce flicker when using CRT technology a refresh rate is recommended in accordance with (multiples) of the mains frequency of at least 50-60 Hz. A minimum of 80 Hz is recommended. Medium and short phosphors such as P31 and P4 are acceptable. This type of instability can also be reduced when brightness or contrast is lowered. A second type of character instability when using CRT technology is drift (swim): the instability of character location with respect to time. The main causes are inadequate smoothing of power supplies or magnetic induction from the mains transformers.

3.1.3. *Presentation of information*

3.1.3.1. Enhancement coding

This is used to make a particular part of the display stand out from the remainder. This can be accomplished by brightness differences, inverse display (negative image), flashing, alternative character sets, underlining, colour differences or combinations of these.

Too much coding or coding combinations reduce the readability considerably. With brightness coding a difference factor of 3 is needed. Usable colours are red, yellow and green; don't use colours together that lie far apart in the colour spectrum and pay specific attention to colour blindness.

3.1.3.2. Scrolling

When the amount of textual information exceeds the display screen capacity, there are several techniques to offer the text on the display screen:

— roll-scroll: the movement of the text is such that all existing lines of text in the display move up or down by one line to make room for the new line. A line of text is removed from the display unless the amount of text remaining on the screen is less than the available display capacity;
— pan-scroll: a more continuous form of roll-scroll;
— page-scroll (paging): the text is presented page by page.

The choice between these various forms of scrolling depends on the service, the task to be performed, the phospor persistence ('smear effect') and personal preference.

3.2. **User input requirements**

In this paragraph the following topics are considered: physical requirements of the keyboard, key requirements, keyboard lay-out and other input media.

3.2.1. *Physical requirements of the keyboard*

3.2.1.1. Keyboard angle

Suitable choice of keyboard angle (the angle of the keyboard surface with the horizontal) can improve keying performance and comfort by reducing the physiological loading on the hands and by aiding correct posture (see also Appendix 1). An angle of 5-15 degrees is recommended.

3.2.1.2. Keyboard thickness

This is measured from the base of the keyboard to the top of the home row (A to L) and is primarily important for the reduction of postural discomfort. Keyboard thickness is preferred to be less than 30 mm.

3.2.1.3. Keyboard manœuvrability

To enable the user to adjust the keyboard into the most comfortable position it must be easily manœuvrable while at the same time being sufficiently stable to resist unwanted movement. The specification of weight alone is inappropriate as this does not adequately encompass the requirements of manœuvrability which depends on the frictional characteristics of the keyboard base as well as height.

Also as regards comfort, a detachable keyboard is recommended.

3.2.1.4. Keyboard finish

What holds for the screen unit, is important here too. However, additional factors such as the need for colour coding of keys and the different reflectances of the background against which the keyboard will be viewed are also needed to be taken into account. The keyboard reflectance should be between 0.4 and 0.6.

3.2.1.5. Keyboard profile

The profile of the keyboard should be sculptured.

3.2.1.6. Keyboard size

The size of the keyboard should not be much greater than the amount of space which the different keysets (numeric, alphanumeric, function keyset) require.

3.2.2. *Key requirements*

3.2.2.1. Key feedback

Quantity and quality can be improved if suitable key feedback is given in tactile, acoustic or visual form. However, this effect is lowered as the user's typing experience grows. The visual feedback is certainly necessary. Tactile or acoustic feedback can be annoying and therefore there should be the option of turning off the acoustic feedback and smoothing the tactile feedback.

3.2.2.2. Key actuation force and travel

Key pressure and travel give feedback about the moment of registration of the symbol entered. They should be the same for all keys on a keyboard. Key actuation force is preferred to be 0.25 to 1.5 N, which corresponds to about 25 to 150 grams. The more experienced the user, the less resistance is needed.

Recommendation for key travel range from 0.8 to 10 mm.

In some circumstances no-travel keys can be used. In these cases other non-tactile (e.g. visual or audible) means of giving feedback to users is recommended.

3.2.2.3. Key roll-over

The function of key roll-over is to preserve key strokes in correct sequential order when more than one key is in the operated position. N key roll-over, in which each key stroke is activated irrespective of other key operations (in sequential order) is preferred to 2 key roll-over, in which the information is preserved when the first key depressed is released before the second and to no key roll-over.

3.2.2.4. Key legend

To allow good legibility, a suitable contrast between key and legend colour is needed (1:3). Dark characters on light keys are preferred, also in relation to reflections. Two legends per key is the maximum for the top surface, with the possibility of a third legend on the front surface of the key. The legend size for the main alphanumerics should be 6 mm. Minor legends (e.g. for secondary functions) and textual legends should have a minimum size of 3 mm.

As to legend wearing, the legends should be moulded into the keys.

3.2.2.5. Key shape and reflectance

To aid finger location the surface of the key should be concave and ideally square. The keys should have a matt finish. Reflectance should be 0.2 to 0.7.

3.2.2.6. Key size and spacing

As regards key size a width of 12-15 mm is recommended. For key spacing, the distance between two successive key centres should be 18-20 mm.

3.2.3. *Keyboard lay-out*

3.2.3.1. Alphanumeric keyset

The alpha part of the alphanumeric keyset should have the QWERTY lay-out. The numeric part should form the top row. The presentation of digits and letters on one key should be avoided.

Relative positions of the keys (intersection of rows and columns) should be in accordance with the ISO lay-out.

3.2.3.2. Numeric keyset

For numeric data entry tasks, a specific numeric keyset is recommended, to the right of the alphanumeric keyset. When a numeric keyset is positioned on the telephone part of the terminal (e.g. under the handset) the lay-out should be in accordance with the CCITT recommendation (1 2 3 as the upper row).

To facilitate blind typing a sensible dot on the 5 gives tactile feedback.

3.3. Additional terminal requirements

3.3.1. *Automatic adjustment of lighting*

The user should be satisfied with the performance of the terminal in all lighting conditions which are likely to be met in practice. The range of natural lighting of 50-50,000 lux should be considered, although levels most commonly encountered will be at the lower end of that range.

The terminal should have adequate automatic controls for adapting to the prevailing ambient lighting. A manual override of these controls may be desirable in order to cope with extreme conditions.

Guidance should be given to the user for placing the monitor in the subscriber's premises taking into account the overall illumination conditions and possibilities to adjust and control the ambient lighting conditions.

The monitor could be equipped with appropriate additional furnishing such as an adjustable visor to meet the actual lighting conditions.

Terminal screens should have a non-reflective surface.

3.3.2. *Connecting point for recording devices*

The connection of a recording device (e.g. video recorder) should cause an indication to be given at the distant end.

3.3.3. *Power feeding security*

Local power may be needed for visual displays but there is a need for the power feeding requirements for the basic telephone service to be secure in the case of local power failure.

3.3.4. *Noise*

Any kind of audible noise generated by the terminal is not allowed to exceed 35 dB (A) rel 2×10^{-5} Pa.

3.4. Control procedures

User control procedures may be needed to handle displayed information in order to make changes, corrections and revisions. This may for example require the use of a pointer (note that these procedures may not apply for the videoservice).

Further study of the user control procedures is needed. In this regard the already defined procedures of the computer industry may be of value.

3.5. Workplace requirements

Possible arrangements are presented in Appendix 1 and 2 and apply for professional applications.

Further study required.

3.6. Environmental requirements

Relations between ambient lighting and viewing distances are given in Appendix 2 and apply for professional applications.

Further study required.

4. REQUIREMENTS FOR SPECIFIC TELECOMMUNICATION SERVICES

4.1. Teleconferencing

It should be possible to interconnect:

(a) more than 2 video telecommunication terminals in a conference mode;

(b) video telecommunication terminals with a video-conference room(s).

A connecting point for an extra screen is required in the equipment as a supplement for conferencing purposes.

The display of 2 head and shoulders on the screen is just acceptable. The display of up to 4 head and shoulders could be achieved using split-screen techniques, for which special camera arrangements will be required. When considerable use is made of the terminal for conferencing purposes, the use of a supplementary monitor with a relatively larger screen size will probably be necessary.

4.2. Videophone

4.2.1. *General*

The videoservice equipment is considered as a multipurpose terminal (face-to-face, conference and graphics) with the camera and monitor co-located and requiring wideband transmission capabilities. While the other recommendations are general for all the displays providing visual telecommunication services the following recommendations apply only for displays providing videoservice where the source of information to be displayed is a camera(s) or a video recorder working in wideband mode.

4.2.2. *Self view*

Self view enables the user to check his appearance previous to or during the call, or the appearance of a document before the strat of transmission to the distant end.

This feature could be realised without occupying exchange equipment. The control should be easily accessible to the user. It would be useful to have 'mirror-view' options for checking own appearance (i.e. left/right reversed).

4.2.3. *Optical control*

A control should be easily accessible to the user to change the field of view and focus of his own camera.

4.2.4. *Camera kill*

A user should be able to inhibit the sending of his picture during a call made or received by him. The control should be easily accessible to the user.

The inhibition could be:

— self-restoring at the end of a call and thus require a user to take a positive action to apply the inhibition on a subsequent call, this would encourage full video calls from the outset,

— not self-restoring at the end of a call.

Further studies are required to establish whether the control should be self-restoring and what should be default. There should be a conspicuous indication at both ends of the call that "camera kill" is operative. Means of presenting this indication should be studied further. The title "camera kill" requires further study.

4.2.5. *Graphics and document mode*

There should be easily accessible arrangements for showing graphics and documents.

4.2.6. *Different types of lenses*

The service should be capable of providing different types of lenses (e.g. zoom, wideangle). This may be achieved by using interchangeable lenses.

4.2.7. *Usage*

A visual telephone service customer will wish to be able to use his terminal for both visual-telephone calls and other types of calls if the terminals are compatible.

4.2.8. *Numbering*

Ideally both visual telecommunication service and telephony service should have the same identity from the outset, i.e. a common numbering scheme, although it is recognised that this may not be possible in the early days. This would permit a smooth transition from one service to another.

4.2.9. *Acoustic condition*

It seems likely that for satisfactory operation, the reverberation time of a room containing a videophone terminal should not exceed 500 ms. The room noise should not exceed 50 dB (A) rel 2×10^{-5} Pa (preferably much less).

4.3. Telephony

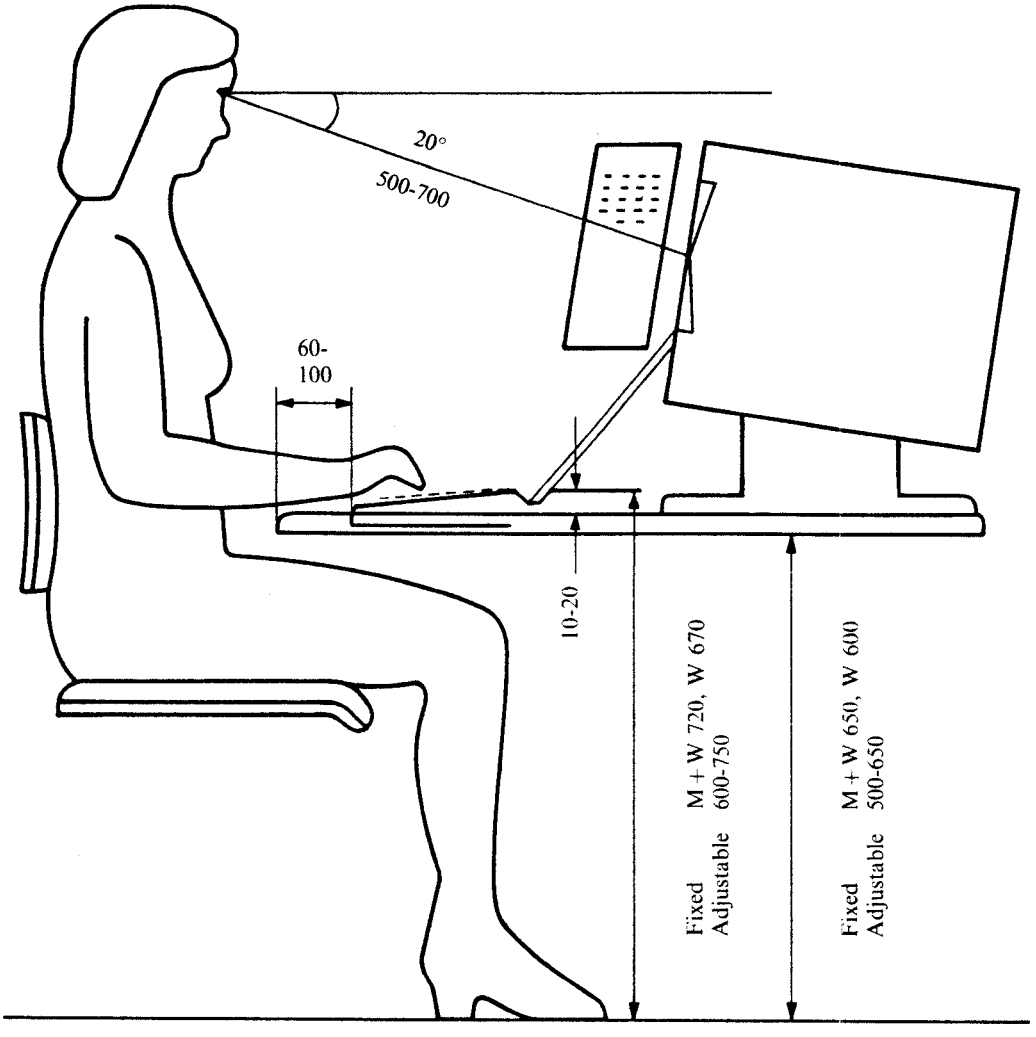
4.3.1. *Visual indications*

Visual indications should be given at certain times during call set-up and during subsequent periods, e.g. when the call is being held. The nature of the visual indications and the circumstances in which they should be applied shall be common among Administrations.

Further study is required.

Appendix 1

Possible ergonomical arrangements for visual display terminals



Legend: Linear measures are in millimeters.
M = Men.
W = Women.

Viewing distance

Viewing distance is depending on the size of the characters, the nature of the viewing and ambient lighting. General recommendation is given in terms of the height of the characters in relation to the viewing distance as follows:

	Short viewing time (intermittent use)	Long viewing time (continuous use)
Bad lighting	1:100	1:200
Good lighting	1:150	1:300

For a flexible use and place of the screen a minimum character height of three millimeters is recommended. The screen is a light emitting device and therefore the viewing is hampered by a too abundant lighting e.g. that of 1,000-1,500 lux recommended for offices. A suitable level for ambient lighting is about 300-500 lux depending on the properties of the screen (darkened screen or screen with a filter tolerates more light).