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SERIES E: OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

International operation – General provisions concerning users

Human factors aspects of public telephones to improve their usability for older people

ITU-T Recommendation E.138

ITU-T E-SERIES RECOMMENDATIONS

OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

INTERNATIONAL OPERATION	
Definitions	E.100–E.103
General provisions concerning Administrations	E.104–E.119
General provisions concerning users	**E.120–E.139**
Operation of international telephone services	E.140–E.159
Numbering plan of the international telephone service	E.160–E.169
International routing plan	E.170–E.179
Tones in national signalling systems	E.180–E.189
Numbering plan of the international telephone service	E.190–E.199
Maritime mobile service and public land mobile service	E.200–E.229
OPERATIONAL PROVISIONS RELATING TO CHARGING AND ACCOUNTING IN THE INTERNATIONAL TELEPHONE SERVICE	
Charging in the international telephone service	E.230–E.249
Measuring and recording call durations for accounting purposes	E.260–E.269
UTILIZATION OF THE INTERNATIONAL TELEPHONE NETWORK FOR NON-TELEPHONY APPLICATIONS	
General	E.300–E.319
Phototelegraphy	E.320–E.329
ISDN PROVISIONS CONCERNING USERS	E.330–E.349
INTERNATIONAL ROUTING PLAN	E.350–E.399
NETWORK MANAGEMENT	
International service statistics	E.400–E.409
International network management	E.410–E.419
Checking the quality of the international telephone service	E.420–E.489
TRAFFIC ENGINEERING	
Measurement and recording of traffic	E.490–E.505
Forecasting of traffic	E.506–E.509
Determination of the number of circuits in manual operation	E.510–E.519
Determination of the number of circuits in automatic and semi-automatic operation	E.520–E.539
Grade of service	E.540–E.599
Definitions	E.600–E.649
Traffic engineering for IP-networks	E.650–E.699
ISDN traffic engineering	E.700–E.749
Mobile network traffic engineering	E.750–E.799
QUALITY OF TELECOMMUNICATION SERVICES: CONCEPTS, MODELS, OBJECTIVES AND DEPENDABILITY PLANNING	
Terms and definitions related to the quality of telecommunication services	E.800–E.809
Models for telecommunication services	E.810–E.844
Objectives for quality of service and related concepts of telecommunication services	E.845–E.859
Use of quality of service objectives for planning of telecommunication networks	E.860–E.879
Field data collection and evaluation on the performance of equipment, networks and services	E.880–E.899

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation E.138

Human factors aspects of public telephones to improve their usability for older people

Summary

This Recommendation contains guidelines for the design of public telephone terminals for voice communication to make them more usable for older people, whose sensory, cognitive and motor functions may have deteriorated. "Public telephones" include all telephones that are not in private offices or households, but that are generally accessible to many people. These guidelines are derived from the requirements of older people that can be identified for each of the steps connected to using a public telecommunication terminal: locating it; initiating a call; providing payment; identifying oneself and the communication counterpart; actually communicating; possibly setting up a further call; terminating the communication.

Source

ITU-T Recommendation E.138 was prepared by ITU-T Study Group 2 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 June 2002.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

Throughout the Western world, as well as in parts of Asia, life expectancy has changed significantly during the 20th century [Dall, 1992]; [Collins *et al*., 1992]. Not only are more people getting older, they also tend to be better educated and in better health than their forbears, which means that they lead much longer active lives. This activity includes the use of telecommunication facilities. But, many older people find it difficult to use many of today's telephones, and other telecommunication terminals. This is because sensory, cognitive and motor faculties deteriorate with advancing age. Such reductions in severe cases lead to impairments or even disabilities, but it would be misleading to equate older people with disabled people – although this is often done. In fact, provided that proper measures are taken, the majority of older users of telecommunications need not experience serious hindrances. It is important to society as a whole to enable older people to remain active as long as possible, and to participate in activities such as travelling and to communicate via public telecommunication terminals [Collins *et al*., 1992]. This means that available data on changes in human faculties with progressing age must be taken into account. Missing information in this field must be compiled through appropriate research [Garbe *et al*., 1992]. It should be realized that any adaptations of public telephones that increase their usability for older people, such as larger font size and higher contrast on visual displays, will normally also benefit younger users [Blaich, 1992].

ITU-T Recommendation E.138

Human factors aspects of public telephones to improve their usability for older people

1 Scope

This Recommendation proposes guidelines for the design of public telephone terminals for voice communication to make them simpler to use for older people whose sight, hearing, information processing and motor functions have deteriorated. This Recommendation provides information on the requirements of older people and how telephones can be adapted for their use. This Recommendation addresses manufacturers, designers, procurers, network operators, regulatory authorities, and those who deploy telecommunication terminals intended for general (public) use. In this Recommendation the term '*public telephone*' shall include all telephones that are not in private offices or households, but that are generally accessible to many people, for instance, public pay-phones, telephones for general use in hotels, airports, hospitals, shopping malls, universities, schools, official agencies, etc.

This Recommendation is regarded as necessary, next to the already-existing ITU-T Rec. E.135: Human factors aspects of public telecommunication terminals for people with disabilities, because:

i) although older people are frequently associated with the disabled in literature and general opinion, this is incorrect and misleading in terms of specific user requirements;

ii) by ITU-T Rec. E.138's restriction to public telephones, as opposed to public terminals, its scope in this respect may seem to be narrower than that of ITU-T Rec. E.135, but on the other hand is wider because all types of 'public places' such as hotels, airports, hospitals and shopping malls are included, with the available telephones that are there.

It is of interest to everybody involved in the telecommunication business to be informed about the relation between their products and the needs of an ever-increasing proportion of their customers, i.e., older people.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The referencce to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation E.121 (1996), *Pictograms, symbols and icons to assist users of the telephone*.

– ITU-T Recommendation E.134 (1993), *Human factors aspects of public terminals: Generic operating procedures*.

– ITU-T Recommendation E.135 (1995), *Human factors aspects of public telecommunication terminals for people with disabilities*.

– ITU-T Recommendation E.136 (1997), *Specification of a tactile identifier for use with telecommunication cards*.

– ITU-T Recommendation E.137 (1997), *User instructions for payphones*.

– ITU-T Recommendation E.161 (2001), *Arrangement of digits, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network*.

– ITU-T Recommendation E.180/Q.35 (1998), *Technical characteristics of tones for the telephone service*.

– ITU-T Recommendation F.901 (1993), *Usability evaluation of telecommunication services*.

– ITU-T Recommendation P.370 (1996), *Coupling of hearing aids to telephone sets*.

– ITU-T Recommendation V.18 (2000), *Operational and interworking requirements for DCEs operating in the text telephone mode*.

– ISO 13406-2:2001, *Ergonomic requirements for work with visual displays based on flat panels – Part 2: Ergonomic requirements for flat panel displays*.

– EN 1332-4, *Machine-readable cards, related device interfaces, and operations. Part 4: Coding of user requirements for people with special needs*.

– ETSI EN 301 462 (2000), *Human Factors (HF); Symbols to identify telecommunications facilities for deaf and hard of hearing people*.

– JIS S 0012:2000, *Guidelines for all people including older people and people with disabilities – Usability of consumer products*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 older people: This term has succeeded 'the elderly' and equally should be understood in a broad sense. 'Older people' are often, but by no means always, characterized by deterioration of their sensory, cognitive and motor facilities.

3.2 public telephones: This term shall include all telephones that are not in private offices or households, but that are generally accessible to many people, for instance, public payphones, telephones for general use in hotels, airports, hospitals, shopping malls, universities, schools, official agencies, etc.

4 Abbreviations

This Recommendation uses the following abbreviations:

CEN Comité Européen de Normalisation (*European Committee for Standardization*)

EN European Norm

ES European Standard

ETR ETSI Technical Report

ETS European Technical Standard

ETSI European Telecommunications Standards Institute

ISO International Organization for Standardization

LCD Liquid Crystal Display

LED Light-Emitting Diode

lux Unit of illumination strength

N Newton (the SI unit for force, and weight)

PIN Personal Identification Number

point Typographical unit of character font size; 1 point = 0.376 mm

SI Système International d'Unités (*International System Of Units*)

5 Characteristics of older people

Older people may suffer to varying degrees from any of the following impairments or from any combination thereof (based on [Gill, 1997]):

- **Visual impairments**. Blindness implies a total or near total loss of the ability to perceive form visually. Low vision implies an ability to utilize some aspects of visual perception, but with a greater dependency on information received from other senses. For everybody, near visual acuity starts to diminish around age 40, and continues to do so through the 50s and 60s (presbyopia). Other visual impairments arise in older people, including cataracts, clouding of the optical media, glaucoma, macular degeneration and retinopathy as a result of diabetes.

  The use of colours to identify various functions or services may confuse older people. As vision deteriorates with age, so does colour perception. Bear also in mind that at least 7% of all males are colour-blind (protanopes and deuteranopes) and at least another 7% of all males are colour anomalous (protanomalous and deuteranomalous) to some degree. Less than 1% of women are colour-blind or colour-anomalous. Colour should therefore never be used alone to identify any function, but always in addition to some other information (the principle of redundancy).

- **Hearing impairments**. The sense of hearing starts to deteriorate early in life and this continues throughout life, slowly at first, but faster in old age. However, hearing in older people may deteriorate at very different rates. One must not make the fallacy of perpetuating the popular myth that all older people are hard of hearing – the deterioration rate may vary significantly and some 80-year-olds may actually have better hearing than some 50-year-olds. The most typical characteristic of old-age hearing impairment is the continuous loss of high frequencies, eventually spreading downwards to the middle frequencies and sometimes afflicting the lower frequencies. The hearing losses may vary from slightly hard of hearing (some high frequency loss) to profoundly deaf. A second type of effect is that a significant, but as yet undefined number of older people have decreased ability to tune out background noise and thus have more difficulty hearing in noisy settings than younger people with otherwise comparable hearing ability [ETSI ETR 334, 1996]. This can be a significant factor in choosing a site for a public phone. In addition to any practical problems caused by a hearing disorder, a hearing loss first and foremost obstructs interpersonal speech communication, both face-to-face and over the telephone. To compensate for different degrees of hearing loss, various changes in telephone terminals should be implemented according to the severity of the hearing impairment. These actions are listed below under each call procedure.

  Hearing impairment can affect the whole range or only part of the auditory spectrum of which, for speech perception, the important region is between 250 and 4000 Hz – which, more or less, corresponds to the regular telephone bandwidth of 300 to 3400 Hz. The term "deaf" is used to describe people with profound hearing loss such that they cannot benefit from amplification, while "hard of hearing" is used for those with mild to severe hearing loss but who can benefit from amplification.

- **Cognitive impairments**. What we sometimes call 'intelligence' changes very little with ageing, when neural and psychiatric conditions (e.g., Alzheimer, dementias, and other debilitating conditions) are not counted. The intellectual capabilities of older people should not preclude their use of telecommunications.

Timing of control acts may be a critical issue for older people, since they often require more time than younger people for activities such as locating, reading and understanding descriptions of these control acts. Consequently, the transaction process may be halted before it is even properly started, through an assumed lower default time-out period.

Memory impairments can cause significant problems in remembering numbers in the correct order, such as a telephone number or a personal identification number (PIN code). The sequence of steps to be taken in setting up the communication process should be clearly indicated on the terminal, for example by describing them in text blocks with differing letter or background colours. People with a cognitive impairment can often function well in familiar environments, but can easily be confused when required to respond to instructions or prompts quickly.

Because of memory impairments and the need for more time to locate, read and comprehend, the ability to learn new procedures declines with increasing age. Also, the ability to divide attention, e.g. to perform more than one task simultaneously, declines with increasing age. Older people must often attend to one action at a time.

- **Speech and language impairments**. Speech impairment may influence speech in a general way, or only certain aspects of it, such as fluency or voice volume.
- **Mobility impairments**. Reduced function of legs and feet may lead to people depending on aids for walking or on a wheelchair for locomotion.
- **Motor impairments**. Reduced handgrip strength may make it difficult to grab, hold and handle objects. Old age may lead to reduced stamina, which will make it difficult to stand unsupported for any length of time.
- **Dexterity impairments**. Reduced function of arms, hands and fingers makes activities related to moving, turning or pressing objects difficult or impossible. Accurate, fine movements, for instance of the fingers, are more difficult to perform, and tactile feedback may be diminished due to a reduced sensitivity of touch.

Table 1 illustrates to what degree people tend to be affected at different ages in their lifespan (from [Charness & Brosman, 1992], Age and human factors.

Table 1/E.138 – Age and human factors

	Middle age (45-64)	**Old age (65-74)**	**Late old age (75+)**
Perceptual			
Vision	Near focus declining, hence needs reading glasses or bifocals. Increased susceptibility to glare. Less successful dark adaptation. Some decline in static and dynamic visual acuity. Some loss in ability to discriminate colours.	Little focusing ability left, and loss of acuity even with corrective lenses. Less (1/3 compared with young adult) transmission of light through to the retina. Greater susceptibility to glare. Slow dark adaptation. Significant declines in static and dynamic visual acuity, in useful visual field, and colour discrimination ability.	Significant loss of visual acuity (dynamic and static), colour discrimination, and extent of the visual field. Significant risk of visual dysfunction from cataracts, glaucoma, and macular degeneration.
Hearing	Some loss at high frequencies.	Significant loss at high frequencies and some loss at middle frequencies. Can be helped by hearing aid. Greater susceptibility to masking by noise.	Significant loss at high and middle frequencies. Likely needs a hearing aid.

Table 1/E.138 – Age and human factors

	Middle age (45-64)	Old age (65-74)	Late old age (75+)
Perceptual			
Taste, smell, cutaneous sensitivity	Minimal loss.	Minor loss.	Significant loss.
Cognitive			
Response time	Some slowing in response time.	Significant slowing in response time.	Pronounced slowing in response time.
Working memory/attention	Minor decline in learning ability and ability to divide attention.	Moderate slowing in learning rate and ability to divide attention.	Learning rate is halved from the twenties, and significant declines are observed for dual task performance.
Knowledge base	Little change in fluid intelligence, and stability or increases in crystallized intelligence.	Some decline in fluid intelligence and stability or slight decreases in crystallized intelligence.	Significant declines in fluid and crystallized intelligence.
Physical and motoric			
Size changes	Limited height loss and some weight gain.	Significant height and weight loss coupled with cohort differences that exaggerate these effects.	Cohort is significantly smaller and there is significant loss of height and weight.
Physical strength	Modest decline in strength and aerobic capacity.	Moderate decline in strength and aerobic capacity. Some bone density loss.	Significant declines in physical strength and aerobic capacity. Significant bone density loss.
Balance and mobility	Slight declines in balance ability with little mobility loss.	Significant declines in balance ability and some difficulties with mobility.	Balance likely to be impaired and mobility likely to be restricted.
Health	Fairly robust.	Greater susceptibility to chronic conditions (e.g., arthritis, diabetes, osteoporosis, hypertension).	The presence of multiple chronic conditions is highly likely.

6 Organization of this Recommendation

The process of using a public telecommunication terminal may be divided into steps:

- Locating and accessing the telephone;
- Arranging conditions for the call;
- Initiating a call;
- Providing payment (when applicable);
- Identifying oneself and the communication counterpart;
- Performing the communication;
- Possibly setting up a further call;
- Terminating the communication.

Before, in between and during these steps there may be a need for further instructions. For each step, user requirements, often age-dependent, may be identified. These requirements will be dealt with below; they are, for each step, split up in the categories:

- Visual (where appropriate, this category is combined with the tactile and dexterity categories);
- Hearing;
- Tactile and haptic (touch and movement);
- Cognitive, speech and language;
- Dexterity, strength and mobility.

7 Locating and accessing a telephone: Visual requirements

7.1 Terminal identification signs

In public and often busy (and visually cluttered) places, locating a telephone can be difficult – particularly for people who are blind or have low vision. A standardized sign with accompanying text, displayed in sufficient size (letter size to maximum viewing distance at least 1/200) and placed in close context with the telephone (i.e. immediately above it or with further indications like arrows indicating its location) helps a visually impaired person to locate the telephone. In addition, the sign should be high contrast (preferably white or yellow characters on a dark background) and well illuminated.

When people have located the telephone, they need to know what type of telephone it is, what it will do and how they can interact with it. The initial instructions are usually in the form of labels and signs applied to the surface of the casing or as messages on the screen.

Labels should be placed where they can be easily read. If labels are positioned near the keyboard, it is important that the labels are not easily scuffed or worn away. If this is likely, then the labels should be replaced periodically.

On outdoor terminals, Braille has limited value in cold weather since tactual sensitivity is dramatically reduced at low temperatures. Given that only a minority of blind people are capable of reading Braille, relying solely on Braille is not a good solution.

Please refer to ITU-T Rec. E.137 for additional information.

7.2 Lighting

The illumination on the interactive areas of the telephone should be at least 200 lux. The lighting should not cause any direct glare to the eyes of the users, or reflections from, for instance, the screen. It is recommended that the illumination at the floor level is at least 50 lux so that dropped objects can easily be located.

7.3 Operating instructions

7.3.1 General

For Latin alphabets, the guidelines on user instructions for public telecommunications services in ITU-T Rec. E.137 and [Gill, 1997] apply. For Japanese characters, JIS S 0012-2000 "Guidelines for all people including older people and people with disabilities – Usability of consumer products" contains some general, qualitative guidelines. Good standards of legibility help all users, but for many people with low vision the issue is crucial as to whether they can use the telephone.

All instructions should be at least in the national language(s) [Brandt, 1995].

Instructions placed on a wall behind the telephone should be placed rather low to make it easier for people in wheelchairs or for people reading through the lower part of their bifocals to read the text.

7.3.2 Type size and type weight

Up to a certain point, larger type will significantly improve legibility for most people with low vision. Beyond that point, further increases in type size will decrease legibility. Sixteen-point type can be recommended as the minimum type size that will help low vision users. Larger type size may partly, but only partly, compensate for low contrast and may therefore be used if contrast cannot be made high enough; see 7.3.4. For Japanese characters, the Kyoyo-Hin Foundation recommends at least 23-point text size in instruction manuals for older people or people with low vision. See http://kyoyohin.org/eng/02kyoyohin/specifications.html.

Type weight is very important in determining legibility. Light-weight typefaces should be avoided. Regular weight type is sometimes not sufficiently legible, and it is recommended that medium or bold typefaces are used to give maximum legibility. Extra bold typeface is not recommended because the inner spaces of the letters get very small and become blurred for many people with low vision.

For Japanese characters, it is also advisable to use fonts that have bold horizontal lines instead of thin ones; that is to say, rather Gothic than Minchou fonts.

7.3.3 Contrast

An important factor affecting legibility is contrast between the type and the background. For dark print on bright backgrounds, the contrast ratio should be at least 1:3. However, for light print on dark backgrounds, the contrast is considerably more critical and should be at least 9:1. It should be taken into account that the above limits for contrast values are inclusive of any reflections in the monitor screen [Peli, 1996]; [Roelofs, 1997].

For LCD screens, contrast also depends strongly on the viewing angle [ISO 13406-2]. Older people often report having trouble with LCD screens, and there are many reasons besides ambient light and glare problems – parallax, poorly formed letters and dirty screens all add to the problems. Other flat panel display technologies may cause similar problems for older people.

7.3.4 Contrast reversal

For older people with clouded optical media, white or yellow type on black or a dark colour is more legible providing that the typeface weight and size are suitable. With reversed contrast line weight should be slightly less and font size slightly greater for equal legibility.

7.3.5 Visual confusion

Text should not run across photographs, illustrations, or patterned backgrounds. This will usually limit the contrast and confuse the eye.

7.3.6 Typeface styles

Most typefaces in common use are legible. Many people with low vision find contrast, size and weight more important than the choice of typeface. However, bizarre and indistinct typefaces should be avoided.

When choosing a typeface it is very important to consider the numerals and choose a typeface that has an open design. Many people with low vision can easily misread the numerals 3, 5, 6, 8, 9 and 0. For example, on some typefaces the tails of the numerals curl over and thus can appear to join up, making a 3, 6 and 9 look like an 8.

In general, a sans serif typeface text (e.g. Arial) is easier to read by people with low vision. The "Tiresias" typeface has been specially designed to provide high legibility and low confusion risk for people with low vision.

7.3.7 Capital letters

Text set in upper and lower case type is easier to read than text set in all capital letters, although a few words in capitals may present no serious difficulties.

7.3.8 Spacing and line length

Many readers are daunted by large amounts of close-set type. Space between lines of type should be as open as possible. Word spacing on screens should be even and slightly more open than on printed documents. Unjustified right hand margins are helpful to persons with low vision – as well as to persons with normal visual acuity – because they permit even word spacing. Avoid splitting words at the ends of lines.

The width of text columns is an important factor that affects legibility. If lines of type are too long or the interline spacing is too small, the eyes have difficulties finding their way back to the beginning of the next line. A maximum of 12 words per line has been recommended for continuous text [Bouma, 1989]; as a rule of thumb, lines should be kept short, i.e. 6-7 words.

7.3.9 Layout

Good 'navigational' aids such as bullet points, differentiated headings and rules to separate lines in lists or unrelated sections will improve legibility significantly.

If type is set in two or more columns, the margins should be wide enough to clearly separate the columns. If space is limited, then a vertical rule can help. Moving text on a screen can be very difficult to read with even a mild visual impairment, and should thus be avoided.

7.3.10 Diagrams

It is recommended that illustrative and clear diagrams are included where appropriate [Brandt, 1995]; [ETSI ETR 167].

7.4 Information displays and visual indicators

On many telephones, the visual instructions on the screen are the main guide for the user. There is a large number of factors that determine whether reading the screen will be difficult or easy for older people. People who wear bifocal glasses find it difficult to read the screen of many public access telephones, since the screen may not be at a suitable distance for neither the near nor far segments of their spectacles. In addition many people leave their spectacles in their car or do not wear them in public out of vanity. So the number of people who have problems in reading the screen is many times more than the 1.5% of the population considered to be blind or to have very low vision [Gill, 1997].

Therefore, the characters must be large enough (at least 9 mm high), correctly proportioned, and there must be a strong contrast between characters and background. As an alternative, it may be very useful when, early in the transaction process, the user can select the letter size in an easy way. In addition, the display should be set at an angle to enable the greatest possible legibility and to avoid light reflections [Brandt, 1995].

Any visual indicators, such as LED indicators of line state, LCD payment prompts, etc., must be located in an easily visible place, for instance, on the upper front surface of the terminal and the indicator lights should be bright.

7.4.1 Colour blindness

Total colour blindness is rare (less than 0.003% of the population) but problems with discriminating red and green are common (over 7% of the male population). Sunlight can degrade the legibility of colour displays for all users.

The ocular media (i.e. the cornea, lens and vitreous) turn more yellow with increasing age. This will reduce certain colour contrasts. Pale colours or subtle colour contrasts should therefore be avoided.

7.4.2 The position of information displays

Displays that are not designed for viewing in bright light should be shielded from direct or reflected sunlight or other bright light sources. They should not be positioned so that bright sources behind the display (large windows or bright spot lights) will dazzle the viewer. The display should be viewable from the eye level of a person sitting in a wheelchair. It should be possible for people with low vision to bring their eyes close to the screen (e.g., to be able to use a magnifier or other optical aid).

The conflicting requirements of tall pedestrian users and wheelchair users can lead to a significant group of users having parallax problems when lining up the function keys with their displayed options. Clear lines drawn from the key to the information on the surface of the display can alleviate this problem [Gill, 1997].

8 Locating and accessing a telephone: Hearing requirements

Hearing-impaired people do not normally encounter any hearing-related problems in locating and physically accessing a telephone terminal. However, we should note that hearing-impaired people may wish to access terminals that have special features for hearing-impaired people (e.g., inductive coupling to hearing aids, text telephones, video-telephones for sign language or lip reading), which can be indicated by symbols, icons and signs. It is important that older people with hearing impairments understand the meaning of these icons. See ITU-T Rec. E.121 and also ETSI EN 301 462 (2000) "Symbols to identify telecommunications facilities for deaf and hard of hearing people".

9 Locating and accessing a telephone: Strength, mobility and dexterity requirements

9.1 Space surrounding the telephone

Public telephones should be accessible to all individuals, including older people with mobility impairments. The physical location should be such that mobility-impaired users have free and unimpeded access. Furthermore, public telephones should be located and designed in such a manner that they can be easily operated by someone in a wheelchair, using a walker or a cane. See ITU-T Rec. E.135. Thus, to allow easy approach "The floor surface should be level in the direction parallel to the facia of the terminal. The gradient of any "crossfall" should not exceed 1 in 20." [Gill, 1997].

9.2 Area immediately around the telephone

There should be sufficient room under and around the public terminal equipment for wheelchair access and temporary parking of walking aids. A clear floor or ground space of at least 760 mm deep by 1220 mm wide that allows for a wheelchair to approach either perpendicular or parallel to the wall where the terminal is mounted should be required. Knee space required for forward approach should also be taken into account when determining clear floor and ground space. The minimum knee clearance should be 685 mm.

The height of the highest operable part of the public terminal equipment should be within reach of people in wheelchairs as well as standing persons. If the clear floor space only allows for forward approach, the maximum high forward reach should be 1220 mm from the floor. If parallel approach is used, the maximum high sideward reach allowed should be 1370 mm from the floor (from 3.3/E.135). The height of the lowest operable part should not be less than 700 mm from the floor.

To cater for older people with reduced stamina, some support for sitting or at least for leaning is desirable.

10 Initialization step: Call set-up: Visual, tactile and dexterity requirements

10.1 Keypads

10.1.1 Arrangement of keys

A standard arrangement of the keys, in particular the numeric dialling keys, is essential for blind people and helpful for all others, especially under conditions of poor illumination. Therefore, the numeric keys shall be arranged in a four-row by three-column pattern as recommended in ITU-T Rec. E.161. To aid the orientation on the numeric keypad, in particular for blind people, a single raised dot should be used on the '5' key, as indicated in ITU-T Rec. E.161. This should be positioned so as not to reduce legibility.

Possible other function keys should preferably be located to the right of the numeric keys, to reduce the chance of confusion with those keys for people with low visual acuity, and of accidentally being touched during number entry. The latter happens more easily where special function keys are positioned beneath the numeric keys.

10.1.2 Inter-key distance

All keys, and especially groups of keys, should be spaced far enough from each other to avoid users with reduced dexterity from depressing several keys simultaneously. For the same reason, none of the procedures necessary should actually require the simultaneous pressing of more than one key. The inter-key distance (from the edge of one key top to the near edge of its neighbour) within a key group, such as the numeric dialling keys, should be 5.6-7.5 mm [Brandt, 1995]. The distance between the numeric part and the other part(s) of the keypad should preferably be larger than the inter-key distance within the numeric part, in order to aid people with low vision and blind people to identify the various key groups.

10.1.3 Key characteristics

Key shape. To help differentiate keys from the numeric dialling key group from those of other groups, the shapes (and/or sizes) of the keys from the various key groups should, preferably, be clearly different [ETSI ETR 166, 1995]. As to the transversal shape of the top of the key caps, there are three possibilities: convex, flat, and concave. The latter is preferable, since such caps guide trembling, fingertips to the key centres. Convex caps should not be used since:

i) they may cause the fingers to slip off the keys; and

ii) specular reflections can make it difficult to read the characters on the key tops.

This also holds for key caps made of glossy material [ETSI ETR 345, 1997].

Key size. Keys should be large enough:

i) to enable people with a mild finger tremor to depress them comfortably; and

ii) to allow for key labels of sufficient size to be legible.

The area of the tops of the numeric dialling keys should ideally be approximately 150 mm^2 (i.e. 12×12.5 mm), whereas the tops of the function keys should be 165 to 350 mm^2 [Brandt, 1995].

Key luminance and colour. The luminance contrast between individual keys and control buttons and their background should be sufficient to enable visually impaired people to distinguish them. Keys and control buttons should, therefore, have another colour than the telephone [Brandt, 1995], which itself also should stand out from its surrounding. Colour may be used to distinguish between the keys from different key groups. The important thing is that the markings of the keys are clearly legible with the chosen colour.

Key illumination. Ideally, keys should be internally illuminated when the terminal is waiting for input from the relevant keypad.

10.1.4 Key activation force and tactile feedback

The force to activate a key should neither be too light (to avoid accidental activation, for instance through tremor of the hands), nor too high (to avoid difficulties to activate by people with little strength). Activation forces between 0.25 and 1.5 N are recommended for general use [LUSI, 1996] – but a smaller range has been recommended for disabled and older people, namely 0.5 and 0.9 N [Brandt, 1995].

Keys that actually move down when depressed provide tactile feedback during key travel. This feedback is clearest when the required force for depressing first gradually increases, and then sharply decreases during key travel (a clearly perceived "break-point").

10.1.5 Legibility of key labels

The keypads of desktop telephones should be tilted at an angle of 10° to 20° with the horizontal plane [Brandt, 1995]. Such keypads show less symbol shape deformities when viewed from above, and also are in general less subject to glare.

Wall-mounted telephones must be usable by people in wheelchairs; therefore, they should have vertical or nearly-vertical keypads.

Keys and control buttons should be labelled by means of numbers, text in the national language(s), and well-known and widely used symbols – see ITU-T Rec. E.121 and also [Brandt, 1995].

People with reduced visual acuity find some numeric characters are easy to confuse. It is important that a typeface is used that has numerals with open shapes (i.e. the 'six' and 'nine' should look like 6 and 9, not like 6 and 9, which can be confused with 8 and 3).

Characters on keys should be of a sufficient size, correctly proportioned and in high luminance contrast, not colour contrast, with their background [Brandt, 1995]. They should be wear-resistant, for instance engraved in the key surface. In addition:

- characters must have a height of at least 7.5 mm;
- the ratio of a character's height and line thickness should be approx. 7:1;
- characters should be in a sans-serif font;
- there should be at least 1 mm between the edge of the key and the character.

11 Initialization step – Call set-up: Hearing requirements

Most hearing-impaired people capable of communicating over the telephone should be able to hear the call progress tones which are generally of lower frequencies. It should be noted that the telephone system itself has an inherent amplification compared to face-to-face communication. It is only the deaf (who would be using a text-telephone) who would require visible call progress indications. However, if a deaf person communicates with people on ordinary telephones, telecommunications relay service is used; in the USA this means that a live operator is interposed who can pass along the call progress signals.

A volume control can assist people with significant hearing disability who are not using a hearing aid but it should be noted that stepped volume controls which give an X dB increase per step should work on a per-call basis, to protect the hearing of the next user of the telephone. Those using in-the-ear aids may require volume reduction to avoid overloading the aid.

12 Initialization step – Call set-up: Cognitive requirements

Because older people may require more time to carry out dialling tasks, time-outs in the call set-up procedure should not be too short. Time must be allowed for the older person to look at a reference, such as a telephone directory, to memorize part of a number, and then to dial that bit of the number, with this process repeated possibly three or four times to dial long numbers. A shelf, reasonably near the keypad, to rest any reference material may provide assistance, although such a shelf brings with it the risk that users may forget and leave behind articles placed on it. To accommodate the difficulty some older people experience if required to divide attention between two tasks, the call set-up procedure should be as simple and linear as possible. For example, the dialling procedure should not require reference to instructions after starting and before ending. Off-line, or *en bloc* dialling, in which the entire number is entered and can be checked before any digits are sent to the network (as in mobile phones), can be helpful by avoiding the need to encounter network time-outs.

13 Initialization step – Call set-up: Mobility requirements

All keys and buttons as well as the handset should be located so that they are easily accessible by people with mobility and/or dexterity impairments. A person using a walking aid should find an easy way to park this aid while dialling, without the danger of it falling to the ground.

14 Initialization step – Payment: Visual requirements

14.1 Cards

14.1.1 Smart cards

"A smart card is a credit-card-sized plastic card incorporating an integrated circuit. This circuit holds information that can be securely and accurately read by all sorts of terminals. Smart cards are able to carry larger amounts of information than magnetic stripe cards. Smart cards provide the opportunity to make machines much more 'user friendly' than they have ever been before. For older people, a smart card can carry information that tells a telephone to show larger text prompts, give prompts as audible comments or allow the user more time. Many older people and those with a cognitive impairment do not like to be rushed or to think that they are likely to be 'timed out' by the machine, so it is necessary to allow for these people to use the terminal at their own pace:

- To simplify the choices such as issuing a pre-set amount of money,
- To use larger characters for people with low vision, and
- To use audio output of non-confidential information." [Gill, 1997]:

The specification of user requirements can be found in ETSI EN 1332-4.

14.1.2 Embossing on cards

Blind persons face the problem of selecting the right card from their wallet. It is recommended that cards incorporate up to four embossed symbols such as capital letters with a maximum height of 7 mm, a maximum width of 7 mm, a spacing of 5 mm and a relief height of embossing between 0.45 and 0.48 mm. For further details, see [Gill and Devine-Wright, 1999].

14.1.3 Contactless smart cards

"A contactless card, working at a distance of up to 10 cm, will help those who have problems inserting a card in a slot. This is of particular importance to wheelchair users, those with Parkinson's disease or arthritis, and people with a visual disability." [Gill, 1997].

14.1.4 Card orientation

"Blind persons, and many older persons, have problems in inserting the card in the correct orientation; this is a particular problem with cards which are not embossed." [Gill, 1997]. ITU-T Rec. E.136 gives a precise recommendation on a tactile marker to facilitate the use of telecommunications cards by older and visually impaired people. The orientation problem can of course be avoided by the general introduction of card readers that accept cards in any orientation

15 Initialization step – Payment: Hearing requirements

Hearing-impaired people should have no major problems in paying for calls in public payphones (by coins, pre-paid phone-cards or credit cards). The exception is if they cannot hear acoustic warning signals, e.g. to inform that more coins must be inserted, that a phone-card has expired, or prompts to authorize a credit card by entering a PIN code, etc. A visual display of the auditory message as text should be provided.

16 Initialization step – Payment: Tactile, strength, mobility and dexterity requirements

16.1 Location of coin, card and token slots

All coin, card and token slots should be located so that they are easily accessible by people with mobility and/or dexterity impairments. Clause 9.2 describes the physical dimensions recommended to this aim. For coins this includes the space where these fall if rejected by the machine; their retrieval should not be unduly difficult.

16.2 Cards to be inserted

Inserting cards, in particular thin flexible ones, is often more difficult than inserting coins. Insertion may be helped, especially for users with hand tremor, when the card reader entrance is somewhat funnel-shaped [Gill, 1997].

16.3 Cards to be swiped

Swipe card readers only function at a particular, not-too-low speed of swiping and if the card is moved smoothly. This is known to present difficulties to many users without strength or dexterity impairments, and may be even more problematic for users with such impairments. To reduce the chance for those difficulties, swipe card readers should accept a range of swipe speeds, from fairly low onwards. In addition, their location is especially critical, since they need not only to be reached, but also to be operated, with sufficient grip in the hand holding the swept card [Gill, 1997].

17 Communication step: Tactile, strength, mobility and dexterity requirements

17.1 The cord connecting handset and terminal

The cord connecting the handset to the telephone should have sufficient length so that the handset can easily be used by people in wheelchairs (as well as by very short or very tall users). The cord should therefore be at least 1.7 m long [ETR 166, section 1.2.1]. It should be attached so that it will not be in the way when the handset is replaced. If it is armoured the combination of cable and armour should not be too stiff, and the armoured cable plus handset should not be too heavy. If the cord is coiled, stretching it should not require too much effort.

17.2 The handset: location, weight and shape

Clauses 9.2 and 13 describe the location requirements for the handset. As to its shape, reduced handgrip strength may make it difficult to grab, handle and hold the handset, especially to hold it for an extended period. This applies in particular to heavy handsets and very wide ones. The shape of the handle's cross-section should not be (more or less) triangular, because that prevents "cradling" the handset between head and shoulder, but rather rectangular (without sharp edges), or oval. Handles with round cross-sections can be difficult to orient. Preferably, the weight of the handset and the part of the possibly armoured cable that has to be lifted by the user should be between 150 and 175 g [ETR 166, section 1.2.6]. Furthermore, the handset should be balanced in the hand. The earpiece should not be substantially heavier than the mouthpiece, or vice versa.

17.3 Hands-free operation

The availability of a hands-free mode is a clear advantage to older people. The hands-free operation key should be easily accessible, for instance in the bottom or right-hand row of non-numerical keys. The volume should be adjustable. If the microphone can be switched off there should be unmistakable visual and audible indication as to whether the microphone is switched on or off. The design of the handset holder should facilitate cradling; in particular, it should ensure that the handset relocates correctly under its own weight. A tilted empty space to support a note pad may be provided; tilted to prevent people from forgetting belongings on it.

18 Communication phase

Many older people experience a gradual loss of hearing, while the capability to speak remains more or less unaffected. Even when the ability to speak is retained, hearing loss is the loss that interferes most with speech communication, either face-to-face or over the telephone. Speech communication is impeded to various degrees depending on the severity of the hearing impairment, from problems with perceiving some speech sounds, to not being able to hear any speech at all. Below the problems and solutions have been organized according to severity of hearing loss.

18.1 Mildly hard of hearing (some high frequency loss)

This condition normally does not warrant any special provisions other than a good acoustic treatment of the phone booth or of the environment around the telephone. The ordinary telephone usually provides several dB of amplification and does actually provide some measure of compensation for a slight hearing loss compared to face-to-face communication. Some people in this group may benefit from a telephone with a high-quality earphone, but otherwise there is little that needs to be done for this group.

18.2 Moderately hard of hearing (significant loss of high frequencies and some loss of middle frequencies)

This group should be the main users of hearing aids, but unfortunately pride and vanity often turn many older people with hearing losses away from using them because hearing aids are considered to be more stigmatising than, for instance, spectacles.

In former times, the electromagnetic field around the coil in the earphone (actually electromagnetic pollution) provided an inductive field that could be picked up by hearing aids with a 'T' setting (for use in rooms with amplifier and induction loop). As the new piezoelectric earphones were introduced, and quickly became predominant, people using hearing aids lost this special advantage, and there was soon a demand for telephones that provided inductive coupling.

Various national and regional standards bodies have responded by creating standards for inductive coupling between telephones and hearing aids. It is not particularly expensive to provide inductive coupling to a telephone (a special handset), and it provides a great benefit to users of hearing aids. ITU-T Rec. P.370; (The Coupling of hearing aids to telephone sets), gives figures for the sensitivity and frequency characteristics of coupling coils intended to couple to hearing aids equipped with induction pick-up coils. An annex describes measurement methods. The provision of additional receiver amplification and electrical coupling are also dealt with in ITU-T Rec. P.370.

Low signal-to-noise ratio will create problems with failing hearing. In this case it is difficult to pick out the acoustic signal from the background noise. This becomes even more difficult if there is a large difference in hearing loss between the two ears (which is not unusual). It is then important to exclude all unwanted noise. One way is to occlude the weaker ear, but a better way is to provide the acoustic signal to both ears. The provision for an extra handset is often of significant help to hard-of-hearing people. The extra handset can also be used by a second person to 'repeat' or 'shadow' the speech in the phone to help the hard-of-hearing or deaf person to lip-read.

Extra amplification is often seen as an important measure for dealing with the hard-of-hearing. However, we should note that extra amplification might often put hard-of-hearing people worse off than not having the extra amplification. The reason for this is that neural hearing loss is usually accompanied by *recruitment* or *over-recruitment*. Recruitment means that the experienced sound intensity (loudness) grows faster with increasing acoustic intensity than for people with normal hearing. With over-recruitment, even just a few dB of amplification can render a sound unbearably loud and distort the sound (speech) so much that it becomes unintelligible.

Extra amplification is therefore not always the first choice for many people with middle to serious hearing loss. Again, a good acoustic environment with no distorting echoes and low ambient noise, and an extra handset to exclude extraneous noise, are the best option.

18.3 Severe hearing loss (significant loss of high and middle frequencies)

People suffering from this have very great problems communicating verbally, either face-to-face or via telephone. Many of these people have to get support from lip-reading, which means that they must be able to see the other party. The video-telephone provides this possibility, but most ordinary video-telephones have too low picture quality to support lip-reading.

18.4 Profoundly deaf (cannot use hearing for any form of verbal communication)

Profoundly deaf people cannot communicate acoustically at all and must rely on other forms of communication (sign language, text telephones, internet chat, instant messaging, SMS (short message service)). Video-telephones for sign language do not need to have as high spatial and temporal resolution as video-telephones used for lip-reading. To provide video-telephones and text telephones for this group will eventually be necessary. It may be noted that some countries already require a proportion of payphones to have text-telephone facilities. Text-telephones provided should comply with ITU-T Rec. V.18: (Operational and interworking requirements for modems operating in the text telephone mode). Also, some countries already require that a relay service should be provided to enable communication with deaf people without a text-telephone. ETSI TR 101 806 gives "Guidelines for telecommunication relay services for text telephones".

19 Next call (follow-on call): Visual, tactile, strength, mobility and dexterity requirements

In general, the same issues apply here as in the steps on Initialization: Call set-up, and in Initialization: Payment (see above). In particular, the following issues should be mentioned:

19.1 Redial

For older people with motor impairments, blind and visually impaired people and people with poor memory, it is an advantage that the telephone terminal is equipped with an automatic redial facility. This saves them from many keystrokes and from having to remember a telephone number when they need to redial e.g. in the case of busy line. It is important that the redial facility is easy to use and only requires pressing one key, and that the redial key is accessible (e.g. in the bottom or right-hand row) and easy to locate and identify. The redial facility should be labelled in the national language of the country in question or a widely recognized symbol or icon, See also 6.11-6.13/E.137.

19.2 New number call

The 'next call' key (for a new number) when and if provided should be located so that it is easily accessible by persons who are mobility impaired. Clauses 9.2 and 13 describe the physical dimensions recommended for easy accessibility.

20 Terminate call: Visual requirements

20.1 Receipts

To aid users with low vision, receipts should be printed with a minimum type size of 12 points with a sans serif typeface with upper-and lower-case text. If space permits, 16-point type would be preferable. It is important that the print has good contrast on opaque paper with a minimum of background pattern. A common complaint is poor print quality on receipts; often this is the result of the printer ribbon not being replaced regularly.

21 Terminate call: Hearing requirements

There should be no special problems to terminate a call for hearing-impaired people except for any warning prompt to take the phonecard or any remaining unused coins or change given by the payphone. Since deaf and hard-of-hearing people cannot hear any warning tones to advice them to take the card, some alternative means must be found, for instance, a flashing light or optical message.

22 Terminate call: Tactile, strength, mobility and dexterity requirements

22.1 Retrieving remaining coins

As described in 16.1, coin retrieval at the end of making a call should not be unduly difficult. This implies that, first, the space where these remaining coins are held should be within easy reach, also for wheelchair users; see clauses 16.1, 9.2 and 13. But, secondly, the flap or lid that may be used to close the space for the remaining coins, to prevent them from falling to the ground and hiding them from view, should not be too difficult to open for people with low dexterity and finger strength, possibly having to do this from an awkward position.

22.2 Card retrieval

As with the remaining coins-space, described in 22.1, the card exit slot should be located within easy reach for everybody; see clauses 9.2 and 13. In addition, when the card has come out it should protrude at least 2 cm from the slot, and only a small force should be needed to pull the protruding card out of the terminal [Gill, 1997].

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