TECHNICAL REPORT

ISO/TR 22411

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Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities

Données d'ergonomie et lignes directrices pour l'application du Guide ISO/CEI 71 aux produits et services afin de répondre aux besoins des personnes âgées et de celles ayant des incapacités

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Contents

Page

Foreword v
Introduction vi
1 Scope 1
2 Normative references 1
3 Terms and definitions 1
4 General considerations 3
4.1 Need for technical guidance in implementing ISO/IEC Guide 71 in individual standards 3
4.2 Approaches for achieving accessibility 3
4.3 Human abilities data 4
5 Using this Technical Report 4
6 Developing standards — Issues to consider during the standards developing process 4
6.1 General 4
6.2 Definition of the standardization project 4
6.3 Composition of the drafting committee 5
6.4 Content of the standard 5
6.5 Review process 6
6.6 Publication of the standard 6
7 Resolution of contradictory requirements 6
8 Factors to consider with design guidelines 7
8.1 General 7
8.2 Alternative format 7
8.3 Location and layout of information and controls and positioning of handles 17
8.4 Lighting levels and glare 20
8.5 Colour and contrast 22
8.6 Size and style of font and symbols in information, warnings and labelling of controls 24
8.7 Clear language in written or spoken information 27
8.8 Graphical symbols and illustration 31
8.9 Loudness and pitch of non-spoken communication 33
8.10 Slow pace of information presentation 33
8.11 Distinctive form of product, control or packaging 35
8.12 Ease of handling 36
8.13 Expiration date marking 50
8.14 Contents labelling and warning of allergens 51
8.15 Surface temperature 52
8.16 Accessible routes 52
8.17 Logical process 58
8.18 Surface finish 61
8.19 Non-allergenic/toxic materials 62
8.20 Acoustics 63
8.21 Fail-safe 64
8.22 Ventilation 65
8.23 Fire safety of materials 65
9 Ergonomic data on human abilities and the consequences of impairment 65
9.1 General 65
9.2 Sensory abilities 66
9.3 Physical abilities 96
9.4 Cognitive abilities 125

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9.5 Allergies **131**

Annex A (informative) **Principles of accessible design** **134**

Annex B (informative) **Data on spectral sensitivity of the eye as a function of age and application** **136**

Annex C (informative) **Visual acuity data as a function of viewing distance for different age groups** **140**

Annex D (informative) **Span of fundamental colours** **144**

Annex E (informative) **Cases of allergy** **148**

Bibliography **154**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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ISO/TR 22411 was prepared by Technical Committee ISO/TC 159, *Ergonomics*.

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Introduction

This Technical Report is intended to help standards developers understand the accessible design principles of ISO/IEC Guide 71 and implement them into individual standards by providing design considerations and ergonomic data related to human abilities. While this Technical Report was written primarily for standards developers, it is recognized that much of the information is technical in form and committees are advised to seek technical advice on the interpretation of such data where relevant expertise is not available within the committee. In addition to its application by standards developers, this Technical Report could also be useful to manufacturers, designers, service providers, educators and others.

ISO/IEC Guide 71 stresses the concept that taking care of the needs of older persons and persons with disabilities is important in developing relevant International Standards. The underlying idea is that products, services and environments encountered in all aspects of daily life and intended for the consumer market and the workplace should be designed to be accessible for all people including those with special requirements, such as older persons and persons with disabilities. This idea, called accessible design, has been spreading all over the world. Some regional and national standard bodies have adopted the ISO/IEC Guide 71 as their own standard or guidance.

ISO/IEC Guide 71 has successfully addressed the importance of being aware of the needs of older persons and persons with disabilities. For seven design fields it provides structured tables of factors and human abilities that need to be considered in designing products and services. Its tables are intended to also direct the attention of standards developers to these factors when they draft or revise standards. However, ISO/IEC Guide 71 does not exhaustively describe how to consider those factors or how to find solutions for them. What is required is to establish design methods for implementing the concept of accessible design into individual standards. The methods demand a wider range of knowledge on properties and ergonomic data of human abilities. Without such knowledge, better design for persons with special requirements will not be realized.

Social and economic effects are expected from accessible design. In the social dimension, a greater number of individuals — including older persons and persons with disabilities — will be able to be involved in social activities without any restriction in using products or enjoying services and environments. The economic effect is that products developed using accessible design can be purchased by a wider range of people, including older persons and those with disabilities, who are now a significant proportion of consumers with buying power.

ISO/TC 159, *Ergonomics*, has been involved in this challenging work, firstly with an ad hoc group and then with Working Group WG 2, *Ergonomics for persons with special requirements,* the result of which has been the development of this Technical Report, which also incorporates factors that do not appear in ISO/IEC Guide 71 where considered necessary. Nevertheless, these design considerations and human ability data are arranged in accordance with the structure of ISO/IEC Guide 71, for ease of reference.

This Technical Report widens the scope of users as far as possible and is not limited to the 5th to 95th percentiles of working populations[1)]. It constitutes a starting point from which to offer technical information for accessible design. It is not exhaustive and does not fully reflect the present state of knowledge and data for accessible design: while some of the design considerations are well established, others are still under development.

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1) A percentile describes the percentage of people in a population group (e.g. 5 % or 95 %) for which the relation to a certain body size is greater or smaller than the value given in each case. For more details, see ISO 7250.

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Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities

1 Scope

This Technical Report presents ergonomics data and guidelines for applying ISO/IEC Guide 71 in addressing the needs of older persons and persons with disabilities in standards development.

It provides:

— ergonomics data and knowledge about human abilities — sensory, physical, cognitive abilities — and allergies;

— guidance on the accessible design of products, services and environments.

Each of its design considerations or recommendations is based on ergonomic principles that are necessary for making products, services and environments accessible to older persons and those with disabilities. It is applicable to products, services and environments encountered in all aspects of daily life, as well as in the consumer market and workplace (herein, the term “products and services” is used to cover all these areas). While it does not provide techniques for designing assistive devices, some of its provisions do, however, support interoperability with assistive technology. Conformity assessment of any international, regional or domestic standards is outside its scope.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 71:2001, *Guidelines for standards developers to address the needs of older persons and persons with disabilities*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
accessible design
design focused on principles of extending standard design to persons with some type of performance limitation to maximize the number of potential customers who can readily use a product, building or service, which may be achieved by

— designing products, services and environments that are readily usable by most users without any modification,

— making products or services adaptable to different users (adapting user interfaces), and

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— having standardized interfaces to be compatible with special products for persons with disabilities.

NOTE 1 Terms such as design for all, barrier-free design, inclusive design and transgenerational design are used similarly but in different contexts.

NOTE 2 Accessible design is a subset of universal design, where products and environments are usable by all persons, to the greatest extent possible, without the need for adaptation or specialized design.

[ISO/IEC Guide 71:2001, 3.2]

3.2
assistive technology
assistive device
piece of equipment, product system, hardware, software or service that is used to increase, maintain or improve functional capabilities of individuals with disabilities

NOTE This can be acquired commercially off-the-shelf, modified or customized. The term includes technical aids for persons with disabilities. Assistive devices do not eliminate impairment but may lessen the difficulty an individual has in carrying out a task or activity in specific environments.

[ISO/IEC Guide 71:2001, 3.3]

3.3
user
person who interacts with the product, service or environment

NOTE Adapted from ISO 9241-11:1998.

[ISO/IEC Guide 71:2001, 3.6]

3.4
alternative format
different presentation which may make products and services accessible by the use of another mobility or sensory ability

[ISO/IEC Guide 71:2001, 3.8]

3.5
impairment
problem in body function or structure such as a significant deviation or loss which can be temporary due, for example, to injury, or permanent, slight or severe, and which can fluctuate over time, in particular, deterioration due to ageing

NOTE 1 Body function can be a physiological or psychological function of a body system; body structure refers to an anatomic part of the body such as organs, limbs and their components, as defined by the World Health Organization (WHO), see Reference [42].

NOTE 2 This definition differs from that in ISO 9999:2002 and, slightly, from the WHO definition, see Reference [43].

[ISO/IEC Guide 71:2001, 3.4]

3.6
accessibility
extent to which products, systems, services, environments or facilities can be used by people from a population with the widest range of capabilities to achieve a specified goal in a specified context of use

NOTE 1 Context of use includes direct use or use supported by assistive technology.

NOTE 2 Term and definition adopted by TC 159 and first published in 2007.

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4 General considerations

4.1 Need for technical guidance in implementing ISO/IEC Guide 71 in individual standards

ISO/IEC Guide 71 provides standards developers with guidance on taking into account the needs of older persons and persons with disabilities when developing new standards or revising existing ones. It defines seven design fields and human abilities and summarizes ergonomic factors to be considered in the form of tables. These are followed by possible solutions with some practical examples.

However, ISO/IEC Guide 71 neither fully describes methods for realizing its principles nor shows ways to consider the factors in developing standards, and the examples and possible solutions explained therein are not exhaustive. Standards developers need to interpret the principles of ISO/IEC Guide 71 and find their own technical solutions, applicable to individual standards. To achieve this, ergonomic data on human abilities as a function of age and impairment (grouped by their nature) are necessary. This technical information is currently distributed across multiple standards and documents. Therefore, it would be preferable and helpful for users of ISO/IEC Guide 71 to have common technical guidance that they could consult during their drafting work from time to time. This technical guidance, provided by this Technical Report, is intended to bridge ISO/IEC Guide 71 and other, individual standards, as shown in Figure 1. Furthermore, standards for different products or services can become inconsistent or contradictory if they lack common data sources on accessible design.

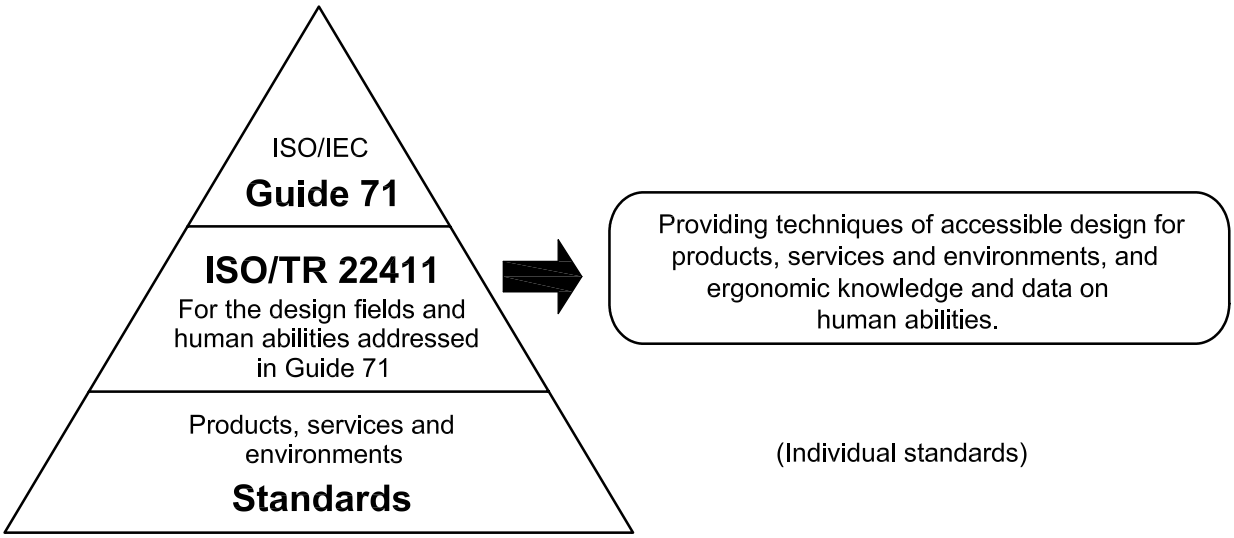

Figure 1 — ISO/TR 22411 in relation to ISO/IEC Guide 71 and individual standards

4.2 Approaches for achieving accessibility

This Technical Report describes two different approaches.

The first is concerned with compensation for impaired abilities with alternative modalities. An example of this is providing visual information for visually impaired persons by means of other sensory modalities such as hearing and/or tactile sense(s). This approach is called the *alternative format* in ISO/IEC Guide 71. Although this method is primarily intended to compensate for serious impairments, it is also helpful for persons when one of their modalities is occupied by another busy task, such as using auditory information for a person who is involved in tasks with visual displays.

The second approach is to design products and services taking into account the extent of impairments, including those related to ageing. Impairments occur in every aspect of sensory, physical, and cognitive abilities. Many can be compensated for by ergonomic design methods provided the impairment is not serious. Giving auditory information at a higher sound level for persons with hearing impairment is an example of this approach, which relies on sets of data derived from knowledge on human abilities.

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Some design methods extend over both approaches.

4.3 Human abilities data

In addition to design considerations, this Technical Report supplies human ability data relevant to the accessible design of products and services. The data were adopted from scientific journals or publicly available sources such as international or domestic standards and academic books. When ergonomic data were not available, recommended, *de facto*, values have been described.

5 Using this Technical Report

This Technical Report follows the same structure as that of ISO/IEC Guide 71, for easy reference.

Clause 6 describes additional issues to consider when standards developers draft or revise a standard.

Clause 7 briefly mentions the present status of knowledge pertaining to the factors adopted in this Technical Report. It also addresses the need to cope with competing requirements in standards which can arise in drafting or revising a standard.

Clause 8 provides design considerations for each factor described in ISO/IEC Guide 71. Each subclause begins with a citation from ISO/IEC Guide 71 (in a box) relevant to the subclause. Then design considerations about the factors follow, where available. The subclauses are linked to the rows in the tables of ISO/IEC Guide 71, Clause 7. When no information is given, none was available at the time of writing: further research is necessary.

Clause 9 provides basic knowledge of and reference data for human abilities. Some are directly related to the design considerations in Clause 8 to supplement them with human ability data, where available. The subclauses are linked to the columns in the tables of ISO/IEC Guide 71, Clause 7.

Annex A introduces some guiding principles of accessible design to supplement the descriptions in ISO/IEC Guide 71. Annexes B to D describe visual ability data which supplement the relevant descriptions in Clause 9. Annex E shows a case report on cases of allergy.

6 Developing standards — Issues to consider during the standards developing process

6.1 General

ISO/IEC Guide 71:2001, Clause 6, describes a helpful process for ensuring that the needs of older persons and persons with disabilities are included when standards developers draft a new standard or revise an existing standard. Users of this Technical Report are advised to refer to ISO/IEC Guide 71 for an overview. Additional guidance is provided below.

6.2 Definition of the standardization project

While the standards project is being defined and the purpose clarified, it is important to identify the end-users of the product or service being standardized. Various standards, such as ISO 20282-1:2006 (for everyday products), provide methods for identifying important user characteristics.

During this process, the following fundamental design recommendations apply. See Annex A.

— Accessible products and services should find acceptance with as many persons as possible.

— Accessible design should not have adverse effects on the functionality of the product or service or on the usability for any user.

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— Accessible design should not impact the privacy of the users.

EXAMPLE 1 The voice output of cash dispensers is not audible to a third party.

— Products and services should not discriminate against, stigmatize or disadvantage users in any other way.

EXAMPLE 2 A separate entrance for wheelchair users that takes the occupant to a back corridor rather than into the main foyer.

EXAMPLE 3 Voice output or key tones that can be switched off so as not to disadvantage users who are sensitive to noise.

— Products and services should pose no safety risk to their users and should comply with the relevant International Standards under the technical safety laws of the respective countries.

— Products and services should be designed for the intended environment and context of use.

6.3 Composition of the drafting committee

The members of the committee drafting the standard should be aware of ageing and disability issues. Data on issues affecting older persons and persons with disabilities should be collected. This Technical Report can serve as a starting point for that information. However, experts in the subject should be consulted or placed on the committee so that appropriate use of the data can be made within the context of the specific standard being developed. The following considerations concerning the committee composition are also relevant.

— Experts in ergonomics or human factors can help to interpret data on human physical, sensory, perceptual and cognitive abilities. They have the skills necessary to apply the data for the intended user groups that will be affected by the standard.

— Older persons and persons with disabilities should be included for their first-hand experience.

— Accessibility experts can provide a more general knowledge on accessibility requirements.

6.4 Content of the standard

To keep the needs of older persons and persons with disabilities in mind during the writing of the standard, it is beneficial to consult, for example, the principles of universal design (see Annex A) [44].

It is presupposed that a product or service complies with the relevant International Standards under the technical safety laws of the respective countries. However, persons with certain impairments have requirements that differ from, and may run counter to, safety regulations. For example, someone with one hand could wish to disengage a control which requires two-handed operation, for safety reasons, or to de-activate the child-safety mode.

It is also prerequisite that the surroundings (such as the lighting conditions, climate and noise level) promote the accessibility of the product or at least in no way restrict it.

However, there can be situations where, despite following the guidelines and recommendations of this Technical Report and other standards, the product or service is not equally usable by all persons to the greatest extent possible. In those cases, the following measures can be taken to prevent the exclusion of users.

a) Provide instructions and recommendations specific to users with special requirements to help them adapt the product to their needs.

b) Ensure compatibility with assistive technology.

EXAMPLE 1 Mobile telephones can be fitted with an interface (i.e. according to the ETSI standards) which enables connection to voice output or a Braille display.

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c) Offer supplementary aids.

EXAMPLE 2 Supplementary modules or templates.

d) If accessibility of the product or service is affected by its installation or configuration, provide information to the user or service provider to help him or her optimize the product or service use during this first assembly.

e) In certain cases, train users with special requirements to facilitate the use of the product or service.

EXAMPLE 3 Accessible design can promote activities of specialists for adapting aids to the product, for preparing special instructions and for training users.

f) Provide appropriate information on product properties that allows users to determine whether the product

1) is appropriate for their abilities to the full extent,

2) can be re-equipped and adapted so that they are able to benefit from the expected use, or

3) cannot be used by them.

6.5 Review process

During the standardization process, existing ergonomic data and design guidelines can help to guide the product or service standard definition. When possible, this information should be further validated with members of the intended user groups. This step is especially important when considering the needs of older persons and persons with disabilities. This validation includes verifying the physical, sensory and cognitive requirements, including the understanding of how to use the product or service. Various standards, such as ISO 13407:1999, provide processes for human-centred design and evaluation activities.

EXAMPLE A new standard is being drafted to define graphical symbols for medicine prescription bottles. Existing data helped identify the possible colours and sizes for the symbols. As a check on the requirements identified for the graphical symbols, they are tested with a representative sample of the target user group (50 % of which is over the age of 65) to determine whether the symbols can be visually identified and whether they are correctly understood.

Just as it is important to review the standard definition of the product or service, it is also worthwhile reviewing the actual standard document itself from the standpoint of (or with) older persons and persons with disabilities.

6.6 Publication of the standard

The standard should be available in alternative formats that meet the needs of older persons and persons with disabilities. See 8.2.

EXAMPLE A standard is made available in large print, Braille or in an accessible electronic format, which allows users to adapt the documents to their needs.

7 Resolution of contradictory requirements

The accessibility of a product is perceived very differently by individuals depending on their experience, training and/or type or degree of impairment. In order to resolve conflicts between competing requirements that can arise from different types of impairment, these should be weighed against each other using the following criteria.

a) Number of potential users

The decision about what is readily achievable and what would be acceptable to the user should be oriented towards the alternative which would address as many additional potential users as possible.

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b) Application areas for the product

When designing products and services for the public sector, it is particularly important to take into consideration as many requirements and recommendations as possible since, in contrast to the private sector, the user is usually not in a position to choose from several alternatives the product or service that would be most appropriate for his or her personal abilities. Until fully accessible products and services are available, accessibility can be secured by the installation of several supplementary units (such as machines for wheelchair users and blind persons). These can be conventional products or services or products or services designed for persons with a specific impairment (if necessary with adaptation).

c) Economic appropriateness

Accessibility should not result in an inappropriately high cost of the product or service. Therefore, the considerations and recommendations of this Technical Report can already be taken into account or followed during the early design stages of new products and services. Economic appropriateness may also be achieved by making only intended product or service functions or only certain products in a product line or services in a service line accessible.

Accessible products need to avoid the inappropriate implementation of recommendations that benefit a few to the disadvantage of many.

EXAMPLE 1 If the loudness of speech or a signal intended to assist a hearing-impaired user is set too high, it may disturb or be audible to others in the vicinity who do not need to hear.

Where a product or service appears to breach accessibility guidelines, compromise solutions are required.

EXAMPLE 2 If there is a demand for miniaturized products, the recommendations in this Technical Report could still be implemented to a reasonable extent when designing the product.

EXAMPLE 3 Where it is not possible to make all products in a product line fully accessible, accessible versions for certain impairments could be provided as part of the product range.

8 Factors to consider with design guidelines

8.1 General

This section is structured to present the relevant guidance from ISO/IEC Guide 71 first (in a box), followed by design considerations about the factors presented in Guide 71. The considerations are presented in the same structure as those of Guide 71. For some factors useful information is not currently available, therefore no extra considerations will be given in these cases.

8.2 Alternative format

8.2.1 General considerations

An alternative format (defined in 3.8) describes a different presentation or representation intended to make products and services accessible through a different modality or sensory ability. By providing all input and all output, i.e. information and functions, in at least one alternative format, for instance visual and tactile, more people, including some with language/literacy problems, may be helped. In terms of function for people with dexterity and strength impairment, alternative packaging solutions may need to be envisaged.

[ISO/IEC Guide 71:2001, 8.2.1]

Providing several alternative formats increases the probability of making a product or service accessible to the greatest number of people. There are two basic approaches (see also ISO 9241-20 and ISO 9241-171).

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a) Presenting information via different senses

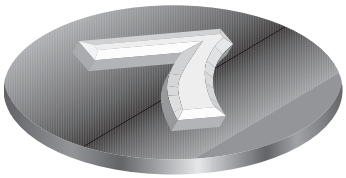
In this approach, the same information is provided through more than one sense, such as providing visual and auditory information for the same content.

EXAMPLE 1 Floor designation in an elevator is displayed in both visual and tactile format so that blind persons can identify the floor number by touch. See Figure 2 a).

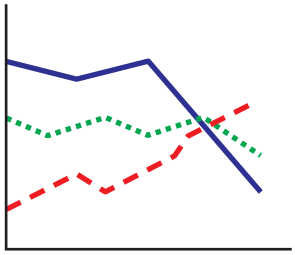
b) Presenting information via different aspects of the same sense

In this approach, additional cues are provided, such as showing two different visual implementations of the same content.

EXAMPLE 2 Lines in a graph are displayed in different colours and different patterns so that colour deficient persons can identify the lines by the patterns. Persons without colour deficiency can also identify the lines under low illuminance conditions. See Figure 2 b).



a) Raised sign for floor designation in elevator



b) Colour and line pattern in graph

Figure 2 — Examples of alternative format

8.2.2 Alternatives to visual information

The type and texture of surface finishes can be important in providing tactile feedback which can reinforce instructions and warnings for those with visual impairment. Where the principal form of instruction on a product or in a building is written, alternatives would be voice (instructions “spoken” by a product or service), sound (feedback from clicks, bells and buzzers) or touch (tactile marking or grip).

Wherever feasible, visual information which is presented on electronic products should be available from the product in audio or other sensory stimuli for those with a visual impairment including those who cannot read Braille, as well for those who have difficulty with reading or are unable to read. Printed visual information should be available in alternative formats (electronic audio, large raised letters or Braille, etc.) which are readable by individuals without vision and in large print for those with low vision.

[ISO/IEC Guide 71:2001, 8.2.2]

8.2.2.1 Tactile markings

Tactile markings can be used as an alternative to visual information not only for persons with visual impairments but also for persons whose eyes are occupied with other tasks. In principle, tactile markings can be used anywhere visual information is needed. However, some persons with touch impairments (e.g. older persons or persons with diabetes) have difficulty sensing tactile information. Surface temperature is unsuitable for conveying precise information. See 9.2.3.4.

Tactile markings are useful for indicating locations, recognizing surface structure, perceiving shape of goods, and presenting information contained in characters, signs or plans.

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EXAMPLE The distinction of a shampoo bottle with tactile grooves from a rinse bottle that has a smooth surface without grooves [45].

The following accessibility considerations are relevant to the use of tactile markings [46].

— The shape of the markings is designed to clearly correspond to the function assigned to it.

EXAMPLE 1 Door handles, rocker switches, emergency stop switches.

— The surface is designed so that the function can be recognized.

EXAMPLE 2 Walking areas, handle zones.

— A pyramid shaped cross section is preferred for raised letters and lines. See Figure 3.

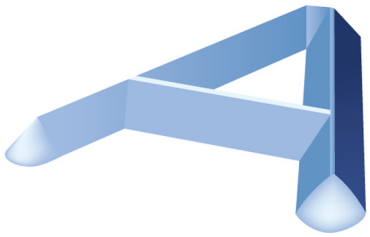

Figure 3 — Raised letter with pyramid shaped cross section

— Smoothing sharp edges increases accessibility.

— Dots with a convex shape (in contrast to cylindrical or peak form) and a sufficient amount of raised height above the surface increase accessibility.

— The dimensions like height and size are designed suitably to the spatial and temporal resolution of tactile sense. See 9.2.3.2 and 9.2.3.3.

— If there is sufficient space, Braille and raised characters can be provided additionally.

— Non-abbreviated Braille is preferred due to the international use and support of elderly blind users.

A large variety exists in the recommendations for spacial dimensions of tactile markings and Braille depending on, for example, material used, body dimensions (fingertips, feet, etc.) and environmental conditions. Table 1 summarizes them.

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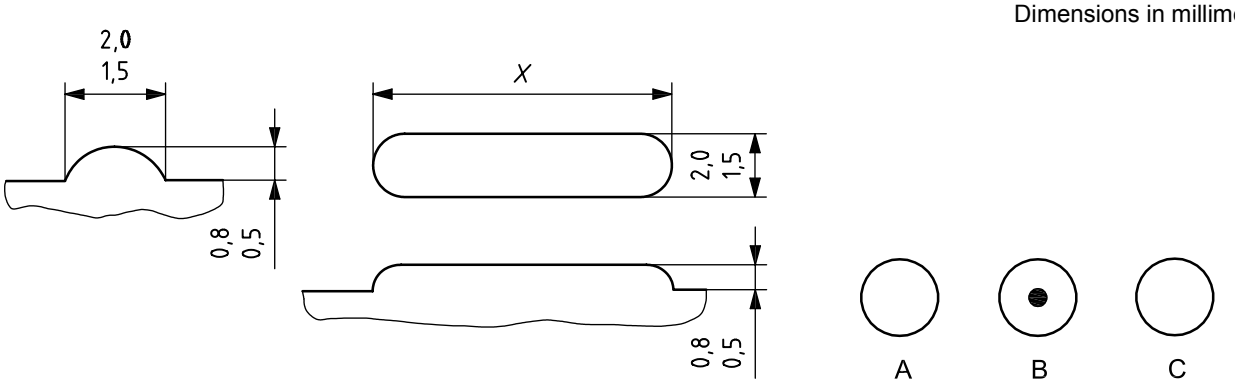
Table 1 — Dimensions of tactile markings used in applications (for fingers)

Unit: millimetres

Dimension		Tactile markings		Braille
		International Standard	National standard	
Raised height of dots, bars and symbols	Dots	0,6 ± 0,2 [47]	0,5 to 0,8 [48] 0,8 to 2,0 [46]	0,4 ± 0,1 [49] 0,7 to 1,3 [46]
	Bars	0,5 ± 0,1 [47]	0,5 to 0,8 [48]	
	Symbols	0,25 to 0,5 (ISO 11683:1997) 0,40 to 0,48 (for embossed characters) (ISO/IEC 7811-1:2002)	—	
Size dimensions of dots, bars and symbols	Dots (diameter)	1,5 ± 0,2 (ISO 11683:1997)	1,5 to 2,0 [48]	—
	Bars (length)	4,0 ± 1,0 [47]	—	
	Symbols (size)	3-4, 9 ± 1, 18 ± 2 (ISO 11683:1997)	10 to 25 [46]	
Inter-dot spacing (for Braille)		—	—	2,13 to 3,17 (depending on country)
Inter-character spacing (for Braille)		—	—	3,13 to 4,05 (depending on country)
Interline spacing (for Braille)		—	—	4,87 to 9,17 (depending on country)

EXAMPLE 3 Convex dots or bars used to show the centre of an operating part or the standard position of a consumer product. Figure 4 shows dimensions and positions of a tactile dot and a tactile bar.

Dimensions in millimetres



a) Tactile dot and tactile bar for selector switch indicating a centre

b) Selector switch using tactile dot

Key

A slow

B standard

C fast

X longer than 5 × width of convex bar

Figure 4 — Examples of tactile dots and bars [48]

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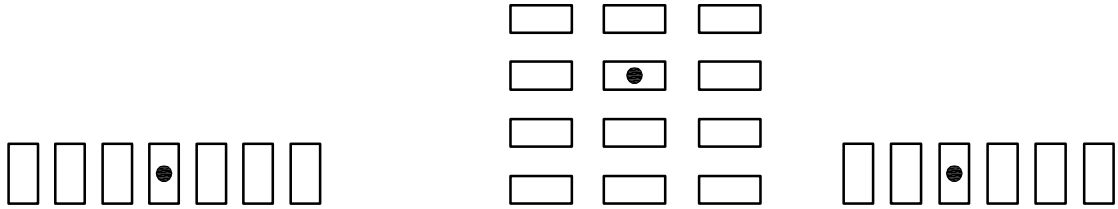


Centre of odd number of controlling part | Centre of controlling part | N/2th position from the left of even number of controlling parts

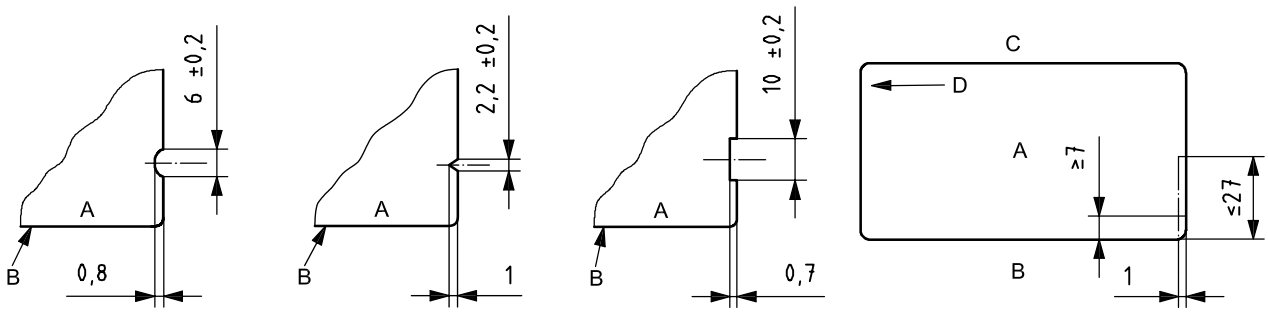
c) Tactile dots used for multiple controlling parts to show a centre

NOTE N is the number of controlling parts.

Figure 4 (*continued*)

EXAMPLE 4 Use notches with different shapes at the edge or on the corner of a card to identify the card type, indicate the direction of card insertion into a machine, or indicate the visual orientation of information presented on the card. Examples of dimensions and positions of notches are shown in Figure 5.

Dimensions in millimetres



For telephone | For transportation | For shopping

a) Shapes and dimensions of tactile notches on cards [50]

b) Location of notch on card

c) Mobile phone SIM card

Key

A front surface of card

B lower edge of card

C upper edge of card

D direction of insertion

The corner part of the notch shall be adequately rounded at the time of processing for the benefit of card-handling by users.

Figure 5 — Examples of tactile notches

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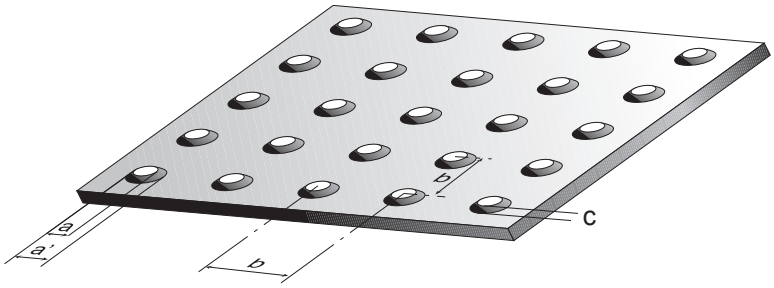
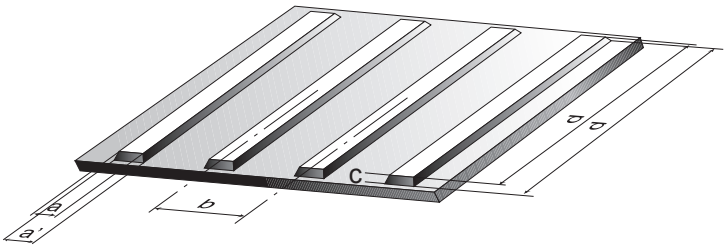
EXAMPLE 5 Use tactile bars or dots installed on the ground and floor surface to aid the mobility of persons with visual impairment. Two patterns of tactile ground/surface indicators are used: a) attention pattern used to call attention to decision points for direction, and b) guiding pattern to direct the direction. Figure 6 shows examples of the dimensions of these patterns.



a) Attention pattern (see Table 2)



b) Guiding pattern (see Table 3)

Figure 6 — Examples of tactile indicators on ground [51]

Table 2 — Dimension of attention pattern shown in Figure 6 a) [51]

Millimetres

Symbols	Dimensions	Tolerances
a	12	+1,5 0
a′	a + 10	
b	55 to 60	
c	5	+1 0
NOTE Within this range of dimensions, one dimension is set in proportion to the size of a block.		

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Table 3 — Dimension of guiding pattern shown in Figure 6 b) [51]

Millimetres

Symbols	Dimensions	Tolerances
a	17	$^{+1,5}_{0}$
a′	a + 10	
b	75	
c	5	$^{+1}_{0}$
d	⩾ 270	
d′	d + 10	
NOTE The distance between the upper surface of the raised parts at the joining part of the blocks (longitudinal direction of the raised part) is 30 mm maximum.		

EXAMPLE 6 Tactile maps to show the routes or layouts of facilities. These include information of present location, tactile ground/surface indicators, stairs, escalators, elevators, entrances and exits, ticket machines, gateways, ticket gates, and information of maps for restrooms including toilet, hand basin, etc.

8.2.2.2 Auditory signals

Auditory signals can be used effectively as an alternative to visual information. They are especially useful for delivering information to visually impaired persons. Auditory signals have the advantage that information can be conveyed to persons who cannot see or whose eyes are already occupied with other tasks such that they cannot attend to a visual display.

Auditory signals used in human-machine interfaces are simple and easy to install, but are sometimes abstract in their meaning compared to spoken instructions. When two or more auditory signals are employed in a product and service or when two or more products and services with an auditory signal are used at the same time and at the same place, those signals are required to be clearly discriminable from each other. Temporal patterns are one of the most robust cues with which the listener discriminates different auditory signals.

The following accessibility considerations are relevant to the use of auditory signals.

— The signals for the same purpose in all products and services have the same temporal pattern across different products and services.

— The signals for different purposes are clearly discriminable from each other.

— The auditory signals are designed functionally so that they can help the user handle the product when visual information is not available or restricted, as in dark conditions.

EXAMPLE 1 Table 4 shows an example of temporal patterns of operation confirmation signals [52]. The reception and start signal indicates the reception of the operation of the apparatus or the start of the action of the product. The stop signal indicates the stoppage of the action of the product. The base point signal indicates the reference position in the case where the plural settings are switched by pushing one button repeatedly.

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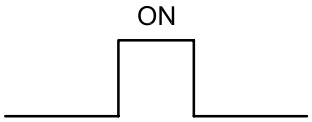
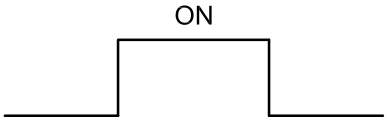
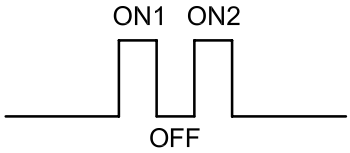
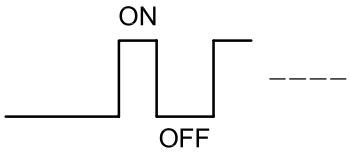
Table 4 — Examples of temporal patterns of operation confirmation signals

Division	Pattern	Type	ON time (s)	OFF time (s)	Information auditory signal
Reception and start signal		Simple signal (one time)	0,1 to 0,15	—	Pip
Stop signal		Simple signal (one time)	0,5 to 0,6	—	Peep
Base point signal	 Remarks: ON time 1 = ON time 2 ON time ⩾ OFF time	Combined signal (one time)	0,05 to 0,075	0,05 to 0,075	Pip pip (quick)

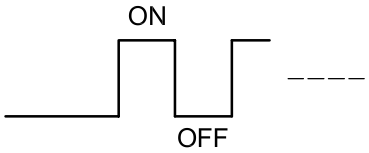
EXAMPLE 2 Table 5 shows an example of temporal patterns of end signals [52]. The end signal indicates the completion of the action after the product has continued the action for a specified time.

Table 5 — Example of temporal patterns of end signals

Division	Pattern	Type	ON time (s)	OFF time (s)	Information Auditory signal
Case of hearing at position distant from the instrument	 Remarks: 1 ON time ⩽ OFF time 2 The number of repetitions is optional.	Simple signal (Repetition)	0,3 to 0,8	0,5 to 1,0	Pip, Pip, pip, pip, … (specified times, slowly)

EXAMPLE 3 Table 6 shows an example of temporal patterns of caution signals [52]. The caution signal indicates that the product cannot be single-handedly in normal motion.

Table 6 — Example of temporal patterns of caution signals

Division	Pattern	Type	ON time (s)	OFF time (s)	Information Auditory signal
Strong caution signal	 Remark: ON time = OFF time	Simple signal (Repetition)	0,1	0,1	Pip, Pip, pi… (quick and consecutive)

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8.2.3 Alternatives to auditory information

Wherever feasible, sound signals should be supported by visual or other sensory stimuli for those with a hearing impairment (e.g. communication in writing, graphical symbols, vibration or sign language). In particular, audible warnings, such as fire alarms, should also activate, for example, visual stimuli, such as flashing lights that are well sited and clearly indicated.

[ISO/IEC Guide 71:2001, 8.2.3]

8.2.3.1 Visual Information

Visual information is one possible alternative to auditory information. Temporal changes of brightness or colour, such as flashing lights, step-changed lights, blinking lights, and flickering lights, can also be used, like auditory signals, to indicate the state of controls such as start, termination and emergency.

The following accessibility considerations are relevant to the use of visual information for signalling.

— A flashing, blinking, and/or flickering light is effective in drawing attention and can be used for conveying task-relevant information to be discerned. However, light that is too bright and a certain range of repetition rates can be avoided to prevent photosensitive seizures. See 8.2.6.

— Choices of colour, colour combination, and intensity of coloured light are appropriately determined. Efficiency of coloured light for detection or discrimination can be taken into consideration for a better choice of visual signalling. See 8.2.5. Some colours have associated meanings such as those related to safety and this enhances the meaning of signs. See 8.8.

— Viewing conditions such as lighting level, brightness level, size, and viewing distance can critically affect the appearance of visual signals. Visual signals can be appropriately designed to consider those viewing factors. Special care can be taken for dark conditions to assure better visibility.

— Graphical symbols as well as text in displays can also be used to convey comprehensive meanings of sound signals. See 8.7 and 8.8.

8.2.3.2 Tactile information

Tactile information is also a useful alternative to auditory information, particularly when vibratory, as in alarm clocks.

The following accessibility considerations are relevant to the use of tactile vibratory signals.

— Human tactile sensitivity to vibratory stimuli depends on the frequency and the part of the body touched. The selection of an appropriate frequency depends on the part of the body with which it is intended to interact. See 9.3.3.2.

— Mode of touch (i.e. active or passive) and temperature of a tactile stimulator are critical for the recognition of tactile stimuli. When skin temperature is too low, the sensitivity to tactile stimuli decreases. See 9.2.3.1.

EXAMPLE Vibration signal used in a mobile phone to indicate receipt of a message.

8.2.4 Alternatives to voice input

Where voice input is used to activate a process, for example, building entry security systems, alternatives such as keypads or the use of video monitoring should be considered.

[ISO/IEC Guide 71:2001, 8.2.4]

A number of biometric and other measures can be used in security systems as alternatives to voice identification and verification. These include keypad or keyboard input of a password and/or username, retinal scanning and identification by fingerprints.

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8.2.5 Biological identification and operation

Where biometric forms of identification are intended, an alternative form of identification or activation should also be provided. For example, if systems require a retinal scan and a person does not have a retina, or the system requires a fingerprint and the person does not have hands or uses a prosthesis, such people are unable to operate the devices unless some alternative form of identification is substituted.

[ISO/IEC Guide 71:2001, 8.2.5]

Voice identification and verification, keypad or keyboard input of a password and/or username, and traditional security measures such as photographic identification and signatures can be used as forms of identification. See ISO/IEC TR 24714-1.

8.2.6 Prevention of seizures

Flicker rates, or flashing or blinking text, objects or video screens should avoid frequencies that are most likely to trigger visually induced seizures.

[ISO/IEC Guide 71:2001, 8.2.6]

The use of blinking or flashing on computer and television screens induces undesirable biological effects, such as seizures, especially in persons who are photosensitive. The extent to which this is a problem depends on the size of the flashing area, the rate of the flashing, and the colour composition of the flashing material. Guidelines on the use of flashing/blinking and moving images so as to avoid such undesirable effects are under development (see also References [41] and [53]). The issue is considered to be applicable to all categories of self-luminous displays such as videos, DVD, computer/video games, movies, and any other form of electric display.

Moving or drifting images, even if they are not flashing or blinking, also cause undesirable feelings such as sickness in some cases. This is called visually-induced motion sickness. The extent of the effect is also a function of screen size, moving type and speed, and contents of the image as well.

The following accessibility considerations are relevant to the use of flashing/blinking and moving images so that these undesirable biological effects can be avoided.

— A sequence of flashes with more than three flashes within any 1 s period can cause undesirable biological effects such as seizures.

  NOTE There is no consensus for the upper limit in a number of flashes that can still cause photosensitive seizures even if it is beyond the frequency that the human visual system can critically see a flickering light [54].

— Rapidly changing image sequences are provocative if they result in flashes on the screen.

— Avoidance of the use of a transition to and from a saturated red, irrespective of luminance, can decrease the possibility of occurrence of seizures.

— Well-lit surroundings of the screen images and viewers can reduce undesirable biological effects.

8.2.7 Alternatives to visually displayed text or graphic information

8.2.7.1 General

Alternative information is “equivalent” to the original information when both fulfil essentially the same function or purpose. Thus, the equivalent fulfils essentially the same function for a person with a disability (at least insofar as is feasible, given the nature of the disability and the state of technology), as the primary information does for a person without any disability.

NOTE This factor has been newly introduced with this Technical Report.

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8.2.7.2 Alternatives to textual information visually displayed

The following accessibility considerations are relevant to the use of textual information visually displayed:

— provision of non-textual information such as pictures, videos or pre-recorded audio as alternatives to textual information visually displayed increases accessibility for persons with cognitive or reading difficulties;

— pictures, videos, or pre-recorded audio that substitute visually displayed text can have information that is equivalent to the corresponding text, e.g. a picture or video of a full moon, or the spoken phrase, “full moon”, can be substituted for the text, “The Full Moon”;

— however, when selecting an alternative graphic, conflicts with common usage of visual signs is avoided, e.g. a graphic showing a full moon is used on heaters to indicate night mode of operation. See 8.8.

NOTE This factor has been newly introduced with this Technical Report.

8.2.7.3 Alternatives to graphical information

The following accessibility considerations are relevant to the use of graphical information:

— provision of textual or pre-recorded audio information as alternatives to graphical information can help persons with visual impairments or blind persons to understand the graphical information;

— text or pre-recorded audio that substitutes graphical information can have information that is equivalent to the information conveyed by the corresponding graphic.

EXAMPLE A picture of a flag is described by text providing the function (e.g. language selection) rather than the visual properties (colour) that are unable to be perceived by a blind person: a picture of a German flag is described by the text “Germany or German” instead of “Flag: black, red, gold”.

NOTE This factor has been newly introduced with this Technical Report.

8.3 Location and layout of information and controls and positioning of handles

8.3.1 Location

The position of information and controls on a product, or in a building, or even the point at which information is available for a service (e.g. warnings about the terms on which dry-cleaners accept clothes for processing) are important. They need to be prominent for someone with a visual impairment or language/literacy disability, visible from the angle of view of someone standing and seated in a wheelchair, and easily accessed by seated or standing users without bending and stretching. This may mean that the positioning needs to be flexible or adjustable or duplicated. Information or controls should be located in a position where they will not be obstructed, for example when a product is held by either or both hands, or held in a different way by someone with manipulation or strength impairment.

[ISO/IEC Guide 71:2001, 8.3.1]

8.3.1.1 Position of information

Detectability of visual information largely depends on its positioning when placed in the periphery of the sight of a person. The detectability depends on the size of the useful field of view, which in turn depends on the viewing condition.

The general shape of the useful visual field is an ellipsoid with the horizontal axis longer than the vertical. The effective range for presenting visual signs is larger in the horizontal direction than in the vertical. The size of the useful field of view becomes larger when the target size is larger, the contrast becomes higher and the colour difference between the target and the background becomes larger also.

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The size of a person's useful field of view is reduced with age and tends to shift to a lower direction (relative to horizontal line), particularly when the person is walking [55]. The useful field of view is considerably limited for persons with low vision. It varies widely in size and shape depending on their impairments, such that persons with macular degeneration have only a limited visual area in the central part of the visual field. Special care needs to be taken for positioning of visual information for those persons. See 9.2.1.5.

The following accessibility considerations are relevant to the positioning of information:

— visual information is placed near the central part of field of view;

— higher contrast, larger size and larger colour difference of the target can increase detectability;

— visual information for older persons can be presented in the lower portion of the environment.

8.3.1.2 Location of controls

Controls are placed such that they can be operated easily by someone standing or seated in a wheelchair, without bending and stretching. The reach envelope of humans is affected by the length and the range of motion (RoM) of upper limbs of the human body. In general, RoM decreases with age, and the reach envelope also becomes smaller. See 8.12.1 and 9.3.2.1.

The following accessibility considerations are relevant to the easy operation of controls:

— controls are easy to reach (see 8.12);

— controls and displays and the way they are grouped together are easy to recognize and easy to assign;

— controls and displays are clearly and meaningfully arranged;

— adjustment steps are implemented logically;

— double- or multi-functional controls are avoided;

— the number of controls required is limited;

— the visibility of controls is considered so that they are placed in the visible range of the user (see 9.2.1.5).

8.3.2 Buildings

The design of buildings can incorporate simple measures that enable people to feel more confident in the physical environment, such as well placed, sturdy handrails. Controls and door handles within easy reach facilitate use by those with impairment in dexterity, manipulation, movement or strength.

[ISO/IEC Guide 71:2001, 8.3.2]

Buildings are designed so that all people can use them without assistance and without restrictions, regardless of their age or their impairment. Accessibility considerations can be given to any building, but are especially important for public buildings and buildings open to the public, as follows:

— rail, road, sea and air travel buildings and associated concourses and car-parks;

— administrative and commercial buildings, e.g. courts, offices, banks, post offices, shops, department stores and shopping centres, and public service buildings, including police stations;

— health and welfare buildings, e.g. hospitals, health centres, surgeries and residential homes;

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— refreshment, entertainment and recreation buildings, e.g. cafes, restaurants, public houses, concert halls, theatres, cinemas, conference centres, community buildings, swimming pools and sports centres;

— religious buildings;

— educational, cultural and scientific buildings, e.g. schools, universities, colleges, zoos, museums, art galleries, libraries and exhibition centres;

— residential buildings, e.g. hostels, hotels, residential clubs, university and college halls of residence, nursing homes and prisons.

In many countries, special laws, regulations, guidelines and standards are of relevance. Some such standards were considered in the preparation of this Technical Report. Detailed measures and illustrations for the construction of parts of buildings are provided via representative examples in 8.12.7 and 8.16. Only those dimensions and representations that are sufficient for the requirement of accessible design are considered.

8.3.3 Layout

> The layout of information and controls will also determine how easy they are to read by someone with a visual or cognitive impairment. Factors to consider include logical grouping of information and controls, line length of text, relevance of information and relationship of controls to actions to be undertaken.
>
> [ISO/IEC Guide 71:2001, 8.3.3]

The layout of controls can be determined considering logical grouping and relationships of controls based on cognitive abilities (see ISO 1503). For text design see 8.7.1, 8.7.2, and 8.7.6.1. For physical issues in layout, see 8.12.7.

Although the logical layout of controls and displays in a system or product is important for all users, it is especially critical for users with visual or cognitive impairment.

The following ergonomics principles and accessibility considerations are relevant to the layout of controls.

— Organize related information into groups and ensure that grouping is made obvious in the display itself.

— Maintain a consistent format from one display to another.

— Clearly label individual displays, so users can easily identify them and understand the relationships between them.

— If tactile markings are provided, ensure that controls are not triggered accidentally by a person feeling the tactile markings.

EXAMPLE 1 Buttons in lifts/elevators are sufficiently separated spatially to avoid misoperation.

— Position controls in a spatial layout on a display or product that corresponds with the layout of the objects they control.

EXAMPLE 2 Objects arranged horizontally are best adjusted by controls also arranged in a horizontal pattern.

— Position controls relative to their use or importance.

EXAMPLE 3 Frequently used controls or those that are safety-critical are placed in a more accessible/prominent location.

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8.4 Lighting levels and glare

8.4.1 Provision of lighting

Appropriate lighting ensures that those with a visual impairment are better able to see instructions and controls. This should also be considered for those with a hearing impairment to assist with lip reading or sign language communication.

[ISO/IEC Guide 71:2001, 8.4.1]

Provision of lighting depends largely on the visual task, environment and visual capabilities of the person. For example, reading small characters requires higher lighting levels to increase visibility, but a lower lighting level is sufficient for relaxing in a living room.

A sufficient lighting level is required to maintain safety, especially in transportation environments such as railway stations, subway stations, bus stops, busy roads and pedestrian areas. Entrances to buildings, stairs, elevators and escalators need also to be lit sufficiently to ensure safety.

For products, a sufficient illumination can be achieved by placing lamps outside (e.g. ticket vending machine, automated teller machine) or inside (e.g. oven, refrigerator). The level of illumination needs to be sufficiently high. Adjustable illumination (e.g. instrument panel) can be used if the product is used at different ambient conditions (e.g. day and night) or if visual capabilities are much different within the user population.

Polished or highly reflective surfaces, as well as glossy papers, can cause a glare from reflected light sources. See 8.18.4.

Appropriate lighting levels for older persons and for persons with visual impairments can be determined by taking into account their visual sensitivity. For many such people, an increased level of lighting may be required. It is noted, however, that there is a large variation in the extent of impairments, and the appropriate level of lighting depends largely on the type of impairment. For example, those who have opacification of the cornea or lens, or albinism, often find it difficult to see in bright light. Care needs to be taken not to cause glare when increasing the light level.

8.4.2 Consideration of ambient lighting

The likely lighting levels in typical use should be considered, for example television controls may be operated in a darkened room, and installation of a product may be in a dark space.

[ISO/IEC Guide 71:2001, 8.4.2]

Lighting for tasks and surroundings can be appropriately designed so that there is no large brightness change between the task and the ambient lighting. Attention to ambient light level for walking areas is also important to ensure safety. This is particularly important for older persons and persons with low vision, because their peripheral vision, which plays an important role in walking, is often limited.

8.4.3 Buildings

Adjustability of lighting levels in a building is desirable to suit different needs but sudden changes in lighting levels should be avoided.

[ISO/IEC Guide 71:2001, 8.4.3]

Appropriate lighting levels in buildings can be defined for each part of the building by taking into account the purpose of the place, such as entrance, living room, dining room, or working room, and the extent of visual impairment. Higher lighting levels may be required for visually impaired persons, depending on the type of impairment, as long as they do not have an effect of severe glare.

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The appropriate lighting level can also be defined by taking into account the type of visual tasks involved. Visual tasks are categorized into the following groups: a) detection of objects, b) recognition of colour, c) reading characters and symbols, d) walking and other behaviour, and (e) relaxation and comfort. For each category, the lighting level can be defined appropriately. Producing a dark spot or bright-to-dark change in buildings causes accessibility problems, because persons with low vision often have difficulty seeing the details of the dark area due to their reduced ability to adapt to sudden changes of brightness.

Standard lighting levels required for various indoor workplaces are defined by the CIE (International Commission on Illumination), see Reference [56] and ISO/CIE 8995-1:2002. They can generally be used for younger and older people as well.

8.4.4 Avoidance of glare

Too high light levels and strong directional light can result in deep shadows or glare. Reflecting surfaces on information panels and glossy paper in instruction books or on packaging containing warnings should be avoided, to reduce the possibility of glare.

[ISO/IEC Guide 71:2001, 8.4.4]

Due to the increase of optical scatter in the eye, the effects of glare are exacerbated for older people and for people with some types of visual impairment (e.g. cataracts, corneal edema, vitreous opacities). Visual acuity decreases in the presence of glare for older people in particular [57]. Recovery from glare also takes more time for older adults, as do light and dark adaptation generally. Glare also causes discomfort and interferes with task performance by decreasing the perceived contrast in visual signs and displays (i.e. disability glare).

The age factor for glare is found in CIE Reference [58]. A unified glare index (UGR) for illumination is also defined by the CIE, and the index for various workplaces is recommended in the CIE Reference [56], although it assumes that light sources are uniform, bright and in the field of view. See 9.2.1.6.

Polished or high-reflection surfaces, as well as glossy papers, can cause glare by reflecting light sources. See 8.18.4.

General solutions to the problem of glare include shielding of bright light sources and the use of indirect lighting for illumination of tasks and workplaces. The following are some considerations for the solutions [59].

— Avoid placing very bright lights against dark ceilings or walls. Choose light-coloured walls and ceilings to soften the effects of bright light.

— Shield bright objects from usual lines of sight. For example, if a light bulb is seen when seated at a dining table, it is better to hide the direct view of the bulb by adjusting its shade or repositioning the fixture.

— Avoid clear lenses or shades on fixtures; they do not shield the light bulb from view.

— Spread light over large areas by lighting ceilings and walls, or by using fluorescent tubes shielded from direct view.

— Choose a deeply recessed fixture to minimize direct view of the bulb when recessed downlights or “cans” mounted in the ceiling are needed.

— Place task lights to the side of the viewer, not in front, to avoid reflected glare from shiny surfaces, like polished wood or glossy magazines.

— Use shades, blinds or curtains to minimize glare from windows.

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8.5 Colour and contrast

8.5.1 Choice of colour

This is important for ease of recognition and ease of seeing. Some colour combinations are also more effective. For example, some colours, such as red/green, are not distinguishable by a significant minority of the population (those with colour blindness).

[ISO/IEC Guide 71:2001, 8.5.1]

Colour is used as a way of marking, distinguishing and drawing attention. The colour appearance of objects or light sources for older persons and for persons with visual impairments, including those with colour deficiencies and low vision, differs from normal colour appearance. Careful choice of colour or colour combinations for those persons increases accessibility.

Colour appearance also changes with luminance levels. At lower luminance levels, namely a few cd/m^2 or 10 lux, bluish colour looks relatively brighter and reddish colour on the contrary darker. Colour becomes more desaturated as luminance decreases. Care can be taken in choosing appropriate colours for use in low luminance. See Annex D.

Colour appearance also changes with age. A typical example of the change for older persons is that bluish colour looks darker due to the absorption of the short-wavelength (blue) component of light in the eye lens (yellowing of the eye lens). Letters coloured blue on a dark background are good examples difficult-to-see for older persons. White appears yellowish, also due to the yellowing of the eye lens, and this brings older people poor colour discrimination between white and yellow.

For the special use of colour for safety, a set of colours is defined in ISO 3864-1:2002.

The following accessibility considerations are relevant to the use of colours and colour combinations:

— Whenever colour is used to convey information, the information accompanied by other non-colour information such as figures or letters can increase accessibility. See 8.2.1.

— Use of too many colours can cause accessibility problems.

— When blue is used, higher luminance of the colour or higher illuminance than the moderate level can increase accessibility for older persons. See 9.2.1.1.

— The colour combinations of green/red and yellow/blue are used with significant luminance contrast for persons with colour deficiencies to avoid confusion of the colours.

— Persons with low vision have reduced discrimination and identification of colours. Care in the choice of colours can increase accessibility for those persons.

8.5.2 Colour combinations

The best colour combinations depend on the purpose of information, whether it is for guidance or a hazard warning, and the lighting conditions under which it is most likely to be viewed. For example, black on yellow or light grey are general purpose combinations which provide strong definition without too much glare, pastel shades on pastel backgrounds or red lettering or symbols on light grey are difficult to see and should normally be avoided.

[ISO/IEC Guide 71:2001, 8.5.2]

Colour combination is a useful tool for identifying and discriminating objects. Colour appearance changes with age, visual impairments, and luminance levels can be taken into account in creating colour combinations to increase visibility. See 8.5.1.

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A conventional method of colour combination is to use opponent colours, such as red/green and yellow/blue. Some combinations of red and green, however, are difficult to discriminate by persons who have colour deficiency. Colour discrimination ability is reduced for people with low vision. Luminance contrast can help the discrimination of colours for those people.

Colours are perceived as a limited number of “similar-colour” groups, such as red, orange, yellow, green, etc. This is called categorical colour perception and is widely used in the application of colour and colour combinations. See 9.2.1.3.

The following accessibility considerations are relevant to the use of colour combinations.

— Large luminance contrast can greatly help persons with colour deficiency, as well as those with low vision, to discriminate colours.

— Colour combination by colours of different colour categories increases detectability. See 9.2.1.3.

Table 7 presents gives colour combinations that are recommended for signs and background in self-luminous displays [46].

Table 7 — Colour combinations for signs and backgrounds

Background colour	Sign colour							
	Black	White	Purple	Blue	Cyan	Green	Yellow	Red
Black		+	+	–	+	+	+	–
White	+		+	+	–	–	–	+
Purple	+	+		–	–	–	–	–
Blue	–	+	–		+	–	+	–
Cyan	+	–	–	+		–	–	–
Green	+	–	–	+	–		–	–
Yellow	+	–	+	+	–	–		–
Red	–	+	–	–	–	–	+	

+ very suitable

– not suitable

NOTE The colour combination of black and purple in Table 7 usually does not appear well in high contrast of luminance due to the age-related sensitivity loss for blue and purple lights for older people. Purple can be used with higher luminance in this combination.

8.5.3 Colour coding of information

All information conveyed with colour should also be available without the perception of colour. Colour coding should not be used as the only means for conveying information, indicating a response or distinguishing a visual element.

[ISO/IEC Guide 71:2001, 8.5.3]

Coding of information by colour is a simple and useful way of making it easily perceivable, identifiable and distinguishable. Colours used for such purposes can be selected based on categorical colours as described in 8.5.2 and 9.2.1.3.

Under some viewing conditions, however, such as in low luminance, and for some persons with colour deficiencies, colours are difficult to discriminate. Accompanying the use of colours that are used for coding by

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other forms of coding (such as: textual, graphical, auditory and/or tactile information) increases accessibility for those with colour deficiencies and low vision. See 8.1.

Some colours have their special associated meanings. See 8.2.3 and 8.8.

8.5.4 Luminance contrast

Contrast of luminance is one of the most critical factors for visibility. The higher the contrast, the better the visibility. The sensitivity to contrast for fine images decreases with age due to optical scattering in the eye. The contrast sensitivity is much lower for persons with low vision due to various types of visual impairments. See 9.2.1.7.

Effective luminance for different colours changes with age and consequently the contrast of colours changes. See 8.5.1, 9.2.1.1 and Annex B.

The following accessibility considerations are relevant to the use of luminance contrast.

— High contrast is clearer in public signs or images and in characters of visual display terminals (VDT).

— Luminance contrast increases discrimination when colours are not well discriminated from each other.

— Extremely high contrast, such as black and white, can cause accessibility problems by generating glare for older persons and persons with low vision.

— Adjustable contrast can increase accessibility.

NOTE This factor has been newly introduced with this Technical Report.

8.6 Size and style of font and symbols in information, warnings and labelling of controls

The required size of font for information, warnings and labelling of controls, relates to the probable viewing distance, level of illumination and colour contrast of the text against its background. The choice of font, whether with or without serif, in upright form or italics and light, medium or bold appearance also has a significant impact on legibility. Standards developers should also be aware that text written in CAPITAL letters is more difficult to read. This is significant for those with a visual impairment. Consideration should be given to specifying size and style of font and symbols for warnings.

[ISO/IEC Guide 71:2001, 8.6]

8.6.1 General

With increasing age, the lens in the eye loses elasticity and the ability to focus clearly. The legibility of font and symbols is associated with the reader's ability to visually discriminate one character from another, and is affected by the physical construction and properties of the font or symbol. Legibility is different from readability, which addresses the meaningful grouping of alphanumeric characters to form words or sentences. Readability is affected by grammar, writing style, or even the spacing between characters or sentences.

Persons with low vision tend to prefer light text on a darker background rather than darker text on a light background. See Figure 7.

Figure 7 — Examples of polarity

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The following accessibility considerations are relevant to the use of style and size of fonts.

— The context in which the font is used can affect the combinations of sizes, styles and colours that can be used to improve accessibility.

— Appropriate font size and style for various presentation media, such as printed information and display screens, can increase accessibility.

NOTE Other International Standards provide additional guidelines for various situations (e.g. ISO 9241-303 for displays).

— Fonts in negative polarity can improve accessibility for persons with low vision.

For tactile characters, see 8.2.2.1. For graphical symbols see 8.8.

8.6.2 Font size

A reader's visual acuity is one of the critical parameters that affect the legibility of letters or symbols. The better the visual acuity he or she has, the smaller the legible font size he/she can see. Viewing contexts affect visual acuity. Visual acuity is a function of luminance and viewing distance. The acuity becomes worse as the luminance decreases. The acuity in near viewing distance (less than about 1 m) becomes worse with ageing. See 9.2.1.2.

The following accessibility considerations are relevant to font size.

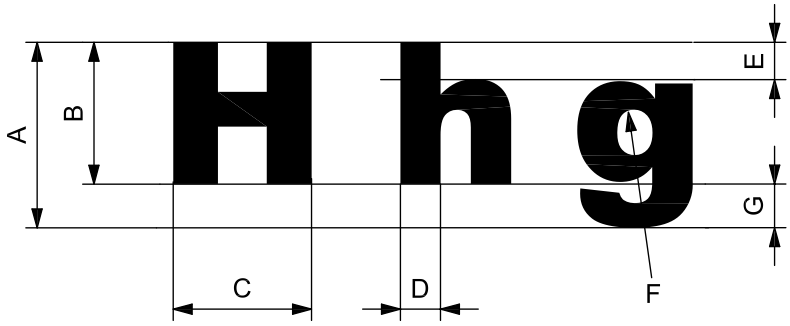
— A larger font size can improve accessibility under low luminance conditions.

— A larger font size can improve accessibility for older persons at near viewing distances.

NOTE "Luminance" here means the luminance of the background (brighter part) when positive picture polarity is used, or luminance of the letter (brighter part) when negative picture polarity is used.

8.6.3 Font style

Font style is also a factor affecting legibility. Figure 8 shows the characteristics concerning font style.



Key

A body height
B font height
C font (body) width
D stroke width
E ascender
F counterform
G descender

Figure 8 — Font characteristics

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The following font design characteristics can improve accessibility for older persons and persons with low vision:

— consistent stroke widths;

— open counterforms (the open space in letters like “e” and “a”);

— clearly visible ascenders and descenders (such as tails on the lower case letters “b” and “j”);

— wider horizontal proportions;

— extended horizontal strokes for certain letterforms (such as the arm of the lower case “r” or the crossbar of the lower case letter “t”).

The fonts used in Figure 9 highlight the differences between several styles.

a) Poor legibility **b) Good legibility**

Figure 9 — Font style comparison

Figure 9 b), “Good Legibility”, uses a font created by the American Printing House for the Blind that is well suited for users with low vision. Other specially created fonts may also be investigated by standards developers.

For older persons, there is some evidence that serif fonts assist reading speed, while sans-serif fonts are actually preferred subjectively. With high resolution displays or printed hardcopy, it is preferable to focus on overall font design, and ensure that serifs, if present, do not negatively affect legibility. However, as Figure 10 shows, when the output resolution (either on paper or screen) is low, a sans-serif font can increase accessibility because there will not be enough dots or pixels to render the serifs clearly.

a) Serif font **b) Sans-serif fonts**

Key

A serif

Figure 10 — Serif and sans-serif fonts on low-resolution 5 × 7 dot-matrix display

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The following are further accessibility considerations for font styles [46].

— Bold letters generally have better visibility than plain ones provided that the line width is not too great.

— The ascenders of lower case characters project above the type height by approximately 20 %.

— Lower case characters with descenders project below the line of text by approximately 20 %.

— Characters are designed to avoid confusion, e.g. between the number zero “0” and the letter “O”, between upper case “i” (“I”) and lower case “L”(“l”).

Font style is not only an issue for visual abilities, but guidance on font styles also exists in relation to the needs of persons with dyslexia. At the most basic level, the sans-serif fonts should be avoided, although a more complex recommendation is to enable the reader to choose his or her own font, as situations do vary between persons with dyslexia.

8.6.4 Special consideration for fonts used in display screens

Visual appearance of self-luminous screen displays is different from reflected images used in printed information (hardcopy documents, books), and the difference affects accessibility of display design. In particular, the appearance of contrast and colour in self-luminous displays differs from that of reflected images, even if the physical characteristics of the light are the same.

Contrast values for a certain range can increase accessibility of screens. See 8.5.4 and 9.2.1.6.

8.7 Clear language in written or spoken information

8.7.1 Information available as text

Information should be made available in text format wherever possible, in addition to other forms, to facilitate recognition and translation into speech and other languages for those who have trouble seeing, recognizing or deciphering non-text information presentations. [ISO/IEC Guide 71:2001, 8.7.1]

Products comply with IEC 62079:2001 if the instructions are prepared in the languages of the country in which the product is to be marketed (see References [34] and [60]).

The following accessibility considerations are relevant to user instructions.

— All essential information can be presented in alternative formats so that it can be perceived and recognized unambiguously. Specialists are consulted when preparing user instructions in Braille or Braille shorthand. For essential information, the use of graphics and graphic elements can be supplemented by explanations in text (see 8.2.7), which also allow the preparation of audio user instructions.

— The user instructions can be structured both visually and logically.

— Audio user instructions (cassette, CD, MP3, Daisy Book, etc.) are usually preferable to a version in Braille. A point in their favour is that an audio version is also accessible to blind persons who are not familiar with Braille. At least with complex products such as telephone systems, a short instruction manual in Braille is preferable.

— Electronic user instructions (such as those on the Internet or on data media supplied with the product) can be prepared in an accessible format, e.g. HTML format according to the guidelines of the Web Accessibility Initiative (WAI) of the World Wide Web Consortium or accessible PDF. Accessible formats can be used in preference to graphical formats (e.g. PS, GIF and JPEG) or offered as an alternative.

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8.7.2 Complexity of information

Instructions or operations which are too complex will often deter older persons and persons with limited intellect from using a product or device. Simple written or spoken messages are also clearer to understand by someone with a visual or hearing impairment.

[ISO/IEC Guide 71:2001, 8.7.2]

Effective communication is promoted by using clear and simple language. Persons with cognitive or learning impairment often have difficulties accessing written information. Using clear and simple language is also useful for persons with a different native language, including those who communicate primarily in sign language.

Keeping document layout consistent, designing apparent graphics and using easily understandable language benefits a wide range of users, especially persons with cognitive impairment and those who have difficulty reading.

The following accessibility considerations are relevant to communication with persons with cognitive impairment or learning disabilities and for those who have difficulty reading.

— Use the clearest sentences and simplest words appropriate for the content of the document.

— Supplement text with graphic or auditory presentations where they will facilitate comprehension of the document.

— Create a style of presentation that is consistent across the document.

8.7.3 Printed instructions

These should use short sentences of simple, straightforward and non-technical language and may include simple illustrations.

[ISO/IEC Guide 71:2001, 8.7.3]

No additional guidance is offered.

8.7.4 Spoken information

Rules for spoken information are similar to those for printed information. The context should always be given to ensure that information is meaningful and instructions should be provided in a logical order. Key points should be reinforced by repetition. People with hearing loss are at an increased risk or disadvantage if spoken announcements are not loud enough, or if the pitch is too high or too low.

[ISO/IEC Guide 71:2001, 8.7.4]

8.7.4.1 Sound level of spoken announcements

The sound level of announcements, or voice instructions, has a large influence on the comprehension of spoken information. Announcements are required to be comfortably loud for listeners; announcements that are too soft or too loud may not be fully understood. Spoken announcements sound comfortably loud when the listener can recognize them nearly 100 % without any special effort.

The comfortable sound level for announcements depends on the environment in which they are presented. In quiet environments, the absolute level of announcements is a key factor. Persons with age-related hearing loss prefer louder speech. However, the amount of increment required is not very large: a few decibels on average.

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In noisy environments, the difference between the level of an announcement and that of the background noise determines the intelligibility of the announcement. When the noise level is low, the effect of noise is usually negligible. When the noise level is high, a constant signal-to-noise ratio is required to attain comfortable listening. Control systems that adjust sound level automatically are available to keep a certain signal-to-noise ratio, and are sometimes used for spoken announcements in public spaces as well as for acoustic traffic signals. When the noise level is even higher, people tend to have difficulty in speech communication. Provision of necessary information in an alternative form of instruction can increase accessibility. For more detailed descriptions of preferred speech levels in noisy conditions, see 9.2.2.3.

Some persons with severe hearing loss prefer an even higher speech level, depending on their hearing profile.

8.7.4.2 Cognitive aspects of voice instruction

Voice instructions are widely used, not only as an alternative format for visually impaired people but also for general information for all people in private as well as public spaces.

Cognitive aspects of auditory processing decline with age. Older people have more difficulty than younger ones in ignoring irrelevant information from one source when processing relevant information from another. They also require more time to switch their processing from one source of auditory input to another. Older people also have greater difficulty in perceiving auditory information via synthetic speech. They also learn new tasks and respond to instructions more slowly. For some persons who have faster processing ability, a slower speed of voice instruction does not necessarily improve their performance. If a task requires that older people simultaneously process or manipulate information, as well as remember it, performance also declines.

Many of the cognitive deficits that accompany increasing age are also seen in younger persons with cognitive disabilities.

The following is relevant to the accessibility of systems and products providing voice instructions.

— Minimize background noise and reverberation when recording voice instructions, and provide the user with the capability to adjust the volume of the presented instructions, where feasible.

— Consider using male voices for instructions, as these voices are sometimes better understood by users with high-frequency hearing impairments. This is especially desirable for voice instructions transmitted over telephone lines. However, there are other considerations relevant to determining the gender of a voice used for instructions (e.g. cultural issues), which can make the use of a female voice preferable.

— Because voice is a serial transient medium, design instructions that are simple to understand and minimize the number of responses a user has to make to a single instruction.

— Minimize requirements on short-term memory. See 9.4.3.

— To address slower processing speeds due to ageing or certain cognitive impairments, use repetitive voice instructions or descriptive information for some users. Provide systems that employ voice prompts or instructions with the capability of replaying instructions on request.

— Consider using a speech rate of approximately 140 words/min for voice instructions, and lengthen pauses between sentences (beyond that of normal speech) to allow more time for processing information. It is advisable to test the product or system with the intended users in order to determine the speech rate and pause length that yield the best performance and highest level of user acceptance.

— Provide users with sufficient time to respond to voice instructions. Older people need at least one and a half times as long to respond verbally to voice instructions, compared with younger ones. They often need considerably more time if a manual response is required (e.g. inputting a number via keypad) instead of, or in addition to, the vocal response. Thus, application response time allowances need to be determined through evaluation that includes older people and persons with physical, cognitive and sensory impairment, if they are members of the intended user group.

— If instructions are to be given in a public setting, consider providing wireless headsets for the benefit of older users, if appropriate to the task situation.

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8.7.4.3 Voice warnings or alerts

Voice warnings and alerts differ somewhat from general voice instructions, in that attracting the attention of the user is a priority. Data suggest that female voices have a greater attention-getting ability than male voices. However, recommendations concerning the use of male vs. female voices are sometimes culture-dependent; for example, male voices are used in fire-alarm systems in Japan.

The appropriate sound pressure level and frequencies for warnings and alerts all differ generally somewhat from voice instructions. See 8.7.4.2.

8.7.4.4 Speech communication in noisy environment

A spoken announcement is understandable when the signal-to-noise ratio is above a certain level. It is comfortably audible for listeners when the signal-to-noise ratio is above a certain threshold (higher than that required for complete understanding).

The boundary of signal-to-noise ratio, both for understanding and comfortable listening, can be determined for young and older listeners. See Figure 43 and ISO 9921.

8.7.4.5 Speaking rate

The speaking rate is defined as the number of speech items uttered in a unit time period. The rate is expressed, for example, as the number of words per minute or the number of syllables per second. A normal rate is, for example, 140 to 170 words/min in English or 8 to 9 mora/s in Japanese. See 8.7.4.2 and 8.10.2.1.

NOTE *Mora* is a unit of sound related to pronunciation, while *syllable* is a unit of sound consisting of a vowel or of a vowel and a consonant or consonants.

8.7.5 Multiple languages

Where instructions are to be provided in more than one language, written information in each language should be presented in separate sections of a manual rather than interleaved on a page; spoken information should be preceded by a clear statement in the language to be used.

[ISO/IEC Guide 71:2001, 8.7.5]

Identification of the language used in a document and the meaning of abbreviations and acronyms is essential. This will improve the readability of the information for all persons.

If instructions are required in more than one language, the instructions for each language can be kept separate and not mixed. Spatial separation of the printed instructions in each language, if printed in the same document, or use of a separate document for the instructions for each language, facilitate accessibility. Identification of the language in the application content also facilitates accessibility.

EXAMPLE “Fine” in English and “fine” in Italian have different meanings, although their spellings are the same. If the language is not identified, they cannot possibly be distinguished.

In the case of abbreviations and acronyms, someone unfamiliar with a particular abbreviation or acronym will not understand what it means. An explanation of each abbreviation or acronym where it first appears in the text facilitates accessibility.

NOTE *Language* means spoken, written, or signed languages such as French, Japanese, American Sign Language and Braille.

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8.7.6 Other factors

8.7.6.1 Document navigation mechanisms

Clear and consistent navigation mechanisms increase the likelihood that people will find what they are looking for in a document and improve readability for all people.

Provision of information about the document layout (e.g. a table of contents for documents or a site map of a Web site) can increase accessibility.

NOTE This factor has been newly introduced with this Technical Report.

8.7.6.2 Language support

Persons who have difficulty in reading, writing or speaking often also have difficulty in using products and services safely and effectively.

The following accessibility considerations are relevant to language support.

— For users who have difficulty reading or who are illiterate:

  1) consider using speech displays for instructions and prompting of actions, as well as the use of multi-media instructional material, including video instructions;

  2) consider the use of task-relevant graphics (e.g. illustrations or photographs) as a supplement or a substitute for text instructions.

— For users who have difficulty writing or typing, minimize the amount of writing or typing required, and consider substituting speech recognition as an input mechanism.

— Provide equivalent alternatives to speech input (e.g. use of keyboard) for users who have difficulty speaking or cannot speak.

— Provide multi-language user interfaces, if appropriate.

— Use simple, unambiguous and easy-to-understand language.

— Avoid difficult terms, complex grammatical structures and long sentences.

— Avoid use of the passive tense.

NOTE This factor has been newly introduced with this Technical Report.

8.8 Graphical symbols and illustration

> The use of meaningful graphical symbols or illustrations, in addition to text, should be considered in instructions and also on a product, for ease of assembly or use. For example the same symbol should be used on the respective ends of parts to be joined, when assembling a product, or in the labels on controls.
>
> [ISO/IEC Guide 71:2001, 8.8]

Graphical symbols as well as pictorial illustrations constitute useful tools that allow people to identify objects, convey meaning and communicate. The use of these symbols and illustrations in addition to text helps people understand the content of the text. International Standards on graphical symbols include ISO 7000, ISO 7001, ISO 7010, ISO 9186 and ISO/IEC TR 19766:2007, as well as References [61] and [62]).

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The following are accessibility considerations relevant to the design and use of graphical symbols and illustrations.

— The same design principles and basic forms, as well as combinations of them, facilitate the understanding of the symbols.

— Special colours or forms are assigned to special attributes of objects, such as safety. For colour coding see ISO 3864-1.

— Some colours have their own special meanings that depend on the culture concerned.

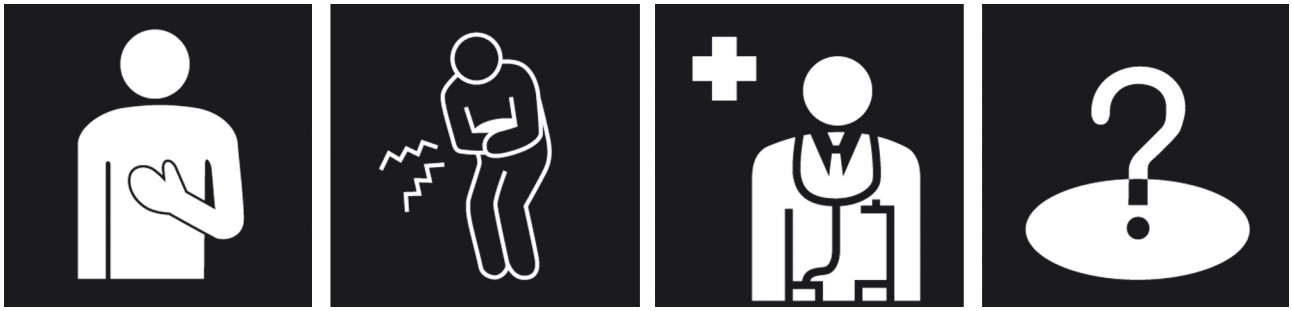
— Graphical symbols and illustrations in the standards cited above can be used.

— For tactile symbols see also 8.2.2.1.

For examples, see Figure 11, taken from ISO 7010 and ISO 7001, and Figure 12 [62].

Telephone | Fire extinguisher | Non-potable water

Figure 11 — Examples of graphical symbols



"I have a stomach-ache. Where is a doctor?"

NOTE ISO 7010:2003/Amd.1:2006 uses a symbol for a doctor different from the one used in Figure 12. See Figure 13.

Figure 12 — Example of communication using graphical symbols

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Figure 13 — Doctor symbol as used in ISO 7010:2003/Amd.1:2006

8.9 Loudness and pitch of non-spoken communication

People with a hearing loss are at increased risk or are disadvantaged if warnings are not loud enough, or if the pitch is too high or too low. Where possible, volume should be adjustable over a wide range. Information should also be presented in multiple frequencies where possible (e.g. an alarm sign signal could consist of a strong component at multiple frequencies). Sudden changes in volume should also be avoided.

[ISO/IEC Guide 71:2001, 8.9]

Sensitivity to higher-frequency sounds decreases with age. This is a key factor when determining a range of sound pressures and frequencies for auditory signals that are to be heard in a quiet environment. See 9.2.2.1 and 9.2.2.2.

When an auditory signal is used in a noisy environment, the sound pressure level difference between the signals and interfering noises becomes critical; a signal level higher by a certain amount than that of the noise can increase accessibility. Comfortable levels of auditory signals in quiet and noisy conditions, taking into account ageing effects, have been determined experimentally. See 9.2.2.2.

For alarms in work and public areas, a sound at an even much higher level is sometimes required to assure audibility. For details on the use of sound in warnings and danger signals, see ISO 7731.

8.10 Slow pace of information presentation

Announcements spoken at a slow measured pace allow listeners to pick out the message; pauses between instructions give time to understand and act on the information. If a message is delivered too rapidly, it is difficult to assimilate by someone with a hearing or vision impairment, or learning disability. Consideration should be given to the length of time information remains in view when presented on moving displays, or when information is temporarily displayed and then removed.

[ISO/IEC Guide 71:2001, 8.10]

8.10.1 Operation not depending on user's memory

Persons with cognitive impairment and older persons tend to forget recently presented information or recently executed actions because of declines in short-term and working memory. Thus, minimizing the degree to which systems and products require memory of prior actions or operations facilitates accessibility. There is a variety of ways in which this can be accomplished, including the following:

— automated customer service applications over the phone can allow callers to pause or repeat messages;

— applications with visual displays can show a list of the most recent user actions or allow information that is referred to later to persist on the display;

— the appropriate pace of information presentation in electric marquee displays can facilitate comprehension of the users.

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8.10.2 User control of time-sensitive content changes

8.10.2.1 Control of auditory information presentation

The following accessibility considerations are relevant to auditory information presentation, including prerecorded speech and synthetic speech.

— The comfortable speaking rate for broadcasting to older listeners is 6 to 7,2 mora/s. In contrast, the typical speaking rate in Japanese broadcasting is approximately 8 mora/s. Many blind persons prefer a faster speech rate, e.g. approximately two to four times the rate of normal speech. Adjustable speech rates covering the wide range of individual differences in preferred speech rate increases accessibility.

— Comprehension can be facilitated by lengthening the pauses between sentences, instead of or in addition to decreasing the rate of speech itself.

8.10.2.2 Control of visual information presentation

Some persons with cognitive or visual impairment are unable to read moving text quickly enough, if at all. Unnecessary movement of display content (e.g. non-task-relevant animation) distracts the user from task-relevant information and interferes with the task performance, particularly in the case of older users and those with cognitive impairment. In addition, assistive technology relies on a certain amount of stability of displayed content.

The following accessibility considerations are relevant to visual information presentation with respect to user control of time-sensitive visual content.

— Avoid causing the screen to flicker. See 8.2.6.

— Avoid causing the content to blink, or else allow users to control blinking. See 8.2.6.

— Allow users to freeze or slow moving content, and avoid unnecessary movement of the content of visual displays.

— Provide the capability to interrupt changes in displayed information until the current information is dealt with.

— Provide the ability to control the rate of speech, if speech output is included in an application or product. See 8.7.4.5 and 8.10.2.1.

8.10.3 Time-constrained task design

Older persons and persons with cognitive impairments often cannot complete tasks or respond to stimuli in a specified or limited amount of time. If systems place limits on the time required for responses, the option to request additional time can increase accessibility for users to complete tasks. In those cases where time limits are set, such limits can be determined through evaluation of the expected user group.

EXAMPLE In telephone-based applications, a user is often required to respond to a voice prompt within a set amount of time (e.g. 2,5 s), after which he/she is presented with an error message due to a partial response or no response at all. Such applications can instead be designed to ensure that there is a time limit imposed on responses.

The following is relevant to time-constrained task design accessibility.

— Accommodate the slowest user.

— Prompt users to request additional time if it appears more time is required.

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— Provide a wait message if users are faster than the systems. The wait message presented by means of at least two senses increases accessibility. See 8.2.

— Allow users to interrupt (i.e. pause) the presentation of a long voice message or instruction. If pause functionality is provided, it is helpful if the user can continue presentation of the message from the point at which the pause occurred with a single action or command (e.g. “Resume” function). See 8.7.4.2.

8.11 Distinctive form of product, control or packaging

8.11.1 Identification by form

A distinctive form can make it easier for those with visual impairment and reduced touch sensitivity to identify a product, to interpret the parts of a product to be joined during assembly and to distinguish between different controls. A familiar form can also aid those with impaired cognitive ability.

[ISO/IEC Guide 71:2001, 8.11.1]

Considerations on properties of tactile sensitivity (i.e. spatial resolution, form recognition, etc.) in designing distinctive forms increase accessibility of product, control or packaging.

EXAMPLE Coins of almost all countries have differing sizes, shapes and tactile grooves differentiating specific monetary values.

8.11.2 Orientation of product or control

Where possible, the form of the product or control should also indicate the orientation of the product or control, so the top or bottom, front or back, can be easily located by someone with a visual impairment.

[ISO/IEC Guide 71:2001, 8.11.2]

Tactile marking is a useful tool to indicate the orientation of the product or control. See 8.2.2.1. The location of tactile marking critically affects accessibility and similar positioning and spacing of markings facilitate accessibility.

EXAMPLE A prepaid card has a notch near the bottom-right corner so that users can know the correct direction for inserting the card into the machine. See 8.2.2.1 and Reference [63].

8.11.3 Tactile warnings

The use of universally recognized tactile warnings on the container or packaging enables identification of toxic or corrosive materials. Similarly, tactile warnings are normally required in buildings, such as at stair openings, on steps, on platforms and at dangerous storage areas.

[ISO/IEC Guide 71:2001, 8.11.3]

Tactile information of a common meaning is useful for identifying and avoiding a particular product containing toxic or corrosive materials. This can be used for indicating danger to visually impaired persons.

EXAMPLE A tactile triangle or a three-pointed symbol is used to indicate dangerous contents of containers. It is placed on the handling surface such that users will notice it immediately when they hold a container. See ISO 11683.

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8.12 Ease of handling

8.12.1 Size, shape and mass

These characteristics of a product will affect how easy it is to lift, hold and carry. Lifting and carrying is eased if articles are shaped to facilitate easy grasping, with either or both hands. Light, compact articles are generally preferable thus the density of manufacturing materials needs consideration. Provided safety is not compromised wherever possible, products should be capable of operation by only one hand, preferably either hand.

[ISO/IEC Guide 71:2001, 8.12.1]

Products of appropriate size, shape and mass that meet the needs of the target user population and the task facilitate accessibility. For example, users drop objects they are required to whose weight exceeds their strength or gripping ability. The aspects of handling which require particular attention to ensure ease of use by a greater number of older persons or persons with disabilities are summarized in Table 8.

Table 8 — Aspects of handling for ease of use

Aspect	**Influence of the aspect in a product or service**	**Example**	**Additional data**
Strength required	For a product to be handled easily with one or both hands, avoid excessive load of the skeletal muscle of upper limbs (i.e. muscles that contribute to forward elevation of upper limbs or holding of products, and so on). The muscular strength of the skeletal muscle is greatest in youth and middle age.	The strength does not exceed 30 % of the physical strength of a 5th percentile woman [46].	See 9.3.4
Posture	Some users have difficulty kneeling or squatting. Some users are limited to a seated position or are unable to bend joints.	Ensure products/services can be used while seated.	—
Reach and grasping area	Users have a limited region to comfortably reach and grasp objects.	An example of the grasping area is shown in Figure 14 [46].	See 9.3.2 & 9.3.2.1
Safety	Users can be injured if required to reach over unsafe areas, such as hot surfaces, or if handling unexpectedly sharp objects.	—	—
Angle of rotation of the joints	Some users have difficulty rotating their wrist or arms through large angles.	—	See 9.3.2.3
Frequency of actions	Strain on a joint can result from repeated actions, particularly where force is excessive.	—	—
Movement speed	Some users have difficulty moving quickly.	—	See 9.3.3
Precision required from movements	Some users have coordination difficulties or tremor, making simple actions like inserting a key more difficult.	—	—
One-hand use	Some users have only one functioning hand. Products can be designed for one-handed use of either the left or right hand.	—	—

EXAMPLE Grasping area for right and left hands [46]. See Figure 14.

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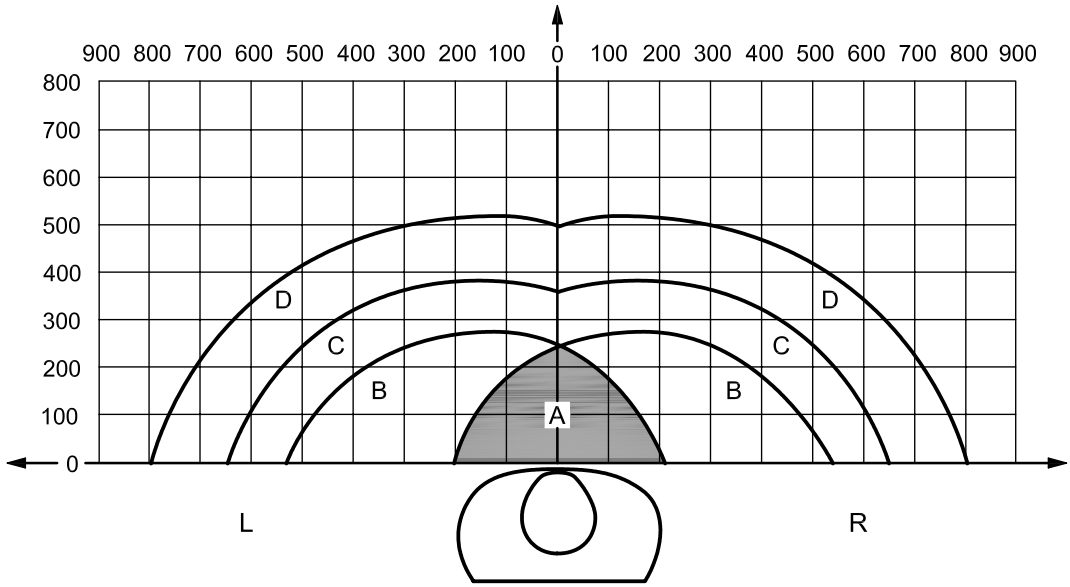
Dimensions in millimetres



Key

A optimum grasping area for both hands (envelope curve)

B optimum grasping area (envelope curve)

C functional grasping area (envelope curve)

D extended grasping area (envelope curve)

L left hand

R right hand

NOTE These envelope curves are related to the body size of the 5th percentile of women grasping with three fingers at a work surface height of 750 mm [46].

Figure 14 — Grasping areas

8.12.2 Instruction manuals and location of markings

The size, number of pages and weight of paper used in an instruction manual can affect the ease with which it is held and pages are turned, which will influence the extent it is used. [ISO/IEC Guide 71:2001,8.12.2]

The following accessibility considerations are relevant to the use of instruction manuals for products.

— User instructions that contain information about placement, configuration or attachment of the product ensure accessibility. This also applies to products that require installation, if the installation of the product is not restricted exclusively to a qualified fitter.

— User instructions that are restricted to the type and design of one product can increase accessibility.

— The binding of printed instruction manuals such that pages remain open easily (e.g. spiral binding) can increase accessibility.

— Instruction manuals printed across the fold of paper can cause accessibility problems.

— Accessibility of audio user instructions is increased with a structure using suitable means such as acoustic signals or tracks (CD, audio cassette, Daisy Books) enabling a desired chapter to be found more

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easily. For tapes, acoustic signals can be indicated by means of low-frequency signals that can only be heard during fast-forward or fast-rewind.

8.12.3 Controls

8.12.3.1 Handling

The force required to twist, turn, push or pull controls or fastenings is significant for people with various impairments. Operating controls should allow comfortable grip, avoid twisting of the wrist, avoid the need for simultaneous actions and offer minimal resistance. Textured surfaces, to increase friction, assist the application of force. Provision of alternative controls offering greater leverage or power-assistance should be considered. Reprogrammable operation and personal preferred settings can be effective, particularly for people with cognitive impairment.

[SO/IEC Guide 71:2001, 8.12.3.1]

The following accessibility considerations are relevant to operating controls.

— Easy to reach controls increase accessibility. See 8.12.1 and 9.3.2.1.

— The force transfer can be supported by an appropriate mechanical design for handling.

EXAMPLE 1 It is easier to grab and move a knob or a hand grip if it fits into the hand.

EXAMPLE 2 Non-slippery surfaces can be used when friction force is utilized.

— Combined adjustment movements (such as simultaneously pressing and turning) cause accessibility problems.

However, for safety reasons some combined movements (such as child-resistant containers) may be used. See 6.2 for accessibility and safety issues.

— The absence of time constraints imposed on the operation of controls can increase accessibility. See 8.10.3.

— The relationship between travel, adjustment duration and feedback (reaction time and reaction speed) that meet the expectations of the user group can increase accessibility.

— Feedback directed towards at least two senses is more effective for a wider range of people. See 8.2.

— Provision of tactile feedback to the users of controls with a key drop (no touch key) and a pressure point can increase accessibility.

— The assembly and disassembly of products (for example a kitchen aid) can be facilitated by appropriate design.

— Foot operation replaced with another form such as voice operation can increase accessibility.

— An alternative to two-handed operation can increase accessibility for persons who have only one functioning hand.

EXAMPLE 3 Design of controls in accordance with Table 9 for dimensions and with Table 10 for adjustment [64].

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Table 9 — Dimensions of manual controls [64]

Millimetres

Method of grip	Part of the hand applying force	Width or diameter of manual control	Length of manual control along the axis of movement or axis of rotation
Contact grip	Finger	⩾ 7	⩾ 7
	Thumb	⩾ 20	⩾ 20
	Hand (flat)	⩾ 40	⩾ 40
Pinch grip	Fingers, thumb	⩾ 7 to ⩽ 80	⩾ 7 to ⩽ 80
	Hand, thumb	⩾ 15 to ⩽ 60	⩾ 60 to ⩽ 100
Clench	Finger, hand	⩾ 15 to ⩽ 35	⩾ 100
NOTE Details of the different types of grip including explanations and figures can be found in ISO 9355-3. See 9.3.4.2.			

Table 10 — Classification of force/torque for manual controls [64]

Force/torque for female	Class
< 7 N	Negligible
< 0,33 N·m	
7 N to < 17 N	Low
0,33 N·m to < 1,0 N·m	
17 N to < 33 N	Low to average
1,0 N·m to < 2,0 N·m	
NOTE The data given in Table 10 are standard ergonomic values and maximum for accessible design. To address the needs of persons with less force, the values for a small female can be a good approach for ensuring accessibility.	

8.12.3.2 Spacing

Controls should be spaced to avoid interference when another one is being operated.

[ISO/IEC Guide 71:2001, 8.12.3.2]

Tactile markings can be used in conjunction with controls to avoid interference for persons with visual disabilities. The placement of the controls, however, can take into account the potential for control interference on the use of tactile markings. See 8.2.2.1. This issue also relates to the dexterity of the user and design for enhancing dexterity. See 9.3.1.

8.12.3.3 Status

Multisensory feedback should be provided on the status of controls.

[ISO/IEC Guide 71:2001, 8.12.3.3]

The status of the controls and of the condition of the operation of the total system is required to be clearly recognisable by the user in due time. Thus, provision of status information via two senses is important. For example, tactile or auditory information can be used as well as visual information.

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8.12.4 Containers and packaging

Containers should allow easy opening and closing by adopting appropriate shapes, sizes and surface finish. Packaging, such as some food wrappings which are difficult to open can result in injuries as users resort to sharp knives or other gadgets to attempt opening. Operating forces should be as low as reasonably attainable, compatible with security of contents. [ISO/IEC Guide 71:2001, 8.12.4]

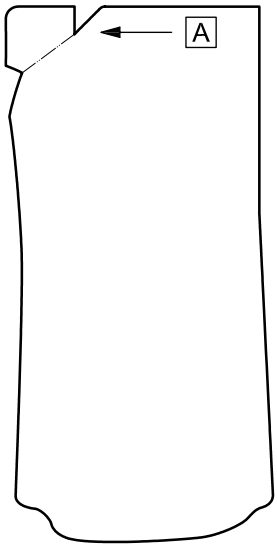
The design of containers can facilitate opening and closing by use of appropriate shapes, sizes and surface finishes. Particular attention can be given to the needs of older persons, whose grasping power is often weakened.

Where the manufacturer intends the packaging (both disposable and re-usable packaging) to be used by the consumer, opening and closing, if necessary, by one hand can increase accessibility. See 8.12.1.

There is a trade-off to be made between the requirement for child safety and the need for ease of opening (e.g. pill bottles). For child safety, see ISO/IEC Guide 50.

The following accessibility considerations are relevant to ease of opening.

— In a soft plastic container, a notch in the shape of a wedge can be provided to help the user to tear off a corner. See Figure 15 [45].



Key

A able to be opened by hand

Figure 15 — Example of soft plastic container openable without tools

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— Containers sealed with soft packaging material can provide a tongue with a large area to grip. See Figure 16 [46].

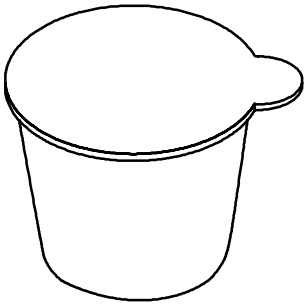

Figure 16 — Example of container with tongue for gripping

— For screw-top containers, texturing or knurling can be formed on the cap to enable it to be unsealed even by wet hands. See Figure 17.

Figure 17 — Example of screw-top container with longitudinal groove

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— Unlike bottle caps, a swing-stopper or a flip-top closure on bottles can be opened using one hand. See Figure 18.

Figure 18 — Example of bottle designed for easy opening

The following accessibility considerations are relevant to the design of the shape of containers so that they can be used easily, even by users with weakened grasping power.

— An appropriate shape for the entire weight and size of the container and its contents can prevent it slipping when held.

— The provision of ridges in a rugged or spiral state so that the fingers of the hand can firmly grasp the surface of the container can increase accessibility. See Figure 17.

— Devices and products that are designed to be opened can follow the requirements and recommendations for accessible products — except, of course, for safety caps. In principle the requirements of 8.12.3 are applicable.

8.12.5 Duration of actions

Products should not need a long handling time and unnecessary repetition of operations should be avoided. [ISO/IEC Guide 71:2001, 8.12.5]

For operation using auditory and visual information, see 8.10.2.

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8.12.6 Timed responses

Whenever possible, users should be able to control any limits on the amount of time available to them to read or respond.

[ISO/IEC Guide 71:2001, 8.12.6]

Typical in the application of timed responses are elevator doors that open for a sufficient amount of time to allow persons using a wheelchair to enter or exit. For example, a 10 s duration has been adopted by the Japanese Elevator Association as its *de facto* standard value [65]. The EC standard requires a duration up to 20 s, configured depending on the type of use [66].

For timed responses in applications operated via speech or touch-tone input over the telephone, see 8.10.3.

8.12.7 Elements in buildings and the built environment

Elements and parts of buildings such as windows, doors, bathroom-elements, lifts/elevators, lobbies, intercom systems, etc., should be accessible and easy to handle. This concerns the application of force, positioning, logical structure and having enough space to move around when using assistive devices.

The same applies to the built environment (for example, street furniture, pedestrian crossings, and parking meters) and handling in public transport (doors, ticket machines, etc.).

These aspects are particularly valuable for those with impairments in seeing, balance, dexterity, manipulation, movement, strength and cognition. See also 8.3 and 8.16.

[ISO/IEC Guide 71:2001, 8.12.7]

8.12.7.1 General consideration

Elements of the built environment are used by persons with a wide range of impairments, including residents, visitors, spectators, customers, employees, or participants in sports events, performances and conferences. Management and maintenance can affect safe access to, and use of, facilities by persons with disabilities.

A built environment designed to anticipate and overcome restrictions preventing disabled persons from making full use of premises and their surroundings increases accessibility. An accessible environment is one that a disabled person can enter and make use of independently or, if necessary, with the assistance of another person. New facilities can be designed to increase accessibility for persons with disabilities. In existing buildings, additional features such as handrails, tactile signs and hearing enhancement systems enhance accessibility. In principle, the descriptions of 8.12.1 and 8.12.3 apply.

The following basic concepts and considerations increase accessibility to elements in buildings and the built environment.

— The body size and stature of a person can determine the spatial dimension and proportion of constructional facilities and their equipment.

— The planning and location of features of buildings that take account of variations in the height of a person's eye and consequently his or her field of view increase ease of orientation.

— The area of movement can be determined not only by body size but also by assistive technologies such as walking frames, walking sticks and wheelchairs. Wheelchair users need the most space to move, particularly when turning. That is why the necessary areas of movement for wheelchair users can be the basis for the measurement of areas of movement (e.g. traffic areas, corridor widths) in accessible facilities.

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— The reaching area can be determined by body stature (size, width) and the person's mobility, and thereby defines the accessibility of service elements. The reach of persons with walking aids or persons in wheelchairs is very heavily dependent on their individual skill in moving the upper body.

— Visibility and other operational elements can be considered as well as reaching.

The following dimensions for elements in buildings are taken from existing standards and guidelines [67], [68].

— For a wheelchair user with an upper-body impairment, the area between 400 mm and 1 050 mm above the upper edge of the finished floor is reachable by hand. The lateral reaching area is up to 250 mm from the wheelchair's outer edge. See 8.12.1.

— With respect to the lateral reaching area of wheelchair users, controls need 500 mm clearance from adjacent walls and/or constructional facilities to allow for the dimensions of a wheelchair.

— The recommended height for controls is 850 mm. The fingertips of standing adults lie between 730 mm and 750 mm. Adults can thus always reach controls installed at the recommended height. Persons with mobility impairment can reach controls at this height without lifting their walking aids. Also, wheelchair users with an upper-body impairment can directly — with the arm still partly resting on the arm rest — grip a control positioned at a height of 850 mm.

— The height of doors and passages can be determined by the body size of the people who use them.

EXAMPLE 1 The minimum height of doors is 2 000 mm [71].

— The width of doors and passages can be determinated by the needs of wheelchair users. See 8.12.7.2.

EXAMPLE 2 The minimum width of doors is 900 mm. Due to construction problems in special cases like high-speed trains, a door width of 800 mm can be acceptable [69].

8.12.7.2 Clear floor or ground space

The following accessibility considerations are relevant to the maximum dimensions for clearance of a manually driven wheelchair (overall length 1 200 mm; width 700 mm in ISO 7193).

— The width is increased approximately 50 mm to 100 mm on each side for the elbows of the user. That means that the optimum width overall for wheelchair and elbows on both sides is 900 mm.

— Approximately 50 mm to 100 mm is added to the wheelchair length with respect to the user's protruding feet.

EXAMPLE The width overall for wheelchair and elbows on both sides is 900 mm (optimum) [70], [71].

8.12.7.3 Manoeuvring clearance

Buildings and other constructional facilities can be arranged to fulfil the fundamental geometric requirements of all persons with regard to areas of movement, areas of approach, movement spaces, height of handles and the ability to drive under objects.

The following accessibility considerations and measurements (given as minimum values) are relevant to manoeuvring clearances.

— Areas of movement and movement spaces restricted by obstacles can cause accessibility problems.

— The areas of movement in the same room, for example for toilets and hand-wash basins, may overlap. See Figure 19.

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