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Information and documentation — Qualitative conditions and basic statistics for library buildings — Space, function and design

*Information et documentation — Conditions qualitatives et statistiques
fondamentales pour bâtiments de bibliothèques — Espaces, fonctions
et conception*

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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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 11219 was prepared by Technical Committee ISO/TC 46, *Information and documentation*, Subcommittee SC 8, *Quality — Statistics and performance evaluation*.

Introduction

This Technical Report provides guidance for the planning of library buildings by identifying requirements of space and technical equipment. It supports decision making for librarians, architects and financing institutions.

This Technical Report considers planning, both for new buildings and for the reconstruction of existing library buildings or the conversion of other buildings for library use.

In order to plan new or reconstructed buildings, libraries need reliable data that can help them to calculate their space requirements and to define the respective technical building equipment for housing the collections, as well as for offering adequate user areas and background areas for the internal library operations. Such data are not yet available in International Standards.

This Technical Report includes data and specifications for all types of libraries, but especially for academic and public libraries. Its main topics are space requirements for:

- user areas (user places, reference and information services, lending services, user training, recreation and communication areas, meeting and exhibition areas);
- collection storage areas (including non-book materials);
- library operations (media processing, bindery, computing and management).

This Technical Report also covers technical aspects like security and safety systems, floor loading, transport systems, acoustic conditions, lighting systems and wiring and the issues of barrier-free construction and sustainability.

Annex A gives an overview of issues to consider when planning to reconstruct or reorganize existing buildings for library purposes. Annex B provides a list of functional areas and rooms to be used when checking the completeness of the plans.

Several clauses of this Technical Report are partly based on References [13] and [18].

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Information and documentation — Qualitative conditions and basic statistics for library buildings — Space, function and design

1 Scope

This Technical Report specifies data for the planning of library buildings. It also provides guidance on the selection of technical building equipment for the different functional areas of libraries.

This Technical Report is applicable to all types of libraries in all countries, but especially to academic and public libraries.

It does not include details on national, regional or local regulations that can affect the planning of library buildings.

2 Terms and definitions

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

2.1

academic library

library whose primary function is to cover the information needs of learning and research

Note 1 to entry: This includes libraries of institutions of higher education and general research libraries.

2.2

accession order

arrangement of books or other documents on shelves in the chronological and numerical order of their addition to a specific category or class, as opposed to an arrangement based entirely on a classification system

Note 1 to entry: Antonym: classified shelving.

2.3

area for events

floor space for events and exhibitions with special technical requirements as to acoustics, lighting, darkening, climate and catering

2.4

art lending library

department of a public library with collections of art books, works of art (e.g. pictures, sculptures) and reproductions, commissioned to lend those books and objects for a specified time period to users

2.5

audiovisual media

documents in which sound and/or pictures are prominent, and which require the use of special equipment to be viewed and/or heard

Note 1 to entry: This includes audio documents, pictures and films on different physical carriers.

Note 2 to entry: Adapted from ISO 2789:2006.

2.6

automated storage

ASRS

high-density storage facility with retrieving function of library materials, generally called Automated Storage and Retrieval System (ASRS)

Note 1 to entry: Advantages of this kind of storage are the efficient use of space and the speed of retrieving and returning of materials.

2.7

axis centre distance

distance between centres of repeated or similar objects

Note 1 to entry: Such objects can be constructional elements or furniture in a row. For shelves, the axis centre distance is the distance from centre post to centre post of two parallel single-sided (single-faced) or double-sided (double-faced) shelves.

2.8

barrier-free access

universal access

accessibility of the library to users with physical requirements other than those of the average user, e.g. as to the height of shelves, tables and equipment or as to working places for visually impaired persons

2.9

bindery

book binding studio

in-house workshop in a library that performs binding and repair of physical media, especially the daily work such as repairs, binding in urgent cases, production of brochures for the institution's own publications, etc.

2.10

book drop

slot, chute, bin or box with a collection container to which materials borrowed from a library can be returned, especially during hours when the library is closed

Note 1 to entry: Book drops can be free-standing (usually outside the walls of the library) or built into the circulation desk or an exterior wall.

Note 2 to entry: Book drops are often linked to the library system and/or a transport system.

2.11

book transport system

conveyor transporting media from closed stacks to the check-out or user area and back again after check-in

2.12

carrel

work space for information users in the reader area which is shielded against its surroundings but not completely closed

Note 1 to entry: In a carrel, working papers can be kept for continuous research.

Note 2 to entry: Adapted from ISO 5127:2001.

2.13**cartographic document
map**

conventional representation, on a reduced scale, of concrete or abstract phenomena which can be localized in space and time

Note 1 to entry: This includes documents such as two- and three-dimensional maps, globes, plans, topographic models, tactile maps and aerial representations, but excludes atlases and any other cartographic documents in codex, micro, audiovisual and electronic form.

Note 2 to entry: Adapted from ISO 2789:2006.

2.14**catalogue**

ordered list or bibliographic retrieval system allowing access to data and addresses of documents in one or several collections

Note 1 to entry: Catalogues are for the most part offered in the form of online catalogues accessible via terminal or workstation. Older forms are catalogues in book form on shelves and card catalogues sorted in drawers of catalogue cabinets.

Note 2 to entry: Adapted from ISO 5127:2001.

2.15**children's library**

public library area offering special collections and services for children up to 13 years

2.16**circulation space**

space needed for access to the rooms, in-house traffic and evacuation of the building in case of need

Note to entry 1: This includes, for example, floor space of corridors, stairway space, lift shafts and traffic area for vehicles.

Note to entry 2: Movement areas in rooms that belong to the usable area are excluded.

[DIN 277-1:2005-02]

2.17**citizens' service**

service point of the local administration offering easy access for citizens to administrative services (e.g. renewing passports or driving licences, paying dog licence fees)

Note 1 to entry: The service point can be located in a library.

2.18**classified shelving**

storage of media in the order of a subject classification

Note 1 to entry: Classified shelving is usually applied in open-access stacks.

Note 2 to entry: Antonym: **accession order** (2.2).

2.19**closed stacks**

stacks that are not accessible to users

Note 1 to entry: Antonym: **open stacks** (2.58).

2.20

compact shelving

shelves or cupboards which are movable on rails with manual or electric steerage and which can be moved close to each other, thus maximizing the storage capacity of a given space

2.21

conservation

intervention techniques applied to prevent, arrest or delay deterioration

[ISO 5127:2001, definition 6.1.03]

2.22

cross-aisle

corridor or passageway that intersects at a 90-degree angle the shelving ranges and stack aisles in the stack area of a library, allowing staff and users to move from one range to another without walking to the end of the range

2.23

delivery entrance

entrance for the receipt or dispatch of library materials or other goods or for the pick-up of waste materials

2.24

desk sharing

policy for minimizing the floor space required for office rooms by which two or more persons share a desk and equipment, especially useful when allocating background space for staff mainly working in contact with users

2.25

double-faced shelf

double-sided shelf

shelving unit with shelf boards on both long sides

2.26

ductwork

system of ducts for ventilation or the conveyance of liquids, gases, electricity, etc.

2.27

electronic collection

all resources in electronic form in the library collection

Note 1 to entry: The electronic collection includes databases, electronic serials and digital documents such as eBooks, electronic patents and networked audiovisual documents.

Note 2 to entry: Adapted from ISO 2789:2006.

2.28

exhibition

time-limited display of objects, organized or co-organized by the library

Note 1 to entry: Exhibitions can take place inside or outside the library premises.

2.29

file

dossier

organized unit of documents grouped together either for current use by the creator or in the process of archival arrangement, because they relate to the same subject, activity or transaction

Note 1 to entry: Adapted from ISO 5127:2001.

2.30**frontal display****face-out**

method of displaying media face forward, especially in public libraries, which requires considerably more shelf area

Note 1 to entry: Antonym: **spine-out** (2.87).

2.31**functional space**

part of the gross floor area that houses the central operational equipment of a building

Note 1 to entry: This includes, for instance, sewage disposal, heating, conveyor technique.

2.32**gross floor area**

sum of all floor areas of all levels of a building

Note 1 to entry: This includes the usable area, circulation space, functional space and space occupied by the constructional elements of the building (pillars, walls, etc.).

2.33**group study place**

workplace for joint studying by several users

Note 1 to entry: These places are usually constructed in a way that their use does not materially affect the other users.

2.34**inside width**

distance between the inside margins of an object, without taking account of the marginal parts themselves

2.35**interactive spaces**

spaces in buildings where ICT (Information and Communication Technology) is integrated in the furniture (e.g. tables) and in the walls

2.36**interlibrary lending**

loan of a document in its physical form or delivery of a document, or part of it, in copied form, from one library to another which is not under the same administration

Note 1 to entry: Adapted from ISO 2789:2006.

2.37**IT-workplace**

workplace equipped with information technology (personal computer, terminal or multimedia equipment, etc.)

2.38**kinderbox**

special furniture for presenting large books (picture books, comics) or other media in frontal display

2.39**learning centre****information commons**

library service area specially dedicated to learning purposes

Note 1 to entry: Usually, a learning centre integrates library and computer application services, in most cases with a wireless network, equipment for multimedia use and support services for users by librarians and/or IT specialists.

Note 2 to entry: A learning centre can be a separate facility, inside or outside the library, or an integral part of the library.

2.40

lending area

library service area for supplying and returning books and other media for loan

2.41

lending library

circulating library

library that offers collections for loan outside the library

2.42

library

organization, or part of an organization, the main aim of which is to facilitate the use of such information resources, services and facilities as are required to meet the informational, research, educational, cultural or recreational needs of its users

Note 1 to entry: The supply of the required information resources can be accomplished by building and maintaining a collection and/or by organizing access to information resources.

Note 2 to entry: These are the basic requirements for a library and do not exclude any additional resources and services incidental to its main purpose.

Note 3 to entry: Adapted from ISO 2789:2006.

2.43

linear metre

measure of shelf space for the net space on a shelf, without supporting construction

2.44

live load

variable or movable load of a building unit

Note 1 to entry: This includes persons, equipment (e.g. shelving or compact shelving, inclusive of books and other media), light partition panels without load, machines and snow.

2.45

loading bay

area at the side of a building where goods are loaded on and off delivery vehicles

2.46

loading ramp

inclined plane between two levels for the passage of delivery vehicles

2.47

loan desk

circulation desk

service point at which media are checked in and out of a library, usually a long counter located near the entrance or exit with one or more working places for staff

2.48

lounge

meeting and waiting space for users, offering relaxed seating

Note 1 to entry: See also **staff lounge** (2.91).

2.49

main aisle

stack aisle that serves as access to a larger unit or shelving section, in a room

Note 1 to entry: A stack aisle does not necessarily meet the requirements for a traffic route.

2.50**media centre**

library service area providing audiovisual and multimedia documents, equipment and services, staffed to assist users in using these collections

2.51**microform**

photographic document requiring magnification when used

Note 1 to entry: Microforms are to be used with adequate reading devices. Special reader printers allow re-magnifying of minimized texts and printing on paper.

Note 2 to entry: Adapted from ISO 5127:2001.

2.52**movement area**

free area between storage areas or walls

Note 1 to entry: This includes the space which is necessary for usage or operation in front of equipment and functional areas. Additionally, it includes space for doors that open into the room. Mandatory safety clearance is not included.

2.53**multimedia document**

document combining different information media, text, graphics, photos, video, audio for interactive use, in digital format

Note 1 to entry: Multimedia documents can be available on physical carriers such as CDs (compact disks) or DVDs (digital versatile disks) or as networked publications.

Note 2 to entry: Adapted from ISO 2789:2006.

2.54**multimedia workplace**

workstation with special hardware and software for using multimedia documents

Note 1 to entry: The characteristics of such workplaces are high capacity computers and large screens, as a result of the contents, presentation and combination of electronic media (e.g. moving pictures simultaneously with text and audio). Where appropriate, these places can also be equipped with headphones.

2.55**multi-touch technology**

type of interface allowing interactive data processing by touch or motion, equipped either with a touch-sensitive surface and/or with motion sensors.

Note 1 to entry: Multi-touch interfaces can be small, as used in smartphones, or large, as used in multi-touch collaboration walls.

2.56**music library**

department of a public library with collections of materials on music and musicians, including sheet music, recorded music (CDs, audiocassettes, records, etc.), discographies and music reference material, offering lending services and user places for listening to music

2.57**non-book material**

library materials that have physical form but are not bound in codex form like a book, e.g. autographs, maps, plans, microforms, audiovisual documents, games or pictures

Note 1 to entry: Electronic media are excluded.

Note 2 to entry: Some of these media need special furniture for presentation or special equipment for using them, e.g. tables for consulting maps, a reader printer, etc.

2.58

open stacks

stacks that are accessible to users

Note 1 to entry: Antonym: **closed stacks** (2.19).

2.59

pay machine

machine for the paying of fees and fines that should, if possible, be linked with the automated library system

2.60

periodical stand

piece of display furniture, often with sloping shelves, used in libraries to display current issues of periodicals face out

Note 1 to entry: This is not as compact as conventional shelving but it is more accessible to users for browsing.

Note 2 to entry: The shelves or cupboards usually have separate compartments for each periodical; the cases can be hinged to allow a limited number of back issues to be stored on a flat shelf behind it.

2.61

plan cabinet

plan case

cabinet for flat storage, where the items are stored horizontally

Note 1 to entry: Plan cabinets are usually metallic.

2.62

population to be served

number of individuals for whom the library is set up to provide its services and materials

Note 1 to entry: For public libraries, this will normally be the population of the legal service area (authority); for libraries of an institution of higher education, this will normally be the total of academic and professional staff plus students.

Note 2 to entry: Adapted from ISO 11620:2008.

2.63

presentation area

user area that serves for presenting media in a user-friendly way, e.g. by frontal display

Note 1 to entry: This type of media presentation requires more floor space than conventional methods.

2.64

preservation

all measures taken, including financial and strategic decisions, to maintain the integrity and extend the life of documents or collections

[ISO 5127:2001, definition 6.1.01]

2.65

printed music document

document, the essential content of which is a representation of music, normally by means of notes

Note 1 to entry: Printed music documents can be in sheet or codex form.

[ISO 2789:2006, definition 3.2.35]

2.66**public library**

library that offers collections and services for the general public

Note 1 to entry: Public libraries serve the information needs of the whole population of a local or regional community, with emphasis on both formal and individual education, literacy, life-long learning, creative development, cultural and recreational activities.

2.67**reading room**

room for using books and other media in the library, which can also contain open stacks

2.68**record****phonograph record**

thin, flat disk, usually made of vinyl, impressed on one or both sides with a continuous spiral groove in which audible sound is recorded

Note 1 to entry: As the disk revolves on a playback machine, called a record player, the groove causes a stylus to vibrate, producing electrical impulses in a cartridge that can be amplified as sound. The most common playing speed is 33 1/3 rpm (long-playing).

2.69**reference and information area**

library space for reference and information services, generally including a reference desk, a reference library and workstations

2.70**restoration**

actions taken to return a document which has suffered deterioration or damage as closely as practicable to its original state

Note 1 to entry: In archival restoration, no attempt is made to recreate missing text, etc., and all restoration work is kept clearly evident.

[ISO 5127:2001, definition 6.1.04]

2.71**RFID****radio-frequency identification**

electrical transponder which stores information that can then be used to identify an item to which the transponder is attached, similar to the way in which a bar code on a label stores information that can be used to identify the item to which the label is attached

Note 1 to entry: In libraries, RFID techniques are used for the identification of media and library cards, especially for checking loans. Using RFID for self-service checking requires exit gates with adequate equipment.

Note 2 to entry: Adapted from ISO 18185-4:2007.

2.72**security case**

frame in which videos, CDs and cassettes are presented in their original cover in free-access areas, but are protected by the frame, preventing usage

Note 1 to entry: The frame can only be opened by means of mechanic or electronic equipment at the circulation desk.

2.73**security system for media**

system that, by electromagnetic or RFID-controlled protection, secures media against theft

Note 1 to entry: The media are each equipped with an adequate RFID chip or magnetic strip. An electronic alarm system is installed at the exit of a library to detect the unauthorized removal of media.

2.74

self-service terminal

self-service machine for users that automatically registers the check-out or check-in of media in the automated system via scanner or RFID technique

2.75

sheet music

printed music issued without covers, whether actually printed on single sheets (pages) or not

[ISO 5127:2001, definition 2.4.18]

2.76

shelf

set of thin, flat pieces of rigid material placed horizontally at right angles into a frame or wall, to hold books and similar items

2.77

shelf board

single board in a shelf

2.78

shelf capacity

average number of media that will fit on a shelf board, depending on the width of the shelf from upright to upright, the average depth (thickness) per item, and the portion of each shelf left empty to facilitate re-shelving

2.79

shelf depth

depth of a single shelf (board), but also depth of shelving in a rack or range of shelving

Note 1 to entry: Shelf depth can vary depending on the formats of the media to be stored.

2.80

shelf height

vertical distance between two shelves

Note 1 to entry: Adjustable shelving allows the distance to be altered to accommodate items of varying height.

Note 2 to entry: Average shelf height is one of the factors determining stack capacity.

2.81

shelving range

component of a library stack, consisting of a row of two or more sections of single- or double-faced fixed or adjustable shelving, with common uprights or shelf supports between sections

Note 1 to entry: The row can be free-standing or assembled against a wall.

2.82

shelving section

block of several shelving ranges with stack aisles between the ranges

2.83

sign system

signage

signposting for the users' orientation in the building, showing the way to the individual service areas of the library

2.84

single-faced shelf

single-sided shelf

shelving unit with shelf boards only on one long side and therefore accessible only from one aisle face

2.85**sorting system**

machine for automatic sorting of returned media, whose number of sorting categories depends on the capacity of the sorting system

2.86**special library**

independent library covering one discipline or particular field of knowledge or a special regional interest

Note 1 to entry: The term “special library” includes libraries primarily serving a specific category of users, or primarily devoted to a specific form of document, or libraries sponsored by an organization to serve its own work-related objectives.

Note 2 to entry: Adapted from ISO 2789:2006.

2.87**spine-out**

books displayed on a shelf with their spines facing the front, usually one alongside the other with a bookend at the end of the row to keep them upright

Note 1 to entry: The shelving method is used in the stacks of most libraries because it allows the spine title and call number on each volume to be seen at a glance.

Note 2 to entry: Antonym: **frontal display** (2.30).

2.88**stack aisle**

path between two shelf ranges for the retrieving and shelving of library materials, trafficable for book trolleys

2.89**stack capacity**

amount of material that can be contained in the stack area of a library, expressed as the total linear metres or metres squared of available shelving, or the maximum number of volumes or other physical units that can be accommodated, sometimes calculated by means of a formula

2.90**stacks**

areas in a library that serve for storing books and other media

2.91**staff lounge**

room or area in a library usually equipped with comfortable furniture and a kitchenette, where staff members can go when they are not on duty to eat, relax on a break, or meet informally

2.92**storage library**

library whose primary function is to store less-used material from other administrative units

Note 1 to entry: Storage libraries that are part of, or administrated by, another library (e.g. national or regional library) are excluded.

Note 2 to entry: Libraries whose stock remains the possession of the storing libraries are excluded. The collections and their use are counted with the proprietary libraries.

Note 3 to entry: Adapted from ISO 2789:2006.

2.93**storage space**

space requirement of facilities in the floor plan

2.94

study booth

lockable room, usually with one user workplace and shelves

2.95

sustainability

state in which components of the ecosystem and their functions are maintained for the present and future generations

Note 1 to entry: Sustainability is the goal of sustainable development and can result from the application of the concept of sustainable development.

Note 2 to entry: In building construction, it relates to how the attributes of the activities, products or services used in the construction work, or the use of the construction works, contribute to the maintenance of ecosystem components and functions for future generations.

Note 3 to entry: While the challenge of sustainability is global, the strategies for sustainability in building construction are local and differ in context and content from region to region.

Note 4 to entry: "Components of the ecosystem" includes plants and animals, as well as humans and their physical environment. For humans, this includes a balancing of key elements of human needs: the economic, environmental, social and cultural conditions for societies' existence.

[ISO 15392:2008, definition 3.20]

2.96

training room

classroom

room with workstations or laptops and presentation technology, where a group supported by a moderator can work practically (hands-on use) on a specified topic

2.97

undergraduate library

libraries that are established, supported and maintained by institutions of higher education to serve the information and research needs of undergraduate students and the instructional requirements of the undergraduate curriculum

Note 1 to entry: Undergraduate libraries are either operated as branch libraries or as independent administrative units.

2.98

usable area

part of the gross floor area which serves the main purpose of the building

Note 1 to entry: This includes space for user services (including areas for recreation and communication), materials storage, library management and technical services, events, exhibitions and meetings, equipment areas, aisles, toilets and janitorial areas, and all other space used for library resources and services.

Note 2 to entry: This excludes circulation areas (corridors, stairway space, lift shafts and traffic area for vehicles).

Note 3 to entry: This excludes the functional space that houses the central operational equipment of a building (e.g. sewage disposal, heating, conveyor technique).

2.99

user place

place provided for users for reading or studying, whether with or without seating or equipment

Note 1 to entry: This includes places in carrels, in seminar and study rooms and the audiovisual and children's departments of the library, also places for relaxed seating of various types.

Note 2 to entry: This excludes seats in halls, lecture and auditory theatres intended for audiences of special events. It also excludes floor space and cushions on which users can sit.

Note 3 to entry: Adapted from ISO 2789:2006

2.100**user service area**

part of the library that is accessible to users

Note 1 to entry: This includes space for reading, studying, information delivery, and any other services delivered to users, as well as open-access storage areas as integrated parts of user service areas, media centres, workplaces for staff in these areas, and exhibition areas.

2.101**visually impaired**

person whose sight makes using library materials in conventional formats difficult, if not impossible

2.102**workplace for blind and visually impaired persons**

workplace with special equipment that allows persons with reading difficulties to understand print materials, e.g. via a computer where Braille function or a screen reader with loudspeaker/earphone are available

2.103**young adults' library**

public library area offering special collections and services for young persons (aged between approximately 14 to 18 years)

2.104**zones**

breakdown of the user area into spaces for specific user activities or user interests, especially in open-plan libraries

Note 1 to entry: Examples of zones are the entrance and lounge area, children's areas, fiction and non-fiction areas with face-to-face guidance, reading and working areas, etc. The "zoning" concept is also used to indicate acceptable noise levels, e.g. quiet or group study area.

3 Planning library buildings**3.1 First steps in planning****3.1.1 Reasons for new planning**

Whether a community or institution determines to establish and build a library will depend on political developments. The definition of the library's mission and the assignment of specified tasks will influence the size and structure of the new building.

A planning process for replacing an old library building usually originates from the following causes:

- a) a growing number of users;
- b) a growing physical collection;
- c) new service areas of the library;
- d) organisational changes in the library;
- e) a conceptual change of the library's mission and goals;
- f) structural damage or contamination in the old building.

Traditionally, the usual reason for building a new library was the need for more space as collections expanded. Today, with a growing percentage of library acquisitions being available electronically, that reason will only be valid in libraries whose mission includes preserving their physical collections. In many countries, new library

building projects are trying to respond to the needs of the changing media context and new ways of user behaviour. Structural changes in the community or on the campus can also give reasons for planning a new location for the library.

3.1.2 Definition of purposes

Whether a community or institution determines to establish and build a library will depend on political developments. The definition of the library's mission and the assignment of specified tasks will influence the size and structure of the new building.

The road to planning a successful new library building includes a set of internal preparatory steps before going into the actual architectural specification:

- a) re-evaluation of existing service areas through user surveys and evaluation projects;
- b) evaluation of user activities in the library and the spread of such activities over the day/week/year;
- c) definition of the services the library will offer in the new building (e.g. training sessions, events, automated services);
- d) definition of future opening hours;
- e) definition of the population the library is going to serve, of the different user groups and their expected changes;
- f) analyses of future collection types and collection development, including analyses of weeding possibilities;
- g) development of new strategies for information delivery to the user, particularly electronic delivery, whether carried out in-house or remotely, taking into account changes in usage patterns, changing technology and general information seeking behaviour.

The following preparatory steps provide important information tools for architects and designers as well as library professionals:

- 1) a framework for an efficient and future-oriented library service, based on the detailed analysis of the context within which the library will have to operate in the near future and on a long-term basis;
- 2) a strategy – devised for updating the physical library as well as for implementing the new services.

These tasks should be carried out before starting the planning process for the building, so that there will be a comprehensive basis for investigating the space needs.

3.1.3 Definition of requirements

Based on the re-defined strategy of the library, the space requirements for the different areas can be calculated. This Technical Report describes the calculation of space for the following areas:

- a) user areas;
- b) collections;
- c) staff;
- d) library management and technical services.

Legal regulations or standards for special areas (e.g. for staff offices, meeting rooms or sickrooms), for safety issues (e.g. exits, fire doors), or for disabled persons have to be considered additionally. For planning facilities like toilets, cloakrooms or locker areas, loan and information desks, it is important to base the calculations on the number of visitors at peak times.

The time period for which space requirements should be calculated has been a vital question in times of print collections. A general rule was that stacks should be planned for housing at least 10 years of average additions to the collection. This has become less calculable but also less important in times of electronic collections. But as far as possible, foreseeable developments of the next ten years, e.g. of the population to be served and the services to be delivered should be incorporated into the space calculation.

3.1.4 Defining the location of areas in the building

The preparatory steps include assessing the processes and activities necessary for the library's services and defining their coherence. A detailed planning paper with diagrams will help the planning team and the architect to understand the workflows.

Traditionally, the floor plan follows the processing paths, as far as a transport of physical media is involved. In the case of electronic media or electronic delivery procedures, the location becomes more independent of workflows. It will be more important to follow the ways of users, e.g. to have short ways from the entrance hall to information desks and open stacks, or from open stacks to the loan desk or self-service terminal.

If possible, there should be separate entrances for staff and suppliers. The entrance for suppliers should have space for parking vehicles nearby.

3.1.5 Choosing the site

The librarians will in most cases be dependent on the funding authorities for the choice of a site, but they can influence the choice by showing the impact of a site on the effectiveness of the library. The site of a library can be even more important than the building itself, as the building can be remodelled, while disadvantages of a site will be permanent.

Choosing a site for a library should include the following considerations:

- a) the accessibility of the library to its population, e.g. by being located in walking distance, or by good transport connections;

This will usually mean that the library should be situated near public transport. Especially in urban centres, provision of parking space for private transport will be expensive.

- b) the proximity to institutions with which the library cooperates, e.g. civic facilities in a community or the centre for information technology in a university;
- c) the visibility of the library in a community, on a campus;
- d) the function of the library as local landmark or icon;
- e) the central location, either in the community or quarter, or in a campus;
- f) the acoustic characteristics of the surroundings (traffic, schools, industries, etc.);
- g) the adequacy of the site for the building as to soil, dimensions and the possibility of a later expansion of the building (poor quality soil or high groundwater levels can require special techniques for foundations that raise the cost of the building);
- h) regulations of building law in the prospected area, e.g. restricted height or dimension, prescribed distances, style of roofs, consideration of historic monuments nearby;
- i) environmental issues like angle of incidence of the sun's radiation, shadowing by larger buildings, a possible contamination of the site, problems of air pollution, especially in town centres, and fresh air supply;
- j) risk analysis of natural and man-made threats in the surroundings of the site.

Risk factors in the natural surroundings include the potential occurrence of earthquakes, seismic activities, hurricanes, storms or floods. The possibility of high water levels should be considered when planning to place stacks or other areas below ground level.

Man-made risks include danger from riot and civil commotion, terrorism, fires, or explosions, most of which cannot be foreseen when planning the building. But attention should be given to a possible contamination of the site and to problems of air pollution, especially in town centres.

3.2 Factors affecting library space requirements

3.2.1 General

Space requirements of an individual library are in the first place dependant on its mission, that is to say on the tasks the library is set up to perform and the population it is meant to serve. The specific mission and population to be served will require different services and products, and this will determine the amount of space that is required. A library that is open to the public, with heavy user traffic during opening hours, will have different space requirements than a special library serving a defined limited population.

The space requirements will also be influenced by the library's vision, its concept of service delivery, e.g. providing an inspiring atmosphere for learning and research as well as for recreation and communication.

In the recent decades, electronic media and electronic services have been added to the traditional library's physical collections and services, so that all types of libraries today have to consider space requirements for both types of media and for integrated services. While print and other physical media require storage space, the use of electronic media and services involves an adequate amount of technical equipment and, where appropriate, designated areas for visual display and dissemination in the physical library.

The main factors that influence space requirements in libraries are:

- a) type and size of collections, e.g. serials, audiovisual media, rare materials, electronic collection;
- b) type of shelving: open or closed stacks, accession order or classified shelving, presentation of media according to specified user interests;
- c) usage policy (loans, in-house use);
- d) type of services offered: user places, lending and delivery services, reference and information services, user training, learning centre, events, interactive services, citizens' services;
- e) types and coverage of self-service options;
- f) type of logistical facilities, e.g. transport systems or self-service terminals;
- g) user activities in the library: individual or group work, learning and research, browsing, reading and borrowing media, information and communication, meeting, listening, and "playing";
- h) special services for user groups, e.g. children's library, workplaces for visually impaired persons.

3.2.2 Types of libraries

Libraries can be roughly subdivided according to their mission and tasks into the following types.

- a) *Academic libraries*: libraries whose primary function is to cover the information needs of learning and research (libraries of institutions of higher education, general research libraries).
- b) *Public libraries*: general libraries that serve the information needs of the whole population of a local or regional community, with emphasis on both formal and individual education, literacy, life-long learning, personal creative development, cultural and recreational activities.

- c) *School libraries*: libraries attached to all types of schools below the third (tertiary) level of education whose primary function is to serve the pupils and teachers.
- d) *Special libraries*: libraries covering one discipline or particular field of knowledge or a special regional interest, or primarily serving a specific category of users. Special libraries can also be sponsored by an organisation to serve its own work-related objectives. Examples are industrial and commercial libraries, media libraries, government libraries, health service libraries, or libraries of professional and learned institutions and associations.
- e) *National libraries*: libraries which are responsible for acquiring and conserving copies of all relevant documents in the country in which the library is located, usually via legal deposit.

3.2.3 Functional areas

The net usable area of a library can be allocated to the following main functions (see ISO 2789:2006):

- a) *user services*: includes space for reading, studying, lending and delivery (including self-service), reference and information, user training, and any other services delivered to users, open-access storage areas as integrated parts of user service areas, lavatories, and areas for recreation and communication;
- b) *library operations*: includes media processing, bindery and reprography, computing and management, projects;
- c) *materials storage*: includes all areas devoted principally to storing materials, whether open access or closed;
- d) *events, exhibitions, etc.*: includes areas/rooms for meetings and events, auditoria, and formal exhibition space.

This differentiation of areas can be used both for academic and for public libraries, but the emphasis laid on each area is generally different.

In academic libraries, user places, especially for long time working, will in most cases be crucial. Sufficient space for storing the media is still an important issue, as research collections can keep their relevance for a considerable time, and rare or special collections will have to be stored even longer. Closed stacks with compact shelving can be an efficient way of storing such collections. Closed stacks can be necessary because of preservation reasons.

In public libraries, collections are commonly weeded regularly to prevent constant growth. Public libraries present their collections nearly exclusively in open access, arranged as to topics or user groups. In order to promote the collections, media are often singled out and presented in an eye-catching way, e.g. in special furniture or frontal display. This kind of presentation will need more space than normal shelving.

Areas for communication, recreation and events, though gaining in importance in all types of libraries, will be more relevant for public than for academic libraries.

The concept of “zones” is especially used in open-plan public libraries. Zones reflect user activities and user interests, e.g. entrance and lounge area, children’s areas, fiction and non-fiction areas with face-to-face guidance, reading and working areas etc. The ‘zoning’ concept is also used to indicate acceptable noise levels, e.g. zones for group work and communication and silent zones for individual reading and studying.

3.2.4 Open or closed stacks

An important issue affecting space requirements is the presentation of the physical collections. Collections can be shelved in open stacks, giving free access to users, or in closed stacks whence they should be fetched by library staff. Public libraries and most special libraries usually offer their collections in open access, Academic libraries in recent decades have been so constructed as to provide open access for the greater part of the collection. Older libraries have taken up this idea, if the building allowed opening the stacks. In libraries

with the task of preserving special or rare materials like national or regional libraries and certain academic and special libraries it will always be necessary to store certain parts of the collection in closed stacks.

Shelving in closed stacks is space saving, as the media can be arranged on the shelves in accession order and according to their formats, and the aisles need not provide for heavy traffic. In open access areas, media are shelved in classification order in order to support browsing, and space for additions should be reserved at each classification number. Generally, the media are not sorted as to format, and therefore there should be a larger distance between shelf boards. The aisles should be wide enough to allow for several users browsing simultaneously, and seats should be provided for short periods of reading.

3.2.5 User activities

The pattern of library use in the physical library is changing. Though still more electronic resources are available at all times via a library access from home, job or elsewhere, the physical library premises have a continuing attraction. Surveys illustrate that a growing number of users visit the library for purposes other than borrowing media or otherwise using the collections. The users come for face-to-face professional librarian guidance, to learn and study, to seek information or inspiration, to search on the Internet and more and more to use the library as a meeting place, either for relaxation or group working.

There is a general trend of users bringing their own books and other materials and their own mobile devices into the library. This entails that libraries are opened as long as possible, even without any staff present. Self-service devices help to maintain important services, and access to the library is made possible by library cards serving as keys. Opening a library without library staff requires special consideration of monitoring and security problems.

Traditionally the calculation of space for library buildings has been primarily based on requirements for the collections and the technical services. Such space is still necessary, but space for user activities in the library has gained in importance and should be included in the calculation. This does not only concern the floor space for lending and delivery services, reference and user training, or the traditional reading-rooms with individual places for users. New working practices in learning and research call for user places with a variety of equipment, ranging from simple seats for short periods of reading to specified multimedia places. Wireless access is increasingly offered in libraries, thus allowing users with own laptop or notebook to access digital materials and online resources from most areas in the library. The role of wireless access is however declining because many users have their own mobile web with flat rate fees.

Group work has become crucial for learning, especially in institutions of higher education, therefore group working areas with appropriate furniture and noise control should be considered. The number and type of user places will of course depend on the library's profile and population to be served and will also be affected by the library's lending policy. If the library does not offer its collections for loan outside the library premises, but allows only in-house use, e.g. in special libraries, more user places can be needed.

The library is an important meeting and communication centre, in many cases the main such centre, both in communities and in universities. Therefore, recreation and communication areas and space for events in the library have to be included in the space calculations.

Public and academic libraries have one trend in common: They tend to function increasingly as the meeting place and social hub of the local community; e.g. a municipality or a campus. This tendency is often emphasised by spectacular and landmark style architecture.

3.2.6 Learning and teaching areas

Libraries have always provided space for working inside the library, but this was mainly meant to accommodate individual users using media from the collections.

Today, use of the library has changed. There is a general trend toward studying and working in the library without using the physical library collections, but with need of Internet access. There is also a growing tendency for group work. Both developments make changes in equipment and seating necessary. Group working areas, wireless access in the whole user area, and informal spaces that allow for social interaction are now important issues.

Learning can occur in different areas of the library. But many libraries provide specially designed spaces that by their structure and equipment facilitate learning. Such learning spaces offer for instance collaborative equipment for group learning. Learning spaces can be organised jointly by libraries and centres of information technology, especially in institutions of higher education. In such spaces librarians and IT-specialists are in direct contact with the users and able to provide differentiated service.

Instructing users in the use of information is a new role in libraries. Traditionally, many libraries have restricted their “user education” to training in the use of their own services, either as guided library tours or as general introductory lessons about the library’s services. Since the information resources as well as the ways of information seeking have changed dramatically, the difficulty for users is how to find and select relevant information. Therefore, libraries have taken up the new task of teaching information literacy, as well in public as in academic libraries.

Teaching spaces are generally specially equipped rooms for interactive teaching, often with computers for hands-on training. Flexible furniture will help to adapt the room to various user groups and teaching methods.

3.3 Special service areas

3.3.1 Children’s library

3.3.1.1 General

Children (usually the age-group between 0 and up to and including 13 years) represent a high percentage of public library users. This group makes special demands on a library in terms of services, media, space and function. Therefore most public libraries offer a children’s library for this target group which can be organised as a separate room or at least as a special zone.

The core services of a children’s library are based on the concept of experience-based learning and literacy, including age-appropriate support of media and information competence, but considering also the recreational activities of children. This concept implies a close cooperation with schools and kindergartens; therefore the library will usually invite group visits from these institutions. The children’s library can also provide child-related services to parents, teachers and educators.

Children’s libraries provide space for browsing, reading and learning, for lending and returning media, for assistance with homework assignments, listening to music, viewing motion pictures, playing and gaming, and events like storytelling or puppet theatre.

In their collections, children’s libraries provide books, audiovisual documents, magazines and games for all ages, for the youngest children mostly picture books. Children’s libraries normally present their collection split up according to the children’s age, e.g.

- a) 0 to 3 years;
- b) 4 to 7 years;
- c) 8 to 13 years.

3.3.1.2 Required space and position in the building

The space needed for the children’s library depends on the structure of the library’s population to be served. Generally, it will occupy a considerable proportion of the overall space of the library. The children’s library should have barrier-free access, and there should preferably be natural light, at least in some parts of the area.

Children’s areas tend to be noisy. Therefore, they should be placed away from, or be insulated from areas that demand quietness.

There should be enough space for programmes with groups of kindergarten children or with school classes. A separate room for events or a sound-proof partition is beneficial.

3.3.1.3 Design and equipment

The interior design and the equipment of the children's library will be heterogeneous, as the interests and demands of different age groups – babies, smaller children and school children of different ages – have to be considered. The furniture should reflect the fact that there will very often be accompanying adults who also should feel welcomed in the area. The special safety issues of children as to furniture, stairs etc. should be kept in mind.

For schoolchildren reading places and tables for doing their homework should be offered (for required space see 4.2.2.7). The number of places necessary depends on the size and social structure of the library's population to be served. For classes and other groups there should be areas for group-working.

Places for computer games need at least 3,00 m². Depending on what type of games the library offers, a separate room should be considered.

The equipment should be flexible (e.g. shelves on castors) in order to accommodate different programmes and events, including reading nights with the possibility to sleep overnight in the library. Fixtures and furniture should incite creative imagination and help children to find their own corner in the area.

Shelves in children's libraries will be lower and need more space than for media in the adult section (see 4.7); the same applies to the special shelf elements for frontal display of the media. Special furniture for picture books and for toys also requires more space.

When the library offers self-service functions for lending the children's library should provide lending machines adapted for children.

Special equipment used for story-telling can require cabling and designated floor space. Story-telling areas can require special sound-insulation, or sound-muffling equipment.

EXAMPLE Story-telling lamps are sometimes installed over seats for small children. A story-telling or reading-lamp is a large, pendant lamp with built-in loud speakers, connected to a remote sound/music supply system, handled by the staff. This installation needs flexible cabling (floor and ceiling) and approximately 4 m² of floor.

Details for equipment and facilities in children's libraries:

- a) toilets and basins suitable for children;
- b) a place with a changing table (baby room);
- c) parking space for perambulators;
- d) separated cosy zones for lap-reading and story-telling;
- e) space(s) or rooms for reading promotion, events and programmes with adequate technology;
- f) walls with whiteboards, blackboards, panels to support programmes for groups;
- g) furniture or devices to present posters or children's works of art.

3.3.2 Young adults' library

3.3.2.1 General

Young adults (usually the age group between 14 and 18 years) are a special, but not at all homogeneous target group of public libraries. This age group needs services related to education and learning as well as services for leisure time and hobbies and should be attracted towards the library by tailor-made offers.

Young adults' demands on collections and services of the library are very diverse and definitely different from those of children or adults. Therefore the library for young adults should be a separate room or at least a separate area, providing space for reading and learning, individually and in groups, and for listening to music, viewing television or movies, gaming and talking. The young adults' area should provide the features of a meeting place for the intense communication demands and activities of this target group.

3.3.2.2 Required space and position in the building

The space needed for the young adults' library depends on the structure of the library's population to be served.

Areas for young adults can be noisy, especially as young adults tend to visit the library in groups. Therefore, these areas should be placed away from or insulated from areas that demand quietness, but they should also not be far from the areas for adults.

There should be enough space for programmes with groups. A separate room for events is beneficial.

3.3.2.3 Design and equipment

The young adults' library should be different in design and equipment from other parts of the library. It should be designed and decorated with elements which are in tune with the tastes of the current young adult generation in order to increase the visits of young adults to the library and to retain them as library users. The area should have casual furniture and might be illuminated with special effects in order to attract the target group.

The equipment should be flexible, so that it can be quickly adapted to changes in demand and services. There should be an area with terminals for Internet use or for computer games. There should also be enough seating capacity for groups, either classes or just several people wanting to work, play or communicate together.

The space needed for study places and seats in recreation areas will be the same as for seats in areas for adults (see 4.2.2). Shelves for media will need the same space as in areas for adults.

Details for equipment and facilities in young adults' libraries:

- a) cosy zones for relaxed use of media;
- b) highly durable floor covering;
- c) areas for programmes or a separate function room fitted with modern technology; at least an infrastructure for mobile technology;
- d) walls with whiteboards, blackboards, panels to support programmes for groups;
- e) technical and electric infrastructure to generate special effects with light and to install audio-visual features, like plasma screens.

3.3.3 Music library

3.3.3.1 General

Music libraries in the sense of this Technical Report are for the most part departments of public libraries, aiming to a large extent at leisure pursuits. In music libraries with a high number of users there can be special trained staff for information and help.

Collections in music libraries contain materials on music and musicians, including music scores, recorded music (CDs, audiocassettes, phonograph records etc.), discographies, and music reference materials. Where digital music is offered to users in the library, some space should be provided for marketing this service, e.g. via flat wall screens or by presenting examples at a specific user place.

The collections and services that music libraries offer differ according to their goals and population. Most music libraries lend out print documents and music on physical carriers (CDs, cassettes etc.) and provide places for listening to music in the library. A number of libraries provide downloading and streaming services on-site or via the library website. Some libraries also provide music production facilities.

Some libraries concentrate on music for children and young adults and on sheet music for young amateurs learning to play an instrument.

3.3.3.2 Space for collections

The collections are in most cases presented in open access. The materials (books, sheet music, CDs, cassettes, DVDs etc.) will generally be stored in classified order, but separately as to print and audio-visual materials.

It is recommended that the audio materials be divided by genres and types of music. This will need more space, but will make it easier for the users to find their special interests.

CDs should be presented in special furniture in frontal display, so that the users can read the title and the names of the performers. There are different types of such furniture, but it is important to position the CDs at least 75 cm above the floor.

For security reasons the library can either display only the empty CD boxes, while storing the CDs behind the loan desk, or CDs can be shelved with security cases (special lockers for the boxes). Both ways will need more space than the simple shelving of CDs in their boxes.

Music DVDs are a growing market for all types of music, not only for operas, musicals and other music theatre. DVDs can be displayed in the same way as the CD collection.

Audio cassettes and phonograph records are no longer in high use. However, some music libraries have still considerable collections of these types of media. Records can be stored either in ordinary shelves or in special furniture; music cassettes should be stored in special furniture.

The space required for storing the collection can be calculated according to the tables in 4.7.

3.3.3.3 Other space

The music library will also need places for reading or listening. Space for reading and studying places can be calculated with the data given in 4.2.2.1 and 4.2.2.2. It will be useful to have a separate sound-proof room for listening. At places for listening, there should be headsets and equipment for downloading and streaming.

Libraries that provide music for downloading need a computer and screen for showing the collection that is available via the library.

The main loan desk of the public library can probably also handle the lending from the music library. In case of a large collection and high use a separate loan desk in the music library will be necessary. (For self-service see 4.4.3)

If the library provides information and reference services for music, it can be useful to have a separate desk for this, staffed by qualified librarians. If there is a loan desk in the music library, information and reference services could be provided there.

If music libraries provide rooms/areas for producing and publishing music, with special equipment adapted to the type of music (e.g. acoustic or electronic music), noise insulation will be especially important. For any type of music including electronic music, headphones will be used.

3.3.3.4 Space for exhibition and events

Generally, the music library will use the normal area for exhibitions and events (see 4.3). But when planning that area, sound protection for musical events has to be considered.

3.3.4 Art lending library

3.3.4.1 General

In this Technical Report, art lending libraries are departments of public libraries with collections of art books, works of art (e.g. pictures, sculptures) and reproductions, which lend those books and objects for a specified time period to users. Art lending libraries usually concentrate on modern art in order to promote it to the public. These libraries are often kept separate from other library areas.

Art lending libraries provide physical documents or objects of various formats and size. Most frequently, the collections consist of:

- a) art books and periodicals;
- b) lithographs, engravings, various prints;
- c) posters;
- d) paintings;
- e) films, videos;
- f) sculptures, 3-dimensional objects.

Depending on the materials in the collection and the number and type of users, a professional librarian can be employed in the art lending library.

The storage area for the collection, especially for the works of art, should have temperature/humidity control and appropriate lighting for the preservation of the art objects (see 5.1 and 5.5). Art lending libraries can also provide facilities for users to produce films.

3.3.4.2 Space requirements

Housing the objects and the packing material for lending needs more space than for other media and requires special furniture for storage and presentation. The shelving and other furniture should be adapted to the materials in the collection. Special requirements are:

- a) special drawers and large working-tables for flat files of unframed prints and other flat art material;
- b) special vertical storage for hanging art (like paintings and framed works of art).

For reference and lending activities there should be a combined reference and loan desk. User places will be needed for reading the print materials.

A number of libraries offer downloading and streaming services on-site or via library websites. If the services are offered on-site, there should be space for:

- computers, scanners, printers;
- screens, projectors, etc.

If the library provides films and videos for lending, a quiet area with user places for viewing the materials will be useful.

3.3.4.3 Space for exhibitions and events

Generally, the art lending library will use the normal area for exhibitions and events (see 5.3). As to requirements for exhibiting works of art, see 4.3.3.3.

3.3.5 Special services for users with reading difficulties

3.3.5.1 General

Users experiencing reading difficulties require special equipment to make printed material accessible, either by reading enlarged text or Braille documents and/or by listening to the content (talking books/newspapers) or both at the same time.

The same services as for visually impaired persons can be used for handicapped persons who cannot hold or handle a book. The audio services can also be useful for persons with dyslexia.

3.3.5.2 Required space and equipment

Usually this equipment is located in a special room with limited access, only users with reading difficulties being allowed to use the facilities. Usually staff will be present at specified hours to support the users in using the equipment. Face-to-face reading service might be offered to users.

The special technical support includes e.g.:

- a) computers with magnifying glass attached to the screen or with magnifier software;
- b) software and sometimes keyboard for translating text on the screen into Braille;
- c) speech synthesis software and software facilitating writing for dyslexic users;
- d) screen reader, reproducing a text via loudspeaker or earphone;
- e) scanner with OCR-software, translating text into audio documents;
- f) audio recorder;
- g) Braille printer.

The tables at the workplaces have to be large enough for a computer, a scanner and maybe other technical equipment as well as for print materials that the user needs. The tables should be adjustable in height. The size of the room depends on how many workplaces are provided. It can be necessary to provide shelves for audio documents on cassettes or CDs whose use is by copyright restricted to visually impaired persons.

Sound insulation of workplaces from each other has to be considered, as users listening to media or face-to-face reading can disturb others.

It can also be necessary to provide space for library staff where they can produce local copies of talking books.

3.3.6 Citizens' services

3.3.6.1 General

Citizens' services are service points of the local administration, offering easy access for citizens to administrative services (e.g. renewing passports or driving licences, paying dog licence fees). Such service points are often located at public libraries, taking advantage of the long opening hours of libraries, of a decentralized library infrastructure (branch libraries in the town districts) and of the library staff's competences in information supply.

Undertaking and/or housing citizens' services is a new task in public libraries. The new service can be established as part of the library service or as a specific service located inside or next to the library.

3.3.6.2 Required space and equipment

The required space for the service will depend on the type of information and help offered and on the number of persons expected to use the service. The service will probably need a special area with information desk plus waiting area. The area should have an un-bureaucratic atmosphere and should include space for more private consultations. There should also be space for displaying community information.

To ensure easy use of the service point's functions side by side with the library functions, the following issues should be considered:

- a) the sign system, inside and outside, should display all activities;
- b) the outdoor facilities and the entrance hall should reflect the needs of all visitor groups, e.g. children, elderly people, immigrants;
- c) if access outside library hours is planned for the service point, the security and safety systems have to be adapted accordingly;
- d) extra wardrobes and toilets may be needed.

3.3.7 Undergraduate library

3.3.7.1 General

Undergraduate libraries are established, supported, and maintained by institutions of higher education to serve the information and research needs of undergraduate students and the instructional requirements of the undergraduate curriculum. They are either operated as branch libraries or as independent administrative units. Not all institutions of higher education provide undergraduate libraries. In many cases, collections of textbooks and other materials for the curriculum are integrated into the general collection.

Undergraduate libraries provide the most-used current literature for the study courses in multiple copies, according to student numbers and needs. The collection is usually restricted to the basic recommended literature in all fields of study. Most frequently, this concerns books, which are increasingly replaced by collections of eBooks with free access for the students.

If the undergraduate library is maintained as independent unit, the collection can be widened to contain materials like periodicals, newspapers, audiovisual materials, maps, etc.

Independent undergraduate libraries can also offer user training, especially on information retrieval, or can serve as learning centres.

If the undergraduate library is located within the building of the central library, it should be placed near the entrance, so that students coming for quick lending and return of materials need not enter other library areas.

3.3.7.2 Space for collections

The collections are stored in open access, generally subdivided as to subjects and materials (books, CDs, DVDs, etc.).

The space required for storing the collection can be calculated according to the tables in 4.7. But as the collection turnover in undergraduate collections is extremely high, the full space as calculated for open access storage areas will usually not be necessary.

3.3.7.3 Other space

The number and type of user places in an undergraduate library depends on the services that are provided. For a loan collection of textbooks, places for quick browsing of the material or for consulting the online catalogue should be provided (see 4.2.2.3). If the undergraduate library provides areas for group work or user training or functions as learning centre, the required space for user places can be calculated according to 4.2.2.

Generally, space for a loan desk or self-service terminal will be needed. If the undergraduate library is housed in the same building as the central library, its lending could be handled in conjunction with the general lending service of the library, if this has been considered in the planning of the building.

For undergraduate libraries that function as independent administrative units, space will be needed for staff rooms, meeting rooms, toilets, etc.

3.3.8 Rare books and manuscripts department

3.3.8.1 General

Usually rare, valuable, unique and fragile materials like rare books and manuscripts will be separated from the rest of the collections, both as regards the stacks and the reading-rooms. The effects on construction and design of the building will differ from library to library, depending on the composition of the special collections.

Risk assessment is necessary; the precautions taken to protect the collections from theft, vandalism and accidents will differ according to the type of library and collection. The risk assessment will give further guidance for security systems, locks, fire protection, assault alarms etc. It is recommended that experts are consulted early in the planning process.

The specifications for strong rooms and stacks for rare books and manuscripts should follow national or international recommendations and rules.

For alarm systems, see 5.4.2.4.

3.3.8.2 Special reading-room

The special reading-room is the area where registered users work with rare materials out of the library's own collection or lent for a time from libraries or other institutions. Generally, the room contains a collection of literature dealing with rare materials, user places for working with the materials, staff places, safes for short storage of rare materials, cupboards for book rests and other equipment, and technical equipment like computers, microfilm readers etc.

If there is space, libraries often use glass cabinets for exhibiting special materials, e.g. their new acquisitions of rare books.

The reading-room needs special security arrangements. It should in principle be locked. There should be an entrance control area, where visitors pass a security checkpoint with registration when arriving or leaving. The desk or counter should be large enough for a registration book or library card scanner / RFID device for signing in and out, and also for a surface where personal belongings could be spread out. The security checkpoint should have an alarm button for cases of need. Lockers should be provided for users' personal belongings that cannot be taken into the special reading room.

The staff and/or guards need to have a good overview of the entrance area, controlling the locking/unlocking of the doors to the reading-room. Staff should also at any time have visual contact both with the users and with the library materials. The tables for users should be placed so that staff can see all the user places, even when working at their own places. Video surveillance can be helpful (see 5.4.2.3). The type and size of user places in the special reading-room should take into account the materials that have to be handled (see 4.2.2.1.4.).

It is recommended that building constructions like pillars, additional walls, built-in shelves etc. be avoided so that they do not hinder surveillance nor give opportunities for undisturbed illegal actions. The required reference collection for the reading-room should be placed so that surveillance is not interfered with.

Windows and doors are weak points, and special care has to be taken to limit opportunities of removing library material outside the reading-room. In some cases it might be advisable to use a room without windows.

Depending on the number of visitors, it can be useful to divide the reading room into two parts, one for quiet work and another where conversation is allowed, for instance when a librarian is consulted by a user, or during group visits.

3.3.8.3 Secure storage units/strong rooms

While the material is not used by the visitors, it has to be kept secure. There are generally two solutions:

- a) the stacks for rare materials are placed as near as possible to the rare books and manuscripts department, so that the material can be fetched directly from its permanent location each time a user requests it;
- b) a strong room adjacent to the reading-room temporarily houses the materials that have been requested during the times when the users are not using them.

The general requirements for storing library collections are described in 5.1.

For the rare books and manuscripts department, the following issues are especially important:

- a secure route from the permanent location of materials to the reading-room or strong room;
- adequate protection against fire, water, theft and other damaging actions (see 5.4);
- permanent control of temperature and humidity (see 5.1);
- lighting adapted to the materials stored (see 5.5.2);
- a safe locking system including a system for logging staff passing in and out.

The shelves and other furniture should be robust and of fire resistant material. Redundant equipment, trolleys etc. should be removed. All electric equipment and wiring should be easy to check for malfunction and to replace frequently.

The shelf boards should be deep enough for the materials to be stored and should be smooth in order to avoid damage. There should be enough space for keeping good order. A good overview over the shelves is a safety precaution.

For some types of materials storage in cupboards, lying flat, will give extra protection against fire or water damage. Compact shelves can give extra protection against fire and water if the mobile units leave no aisles when they are closed. If the stacks or the strong room are large, partitioning will give extra protection.

3.4 Joint facilities

3.4.1 General

The merging of libraries with other public or commercial institutions in one building influences building interiors and layout in various ways and should be considered when planning new buildings or when organizing joint facilities in existing constructions. Libraries can be housed together with cafés, cinemas, community services, galleries, internet cafés, malls, museums, media and news houses, sport and gym facilities, school and learning centres, tourist information offices, or other institutions. Academic libraries are often housed together with the IT-centre or the student advisory service of their institution.

In a number of cases there is only a loose contact between the library and the institution sharing the building. In other cases there can be an effective cooperation, enhancing the number and value of services and furthering cost-efficiency by sharing rooms, facilities and even staff.

Partnerships and cooperation between different local institutions and activities are established for several reasons: to attract more users, to further social inclusion, to better utilize staff competences, to share meeting facilities, and to provide cost-efficient services without administrative overlapping.

3.4.2 Required space and equipment

Space, design and equipment of the jointly used areas are dependent on the type of services and activities offered.

To support effective cooperation a set of planning rules should be kept in mind:

- a) the sign system, in- and outside, should display all institutions and their services;
- b) the outdoor space and the entrance hall should reflect the needs of all visitor groups (e.g. children, young adults, elderly people) and should offer facilities for the different institutions (e.g. book drops for libraries, ramps for galleries and museums, etc.);
- c) if access outside the library opening hours is planned for the other institution(s), the locking and safety systems have to be adapted accordingly;
- d) joint facilities for exhibitions, meetings and workshops should have a lock-up depot for each of the partners' specific materials;
- e) there should be a central janitor's space.

Presumably two or more institutions joined in the same building will attract more visitors than a single institution. Resistance and durability of the flooring should be considered (see 5.7). Entrance area and entrance hall, wardrobes and toilets, meeting rooms and recreation areas should be adapted to the higher numbers.

4 Usable areas

4.1 General

The gross floor area is defined in this Technical Report as the sum of all floor areas of all levels of a building. It is divided into the following spaces:

- a) the functional space that houses the central operational equipment of a building, for instance sewage disposal, heating, conveyor technique;
- b) the circulation space that is needed for access to the rooms, in-house traffic and for evacuation of the building in case of need; This includes for instance floor space of corridors, stairway space, lift shafts and traffic area for vehicles, but not movement areas in rooms that belong to the usable area;
- c) the space occupied by the constructional elements of the building (pillars, walls, etc.);
- d) the usable area, which serves the main purpose of the building. This includes space for user services (including areas for recreation and communication), materials storage, library management and technical services, events, exhibitions and meetings, equipment areas, aisles, toilets and janitorial areas, and all other space used for library resources and services.

For a number of service areas in libraries usable areas cannot be clearly separated from circulation space. Examples are stacks, reading-rooms, or lending areas. In these and other cases, the usable area includes

storage areas as well as movement areas and in addition the space in front of and beside facilities which is necessary for using them. In collection storage areas even the main aisles are defined as usable areas, not as circulation space.

4.2 Space for user places

4.2.1 Calculating the number of user places

4.2.1.1 General

Libraries are valued not only as places for reading, learning and working, but also as information and communication centres. In some libraries, numbers of physical library visits have decreased, due to a high proportion of the library's services and resources being available for remote use. In many libraries, numbers of physical visits remain constant or are even increasing, due to new library services like user training, cultural events, or group working areas. There is also a growing tendency for users working with their own material in libraries. Therefore, provision of an adequate number of user places, with or without equipment, will be one of the most important issues when planning the building.

In case of a re-construction or reorganisation of an existing library building, it will be less difficult to calculate an adequate number of user places. Measuring the occupancy rate of the seats at different times – including peak times – will give valuable information. But foreseeable future developments regarding user behaviour and technical equipment should be taken into consideration. New library buildings will generally cause a rise in user visits.

In the sense of this Technical Report, user places do not include seats in halls, lecture and auditory theatres intended for audiences of special events. Floor space and cushions on which users can sit are also excluded.

4.2.1.2 User places in public libraries

Public libraries are heavily used as information and communication centres. A large number of user places can be basic, as they will be rather used for short periods of reading or searching than for long-time studying. But as there is a growing tendency for using the public library as learning space, places should also be provided for this purpose. Another issue is the public library's role as social place for meeting and communication, which makes it expedient to offer groups of comfortable seats and informal seating. Lastly, the public library offers various types of cultural and educational events, which requires seats in lecture halls, auditory theatres and other such areas.

The number and type of user places in public libraries depends on the specific profile and tasks of the library, on the population to be served, and on the average number of visitors per hour. Small libraries should at least offer sufficient seats to house one school class, which would be about 30 pupils. A general rule is that there should be sufficient places for one third of the users in the building at any one time. This would include peak times, and therefore the number of user places should be calculated based on peak demand.

4.2.1.3 User places in libraries in institutions of higher education

In institutions of higher education the number of user places that the library should offer depends above all on the population to be served, especially the number of students. In several countries, models have been developed that determine what amount of user places could be considered as adequate. Usually, the models recommend a percentage of total students for which places should be provided. In these models, user places are defined as workplaces and do not include purely recreational seating.

Examples for such models are:

EXAMPLE 1 In the UK traditional rules for university libraries allowed 1,25 m² per student, based on one reader place per six FTE (full-time equivalent) students at 0,40 m² plus a book stack allowance of 0,62 m² and an addition for administration. This meant that for 16,7 % of students a workplace should be provided in the library (UK Higher Education Space Management Group 2006). Newer recommendations propose workplaces in the library for 20 % of total students (Edwards 2002).

EXAMPLE 2 Canadian recommendations claim that the library should provide workplaces for at least 14 % of the student population (University Libraries Committee 2005).

The recommendations can differ as to counting students in FTE (full-time equivalent) or as headcounts, considering also part-time students. Some models have taken the average occupancy of user places in libraries as basis for their estimate of an adequate number of places (Vogel and Cordes 2005), but this would not cover the daily peak times, e.g. between 11.00 a. m. to 13.00 p. m. and between 17.00 p. m. to 20.00 p. m. or later.

In some models, user places are calculated for individual faculties. This kind of calculation takes into consideration that library use can vary between students of different subjects. For sciences, technology and medicine, the assumption is that usage of library resources concentrates on electronic textbooks and journals that can be used by remote access. For humanities and social sciences, the assumption is that print materials are still important and that more time will be spent in the library. In such calculations, the number of places per student varies according to the faculty.

Such differentiation as to faculties is becoming less relevant. Though for many subjects resources are increasingly offered in electronic form and though many library services are now available online, the library remains attractive as place for learning and research for students of all faculties. Users discover the advantage of using both print and electronic resources together with the library's help and training services. Additionally, there is a growing tendency for group work in libraries or for users working with their own material in libraries. This tendency is re-enforced by the introduction of study courses with strict time schedules.

Given these tendencies, it is recommended that libraries offer user places for at least 15 % of students. Students should be calculated as persons, not as FTE (full-time equivalent), as part-time students will need a place at much the same time as full-time students. This recommendation includes places for group work and carrels but excludes places that are exclusively designated for recreation and communication, e.g. in lounge areas or in a library-café. Such places should be calculated individually for each library.

4.2.2 Types of user places

In the planning of user places the different requirements of users should be considered. People have different needs depending on their age, information behaviour, cultural background and social relations. Therefore it is necessary to offer a great variety of user places in the library building. This is important for space planning as well as for the choice of furniture.

Types of user places:

- a) places for concentrated work;
- b) single places for reading and listening;
- c) places for information and quick consultation;
- d) group study places;
- e) places in training rooms;
- f) seats in recreation and communication areas;
- g) places in children's areas;
- h) seats in auditoria.

4.2.2.1 Places for concentrated work

4.2.2.1.1 Standard place

The standard-type desk should be minimum 120 cm in breadth and 80 cm in depth. These measurements are adapted for the temporary use of laptops and notebooks or other mobile devices as well.

For the use of laptops and notebooks the places need wired or wireless access, power-supply and a loop for theft protection.

This kind of workplace can be arranged individually or in groups. But it has to be considered that concentrated study requires privacy and an appropriate distance between adjacent places. Some areas should be designed especially for silent learning.

4.2.2.1.2 IT-workplace

If the workplace is equipped with IT (personal computer, terminal or multimedia equipment) it requires a minimum of 160 cm in breadth and 80 cm in depth. There has to be enough space on the desk for monitor, keypad and mouse as well as for additional equipment like scanner or printer and for visual materials like books and writing pad.

4.2.2.1.3 Space calculation

The distance of tables in a row should be minimum 95 cm to offer the necessary moving space. The axis centre distance between the tables is therefore 175 cm. Both the standard place and the IT-workplace need an addition of 0,90 m² per desk to cover the before mentioned distances.

The following formula is valid for the calculation of the single workplace:

$$S = b \times c + 0,90 \text{ m}^2$$

where

S = space required;

b = breadth of the table;

c = centre distance of tables in a row.

The space required for a standard place as described in 4.2.2.1.1 is then:

$$S = 1,20 \text{ m} \times (0,80 \text{ m} + 0,95 \text{ m}) + 0,90 \text{ m}^2$$

$$S = 3,00 \text{ m}^2$$

The space required for an IT- place described in 4.2.2.1.2 is then:

$$S = 1,60 \times (0,80 \text{ m} + 0,95 \text{ m}) + 0,90 \text{ m}^2$$

$$S = 3,70 \text{ m}^2$$

4.2.2.1.4 Places for rare materials

Places for the consultation of rare materials require more space than standard workplaces. The materials have to be handled with special care and sometimes a book rest is needed for vulnerable items. In the study area a desk is needed for the security staff or curator and additional shelves or bookcases to store the materials when not in use. There are different kinds of tables needed for the various materials and the tables should be arranged concerning safety needs. There should be an addition of at least 1,00 m² per place compared to the standard place.

4.2.2.1.5 Closed or screened user places (carrels)

Quiet reading places in academic libraries are often equipped with screens. Such carrels should allow the use of laptops or notebooks in the way described in 4.2.2.1.2. An optimal ergonomic design is necessary because of the heavy use of the places. Because of the screens these places require around 4,00 m² each.

For intensive studying, postgraduates or long term projects libraries offer closed study booths with additional shelves for study material. The minimum space for one booth should be 7,00 m².

4.2.2.2 Single places for reading and listening

Some areas of the library like newspaper or fiction reading areas or music libraries should offer quiet reading and listening places. Comfortable furniture is necessary for such spaces. These places can come with or without desks. Each place requires about 80 cm in breadth and 80 cm in depth. The distance between two places should be 95 cm. The result is an axis centre distance of 175 cm.

The space for one such place should be about 2.00 to 2.50 m².

4.2.2.3 Places for information and quick consultation

These special places for short time catalogue and online research can be standing desks or smaller working desks. They require a minimum of 60 cm in breadth and 60 cm in depth. The distance between the places should be 95 cm.

The space for one such place should be about 1,50 to 2,00 m².

4.2.2.4 Group study places

In academic and in public libraries the demand for group study areas is growing. Collaborative work in the library requires separate study rooms. Otherwise group working tables have to be separated by interior design. Such rooms and areas should offer enough space for 4 to 8 persons each. The tables should be around 160 cm in breadth and 80 cm in depth each and it should be possible to combine them in groups. Two of these tables can seat a group of eight people.

A group study place requires 3,00 m² to 3,50 m².

Multimedia booths offer a great variety of technical solutions for blended learning and multimedia experience. They can be equipped with multi-touch tools for collaborative working with 4 to 6 persons. In the case multi-touch wallpapers are used some space is needed for the movement of persons working at the wallpaper.

4.2.2.5 Places in training rooms

For library instruction and teaching groups, libraries need training rooms. If this is not possible, group study areas should offer the opportunity for teaching and instruction.

Each place in training rooms or areas requires 3,00 m² to 3,50 m². The additional space needed for the instruction place is 7,00 m².

4.2.2.6 Seats in recreation and communication areas

Inviting and comfortable areas for recreation and communication are important spaces in all types of libraries. They can be designed as comfortable lounge areas or as combinations of armchairs and tables for newspaper or magazine reading areas. Sometimes these places are situated close to the library café; sometimes they are comfort zones between the shelves. These social spaces have to be insulated acoustically from quieter areas of the library. Power-points and wireless access should be offered for the use of laptops and notebooks and other mobile devices. A small table with four armchairs requires 4,00 m² to 6,00 m², a lounge area with armchairs and sofas 5,00 m² to 8,00 m² to seat four people.

If areas are used for computer games of groups, there should be two or more flat screens, some shelves for games that are not online based and play stations with comfortable seating for two or four at a time. Some space for lookers-on will be useful.

These seats and spaces don't count in the total number of user places because their purpose is not to fulfil the requirements for studying materials in the library.

4.2.2.7 Places in children's areas

The children's library should offer an elaborated structure of different zones for the age groups and special requirements of children.

Bolsters should be offered for toddlers to snuggle in.

Children between three and six years of age require an area for reading, painting and playing. An armchair for reading aloud and places with chairs, tables and cushions for reading and listening are necessary. Tables should be combinable for group activities.

For schoolchildren reading places and tables for homework require a space of minimum 2,00 m². IT-workplaces and places with computer games should offer at least 3,00 m² and can require up to 6,00 m² for groups or multimedia spaces.

4.2.2.8 Seats in auditoria

Middle-size and larger libraries need an auditorium for lectures, presentations, entertainment, meetings and other public activities. Separated rooms are required for technical equipment and the storage for chairs and scenery-elements.

One seat in a row requires at least 1,00 m².

4.2.2.9 Overview of space requirements for user places

Type of place	Rounded m ²
Standard place for concentrated work	3,00
IT-workplace	3,70
Place for working with rare materials	4,00
Carrel	4,00
Study booth	7,00
Single place for reading or listening	2,00 to 2,50
Place for information and quick consultation	1,50 to 2,00
Group study place	3,00 to 3,50
Training room place	3,00 to 3,50 ¹
Table with four armchairs	4,00 to 6,00
Lounge space for four people	5,00 to 8,00
Place in children's areas	2,00
Multimedia or gaming place for schoolchildren	3,00 to 6,00
Seat in an auditorium	1,00

¹ Training room: Additional 7 m² for instruction place

4.3 Space for events and exhibitions

4.3.1 General

A great number of libraries of all types regularly provide events and/or exhibitions for their population to be served. For a varied range of events it will be useful to have one large hall or area and one or several smaller rooms or areas for specialised events. Having an area or room for events that can be separated from the library will make it easier to organise events, and a separate entrance will render it possible to open the area outside the normal opening times of the library and to rent the area to external organisers.

When planning heating and air conditioning, the potential number of visitors should be taken into consideration.

4.3.2 Required space and equipment

The area for events should include space for lavatories and for a cloakroom or coat racks, if the facilities in the entrance area of the library cannot be used. Wireless access areas should be available and if not, ICT plugs as power supply should be ample. In auditoria all seats should have plug-in facilities.

A kitchen can be needed if there is no cafeteria nearby. The kitchen should be spacious enough for catering, and tap water, dishwasher, cupboards, waste disposal, and power supply should be appropriate for the use of external caterers.

Storerooms for chairs and other equipment (see 4.9.3) should be available. A studio for the preparation of events, especially for exhibitions, will be useful (see 4.8.3.4). If the library presents events on a stage, space for stage technique should be considered.

For planning the space of seats in auditoria and conference halls, see 4.2.2.8.

4.3.3 Requirements for specific rooms/areas

4.3.3.1 Auditorium/conference hall

Auditoria or conference halls have often the shape of a theatre or arena with built-in seating for meetings, lectures, etc. Flexible seating is recommended. There should be a meeting and registration area in front of larger auditoria/halls.

The following equipment is recommended:

- a) a film screen and projector facilities;
- b) a speaker's rostrum that is easy to move and yet stable.

4.3.3.2 Multipurpose hall

The requirements are the same as in 4.3.3.1, but without built-in seating.

4.3.3.3 Exhibition area

Exhibition areas are spaces where information, products or services are displayed. They should be placed close to the entrance or the main traffic flow in the building. Special requirements are:

- a) flexible lighting (both daylight and artificial light) that can be easily adapted to the material exhibited;
- b) easy-to-use curtains;
- c) flexible spot lighting that is easy to mount;

- d) flexible hanging rails mounted in the ceilings along walls;
- e) space for movable display systems;
- f) seating facilities such as benches;
- g) workshop facilities incl. tap water access and power supply.

4.4 Space for lending

4.4.1 General

Lending areas have in most cases a prominent position in the library. Particular attention should therefore be paid to the design of such areas; service-orientation, efficiency of workflows and ergonomic workplace design should be carefully considered.

The main feature of a lending area is usually a central desk where loans are conventionally processed by library staff. Since technology has enabled libraries to switch to self-service charging there is now greater scope for designing lending areas.

The space requirements and the design of lending areas depend on the following issues:

- a) how lending is organized (by staff, self-service, mixed forms);
- b) how the different functions are organized (e.g. check-out, return, registration, reservations, renewals, pay desk or self-service pay points);
- c) the number of staff working at the loan desk and the number and location of self-service terminals (which is dependent on the number of visitors and the average number of loans per opening hour);
- d) the type of lending system used;
- e) the equipment that needs to be installed at the desk (telephones, computers, peripheral devices, receipt printers, tills, security systems, control panels etc.);
- f) the types of material that need to be accommodated at the desk (information leaflets, office supplies, possibly also media if empty cases or security cases are on display in the shelves);
- g) the shelves required for reserved media;
- h) the type of sorting and transport system used (number and size of book trolleys, connections to automatic sorting systems and possibly transport systems).

4.4.2 Staffed loan desks

The loan desk should be located such that visitors' ways are short and sufficiently wide, that orientation is easy and the flows of visitors do not overlap. The desk should also be connected to sorting areas, the internal transport system and security facilities. Care should be taken to separate the lending area from reading and study areas owing to the noise at busy desks.

Media are checked out, returned, or renewed at the loan desk. Depending on how the library is organized, visitors can register, reserve media and pay fees either at the loan desk or at a separate counter. Fees can also be paid at self-service pay points. It can make sense to divide check-out and return between separate desks, depending on the amount of space available.

Workplaces at the loan desk should satisfy the relevant ergonomic requirements. They can be designed for a sitting or standing working position or a combination of both to take account of the needs of the staff. Desks that are adjustable in height enable staff to alternate between standing and sitting at the same workplace.

Adequate wiring for power supply and for data cables should be integrated into the loan desk. The work processes at the desk should be considered in detail when deciding where to install receipt printers, tills, computers and scanners, although aesthetic aspects should not be disregarded either. If RFID technology is used distances from metal components should be considered in order to avoid interference. The supporting structure of the desk should also be compatible with RFID technology.

Surfaces on which library users can place media or bags should be provided. There should be sufficient space in front of the desk for users who are waiting to be served. The provision of seating areas for persons accompanying users is recommended.

Near the loan desk there should be sufficient space for shelves, trolleys and, where applicable, also for a sorting system or for the head end of a media transport system. Space for queuing should also be considered.

The floor space required for a loan desk is 10 m² per workplace.

4.4.3 Self-service terminals

Self-service terminals enable users to check-out and return items and to deactivate or activate the security tags affixed to media. The use of security tags is a prerequisite for the installation of self-service terminals.

Self-service terminals can be installed either so that users can choose between self-service and staff services or so that staff will assist users only if problems arise. It should also be decided whether self-service facilities are made available for check-out only or also for return.

Depending on the system used, self-service terminals can be free-standing or wall-mounted machines. There are also specialized self-service terminals for children and wheel-chair users. Self-service terminals comprise a monitor, the reading device (scanner or aerial) for user cards and media numbers, the surface for check-out (including deactivating or activating security tags), a receipt printer and a surface on which to place media or other items. The terminals require connections to power supply and data cables.

The location of self-service terminals used for check-out is not limited to the entrance area. Terminals can be placed anywhere in the library.

Book drops can be provided for the return of books without the need to visit a staffed service point. There is then the problem of removing the returned items. Self-service book drops with connection to a transport system can also operate outside opening hours. Self-service pay points can be provided for library users to carry out payment transactions. Both for manual and automatic sorting of returned items, space for the sorting of media should be considered in the planning.

Even if check-out, returns and payments are processed entirely at self-service terminals, a staffed desk is still required as a clearing point, to provide users with information or assistance and for security reasons.

For a self-service check-out terminal an area of 4 m² is required. If self-service book drops are installed, allowance should also be made for the space required to connect each book drop to the sorting facility. The space required for self-service pay points depends on turnover and the associated security regulations. The smallest machine without any allowance for particular security considerations requires an area of 2,50 m².

Space for queuing should also be considered.

4.4.4 Shelves for requested and reserved items

If users cannot fetch the material they want to borrow from open stacks or open access areas, the items should be ordered by the user and fetched by library staff. The material should then be kept ready for check-out near the loan desk. The same applies to material that was on loan when the user requested it. Users can make reservations on the material, and the items will be reserved for them when returned and kept ready for check-out.

For both requested materials from closed stacks and reserved materials, shelves should be provided. The number of shelves required depends on the number of loans from closed stacks and on the number of

reservations. Reserved and requested media can also be stored ready for check-out in shelves to which visitors have direct access and which are near the loan desk.

The shelves for requested items should be located within easy reach of the loan desk or self-service terminals and the media transport system, if installed. The distances between shelves, desk and transport system should be kept to a minimum. Adequate shelf space should be planned as the loan desk area has limited flexibility, and it is often impossible to provide more shelving at a later date.

The basis for planning is as follows:

Assuming a shelf height of 2,25 m, an average of 5 shelf boards (0,30 m depth), one above the other, should be planned. The aisles between the shelves should be 1 m wide. This results in an axis centre distance of 1,60 m. The shelf length should not exceed 4 m.

4.4.5 Space for internal activities

Apart from the loan desk and self-service terminals, offices for internal activities such as inter-library loans, handling fines and possibly book care should also be provided in the lending area.

A separate place for talking with users, especially for dealing with complaints, should be provided near the lending area.

4.5 Space for reference and information

4.5.1 General

The reference and information service in a library assists users in finding information and answers to questions. Reference service is offered either as face-to-face reference, with users coming to the information desk with their questions, or by staff communicating with users by telephone, fax, e-mail or other web-based services. Personal assistance is very important in libraries and particular attention should be paid to the reference and information area in the planning process.

The area usually consists of a staffed information point, tables or shelves for placing information leaflets, and shelves for reference materials. As a great part of reference materials are today available in electronic format, the print reference collection can in many cases be restricted to older or local materials.

Some user places for quick consultation of online catalogues and for short Internet browsing will be useful. These places can be standing desks or smaller working desks (see 4.2.2.3).

It will in many cases also be useful to provide a staff workplace in the background of the information point where staff can communicate with users by telephone or online, or handle questions sent by mail.

4.5.2 Information point (reference desk)

Information points are places where one or more library staff members give help and information to users. They should be prominently placed and should be easily identifiable by good signposting. In large libraries with separate areas for specified subject collections or user groups, it is expedient to have special information points in each of those areas.

The information point usually consists of a desk with a staff workplace and a computer. The computer screen should be placed so that the staff person and the user can look at it together. In addition to the ergonomic requirements for staff workplaces, information points should also consider the users' needs. The design should facilitate contact between users and staff and allow them to communicate at eye-level. Seating for the user should be available for a longer consultation. Space for a waiting queue can be needed for peak times.

The floor space required for an information point staffed with one person is approximately 5 m². This does not include the reference collection or the background staff workplace. If possible, the space for the information point should be flexible so that it can be adapted to varying demand.

4.6 Space for other usage areas

4.6.1 General

In all libraries there will be space areas that cannot be calculated with a general formula, but which should be dimensioned individually according to local circumstances, e.g. according to the population to be served, the structure and organisation of the library, or the size and type of the collections.

Though there are no general parameters for such spaces, the required space can often be estimated by using known dimensions for equipment and furniture and adding the necessary movement area. Examples are a library shop attached to the entrance hall or space for entrance/exit control.

4.6.2 Entrance hall, reception desk

Generally, only in small libraries are visitors led directly from the entrance to reading-rooms or open access areas. Normally, libraries need an entrance hall that offers orientation and initial guidance information to visitors.

The entrance is crucial for the first impression of the library; it determines whether the visitors feel welcome or discouraged. In order to give a favourable impression of the library and its services, the entrance hall should be spacious, light and clearly laid out. It should be large enough for visitors to move about and orient themselves, and able to accommodate a group assembling for a guided tour or other activity.

The structure of the entrance hall should make the main options for user activities visible, if possible without conspicuous sign posting. If the hall opens up to other service areas, this will invite visitors to move on. A high ceiling will make the entrance hall more impressive, and good lighting, whether by daylight or artificial, will support the orientation.

For the choice of entrance doors, the needs of handicapped persons and the amount of user traffic at peak times should be considered. Automatic doors are useful for both purposes. As visitors enter from outside, the flooring should be hard-wearing, easy to clean and non-slip.

Many entrance halls contain a reception desk that can combine the functions of initial information, registering for use and entrance/exit control. Another solution is to place the loan desk in the entrance hall and to integrate first information, registering and control functions into the lending activities. As library staff will be working at the respective desks, draught from the entrance doors should be prevented.

Equipment that is usually placed in an entrance hall includes:

- a) lockers and wardrobes;
- b) telephone boxes;
- c) a change machine;
- d) informal seating for waiting persons;
- e) terminals for short searches and activities, e.g. for renewals.

In certain libraries there can be need for security checks (bags and persons) in the entrance hall.

Entrance halls are also a convenient place for presenting new acquisitions of print and other physical media. Shelves or tables can be used for the display. The media are generally sorted as to topics or target groups, e.g. books and brochures about new tax laws, or picture books, CDs and DVDs for small children. There should be enough space for users going round and browsing and some relaxed seating nearby.

4.6.3 Lounge areas

Inviting and comfortable areas for recreation and communication are important spaces in all types of libraries. They can be designed as comfortable lounge areas or as combinations of armchairs and tables for newspaper or magazine reading areas. Lounge areas offer relaxed seating, often wireless access and different types of information. They are frequently placed in or near the entrance hall, where they open up to the different library activities. In larger libraries with specified departments and/or several storeys, there will generally be at least small lounge areas at all levels. In close proximity of a lounge area can be located services such as newspapers, library cafeterias. Internet bars plus more informal exhibition areas. Lounge areas have to be separated acoustically from quieter areas of the library.

In lounge areas, flat screens of different size are sometimes used for news dissemination, e.g. for presenting new services and new media. There should be ample space in front of a screen. If the news is of a kind that users will pick up in passing-by, no seating will be necessary. If there is a kind of news broadcasting there will be need of some type of relaxed seating.

As to space for seating in lounge areas, see 4.2.2.6.

4.6.4 Interactive spaces

Information and communication technology (ICT) provides new ways of communication, mediation and knowledge promotion with active participation of the users. Researchers work with various types of so-called pervasive computing, among other things on projects in connection with libraries.

In order to meet upcoming needs for interactive services future library buildings should incorporate specific spaces prepared for these activities. In interactive spaces in buildings ICT technology is integrated in furniture (e.g. tables), walls, and even in the entire building. This means fully cabled areas with easy access.

EXAMPLE An interactive-information wall would need a space of $4 \times 6 \text{ m}^2$ for back-office servers etc. and a large touch-screen wall including a space before it for the public to access the wall. The area should be insulated from areas that demand quietness. Seating for users waiting to use the wall should be provided.

4.6.5 Sickroom

A special rest facility or sickroom for users will generally be necessary. Depending on the size of the library and the number of daily visitors this facility can be very basic or more sophisticated. A bed or sofa where it is possible to lie down is the main furniture needed; the room could also have a chair, table etc. Sometimes it might be necessary to add an alarm device so that help can be summoned. Water connection will be needed.

In some countries there are recommendations or legal regulations about the size, equipment and furniture of sickrooms.

4.6.6 Toilets/lavatories

It is necessary to provide sufficient toilets for users. The size and number of lavatories are subject to the legal regulations and recommendations of each country. The location can depend on architectural aspects.

The lavatories should be barrier-free and accessible. Cold and warm water should be available.

4.6.7 Lockers and wardrobes

The number of lockers and the size of a wardrobe depend on the average number of visitors per hour and on the number of user places. As control of lockers and wardrobes will be important, they should not be situated too far from staff places.

A locker should be at least 30 cm broad, 40 cm high and 50 cm deep; this is sufficient for a short coat and a brief case. For 12 such lockers, inclusive of movement area, $1,50 \text{ m}^2$ are necessary. Larger lockers should be

offered for long coats and larger cases, 3 such lockers, inclusive of movement area, will also need 1.50 m². A certain number of lockers should be at least 40 cm broad for housing bicycle or motorcycle helmets.

It has proved practical to offer tables between ranges of lockers for short-time storing of clothes and bags when using a locker.

4.6.8 Reprography

Generally, equipment for digital reprography will be provided for users, often with data storing or data communication possibilities. As the size of the machines depends on the amount and type of usage, space for each machine will vary between 4 m² and 10 m², space for depositing the media included.

When placing the equipment in the user area, the following issues should be kept in mind:

- a) noise protection (copying machines, printers);
- b) generation of heat;
- c) ozone pollution (especially copying machines, printers).

Adequate noise protection and ventilation of such areas should be ensured.

4.6.9 Smoking areas

Since smoking has been forbidden in public buildings in most countries, special facilities for smokers inside library buildings have become rare. But there are often designated smoking areas located outside.

If smoking is allowed in a specified place inside the building, that area should be partitioned off so that smoke does not permeate to other areas. Fire protection should be considered. If the smoking area has air-conditioning, the air should be filtered before re-circulating.

When smoking in the building is forbidden by law, institutions can provide an outdoor smoking area, subject to the requirements of the respective law. Outdoor smoking areas should be clearly marked by appropriate signage and ashtrays. The areas should be located at a certain distance, often specified by legal regulations, to entrances, windows and ventilation systems. There are also sometimes regulations as to whether the outdoor smoking areas should be sheltered by a roof or wall against wind and rain.

4.7 Space for collections

4.7.1 General

This subclause proposes methods for calculating the space required for the physical collections. The methods are differentiated as to types and formats of materials in the collections.

The space calculations are based on freestanding double-faced shelves - or on other furniture in back to back position - with constant axis centre distance.

The following parameters should be determined before calculating:

- a) shelf depth;
- b) shelf height;
- c) number of shelf boards on top of each other;
- d) stack aisle width and axis centre distance;
- e) length of shelving ranges;
- f) capacity of the shelves.

For compact shelving, the calculation should follow the description in 4.7.9. For automated shelving, see 4.7.10.

Tables 1 to 12 (4.7.3 to 4.7.8) show directly what value the specific parameters can have for various materials.

When all parameters have been established, the required space can either be calculated by the Formula 1 (4.7.11) or by taking the respective value of required space per 1,000 media out of Tables 13 to 24.

The Tables 1, 3, 4, 5, 6, 9 and 11 are based on using normal shelves. For non-book material in frontal display there are other types of more ergonomic furniture, often in terraced format, for which the required space can also be determined by the Formula 1, if the depth of the furniture and the capacity of the boards are known. Experience shows that the space required using such furniture is similar to the space required for frontal display in normal shelves.

Formula 1 can also be used for media requiring dust protection like microfiches, microfilms, sound recordings and audiovisual documents. Such media are usually stored in metal cupboards.

4.7.2 Limitations

When calculating storage requirements for collections, national or local legislation and regulations concerning public buildings (e.g. security issues) have to be considered and might have precedence over international standards or technical reports. Regulations in legislation and in standards can determine limits of shelving frame height, the distance of bottom shelves to the ground, the length of shelving ranges and the distance between the highest shelf and the room ceiling. Such regulations aim at giving free access to the media and at ensuring adequate circulation in stack aisles.

The tables in this subclause show examples of shelving different materials in different shelves or furniture, according to the size of the materials. This method saves space, but on the other side consistent shelving is more flexible. If the type of collection changes in a library, or if parts of the collection should change their place, it will be easier to move the collections than the shelves that have been adapted to the size and shape of specified areas. In particular, differentiated shelving might not be practical in libraries where a small collection does not justify different types of shelving, except for special display. This does not apply to special furniture, e.g. for picture books.

This Technical Report does not give guidance as to the adequate size of collections, nor does it show calculations for the future growth of the collection. Planning the space for collections will of course not be restricted to the existing collection, but will generally include the space needed for the library's acquisitions of minimum the next 5 to 10 years. The foreseeable growth of the collection depends on several factors:

- a) the weeding policy, especially in public libraries;
- b) the library's mission regarding long-time preservation of its collections;
- c) the expected percentage of electronic publications, which differs widely between subject collections (e.g. medicine or history) and will grow in future.

A basic calculation might be based on the library's number of acquisitions during the last 3 years and the developments in publishing in the subjects and materials that the library is collecting.

Formulas for collection development in libraries have been developed both for public and for academic libraries. Those formulas were for the most part based on print media and therefore are not adequate where there are electronic collections. Each library has to decide whether a specified formula could be used for calculating the growth at least of its print collection.

4.7.3 Shelf depth

Usually, the same shelf depth will be chosen for large parts of the collection because of higher flexibility for reorganisations and removals. But in the first instance, the format of the media to be shelved and the type of

shelving (standing with spine-out, standing with frontal display or lying on the shelves) will determine the shelf depth. (For the book formats, see ISO 216:2007).

Table 1 — Shelf depth recommended for types of media and types of shelving

Type of media	Type of shelving	Depth of single-faced shelf (mm)
books (octavo and quarto)	standing, spine-out	250 to 300
books (folio)	standing, spine-out	300 to 400
books (large folio)	lying	400 to 500
newspapers (unbound issues)	lying	400 to 600
periodicals (unbound issues)	latest issue on slanting shelving, others lying behind	300 to 450
printed music documents	standing, spine-out	250 to 300
maps/plans (folded)	standing, frontal display	250 to 300
phonograph records	standing, frontal display standing, spine-out	300 to 400 300 to 400
Files	Lying, in boards	350 to 400
CD, CD-ROM, DVD, audio and video cassettes	standing, spine-out standing, frontal display	200 to 250 250 to 400

The recommended shelf depth in furniture for special media depends on the design of the furniture.

Table 2 — Shelf depth for special media furniture

Type of media	Type of furniture	Type of shelving	Depth of shelf or drawer (mm)
maps/plans	map case or cabinet	lying	1 000
non-book media	media case with door, to be handled from the front	standing, spine-out	300 to 500
non-book media	media case with sliding shelves or drawers, to be handled from the side	standing, spine-out	600 to 700

For preservation reasons it can be necessary to sort maps and plans by size in adequate cabinets. This will prevent sliding.

4.7.4 Length of shelving ranges or furniture ranges

The calculations assume that there are double-faced shelves. The basic unit has a standardised length of 1 m; additional sections can be added to form a shelving range.

Some manufacturers use units with a reduced dimension of 0,90 m. In historic buildings, it could be space-saving to use shelves of other dimensions beside the standardised units.

Special furniture for media can have units of various sizes. In public libraries, the many varieties of shelving will result in varying lengths of shelving ranges.

For reasons of work organisation, the maximum length of a shelving range should not be more than 8 m. Shelving ranges with a length over 5 m should be open at both ends in order to facilitate movement into the next stack aisle. The general rule is that in shelving areas with high usage of the media the shelving ranges should be shorter.

Table 3 — Recommended length of shelving ranges

Library area	Length of shelving ranges (m)
closed stacks, compact storage	5 to 8
open stacks	5 to 7
open access area	3 to 7
children's area	2 to 5

The average length of shelving ranges will strongly influence the space required for access to the shelves (see Table 12).

In children's libraries, and in all library spaces with multiple functions, especially spaces that are often used for events of all types, shelving units on castors can be very useful. Such shelving units can be quickly removed e.g. when arranging seating for an audience.

Shelves on castors should not be more than 2 to 3 m long and 150 to 180 cm high; for children's areas 2 m length will be more practical.

In countries or regions that are prone to earthquakes there should be escape routes from the shelving sections in order to avoid injury by the drop of materials. The length of the shelving ranges should always be the minimum of the values shown in Table 3, and space should be left between the shelving ranges. If possible, the materials on the upper shelves should be stored with anti-drop devices.

4.7.5 Shelf height and number of shelf boards on top of each other

The number of shelf boards on top of each other is determined by:

- a) The size of the media to be stored; standard book formats are:
 - 1) octavo (8°) : up to 250 mm
 - 2) quarto (4°) : 250 to 350 mm
 - 3) folio (2°) : 350 to 450 mm
 - 4) large folio : more than 450 mm (will usually be stored lying on the shelves)

The shelf height (vertical distance between two shelf boards) follows from the height of the shelved media plus at least 50 mm for the board itself and the necessary space between the media and the next board.

- b) The distance between the floor and the bottom shelf board.
For ergonomic reasons the bottom shelf boards should be at least 200 mm over the floor. For adequate air circulation, especially in areas with rare collections, a distance of 150 mm between the bottom shelf board and the floor and between the highest shelf board and the ceiling is recommended.
- c) The height of the shelf frame.
Usually, the height of the frames should be not more than 2.25 m.
In public libraries, the frame height will vary depending on the functions of the area and the position of the shelves in the room.

Table 4 — Shelf frame height and number of shelf boards on top of each other for books

Library area	Frame height (m)	Number of shelf boards (mean)
closed stacks, compact storage; shelving in accession order	2,25	5 to 7
open stacks (shelving in accession order or classified shelving)	2,25	5 to 7
open access areas, reading rooms, reference and information area	1,80 to 2,05 (public libraries) 2,25 (academic libraries)	4 to 6
children's area	1,50 to 1,80	3 to 4

In most of the humanities, volumes in octavo format size will usually be more common, so that 7 shelf boards on top of each other can be calculated. In technical sciences, natural sciences and medicine the percentage of volumes in quarto format will be higher; it is recommended to limit the number of shelf boards to 6.

For the space-saving storage in accession order, where materials are differentiated as to size, mean values are calculated; the relation of octavo to quarto volumes can vary. In free access areas and reference collections with classified shelving, a lower number of shelf boards are recommended, as formats will be mixed.

For volumes in folio format, 4 shelf boards and a shelf frame height of 2,25 mm are recommended. Shelves for volumes in plano format in standing position should have 3 shelf boards.

Some types of non-book media have standardised formats that facilitate the optimal use of shelves.

Table 5 — Number of shelf boards on top of each other for non-book media

Type and format of media	Type of storage	With or without security case	Shelf boards on top of each other			
			Frame height 2,25 m	Frame height 2,05 m	Frame height 1,80 m	Frame height 1,55 m
periodicals, unbound issues	latest issue on slanting shelving, others lying behind	-	6	5	3 to 4	3 to 4
printed music documents	standing, spine-out	-	5	5	4	3
maps/plans (folded)	standing, frontal display	-	2 to 4	2 to 3	2 to 3	2
files	lying, bound in boards	-	4 to 8	4 to 7	4 to 6	-
phonograph records	standing, spine-out		5	5	4	3
	standing, frontal display	-	2	2	2	1
CD, CD-ROM	standing, spine-out	without security case	10	9	8	7
		with security case	9	8	7	6
	standing, frontal display	with or without security case	4	4	4	3
audio cassettes	standing, spine-out	without security case	12	11	10	8
		with security case	10	9	8	7
	standing, frontal display	with or without security case	4	4	4	3
DVD	standing, spine-out	without security case	7	7	6	5
		with security case	7	6	5	4
	standing, frontal display	with or without security case	3	3	3	2
video cassettes	standing, spine-out	without security case	7	7	5 to 6	5
		with security case	7	6	5	4
	standing, frontal display	with or without security case	3	3	3	2

4.7.6 Shelf capacity

The shelf capacity varies according to the type of media shelved and the functional area of the library.

Shelf capacity will be lower for classified shelving than for shelving in accession order, as classified shelving requires leaving gaps in order to avoid frequent moving of materials.

4.7.6.1 Books

In public libraries, it is normal to use a section of the same shelf for showing media in frontal display beside those in spine-out position. As this function is not included in Table 6, shelf capacity should be reduced accordingly.

Table 6 — Shelf capacity for books (standing, spine-out)

Functional area	Number of books per 1 m shelf board
closed stacks and compact shelving (shelving in accession order)	25 to 35
open stacks (shelving in accession order)	25 to 35
open stacks (classified shelving)	20 to 30
open access areas, reference area and reading rooms	20 to 30
children's books	25 to 50
bound periodicals	15 to 25

The number of 50 children's books per shelf board takes account of small sized material while 25 books per shelf are possible with larger material.

For books and brochures of small formats, the higher values should be used. For rare book collections, the lower values should be taken.

Picture books in larger formats are usually displayed in special furniture (kinderbox).

For preservation reasons, oversize books (e.g. bound newspapers) should best be stored lying in special shelves. For handling the volumes, not more than 5 volumes should be lying one upon the other.

4.7.6.2 Periodicals and newspapers

Unbound periodicals are usually stored in special display shelves (periodical stands) or cabinets that show the recent issues in frontal display. The periodical stands or cabinets usually have separate compartments for the periodicals that can be hinged to allow a limited number of back issues to be stored on a flat shelf board behind them.

The compartments are between 36 to 45 cm deep and high and about 30 cm broad, 4 to 5 shelf boards in a periodical stand or cupboard are recommended as maximum.

Table 7 — Shelf capacity for unbound periodicals and newspapers

Media type	Type of shelving	Compartments per 1 m shelf board
periodicals	sloping shelf boards displaying the latest issues, others lying behind	3 to 4
newspapers	lying on shelf boards	1 to 2

The compartments should not be more than half filled in order to facilitate the retrieval of specified issues.

Table 8 — Required compartments for the yearly issues of one periodical or newspaper

Frequency of publication	Compartments
monthly	1
bimonthly	2
weekly	4

Daily newspapers require two compartments per month.

The newest issues are usually displayed in newspaper racks of different materials and size with either special panels holding the folded newspapers in vertical position, or rods on which the newspapers are hanging.

4.7.6.3 Non-book media in shelves

The shelf capacity for non-book media does not only depend on the type of storage. In free access areas, certain library materials are frequently stored in security cases (frames) in order to secure them against theft of the whole item or a supplement. Frontal display as well as storage in security cases will reduce the shelf capacity.

The values given in Table 9 correspond to 90 % shelf occupancy. There is no differentiation between shelving in accession order and classified shelving. The values could be adjusted accordingly.

Table 9 — Shelf capacity for non-book media

Type of media	Type of storage	With or without security case	Number of media per 1 m shelf
printed music documents	standing; spine-out	-	70
maps folded	standing; frontal display	-	50
files	lying; bound in boards	-	6 to 10 boxes ^a
phonograph records	standing; spine-out	-	160 to 200
	standing; frontal display	-	60
CD CD-ROM	standing; spine-out	without security case	80 to 100
		with security case	40 to 50
	standing; frontal display	without security case	70 to 100
		with security case	40 to 60
audio cassettes	standing; spine-out	without security case	50 to 60
		with security case	35 to 45
	standing; frontal display	without security case	80
		with security case	60
DVD	standing; spine-out position	without security case	50
		with security case	25
	standing; frontal display	without security case	50
		with security case	20
video recordings	standing; spine-out	without security case	25
		with security case	20 to 30
	standing; frontal display	without security case	30
		with security case	25

^a Depends on the height and width of boxes and also on the number of boxes.

Non-book media stored in special cabinets

The capacity of cabinets for non-book media (height × width × depth: 1,90 × 0,60 × 0,70 m) with drawers that are pulled out laterally is as follows per cabinet:

Table 10 — Shelf capacity of cabinets for non-book media

Type of media	Capacity per cabinet
microfiches	25,000
microfilms 35mm	1,400
microfilms 16mm	700
CD/CD-ROM	2,300
audio cassettes	1,900
DVD	1,200
video recordings	470

Maps are best stored lying in plan cabinets. A plan cabinet (height $\times$ width $\times$ depth: 1 $\times$ 1,40 $\times$ 1 m) has usually 8 to 10 drawers. Each drawer has a capacity equivalent to 3 to 7 files and 30 maps per file.

4.7.7 Stack aisle width and axis centre distance

4.7.7.1 Stack aisle width

A stack aisle is the path between two shelf ranges for retrieving and shelving of library materials, wide enough for book trolleys.

Generally, stack aisles should be wider if the media in the shelves are heavily used. The movement area for persons in the stack aisle should be at least 0,75 m. National or local regulations, especially for barrier free building, will often prescribe broader aisles, e.g. 0,90 m for a stack aisle not longer than 5 m, or a minimum of 1,20 m for wheelchairs to move around, 1,40 m is sufficient for two-way traffic, one traffic way meaning the space for one person to move around, 1,50 m width enables a wheelchair user to cross another user, to turn and face the shelf or to turn back.

In reading rooms or open access stacks with tables and chairs, there should be a distance of at least 2 m between shelves and tables for access to the shelves.

The longer the shelving ranges are, the wider the aisles have to be, as passages to other aisles will be farther off and more persons might be busy simultaneously in the aisle.

4.7.7.2 Axis centre distance

Axis centre distance is the distance from centre post to centre post of two parallel single-sided (single-faced) or double-sided (double-faced) shelves. The axis centre distance in shelving ranges is equal to the sum of stack aisle width and twice the shelf depth.

In open access areas and in reading rooms and information areas, an axis centre distance of 1,80 m with shelves of 300 mm depth provides an aisle of 1,20 m, which is adequate for a wheelchair user to go straight.

Table 11 — Stack aisle width and axis centre distance for shelves of 0,25 m to 0,35 m depth in different functional areas

Functional area	Aisle width (m)	Axis centre distance (m)		
		0,25 depth	0,30 depth	0,35 depth
closed stacks	from 0,80 to 0,90	from 1,30 to 1,40	from 1,40 to 1,50	from 1,50 to 1,60
compact shelving (block with 8 shelving ranges)	from 0,80 to 0,90	from 0,60 to 0,65	from 0,70 to 0,75	from 0,80 to 0,85
open stacks	from 0,90 to 1,50	from 1,40 to 2,00	from 1,50 to 2,10	from 1,60 to 2,20
open access areas, reading rooms, information area, children's and young adults' library	from 1,20 to 1,50	from 1,70 to 2,00	from 1,80 to 2,10	from 1,90 to 2,20

For compact shelving, the axis centre distance shows the sum of the double-faced shelves' depth plus that proportion of the stack aisle that belongs to these shelves. For calculating that proportion, the stack aisle width is divided by the number of linked double-faced shelves. In Table 11, it is calculated for a compact shelving block with 8 shelving ranges.

EXAMPLE There are 6 ranges of double-faced shelves in a compact shelving block. The depth of the double-faced shelves is 50 cm; the stack aisle width is 90 cm. Then the axis centre distance is: $50 + (90 / 6) = 50 + 15 = 65$ cm.

See also 4.7.9.

For deeper shelves (see Table 1), wider axis centre distances have to be calculated.

The calculations in Tables 13 to 24 are based on a 300 mm shelf depth where this is compatible with the size of the materials that are stored. Formula 1 applies for other shelf depths either. In case different shelf depths are considered, axis centre distances will have to be re-calculated and the shelving flexibility will be reduced, especially concerning oversized documents.

Where media cabinets are used, the drawers are usually pulled out entirely. The stack aisle width has to be broad enough to allow this.

4.7.8 Access to shelving sections

In contemporary academic libraries there are typically spaces of approximately 15 m width in which two shelving sections find place, separated by a main aisle, and with each section having a secondary aisle at the outside, parallel to the main aisle (see Figure 1). The calculation of the necessary movement area is based on this model.

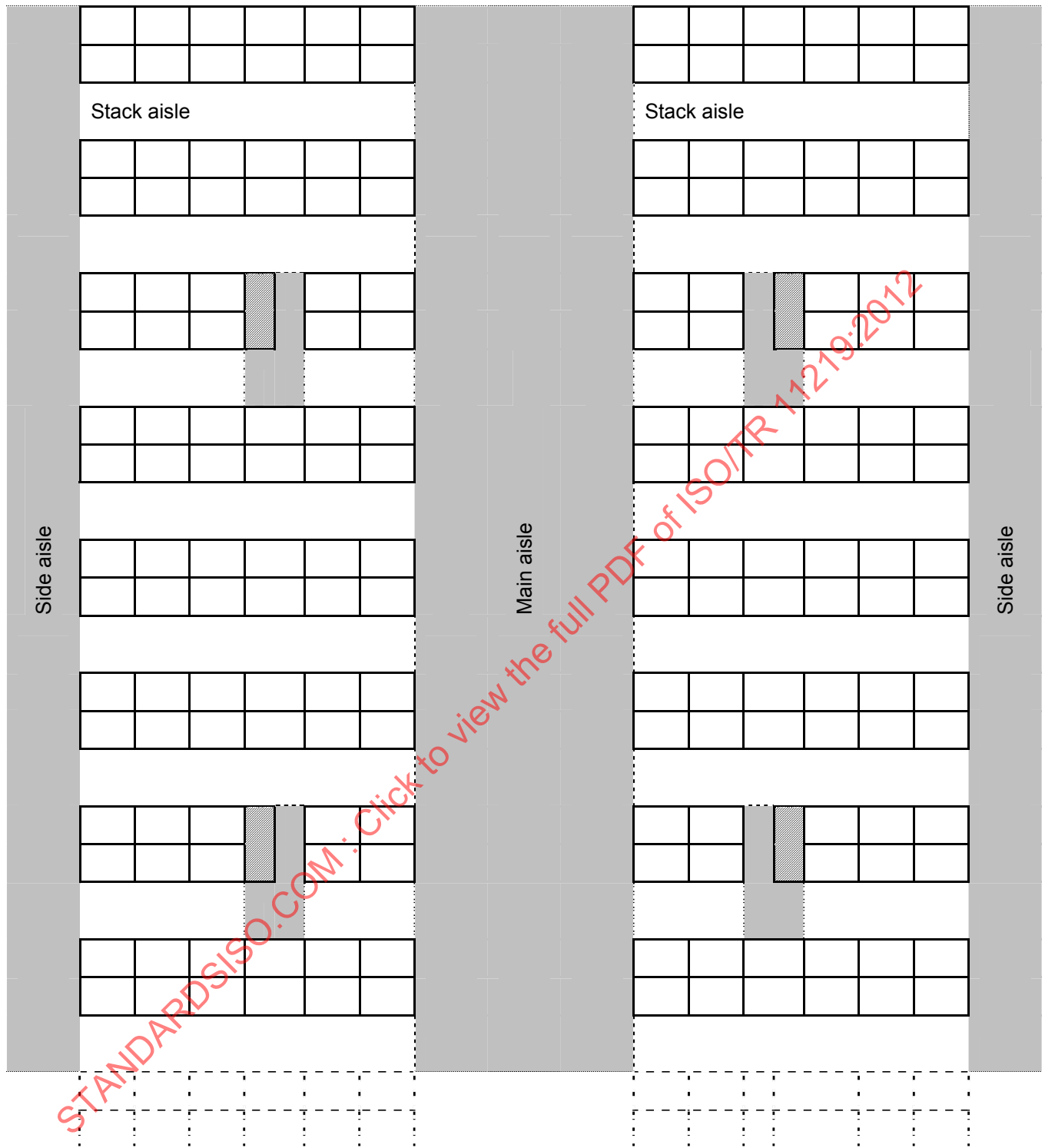


Figure 1 — Access to shelving sections

The space required for access to shelving sections is presented as a factor by which the space of the shelving sections has to be multiplied.

The movement area usually consists of:

- a) main aisles, whose width should not go below 2,50 m;
- b) secondary aisles, whose width should not go below 0,80 m;

- c) spaces near supports that cannot be used otherwise;
- d) other non-usable space because of an unfavourable layout, for example nonrectangular rooms, niches, irregular arrangement of supports, position and number of doors (not considered in the calculations, to be determined for each individual library).

The following steps are necessary for calculating the movement area:

- 1) Calculation of the shelving section space by multiplying the number of shelving ranges with the length of the shelving ranges and the axis centre distance, deducting the space for columns which as an average comes up to 3,48 % of the gross shelving section space:

$$b = (n \times l \times d) - c$$

- 2) Calculation of the movement area using the product of the main aisle width (proportionally) plus the side aisle width multiplied by the axis centre distance of shelves multiplied by the number of shelving ranges:

$$M = (a + m) \times d \times n$$

- 3) The factor is then proportioned with the shelving section space. The aim is to assess what percentage has to be added to the shelving section space for both the necessary movement area and the average space for columns.

$$P = (M + c) : b \times 100$$

M = movement area;

a = side aisle width;

m = proportion main aisle (usually half the width);

d = axis centre distance;

n = number of shelving ranges within the shelving section;

l = length of shelf range;

P = additional space for movement area in percent of shelving section space;

c = additional space for columns (one column every 6 m);

b = shelving section space (excluding space for columns).

EXAMPLE Movement area for closed stacks with seven shelving ranges of 8 m length, axis centre distance 1,5 m, side aisle width 0,8 m, main aisle width 2,5 m.

$$a = 0,8 \text{ m}$$

$$m = 1,25 \text{ m}$$

$$d = 1,5 \text{ m}$$

$$l = 8 \text{ m}$$

$$n = 7$$

$$c = 2,92 \text{ m}^2$$

$$b = 81,08 \text{ m}^2$$

Shelving section:

$$b = (7 \times 8 \times 1,5) - 2,92 = 81,08$$

Movement area:

$$M = (0,8 + 1,25) \times 1,5 \times 7 = 21,53$$

Factor for movement area as percentage of the shelving section space:

$$P = (21,53 + 2,92) : 81,08 \times 100 = 30,2$$

Factor for movement area (rounded) = 1,3

Generally said, the higher the use per document is in a shelving area, the smaller the shelving sections and the larger the movement area should be.

Table 12 — Space needed for access to shelving sections

Average length of a shelving range (m)	Factor for movement areas	
	Areas with standard shelves (rounded)	Compact shelving (rounded)
8	1,30	1,30
7	1,35	1,35
6	1,40	1,40
5	1,50	1,45
4	1,60	1,55
3	1,75	1,70
2	2,10	2,05

Higher factors for movement areas than those shown in Table 12 will be needed, where the shelves are placed in irregular arrangement to enable browsing, often occurring in public libraries, or where rooms are of unfavourable size or shape, so that the shelves should be adapted to the rooms and additional movement area can be necessary.

The use of book transport systems requires provision of adequate space for storage and sorting of media. Moreover, there should be some workplaces where the shelving staff can handle print or electronic orders.

4.7.9 Compact shelving

Depending on their construction (length and height of the shelving ranges) and the structure of the building (loading capacity and layout), compact shelving systems can have up to 100 % additional capacity than fixed shelves in the same space.

The capacity depends on the size of the shelving sections and on whether different media formats are separated. For choosing the size of the shelving sections and shelving ranges, the structure of the building and the expected activities (media retrieval) should be considered.

Each shelving section has a stack aisle opening to at least 0,80 m width, if the shelving ranges are maximum 8 m (can vary as to different manufacturers), for retrieval and re-shelving. Only one person can work in a given stack aisle.

The longer the shelving ranges are, and the more frequently several people work simultaneously in a shelving section, the more and wider stack aisles should be provided.

In case of compact shelving manually operated, it is necessary to consider the maximum bearable load.

Where the length of shelving ranges exceeds 9 m, manual operation is usually not possible.

Double-faced shelves in a compact shelving system require 30 to 70 mm more depth than the sum of the two shelf depths. This is due to installation issues and finger protection.

4.7.10 Automated storage

4.7.10.1 General

Automated storage is a form of high-density storage facility. At present, Automated Storage and Retrieval Systems (ASRS), using containers retrieved by a robotic mechanism, are increasingly being introduced into high-density storage facilities in libraries. Advantages of this kind of storage are the efficient use of space, the speed of retrieving and returning materials, and the possibility to control environmental conditions (humidity, temperature, dust).

The ASRS consists of storage racks, a robot fork lift and conveyors, containers (bins, boxes) for materials, a storage control system (computer system with software), electrical and data wiring, and a loading in/out station. Its high-density offers 15 to 20 times the capacity of traditional library shelving. ASRS can hold some 1 million volumes in a 500 to 1 000 m² building module.

4.7.10.2 Construction and capacity of ASRS

This storage system can be installed within a library building as a free standing structure. The exterior is covered with screening material to protect the system and the stored material. The storage has steel/aluminium pillars and a concrete floor. Multi-level (single or double) storage racks are lined up and one or more gangways are inserted for a robot fork lift (stacker crane) between racks. The robots that carry the containers move on rails horizontally and vertically.

A container usually stores two rows of books standing on edge. The space inside the container can be delimited by dividers to keep the contents organized and firmly in place. Containers are designed to be compatible with standard book sizes, but they can also accommodate variant size books laid out flat, archival materials, CDs, DVDs, etc. Every container has a bar code or RFID as a unique identifier for controlling them, as does every item placed in the containers. The robot carrying a container moves on rails at the speed of more than 3 m per second horizontally and 0.66 m per second vertically. The containers are constructed of material that should be solid enough to carry a load capacity of 40 kg to 70 kg, and light enough to handle easily.

Total storage capacity of ASRS in book volume is determined by the multiplication of a container's capacity of books and the numbers of containers stored on the storage racks. The container's capacity is measured by the average spine size (a thickness of 2/3 cm). The load of the entire automated storage system basically depends on how many levels of storage rack are assembled. In general, the load of an ASRS less than 10m high is 3,5 t per m².

4.7.10.3 Operation of the ASRS

The ASRS is operated at the loading in/out station which is an integrated location for many functions. The in/out station functions simultaneously as a taking-out slot, a user counter, a workstation with a barcode/RFID reader for both container and materials, a monitoring printer, and a work space for operators. It is therefore desirable to locate the station next to the loan desk. When there is not enough space for it, alternatively the station can be located separately from the loan desk. In this case more facilities and equipment are needed to link between the station and loan desk.

When storing materials, an operator puts them into the appropriate container after reading the identifier (bar code or RFID) of materials, and then the container is loaded into the storage shelving. There are two ways to load the material; free addressing and fixed addressing. In a fixed addressing system, each item to be stored has a fixed association with a unique storage container to which it will be returned after use; in a free addressing system, the item is linked to any appropriate container when it is stored, and released from that link when it is removed, so that it can be returned to any other container the next time. Free addressing has high performance in terms of storage capacity because it can allocate the material by size (or distribute items more evenly among containers) to achieve efficient storage and retrieval.

When retrieving material, an operator inputs the call number or other bibliographic information of the material to call it up. If this storage control system is linked to the automated library system, the retrieval can be controlled through the online catalogue. In such a case, the users can operate it directly and fetch their requested material at the loading station. The system should have a maximum output capacity of more than 100 containers per hour out to the stations.

4.7.10.4 Other requirements for ASRS

The requirement for air conditioning is almost the same as for compact shelving. It is easier and more effective to keep ASRS conditions constant than ordinary stack areas. A fire extinguishing appliance should be put in place and earthquake-proof safety is necessary (horizontal seismic co-efficient $k = 0,4$). Lighting is not needed except for maintenance periods. Space for maintenance should be ensured around racks.

A monitoring system of operation control, such as recording the computer operation transactions and digital photo record of operation is needed for the recovery of the operation and for credibility of the system. For the same reason, a backup system should hold the inventory data (database) of the storage materials. A failsafe device is needed to avoid accidents when someone breaks in to the system or earthquakes occur. The noise and vibration of the operation should be controlled to be as low as possible in order not to cause adverse effects to other areas.

4.7.11 Calculation of space

The required space in m^2 of main usable area can be calculated with Formula 1.

The required space for n media, including the movement area, is the product of:

- the space for a single-faced shelf, stack aisle included;
- the number of shelves needed to store the collection;
- the movement area factor.

These three factors are clearly identified in Formula 1.

Formula 1: Space required for a specified amount of media, movement area included.

$$F1 = \frac{e \times l}{2} \times \frac{n1}{n2 \times n3} \times N \quad (1)$$

$F1$ = required space for n media, movement area included, in m^2 ;

e = axis centre distance of the double-faced shelves, in m;

$n1$ = number of media to be shelved;

$n2$ = number of media per shelf board of length l (usually 1 m);

$n3$ = number of shelf boards on top of each other;

l = length of a single shelf in m;

N = factor for the movement area (see Table 12).

In the above formula, and in the results of calculations in Tables 13 to 24, the following issues are not considered:

- a) space for shelving staff (see 4.8);
- b) space for sorting and handling media, for book trolleys (see 4.9.2 and 4.9.4);
- c) space for transport technology (e.g. book transport system, see 5.3);
- d) space for printers for orders via the online catalogue;
- e) space for reprography (see 4.9.13).

The Tables 13 to 24 offer for each functional area (column 2 in the tables) values that are calculated by using Formula 1 for specified conditions (column 3 to 9).

Shelf depth in column 4 is 300 mm where this is compatible with the size of the materials that are stored. For small or large materials (e.g. for newspapers or CDs), other shelf depths have been identified for the calculation.

For non-book material, for more convenience, there is no distinction between classified shelving and shelving in accession order, but calculations are made on the basis of 90 % capacity utilisation.

For compact shelving, column 6 (axis centre distance) is calculated for a shelving block with 8 shelving ranges.

Unfavourable size and shape of the rooms requires a higher factor in column 10.

Legend of column 2 in the following tables:

cls	closed stacks
cos	compact shelving
os	open stacks (general)
os (ao)	open stacks, shelving in accession order
os (cs)	open stacks, classified shelving
oa	open access area (general)
oa (al)	open access area, academic library
oa (pl)	open access area, public library
oa (ch)	open access area, children
s (-)	without security case
s (+)	with security case
fd	frontal display
so	spine-out
ly	storage: lying
box	storage: in boxes

Table 13 — Required space for books and bound periodicals with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis distance (double-sided shelves)	Shelves one on top of each other	Volumes on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 volumes (shelf board length = 1 m)	Volumes per m ²	Volumes on 1m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos	so	0,30	0,80	0,70	6	40	8	1,35	2,0	508	480
2	cls	so	0,30	0,80	1,40	7	40	7	1,35	3,4	296	560
3	os (ao)	so	0,30	0,90	1,50	7	40	6	1,40	3,8	267	560
4	os (cs)	so	0,30	0,90	1,50	6	30	6	1,40	5,8	171	360
5	oa (al)	so	0,30	1,20	1,80	5	25	6	1,40	10,1	99	250
6	oa (pl)	so	0,30	1,20	1,80	5	25	5	1,50	10,8	93	250
7	oa (ch)	so	0,30	1,20	1,80	4	30	3	1,75	13,1	76	240

Table 14 — Required space for one year of one unbound periodical title with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Periodical titles on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Required space for 100 titles	Titles per m ²	Titles on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	N
1	os	ly, fd	0,40	0,90	1,70	6	3	6	1,40	6,6	15	36
2	oa (al)	ly, fd	0,40	1,20	2,00	6	3	6	1,40	7,8	13	36
3	oa (pl)	ly, fd	0,40	1,20	2,00	5	3	5	1,50	10,0	10	30
4	oa (ch)	ly, fd	0,40	1,20	2,00	4	3	3	1,75	14,6	7	24

Table 15 — Required space for one newspaper title (issues of 1 month) with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Newspaper titles on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Required space for 100 titles	Titles per m ²	Titles on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos	ly	0,50	0,80	1,10	6	1,5	8	1,35	8,3	12	18
2	cls	ly	0,50	0,80	1,80	6	1,5	7	1,35	13,5	7	18
3	os	ly	0,50	0,90	1,90	6	1,0	6	1,40	22,2	5	12
4	oa (al)	ly	0,50	1,20	2,20	5	1,0	6	1,40	30,8	3	10
5	oa (pl)	ly	0,50	1,20	2,20	5	1,0	5	1,50	33,0	3	10
6	oa (ch)	ly	0,50	1,20	2,20	4	1,0	3	1,75	48,1	2	8

Table 16 — Required space for printed music documents with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Volumes on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 volumes	Volumes per m ²	Volumes on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos	so	0,30	0,80	0,70	5	70	8	1,35	1,4	741	700
2	cls	so	0,30	0,80	1,40	5	70	7	1,35	2,7	370	700
3	os	so	0,30	0,90	1,50	5	70	6	1,40	3,0	333	700
4	oa (al)	so	0,30	1,20	1,80	5	70	6	1,40	3,6	278	700
5	oa (pl)	so	0,30	1,20	1,80	5	70	5	1,50	3,9	259	630

Table 17 — Required space for maps and plans (folded) with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Maps on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 maps	Maps per m ²	Maps on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos	so	0,30	0,80	0,70	7	50	8	1,35	1,4	741	700
2	cls	so	0,30	0,80	1,40	7	50	7	1,35	2,7	370	700
3	os	fd	0,30	0,90	1,50	3	50	6	1,40	7,0	143	300
4	oa (al)	fd	0,30	1,20	1,80	3	50	6	1,40	8,4	119	300
5	oa (pl)	fd	0,30	1,20	1,80	3	50	5	1,50	9,0	111	300
6	oa (ch)	fd	0,30	1,20	1,80	2	50	3	1,75	5,8	63	200

Table 18 — Required space for maps and plans in cabinets for A0 maps with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double cabinet*)	Drawers one on top of each other	Maps on 1 m cabinet drawers	Average length of a cabinet range	Factor for movement area (table 12)	Space required for 1 000 maps	Maps per m ²	Maps per 1 m double cabinet
			m	m	m	n	n	n	F	m ²	n	n
1	cls	ly	0,90	0,80	2,60	10	60	7	1,40	3,0	330	1 200
* Double cabinet: two cabinets standing back to back, same as double-sided shelves												

Table 19 — Required space for files with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Files on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 files	Files per m ²	Files on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos	box	0,35	0,80	0,80	7	7	8	1,35	11,0	91	98
2	cls	box	0,35	0,80	1,50	7	7	7	1,35	20,66	48	98
* For files with 39 x 28 x 11 cm, 2 files one on top of the other												

Table 20 — Required space for phonograph records with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Media on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 media	Media per m ²	Media on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos	so	0,35	0,80	0,80	5	200	8	1,35	0,5	1 852	2 000
2	cls	so	0,35	0,80	1,50	5	200	7	1,35	1,0	988	2 000
3	os	so	0,35	0,90	1,60	5	200	6	1,40	1,1	893	2 000
4	oa (al)	so	0,35	1,20	1,90	5	200	6	1,40	1,3	752	2 000
5	oa (al)	fd	0,35	1,20	1,90	5	60	6	1,40	4,4	226	600
6	oa (pl)	so	0,35	1,20	1,90	5	200	5	1,50	1,4	702	2 000
7	oa (pl)	fd	0,35	1,20	1,90	5	60	5	1,50	4,8	211	600

Table 21 — Required space for CDs and CD-ROMs with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Media on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 media	Media per m ²	Media on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos s(-)	so	0,25	0,80	0,60	10	80	8	1,35	0,5	1 975	1 600
2	cls s(-)	so	0,25	0,80	1,30	10	80	7	1,35	1,1	912	1 600
3	os s(-)	so	0,25	0,90	1,40	10	80	6	1,40	1,2	816	1 600
4	oa (al) s(-)	so	0,25	1,20	1,70	10	80	6	1,40	1,5	672	1 600
5	oa (al) s(-)	fd	0,25	1,20	1,70	4	70	6	1,40	4,3	235	560
6	oa (al) s(+)	so	0,25	1,20	1,70	9	40	6	1,40	3,3	303	720
7	oa (al) s(+)	fd	0,25	1,20	1,70	4	40	6	1,40	7,4	134	320
8	oa (pl) s(-)	so	0,30	1,10	1,70	8	80	5	1,50	2,0	502	1 280
9	oa (pl) s(-)	fd	0,30	1,10	1,70	4	70	5	1,50	4,6	220	560
10	oa (pl) s(+)	so	0,30	1,10	1,70	7	40	5	1,50	4,6	220	560
11	oa (pl) s(+)	fd	0,30	1,10	1,70	4	40	5	1,50	8,0	125	320
12	oa (ch) s(-)	so	0,30	1,20	1,80	7	80	3	1,75	2,8	356	1 120
13	oa (ch) s(-)	fd	0,30	1,20	1,80	3	70	3	1,75	7,5	133	420
14	oa (ch) s(+)	so	0,30	1,20	1,80	6	40	3	1,75	6,6	152	480
15	oa (ch) s(+)	fd	0,30	1,20	1,80	3	40	3	1,75	13,1	76	240

Table 22 — Required space for audio cassettes with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Media on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 media	Media per m ²	Media on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos s(-)	so	0,25	0,80	0,60	12	50	8	1,35	0,7	1 481	1 200
2	cls s(-)	so	0,25	0,80	1,30	12	50	7	1,35	1,5	684	1 200
3	os s(-)	so	0,25	0,90	1,40	12	50	6	1,40	1,6	612	1 200
4	oa (al) s(-)	so	0,25	1,20	1,70	12	50	6	1,40	2,0	504	1 200
5	oa (al) s(-)	fd	0,25	1,20	1,70	4	80	6	1,40	3,7	269	640
6	oa (al) s(+)	so	0,25	1,20	1,70	10	35	6	1,40	3,4	294	700
7	oa (al) s(+)	fd	0,25	1,20	1,70	4	60	6	1,40	5,0	202	480
8	oa (pl) s(-)	so	0,30	1,10	1,70	10	50	5	1,50	2,6	392	1 000
9	oa (pl) s(-)	fd	0,30	1,10	1,70	4	80	5	1,50	4,0	251	640
10	oa (pl) s(+)	so	0,30	1,10	1,70	8	35	5	1,50	4,6	220	560
11	oa (pl) s(+)	fd	0,30	1,10	1,70	4	60	5	1,50	5,3	188	480
12	oa (ch) s(-)	so	0,30	1,20	1,80	8	50	3	1,75	3,9	254	800
13	oa (ch) s(-)	fd	0,30	1,20	1,80	3	80	3	1,75	6,6	152	480
14	oa (ch) s(+)	so	0,30	1,20	1,80	7	35	3	1,75	6,4	156	490
15	oa (ch) s(+)	fd	0,30	1,20	1,80	3	60	3	1,75	8,8	114	360

Table 23 — Required space for DVDs with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Media on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 media	Media per m ²	Media on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos s(-)	so	0,25	0,80	0,60	7	50	8	1,35	1,2	864	700
2	cis s(-)	so	0,25	0,80	1,30	7	50	7	1,35	2,5	399	700
3	os s(-)	so	0,25	0,90	1,40	7	50	6	1,40	2,8	357	700
4	oa (al) s(-)	so	0,25	1,20	1,70	7	50	6	1,40	3,4	294	700
5	oa (al) s(-)	fd	0,25	1,20	1,70	3	50	6	1,40	7,9	126	300
6	oa (al) s(+)	so	0,25	1,20	1,70	7	25	6	1,40	6,8	147	350
7	oa (al) s(+)	fd	0,25	1,20	1,70	3	20	6	1,40	19,8	50	120
8	oa (pl) s(-)	so	0,30	1,10	1,70	6	50	5	1,50	4,3	235	600
9	oa (pl) s(-)	fd	0,30	1,10	1,70	3	50	5	1,50	8,5	118	300
10	oa (pl) s(+)	so	0,30	1,10	1,70	5	25	5	1,50	10,2	98	250
11	oa (pl) s(+)	fd	0,30	1,10	1,70	3	20	5	1,50	21,3	47	120
12	oa (ch) s(-)	so	0,30	1,20	1,80	5	50	3	1,75	6,3	159	500
13	oa (ch) s(-)	fd	0,30	1,20	1,80	2	50	3	1,75	15,8	63	200
14	oa (ch) s(+)	so	0,30	1,20	1,80	4	25	3	1,75	15,8	63	200
15	oa (ch) s(+)	fd	0,30	1,20	1,80	2	20	3	1,75	39,4	25	80

Table 24 — Required space for video cassettes with standard conditions

1	2	3	4	5	6	7	8	9	10	11	12	13
Nr	Functional area	Display	Shelf depth	Stack aisle width	Axis centre distance (double-sided shelves)	Shelves one on top of each other	Media on one linear metre	Average length of a shelf range	Factor for movement area (table 12)	Space required for 1 000 media	Media per m ²	Media on 1 m double-sided shelves
			m	m	m	n	n	n	F	m ²	n	n
1	cos s(-)	so	0,25	0,80	0,60	7	25	8	1,35	2,3	432	350
2	cls s(-)	so	0,25	0,80	1,30	7	25	7	1,35	5,0	199	350
3	os s(-)	so	0,25	0,90	1,40	7	25	6	1,40	5,6	179	350
4	oa (al) s(-)	so	0,25	1,20	1,70	7	25	6	1,40	6,8	147	350
5	oa (al) s(-)	fd	0,25	1,20	1,70	3	30	6	1,40	13,2	76	180
6	oa (al) s(+)	so	0,25	1,20	1,70	7	20	6	1,40	8,5	118	280
7	oa (al) s(+)	fd	0,25	1,20	1,70	3	25	6	1,40	15,9	63	150
8	oa (pl) s(-)	so	0,30	1,10	1,70	6	25	5	1,50	8,5	118	300
9	oa (pl) s(-)	fd	0,30	1,10	1,70	3	30	5	1,50	14,2	71	180
10	oa (pl) s(+)	so	0,30	1,10	1,70	5	20	5	1,50	12,8	78	200
11	oa (pl) s(+)	fd	0,30	1,10	1,70	3	25	5	1,50	17,0	59	150
12	oa (ch) s(-)	so	0,30	1,20	1,80	5	25	3	1,75	12,6	79	250
13	oa (ch) s(-)	fd	0,30	1,20	1,80	2	30	3	1,75	26,3	38	120
14	oa (ch) s(+)	so	0,30	1,20	1,80	4	20	3	1,75	19,7	51	160
15	oa (ch) s(+)	fd	0,30	1,20	1,80	2	25	3	1,75	31,5	32	100

4.8 Space for library staff

4.8.1 General

The space needed for library staff will depend first and foremost on the number of employees, which contingent on the number of part-time employees and project staff can be considerably higher than the number on the staff establishment. The necessary space for a certain number of employees might be reduced by desk-sharing; but, on the other side, there will be staff needing two workplaces, e.g. when working partly at the information desk and partly in background services. Secondly, the space will also depend on the kind of work done by each employee and the type of equipment needed.

In most countries, there are basic regulations for the size of office rooms in administrative bodies. But such regulations can generally be adapted to the special tasks of specified institutions. For libraries, the daily processing of media, whether newly acquired or returned from bindery, lending or interlibrary loan, and the equipment used for the processing has to be considered. Many workplaces will need additional space for short-time storage of media, e.g. for shelves and trolleys.

Staff with user contacts will need workplaces with adequate furniture for accommodating visitors. Nearly all workplaces today should be equipped with computers and Internet access, most of them also with copying, printing, and scanning facilities, at least nearby.

In planning the staff areas the library should also keep in mind that the need for workplaces and their equipment might change in the different departments. Traditional work might be taken over by automated systems, while additional staff space will be needed for user training and information technology.

4.8.2 Location of workplaces

An important issue when planning staff areas is the consideration of the library's organisation and of workflows in the library. The background services, especially the media processing activities (acquisition, cataloguing, subject indexing, labelling etc.) can be organised in various ways. The processing can be split up according to

- a) types of media (e.g. printed books and journals, electronic media, old and rare materials etc.);
- b) the methods of acquisition (purchase and licensing, gifts and exchange material, legal deposit copies);
- c) specific subjects, especially in academic libraries (e.g. language and literature, sociology, medicine);
- d) media for specific target groups (e.g. children's books, large-print books, media in the languages of immigrant groups).

The location of staff workplaces in background procedures will follow the processing paths, as far as a transport of physical media is involved. In the case of electronic media or electronic delivery procedures, the location becomes largely independent.

In small libraries, even staff working in background services like media processing will often have workplaces that are accessible to users, as in such libraries nearly all staff will be involved in direct user services.

4.8.3 Calculation of space

4.8.3.1 General

For a rough estimate of the amount of space needed for staff workplaces, it might be sufficient to establish the number of workplaces needed and calculate the necessary space by multiplying with 12.50 m² per place.

In addition to the workplaces, the facilities needed for the staff should be considered. This includes toilets and cloakrooms, tea rooms/kitchenettes, meeting rooms etc.

As a rough estimate, this additional space could be calculated on the basis of 5 to 6 m² per FTE (full-time equivalent) staff person.

4.8.3.2 Office space

Workplaces in libraries differ in size, depending on whether the work includes handling a large amount of material or whether the work is mainly administrative, and also on the type and size of equipment needed.

Workplaces for acquisitions, cataloguing and technical processing of media, or for interlibrary lending, need additional space for short-time storage of the media, for shelves, book trolleys etc. The work surface should be large enough for handling materials, 15 m² are generally seen as an appropriate size for a workplace with storage space or special equipment.

For normal administrative work workplaces of about 12 m² per person would be sufficient. For background workplaces of staff members that usually work at the information or lending desk, 9 m² should be calculated.

The executive staff of the library will need offices of a larger size. For a department head 18 m² should be calculated so that up to 3 to 4 people (visitors and employees) can be seated comfortably at a small meeting table. The same size of 18 m² is adequate for the workplace of a subject specialist, since beside space for storing and handling media space for visitors has to be calculated.

The director's office should not be less than 24 m². It should accommodate a large meeting table and enough seats for a small meeting (up to 6 or 7 visitors and employees, depending on the size of the library).

Whether separate offices or open-plan offices are preferred will depend on workflows, issues of confidentiality and privacy, and on the general management policy of the library. In case open-plan solutions are chosen, there is need for privacy areas or separate rooms.

4.8.3.3 Support rooms for offices

In order to save space in the individual workplaces, equipment that is not constantly used can be pooled in separate support rooms near the offices. Such equipment as copying, faxing or scanning machines can be placed there, and such rooms can also have archival functions for a department. Some 4 to 7 m² per machine will be needed, possibly also a table for sorting papers, and a cupboard for materials.

4.8.3.4 Studios

For the preparation of exhibitions and other events and for marketing activities, a special studio will be practical. The room has to be big enough for handling large formats, should have good and flexible lighting, and extra ventilation if paint, glue or other substances containing solvent or with a strong smell are going to be used, 20 to 25 m² is a suitable area.

4.8.3.5 Project room

During the time of a project with a defined staff group a special project room could benefit the work, especially if the staff members devote only part of their working hours to the project. The size and layout will differ from case to case depending on the character of the project, its duration and the number of persons involved.

4.8.3.6 Staff meeting and training areas

Different types of meeting areas for staff will be required depending on the size and the type of libraries.

A conference room will usually be furnished with seats around a meeting table. Such a room could also benefit from a presentation area, but otherwise the meeting table will be the main focus. Allow 2.5 m² per seat at the table as each person should have space for a notebook and some material. A presentation area needs roughly 5 m².

If the conference room will be used for other functions, for instance for training sessions or instructions, a classroom seating might be preferred, 3 to 3,5 m² per seat and about 7 m² for the instructor's area will be needed. The instructor's station includes the IT and communication equipment necessary for training sessions.

In many cases, libraries have tasks of education and training in librarianship and/or information sciences or related fields, often in conjunction with a library school or similar institution. In most cases, libraries undertake the practical part of the training or study course. Generally, the staff meeting and training areas can be used for these tasks. But in addition students/trainees will need a room where they can meet and study and keep their personal belongings in lockers and wardrobes. The size of such a room depends on the normal number of students/trainees being educated in the library. If the students/trainees get practical instruction in departments or branches, there should be an adequate number of additional workplaces in these areas. The size of a background workplace, 9 m², will usually be sufficient for such places (see 5.8.3.2).

4.8.3.7 Staff lounge

The staff members need areas for recreation. Usually, this means tea/coffee rooms or kitchenettes. Such rooms are included in the "common areas" that will be shared by all staff. If the building is large it might be necessary to include several recreation rooms or local coffee and water stations. Even if the library contains a restaurant or cafeteria, a special recreation area for the staff is an essential part of the library.

A special rest facility or sickroom is also necessary, but might be combined with the sickroom for users (see 4.6.5). Depending on the size of the library and the number of staff members this facility can be very basic or more sophisticated. A bed or sofa where it is possible to lie down is the main furniture needed; the room could also have a chair, table etc. Sometimes it might be necessary to add an alarm device so that help can be summoned.

In some countries there are recommendations or legal regulations about the size, equipment and furniture of these common areas for recreation and rest.

4.8.3.8 Toilets, cloakrooms and showers

Toilets for staff are necessary in every library. Separate cloakrooms are needed if the workplaces are not equipped with wardrobes, or if staff members have to change their clothing before starting work, e.g. for working in restoration laboratories. Cloakrooms can be more important in cold, snowy climates.

In case of dirty work showers should be available.

The size and number of the different rooms are subject to the legal regulations and recommendations of each country.

4.8.3.9 Overview

The calculation does not include circulation space.

Table 25 — Space requirements for staff

Type of room	Recommended space
Office place with storage space (for media processing, interlibrary lending etc.)	15 m ² /staff person
Simple office place	12 m ² /staff person
Background workplace (for staff working at reference or circulation desks)	9 m ² /staff person
Office for subject specialists (including a table for 3 to 4 persons)	18 m ²
Office for department heads (including a table for 3 to 4 persons)	18 m ²
Office for the library director (including a table for 6 to 8 persons)	24 m ²
Support rooms for offices (copying, archives, etc.)	2 to 3 m ² /staff person depending on the number and type of machines
Conference room	2,5 m ² /seat + 5 m ² for presentation area
Staff training room	3 to 3,5 m ² /seat + 7 m ² for instructor's station
Place for library students or trainees	9 m ² /person
Studios (marketing activities and preparing exhibitions)	20 to 25 m ²

4.9 Other spaces for library management and technical services

4.9.1 General

All spaces not covered in 4.1 to 4.8 (space for users, collections, and staff) are considered here.

When calculating space for the facilities mentioned in this subclause, it will be important to consider workflows concerning transport of print materials or other goods and supplies as well as people moving from one function to the other.

Different library types will have different needs of spaces for library management and technical services. Whether special facilities such as a bindery, a restoration laboratory or an IT centre exist, depends on the library's mission, the size and type of collections and on the special services the particular library offers. Consequently, the necessary allocation of space will be different in every case.

4.9.2 Parking space/rooms for book trolleys

Libraries use different types of trolleys. The floor space varies depending on the trolley configuration.

Type of trolley	Parking space for 10 book trolleys
Office book trolley, 40 to 45 cm wide, 60 to 80 cm long	c. 4,5 m ²
Transport book trolley, 40 to 50 cm wide, 80 to 100 cm long;	c. 6 m ²

Space for parking other transport vehicles in closed stacks should be provided according to the types of equipment used.

4.9.3 Storerooms

Most libraries need to store furniture and equipment that is not currently in use.

Space for reserves of chairs depends on the type of seating (stackable chairs) and the number of extra chairs. Careful planning of the location of this space will save excessive transportation to and from meeting rooms, auditoria etc.

If applicable, space should be provided for spare shelves, equipment for media presentations and other events (e.g. mobile shelves, display easels, lecterns, mobile partitions, etc.).

Supplies of office materials such as pens, papers, binders etc. might be stored at one central point or at many locations depending on the needs and size of the library.

For janitor's purposes see 4.9.6.

4.9.4 Spaces/rooms for sorting media

The space required is dependent on the organization of the lending services. Manual media return, book drops and re-shelving carried out by library staff require areas for sorting media and temporary storing spaces (as concerns space needed for self-service returns, see 4.4.3). The same applies to libraries packing book boxes for schools, prisons etc.

Depending on the number of workplaces the following dimensions apply:

- Small sorting room with 1 sorting table 1 m × 2 m (= 1 workplace), single set of shelves, space for 5 book trolleys, 14 m², approx.
- Large sorting room with 2 sorting tables (= 2 workplaces), single set of shelves, space for 10 book trolleys, 30 m², approx.

If a book drop from outside the library is planned, the sorting room needs to be adjacent to the outer wall, the door or other location where the users can access the book drop. On the inside space is needed for a box or similar device to hold the books left in the book drop.

Media sorting space will also be needed in libraries supplying mobile libraries, e.g. book vans. Approx. 10 m² will be sufficient. This storage area should for practical reasons be located near the loading bay.

4.9.5 Mail room

In general, the following tasks are carried out in parallel in a mailroom:

- incoming mail: registration, sorting and temporary storing before distribution to individual departments;
- outgoing mail: sorting, packing, weighing, addressing, perhaps stamping, documentation, storing before transport;
- sorting materials for internal transport to and from branch libraries (sorting space needed);
- sorting materials for joint transport systems in interlibrary lending (sorting space needed).

If all these functions are included the floor area of the room can be 70 to 100 m², to which storage space for packing material and parking space for book trolleys should be added.

The mailroom should be immediately accessible from the access road and platform (loading bay). A gate between the mailroom and the loading bay is necessary.

Integration of the mailroom into a book transport system is sensible. Necessary space for that purpose should be added.

4.9.6 Janitor's workshop

The workshop for repairs carried out by the library caretaker should have at least 25 m². In addition, storage space for all kind of materials can be necessary (15 to 20 m²). Water and sewage connection as well as electricity supply with 230 V and possibly 400 V should be provided.

4.9.7 Cleaning staff and equipment

Space for cleaning staff, for detergents and cleaning equipment should be provided. A water hook-up/tap and facilities for waste disposal will be needed (see also 4.9.8). For larger buildings it might be necessary to provide a central facility for cleaners with cleaning machinery, washing machine and cleaning material as well as a number of smaller distributed units.

It is advisable to include the facility management or the cleaning company in planning.

4.9.8 Space for waste handling

There should be space for waste containers, separate for paper, hard plastic, metal etc. In a larger library, it can be necessary to provide a central place for waste handling. Some 50 m² might be a suitable area depending on how many different categories of recycling containers will be used.

A compacting machine for pressing boxes to compact parcels could make the trash handling easier, but the machine needs space as well as the parcels waiting for transport. Calculate ca. 25 m² floor spaces for this function.

4.9.9 Utility management

Space should be provided for monitoring and control units (see 5.4.2.4), for the technical systems and for built-in utility and safety technology (control and communication technology). The configuration of equipment and consequent space demands should be harmonized with the utility and safety technology of the super ordinate institution. For example spaces for uninterrupted-power-supply devices might be needed. Specialist planners should be consulted.

Sometimes it is necessary to plan for some sort of office space for the persons operating the security and surveillance equipment; the space needs will vary in each case.

Special maintenance and storage rooms should be provided for maintenance and repair work on utilities and appliances carried out by outside companies.

In all buildings there are a series of rooms where machinery related to the different building installations (air conditioning, heating, lift machinery, electricity meters, control and communication technology, etc.) is placed. Some of these rooms can reach large dimensions and they determine the architecture of the building, like for example air conditioning machinery.

These rooms are a part of the functional space.

4.9.10 Bindery

Medium-sized and large libraries often have their own bindery that undertakes the ongoing, daily binding work, such as repairs, binding in urgent cases, production of binders and boxes and of brochures for the institution's own papers etc.

When planning the location for the bindery, the load assumption for the floor should be considered, since some of the equipment is very heavy. It is recommended to consult experts in the field of binding in the planning process.

If rare materials are handled in the bindery, the storage conditions for rare materials should be considered (see 5.1).

Shelves and cupboards should be adapted to house large materials. Special shelves for rolls of fabric might be necessary, since they can be both heavy and bulky.

As minimum equipment, the following is recommended:

- a) at least one cutting machine;
- b) one or more screw presses;
- c) stamping press;
- d) stapler;
- e) adhesive-binding machine;
- f) foiling machine;
- g) gathering machine;
- h) storage tables beside the different machines, storage space and shelves;
- i) roller stands for cloth and other materials;
- j) drilling machine;
- k) cold and hot water connections and at least two basins.

The work tables should have a surface area of at least 2 m² for each staff member.

The space for one staff member with basic equipment as described should not be less than 50 m². For each additional staff member another 20 m² should be provided. In addition, storage space for cardboard, paper and other material is necessary. The storeroom can also be used for materials needed in the restoration laboratory, if there is one; it should have a floor area of 15 m² to 20 m².

4.9.11 Space for labelling

In the context of the media processing, the physical processing usually consists of the following steps:

- a) stamping (with an ownership mark);
- b) labelling (affixing a label with the location and call number to the item, e.g. to the lower spine of a book);
- c) jacketing, if applicable;
- d) bar-coding or adding RFID labels (if applicable and if not done during media processing);
- e) applying a magnetic strip to the item to prevent theft.

Physical processing is usually carried out either in/next to the media processing department or in/next to the bindery. The activities can overlap with media processing or with the bindery.

The equipment consists of one or two large tables, an IT-workplace for the administration of the call numbers, shelves for waiting media, and a cupboard with drawers for materials. Usually, there will be only one staff workplace.

The required space depends on the quantity and variety of materials to be handled. The workload will be influenced by the percentage of media that are delivered already supplied with label, jacket and/or magnetic strip from vendors.

In a middle-sized library, 15 m² might be sufficient (see 4.8.3.2). If more than one person is employed, a minimum of 20 m² would be necessary.

In some libraries the labelling will be performed at the staff workplaces for media processing, and each person has a set of necessary equipment at the desk (see 4.8.3.2).

4.9.12 Space for preservation and restoration

Libraries with substantial historic holdings or special collections can have a restoration laboratory in addition to the bindery for individual treatment of manuscripts, incunabula and other historic materials.

For the restoration laboratory the storage conditions for rare materials should be considered (see 5.1).

It is recommended to consult experts in the field of conservation in the planning process.

It could be very useful to divide the space into different zones or rooms depending on the type of restoration activities:

- space for dry/clean work;
- space for wet work;
- space for work with formation of dust;
- space for handling contaminated material;
- space for the documentation of restoration work.

The following equipment is recommended for restoration laboratories:

- a) basins (various sizes);
- b) fluid treating system for treatment of brittle paper;
- c) water-treatment system with pump (2 m × 1 m, approx.);
- d) leaf-casting machine;
- e) drying shelves;
- f) work bench with exhaust system and dust filter (1 m × 2 m) or exhaust hood;
- g) drilling machine with additional equipment, table saw;
- h) fume cupboard;
- i) hydraulic and mechanic press(es);
- j) freezer(s) and vacuum cupboard;

- k) refrigerator(s);
- l) mobile dehumidifiers;
- m) vacuum cleaners;
- n) foiling machine;
- o) material cabinets;
- p) light table;
- q) tables and shelves;
- r) computer desk;
- s) microscope;
- t) photographic equipment;
- u) spaces for trolleys.

Work-table surfaces should be at least 2 m² per staff member.

For a restoration laboratory with up to four staff members intended for the different activities mentioned, 200 m² to 250 m² should be calculated. This includes all equipment. For each additional staff member another 30 m² should be added. Additional space for storage of cardboard, paper, leather etc. can be used jointly with the bindery (see 4.9.10).

For chemicals, a separate storage room with adequate space should be provided; adherence to national regulations is obligatory.

Cold and hot water connections as well as floor drains within areas for fluid-treatment techniques are necessary, likewise electricity supply for 230 and 400 V.

For bulk preservation of acidic paper and/or mould infestation, additional equipment, not mentioned here, would be needed.

4.9.13 Reprography and digitizing

Before planning, the tasks of this department should be defined:

- a) reprographic services for individual users;
- b) reprography for interlibrary loan and document delivery;
- c) digital photography;
- d) digitization on demand;
- e) digitization projects.

If copies in physical form or on a physical carrier (printouts, disks, CDs) are issued by this department directly or by mail, appropriate sorting and storage space on shelves and tables will be needed. For digital transmission, the appropriate IT equipment should be provided: computer with extensive peripheral equipment, scanner, microfilm scanner, large black-and-white and colour printers, and plotters. The space for workstations with overhead scanners should be calculated as at least 6 m². Tables and space for large formats should be considered.

Two-dimensional objects (flat objects like books, maps, posters etc.) and three-dimensional objects (globes etc.) will put different demands on the setting of photo station/studio. The dimensions of the photo studio are determined by the maximum size of the objects; smaller objects can be handled, but not larger.

If a vertical arrangement for photography is going to be used, make sure that there is enough distance between floor and ceiling. For instance to be able to photograph an object up to 70 by 100 cm in scale 1:1, about 4 m between floor and ceiling is necessary.

For digitization projects, whether carried out by library staff or outside contractors, a room with a floor area of 30 m² to 35 m² should be provided.

For mass digitization with a digitization robot (automatic book scanner) another setup is necessary. The space needed for one workstation with a digitization robot will be about 12 m² (3 × 4 m). The floor space for the robot itself depends on the type. The operator should have movement space in front of the robot, and approximately 1 m on each side, to be able to move around the machine. A work desk should be provided for the computer that is connected to the robot. A flatbed scanner is useful if the original document contains fold-outs that can't be handled by the robot.

The original documents, books etc. need a storage space, usually in cupboards that can be locked. The storage conditions for rare materials should be considered (see 5.1).

4.9.14 IT-centres, server rooms

The growing use of information technology in libraries requires the provision of relevant infrastructure. Experts should be involved in the planning.

Passive network components (cable network, distribution boxes etc.) as well as active network components should be taken into account. That includes cable conduits, server rooms and the IT centre itself (if the library has an own computing centre). The spaces should be highly flexible in terms of power and data connections.

Regardless of whether a computing centre is operated by the library itself or not, the installation rooms (data cabinets, server rooms) constitute an important element. In calculating heat load, the potential extension of active network components should be taken into account. Ventilation and possibly air conditioning in the respective spaces should be ensured. This is especially important for those parts that are likely to be crowded with hardware.

The floor area of the IT spaces depends on the amount of passive and active network components installed and the additional appliances. Adequate movement area will be necessary around these appliances (accessibility from more than one side).

As a rule, IT control centres are designed by experts. Nevertheless, some aspects have to be given particular attention in libraries: all spaces should, in principal, be equipped with access flooring (double flooring, raised flooring, cable conduits). Special fire prevention technology can be applicable.

Both dust and shock protection is relevant. Coordination of high- and low-voltage-current planning should be ensured, and in that context, equipment that the library intends to install after the completion of construction work (active network components) needs to be considered. Sufficiently secured high-voltage circuits should be provided. Planning should include adequately dimensioned cable conduits, cable chutes, wall breakthroughs etc. in preparation for all relevant applications.

General statements as to space requirements for computing centres/IT departments are not possible, because hardware, in particular, is subject to ongoing development. It is desirable, but no longer essential, that all IT-staff offices be placed in immediate proximity to the hardware spaces. For large IT departments, storerooms for spare hardware, data archives, printers, packing material, etc. should be provided in the immediate proximity.

5 Technical building issues

5.1 Storage conditions

5.1.1 General

Good environmental conditions of the storage areas are essential for the preservation of the collections. This is especially important for libraries with long-term preservation tasks and/or with rare materials, e.g. national libraries with the task to preserve the nation's cultural heritage for future generations or special libraries with unique material. For public libraries with high weeding rates and most of the collection in open access storage the storage conditions will matter less.

For long-time preservation, collections should be housed in a way that protects them as far as possible against detrimental influences of the climate and the environment, especially against climate fluctuations. Stable conditions are crucial for preservation. Short-time fluctuations, e.g. within a day, will be even more detrimental than long-lasting (e.g. seasonal) fluctuations.

Storage areas should if possible be constructed in such a way that appropriate environmental conditions are for the most part self-regulating. Building materials should be chosen that will produce a stable climate with a minimum dependence on mechanical systems. For instance, materials of a high thermal capacity should be used for floors, walls and ceilings (see also ISO 11799:2003 and the normative references cited there). Self-regulation of the appropriate climate without expensive technical devices will also help to reduce the running costs of energy and of environmental control.

Additional expenses for appropriate storage conditions during the building phase can be regained later when the costs for preservation can be held at a lower level, the lifespan of the collections is extended and the need for replacements is reduced. The financial effort for reaching appropriate environmental conditions can vary between different climates. In zones with extreme climates, it might be difficult to reach an optimal situation with given resources.

This Technical Report describes appropriate environmental conditions in terms of adequate temperature, relative humidity and light, differentiating between normal stacks and special collection stacks and between different types of materials. Requirements for good storage conditions can be in conflict with the needs of staff or users working in the stacks.

5.1.2 Environmental factors

The environmental conditions of the storage areas depend on several parameters that have to be addressed during the planning and building process:

- temperature;
- relative humidity (RH);
- lighting, electromagnetic radiation (visible light, IR- and UV-radiation);
- air pollutants (solid particles, gases);
- vibration.

In some regions protection against insect damage can also be an important problem. Rare book areas should be insect proof, and that raises other issues besides the climate control. There are limitations on the use of chemicals, and instead some insect repellent should be used.

Different types of material (e.g. paper, parchment, microfilms, magnetic tapes, phonographic material) require different environmental conditions. For optimal long-term preservation it is advisable to store the different materials separately. If necessary, the storage areas/stacks could be partitioned to improve the control of the environment. Partitioning would also prevent the spread of damaging conditions from one material to another, e.g. by provoking chemical reactions.

5.1.2.1 Temperature and relative humidity

Temperature and relative humidity, RH, are the two principal environmental factors; both influence the rate of damage caused by pollutants, dust and light. With an adequate control of temperature and RH the effects of the other three factors can be slowed down.

Generally speaking a lower temperature is favourable for the collections, but at the same time the humidity has to be kept under control. Problems with condensation of water will occur when warm air meets cold surfaces. The temperature at which condensation first occurs (the temperature at which the air reaches saturation) is called the dew point. If the dew point is reached, water drops will be released; this situation has to be avoided. A free dew point calculator is available (<http://www.dpcalc.org/>).

For paper in frequently-used stock areas, a temperature between 14° C and 18° C (± 1 daily change) and RH between 35 % and 50 % (± 3 daily change) are recommended. Optimal conditions for long-term preservation are reached if the temperature is kept between 2° C and 18° C (± 1 daily change) and RH between 30 % and 45 % (± 3 daily change). Parchment and leather should be kept in temperatures between 2° C and 18° C (± 1 daily change) and RH between 50 % and 60 % (± 3 daily change).

The recommendations given here are taken from ISO 11799:2003.

Specific climates might make necessary a deviation from the above recommendations. Where humidity is generally very high as for instance in Japan, it will be necessary to use a high number of dehydrators in the storage all through the year to avoid the dew point and mould. Air conditioning is needed to keep the temperature relatively low, especially in summer. The National Diet Library, Japan (NDL) keeps its storage around 22° C (temperature) and 55 % RH for general materials, in the storage of microforms the temperature is kept at 18° C and RH around 25 %.

Heat is a catalyst and will speed up the reactions that lead to degeneration. This is a natural law that applies in all circumstances. When planning the storage areas this has to be kept in mind. It will be useful to know how the different materials included in the collections will react chemically at different temperature levels.

It is essential that the climate is kept as stable as possible; fluctuations will put extra stress on the material whether paper or other materials. Fluctuations of humidity will cause the material to expand and contract, and in the long run the material will become unstable. In Japan, for instance, libraries use wooden shelves for rare book collections in order to avoid the immediate change of temperature and RH.

Objects in the collection that consist of several materials (e.g. a paper manuscript with parchment binding) will have a higher risk of damage as each material will expand and contract at its own rate. Compromises have to be made as to temperature or humidity. If the air is too dry most materials will become brittle, if too damp and with radiation, mould growth or oxidation will be stimulated.

5.1.2.2 Electromagnetic radiation (see also 5.5)

When planning the lighting system two problems areas have to be addressed:

- some light sources produce heat which will affect the climate in the room and cause dehydration of the material in the collection;
- the light system might cause light induced damages to the material.
Radiation of all wavelengths (visible light, infrared and ultraviolet radiation) will cause damage at different rates to organic materials: for instance oxidation will take place. Chemical reactions that started in light will continue even when the material is moved to dark storage.

The effects of radiation are cumulative. The same damage will appear when an object is exposed to high levels of light for a short period, as to a lower light for a longer period of time.

Daylight contains a high proportion of infrared and UV radiation and should therefore principally be avoided in stacks. Where daylight is useful (open access areas) or even mandatory (rooms for shelving staff) it should be

reduced by curtains, screens or other barriers. Sunscreens will be more efficient if mounted outside the walls, but inside sunscreens will be less expensive and less exposed to effects of the weather.

Artificial lighting should generally be UV-free. In stacks there should be a zoned switching system or a central automatic switching system which ensures that only necessary lights are turned on.

For the illumination of stores for rare books, unprotected graphic material in colour and other special documents, a balance should be found between the requirements of protection and the needs of the staff working in these areas. In general, fluorescent lighting is recommended, with ultra-violet and infra-red filters, since this type of lighting does not generate much heat.

Optical fibre is a good solution if manuscripts or other delicate documents are to be displayed: no heat is emitted and the colour response is excellent.

5.1.2.3 Air pollutants

Ventilation in stacks should ensure that the air can circulate everywhere. If natural ventilation is not sufficient, a ventilation system is required. The air should be free of gaseous and other contaminants and dust. Incoming fresh air should therefore always be filtered. There can be also a need of filtering between different rooms to remove pollutants produced in the building.

Water condensation might occur when warm air meets cold surfaces. If the shelves are too close to the wall the ventilation will not be sufficient to remove the condensation. ISO 11799 recommends at least 150 mm between the lowest shelf board and the floor, and the same distance between the ceilings and top shelf board. In climates with high humidity, it can be useful in rare collections to leave the bottom and top shelf boards free to ensure air circulation.

Gaseous or solid pollutants, for instance chemical substances in building materials or furniture could start unwanted chemical reactions in the collection and accelerate the process of deterioration. Furniture and other equipment in the storage areas should be selected carefully with regard to "safe" materials. For instance substances in paint, floor covering, etc. should be checked by specialists.

Potential sources for air pollution could be:

- paper;
- wood;
- rubber;
- adhesives;
- volatile organic compounds (VOC) (gases from paint);
- ozone produced by photocopiers and certain lamps and electrical equipment;
- ammonia;
- smoke;
- insecticides;
- abrasive particles;
- fungus.

Audiovisual and photographic collections are especially sensitive to pollutants.

5.1.2.4 Vibration and transport

Most materials are sensitive to vibrations; therefore this is also a factor that has to be considered during the planning process.

Machinery that generates vibrations should not be placed in the vicinity of valuable collections. Vibrations originating from moving the material should be reduced as far as possible. This is an important factor while planning compact shelving in stacks, as parts of the collection with brittle materials might not tolerate frequent movement.

While planning the building it is also worthwhile to consider doorways, thresholds, passages and entrances to lifts, both as points of increased risk of vibration and as points where other damage could occur. If doorways, etc. do not offer enough space for a safe passage the transported material might be damaged during the passage. If the library's collections include items in very large formats, doorways, elevators, etc. need to have enlarged passages and entrances.

5.1.3 Photographic and film-based collections

Threats to the photographic collections are fluctuations in temperature or RH, exposure to light, UV radiation, atmospheric and particulate pollution (see ISO 11799:2003, Annex B for details about temperature and RH).

A general recommendation is to store films of different types separately from each other. Glass and film negatives, paper contact prints, colour transparencies – all should be stored separately.

Generally the temperature should be kept as low as possible, and the relationship between temperature and RH should be controlled continuously. Colour material needs a cooler environment compared with black and white. Therefore there should be a room for acclimatising the material before bringing it into usage areas in order to avoid a climate shock.

Some of the materials used during the history of photography are extremely self-destructive, others are sensitive to physical contact, but common to all is that they depend very much on the stack environment for a future existence.

Cellulose nitrate, cellulose acetate and polyester are the three main types of film-based photographic materials, for example negatives, positive transparencies, motion pictures, micro films and other photographic products.

Cellulose nitrate and cellulose acetate are highly instable and can cause damage in a photographic collection since during the degradation process by-products are released that will damage other materials.

Cellulose nitrate films put high demand on the storage; they are extremely inflammable, especially during deterioration. At room temperature and lower temperature cellulose nitrate-based film deteriorates at a slow rate; during the deterioration process gases are emitted. If the gases cannot escape due to the containers the films are kept in, the deterioration process will accelerate and in the end result in a complete destruction of the films. Due to the risk of spontaneous combustion some countries demand specially designed storage areas for cellulose nitrate films.

Cellulose acetate films decompose slowly at room temperature, during the process gases are released whose smell resembles vinegar, and the process is known as the “vinegar syndrome”. With time the cellulose acetate films will be destroyed, and the same applies for cellulose triacetate films.

The environment should be stable, cool, and dry. Good ventilation is important and is even more important if the temperature cannot be lowered to a point where the processes are slowed down.

The films described above are also a health problem for the staff, and special consideration should be given to that when planning the storage. Good air circulation is important for the staff's health, and the time spent working with the films should be limited.

The polyester based film is considered to be a “safety film”, and is the type of film recommended for use for an expected long life.

5.1.4 Audio-visual collections

5.1.4.1 Audio disc recordings

The three main types of audio disc recordings are shellac discs, instantaneous discs and microgroove discs.

The shellac discs are of a wide variety; therefore it is difficult to make any general comments about the degradation risk, since this depends on the quality of the shellac. In an appropriate storage environment these disks are suffering from a slow progressive crystallisation of the shellac. With high RH levels this crystallisation will accelerate.

There are several types of instantaneous discs, of which acetate discs are in danger of deterioration, since they consist of a core plate of glass, cardboard or aluminium with a lacquer coating of nitrate or acetate cellulose. Due to a hydrolytic process the coating material becomes brittle, when the coating material shrinks the inner tensions build up and the lacquer coating will break apart and flake off.

Microgroove discs are considered to be more stable, but when exposed to ultraviolet light or to heat a chemical degradation will take place. Microgroove discs are not sensitive to high humidity and are resistant to fungal growth.

For audio disc recordings the recommended temperature is between 16°C and 20°C ($\pm 2^\circ\text{C}$ daily change), RH 30 % to 40 % RH (± 5 % daily change) (see ISO 11799:2003, Annex B, Table B.1). For long-term preservation even cooler temperature and lower RH are recommended, but this should be decided by a specialist in each case.

5.1.4.2 Magnetic media

Magnetic tapes are audio and video recordings on cassettes, audio and computer reel-to-reel tape, computer diskettes, etc. Usually a magnetic tape is made of a magnetic layer of chromium or iron oxide bound with an adhesive on a polyester film base. The weak link is the adhesive that will deteriorate through hydrolysis and oxidation, with an RH more than 40 % the deterioration accelerates. Generally cassette tapes are more fragile than reel-to-reel tapes since they are thinner and weaker, and the lifespan is short. Cassette tapes older than 15 years need careful attention, most tapes older than 20 years need professional care.

It is important for the storage of magnetic tapes to keep them away from magnetic fields; they should not be stored close to electric equipment. A clean and dust free environment is necessary. Dust attracts and traps moisture and speeds up hydrolysis and the onset of degradation. The dust can also cause problems when the tape is played, the recorder heads will scratch the oxide layer of the tape.

As magnetic tapes are sensitive to sun exposure, the storage should be cool and dry. Extreme heat or frost will damage magnetic media; the tapes are sensitive to rapid changes of temperature. When moving tapes from one temperature zone to another an acclimatization room is needed.

The recommended storage temperature and the RH % are dependent on each other. For AV recordings with frequent use of material the recommended storage temperature is 18°C ($\pm 2^\circ\text{C}$) and the relative humidity 30 %. The storage environment should be well controlled and the climate needs to be kept as constant as possible under the variations of the year.

Recordings for long-time storage and preservation should have a lower temperature of 15°C ($\pm 2^\circ\text{C}$).

For other circumstances see ISO 11799:2003, Annex B, Table B.1.

5.1.4.3 Optical discs

Three types of optical discs are common in library collections: Compact Disc (CD), Digital Versatile Disc (DVD) and Blu-ray Disc (BD). All of them are usually made of polycarbonate plastic with layers for data storage, a sputtered metal reflection layer and protection layers.

Optical media need protection from light, dust and climate fluctuations and should never be exposed to sunlight. Optimal storage is a cool and dust-free moderately dry environment. The temperature recommended ranges between -10°C and 23°C (± 2 daily change) and between 20 % and 50 % (± 10 daily change) RH. (ISO 11799:2003, Annex B, Table B.1)

If the temperature or the humidity rises it will lead to oxidation of the metallic reflecting layers, dark fading of dyes and deterioration in polymer substrates and coatings. Deterioration is also caused by electro-magnetic radiation. Optical discs are generally inapplicable for long-term storage of data.

5.1.5 Digital long-term preservation

Storage rooms for digital collections have more or less the same requirements as server rooms.

There should at least be two sites for storage of digital material. To minimize the risk of data loss, the bit streams should be duplicated to multiple copies. At least one copy should be kept in an onsite location, and a back up copy should be kept in an off site location. In case of disaster at one location the duplicate will be safe at the other location.

For especially important digital material one might also consider two parallel carriers, one optical and one magnetic to reduce dependency on one technology.

UV light and daylight should be avoided in rooms where hardware and software for digital collections are stored, stable temperature and relative humidity is important.

A contaminant free environment is required.

It is important to control the content of particles in the air since magnetic carriers are vulnerable to airborne pollution.

5.1.6 Indoor climate for reading rooms and open access areas

In reading rooms and open access areas optimal conditions for the collections housed there cannot be maintained, as the needs of users and staff working there for a longer time should be taken in account. But as far as possible, the requirements for the storage of collections should also be considered in these areas. Fluctuations of temperature and RH will be unavoidable, but the temperature should be kept as stable as possible and the temperature differences between different parts of the library should be reduced. In reading rooms for rare materials, climatic conditions should be as near as possible to those in stacks for rare materials.

For paper based materials kept in reading rooms or open access areas the recommended temperature ranges between 14°C and 18°C (± 1 daily change) and the RH between 35 % and 50 % (± 3 daily change). (ISO 11799:2003: Annex B, Table B.1).

5.2 Load assumption

5.2.1 General

This subclause gives guidelines and numerical values for defining and calculating the structure of buildings intended for libraries. More specifically it aims at establishing numerical values concerning live loads since this has a direct relation to the use of the building.

The following factors should be borne in mind when calculating the structure of a building:

- permanent actions (the structure's own weight and that of the flooring, the permanent walls, actions of the terrain, etc.);
- variable actions (live loads, partitioning elements, wind, thermal actions, snow, etc.);
- accidental actions (fire, seismic movements, etc.).

Buildings being converted for use as libraries require a more detailed study because many old buildings do not support such loads.

5.2.2 Live load

Live load is defined as the weight of all that which might rest upon each part of the building in the course of its use (people, furniture, stored materials, fixed installations, etc.).

The position of the objects whose weight constitutes live load is variable and, in general, indeterminate, but from the point of view of calculating the structure of the building, their effects can be simulated by applying a uniformly distributed load.

To determine this value the types of space within a library need first to be differentiated, so that the live load recommended for each of them can be indicated.

5.2.3 Types of space and recommended live load

In terms of their influence on calculating the building's structure, the following types of space should be considered:

- a) spaces with documents on shelves or in any other sort of storage furniture;
- b) compact shelving areas;
- c) highly frequented areas;
- d) areas with fixed seating;
- e) areas with only tables and chairs;
- f) mobile library parking area;
- g) other areas.

5.2.3.1 Spaces with documents on shelves or in any other sort of storage furniture

Spaces with document storage include in the first place open or closed stacks and all kinds of reading rooms, but also offices for administration where documents are kept on shelves or in other furniture. In the majority of libraries, this type embraces most of the spaces that are counted as main usable area.

Live load: A specific number cannot be given, since the live load can vary according to the kind of material stored and to its distribution. So as to calculate the live load it is essential to establish a hypothetical distribution of the shelves.

In order to offer some guidance figures, the live load is calculated for two hypotheses:

EXAMPLE 1 Open access storage area (e.g. reading rooms with shelves)

- Axis centre distance: 190 cm (aisle width: 130 cm).
- Maximum depth of shelving: 30 cm.
- Maximum height of shelving: 225 cm.
- Number of shelves: 6.
- Information is stored on paper.

In many cases, different types of media will be stored in the stack areas. From the structural point of view, paper is the most unfavourable hypothesis (paper density ranges between 6 and 11 kN/ m³).

New building

- Live load: 5 kN/m².
This value could reach 7 kN/m² if, in a hypothetical case, the documents occupied an 80 % of the total volume of the shelves.
- Reinforced compression layer in the floor slabs: 5 cm thick with mesh.

In floor slabs with the beams all running in the same direction, add reinforcing elements at right angles to the beams. These elements working together will compensate for the linear load of the shelving, equalising deformations and spreading the forces better.

Refurbishment

The load affects the floor slabs, the columns and the foundations. It is therefore necessary to analyse each element in order to determine how to proceed with each of them correctly.

In very general terms the following recommendations can be made:

- Uniform live load for all the structural elements: 3 kN/m² for columns and foundations reinforcement, and 5 kN/m² for floor slab reinforcement.
Add reinforcing elements at right angles to the beams. These elements working together will compensate for the linear load of the shelving. These reinforcing elements should resist 5 kN/m linear, with a gap between centres not exceeding 150 cm.
- Reinforced compression layer in the floor slabs: 5 cm thick with mesh.

EXAMPLE 2 Open stacks

- Axis centre distance: 150 cm (aisle width: 90 cm).
- Maximum depth of shelving: 30 cm.
- Maximum height of shelving: 225 cm.
- Number of shelves: 6.
- Information is stored on paper.

New building

- Live load: 6 kN/m²
- This value could reach 9 kN/m² if, in a hypothetical case, the documents occupied an 80 % of the total volume of the shelves.

5.2.3.2 Compact shelving areas

Live load: It depends on the type of shelving, on the shelf height and on the type of material stored.

Given that the load required is far superior to the rest of the library it is convenient to define these spaces at the beginning of the project. It is recommended to locate such shelving on the lower floors of the building, so that the structural reinforcement need not be applied at the upper levels.

In order to offer some guidance figures, the live load is calculated for two hypotheses, bearing in mind that the information is exposed on paper.

EXAMPLE 3 Compact shelving of 150 cm height

— Live load: 10 kN/m²

EXAMPLE 4 Compact shelving of 225 cm height

— Live load: 15 kN/m²

5.2.3.3 Highly frequented areas

Entrance areas, multipurpose halls, exhibition areas, area/rooms for meetings and events, etc.

— Live load: 5 kN/m²

5.2.3.4 Areas with fixed seating

Auditoria, etc.

— Live load: 4 kN/m²

5.2.3.5 Areas with only tables and chairs

Reading rooms without shelves, classrooms, etc.

— Live load: 3 kN/m²

5.2.3.6 Mobile library parking area

The vehicle's large size and the weight of the lending materials cause occasional large loads at the point of contact between the wheels and the pavement.

The floor slabs should be calculated depending on the size and design of the mobile library.

The following values can be used for reference:

— Approximate live load: 10 kN/m².

— Reinforced compression layer in the floor slabs: 8 cm thick with mesh with a diameter equal to or greater than 8 mm, with mesh cells no larger than 20 × 20 cm.

5.2.3.7 Other areas

Storerooms, automated storage areas, areas with specific machinery (machines for self-service charging, for transport of documents, binding, etc.), utilities management spaces for air conditioning or lift machinery, etc.

— Live load: The live load occasioned by the accumulation of material or of heavy equipment be calculated on the basis of the type and quantity of material stored, as well as with consideration of the way the load is distributed and its effect on the structure.

5.2.4 Overview

Table 26 — Overview of live load (rounded)

Type of space	Live load (kN/m ²)
6.2.3.1 Spaces with documents on shelves or in any other sort of storage furniture	Depending on the kind of material stored and on its distribution.
Example 1 (axis centre distance: 190 cm)	5
Example 2 (axis centre distance: 50 cm)	6
6.2.3.2 Compact shelving areas	Depending on the type of shelving, on the shelf height and on the type of material stored.
Example 3 (150 cm height)	10
Example 4 (225 cm height)	15
6.2.3.3 Highly frequented areas Entrance areas, multipurpose halls, exhibition areas, area/rooms for meetings and events, etc.	5
6.2.3.4 Areas with fixed seating Auditoria, etc.	4
6.2.3.5 Areas with only tables and chairs Reading rooms without shelves, classrooms, etc.	3
6.2.3.6 Mobile library parking area	10
6.2.3.7 Other areas	A specific calculation would be necessary.

A safety coefficient should be applied to all these values. Although each country has its own coefficients for the calculation of building structures, in the case of live load it is reasonable to assume a value of 1,5.

Bearing in mind that in libraries flexibility and the ability to modify the functions of spaces and the distribution of equipment are essential, it is advisable to calculate most of the structure with a uniform live load appropriate for all forms of use. It is therefore recommended to apply the same live load necessary for the spaces with documents on shelves to all the spaces included in 5.2.3.1, 5.2.3.3, 5.2.3.4 and 5.2.3.5.

5.3 Conveyor systems

5.3.1 General

Conveyor systems are mainly employed for the following purposes in libraries:

- conveying media (the technologies used range from horizontal and vertical conveyors between service desk and sorting room to complex, three-dimensional conveyor systems as part of the library's logistics circuit);
- conveying people or goods (by lifts, escalators or moving walkways).

Particular attention should be paid to fire safety regulations from the outset when conveyor systems are being designed. However, it is not possible to go into greater detail here as such regulations vary from country to country. The installation of conveyor systems results in follow-up costs which should be taken into consideration during the planning process.

Every possible effort should be made to avoid thresholds and other barriers in all circulation spaces. The inclination of any necessary ramps should not exceed 6 %.

The dimensions and masses specified in 5.2.2 to 5.2.4 are product-dependent and only serve as a guide for subsequent detailed planning.

5.3.2 Lifts for passengers and goods

Irrespective of which media-conveying systems are installed, passenger lifts in multi-storey library buildings should be dimensioned in such a way that they are also able to transport at least one laden book trolley and staff.

The lift dimension and door width for such multifunctional lifts should be such that persons on stretchers can be transported (internal dimensions of lift car with door closed not less than 2 m × 1.5 m, door width not less than 1,2 m, clear height not less than 2,15 m). The stopping accuracy of the lifts is particularly important in order to facilitate the transport of book trolleys and for the purposes of wheelchair-users.

Lifts designed especially for wheelchair users should have a usable space of at least 110 cm × 140 cm. The door width should be at least 90 cm. There should be a waiting area of at least 150 cm × 150 cm in front of the lift. The control panels inside and outside the lift should be in a height of 85 cm or otherwise additional panels should be provided. The lift needs acoustical and optical signals for the floor, opening and closing of doors and alarm.

At least one material lift for the transport of furniture, pallets and computer equipment should be provided in addition to the passenger lifts. This lift should be suitable for the transport of euro-pallets (DIN EN 13698) on a lift-cart.

5.3.3 Escalators

Escalators are increasingly being installed in the public areas of libraries with high numbers of users. However, escalators take up a great deal of space. In addition, the requirements in respect of accessibility do not permit escalators to fully replace lifts. For instance, the new EU-legislation does not allow taking perambulators onto an escalator. The noise of escalators should be considered when planning their use inside a library; a special noise insulation especially of the engine can be necessary. Due to energy saving and noise reduction escalators should only run when they are in use.

5.3.4 Systems for conveying media

Systems for conveying media should first and foremost connect the stacks and loan desks in the lending section of the library (check in/check out desks) or in reading rooms. Technical complexity will depend on the number of library users and the general layout of the building. Consideration should be given to linking the media-conveying systems with other service points. 24-hour self-service book drops and media-sorting systems should be integrated into media-conveying systems. There should be a concept for the library's logistics circuit before planning the conveyor system.

There are various types of conveyor systems in use, most of which are specially designed modular systems.

Sound insulation should be provided if the conveyor systems are directly connected with reading rooms, other user areas or staff areas.

5.3.4.1 Conveyor belts

Whether designed to transport loose media or media placed in containers, conveyor belts can be used to carry materials horizontally on different levels or, if installed at a sloping angle, to provide a direct connection between stacks and lending areas. Conveyor belts installed beneath the stack ceiling at a reachable height (c. 1,95 m to 2,10 m) ensure that books are transported quickly, especially if the stacks are extensive. The reachable height is governed by the specification for a minimum headroom of at least 1,85 m. Conveyor belts can only transport materials in a single direction.

5.3.4.2 Systems for conveying containers

The advantage of container-conveying systems, irrespective of their type, is that they provide an ideal way of transporting materials to their destination. Materials can be transported in both directions (outgoing and return) and the systems also enable materials to be distributed over different levels and to different service points.

5.3.4.2.1 Systems for conveying boxes

Box-conveying systems are used in libraries in which high-volumes of materials need to be transported. Although such systems have integrated destination-recognition features, they are not very flexible and take up a relatively large amount of space. The open boxes can generally take loads of 25 kg or up to approximately 20 volumes (external length $\times$ height $\times$ width: 580 mm $\times$ 430 mm $\times$ 190 mm). The limits of how much library staff is able to handle should be taken into account if larger boxes are to be used. It is recommended that book trolleys be designed in such a way that they are able to accommodate the boxes transported by this type of system.

The overall horizontal distribution section of box-conveying systems usually comprises conveyor belts installed on a single level in the building (e.g. in the basement). Connections between the horizontal section and the storeys above should then be installed as required. Such connections can take the form of paternoster-style lifts and generally take up a great deal of space.

5.3.4.2.2 Track-based conveyor systems with automated movement of containers

Track-based container-conveying systems with automatic drive and fitted with destination-recognition devices can be used very flexibly in libraries and are also suitable for installation in existing buildings owing to their relatively small dimensions. They are also used where libraries offer a fast or immediate delivery service.

Individual containers generally measure 360 mm $\times$ 120 mm $\times$ 300 mm and can carry loads of up to 12 kg. The systems enable material to be conveyed without damage on horizontal, inclined and vertical planes. Double tracks have a combined width of 400 mm, the radius of horizontal bends is around 600 mm and that of vertical bends around 650 mm. Track-based conveyor systems that have recently come onto the market can transport a larger volume of material but also require a correspondingly greater amount of space. Track-based systems can also be designed with integrated connections to offices in addition to the connections between stacks and lending sections. In this case, consideration should be given to the need to increase normal ceiling heights by 600 mm if conveyor systems cross corridors connecting administrative sections which can have a detrimental effect on the cubage of the building as a whole.

5.3.4.3 Floor conveyors

In addition to conventional book trolleys and the conveyor belts described above, there are various other transporting devices in use for conveying materials quickly on a horizontal level within the stacks, ranging from scooters fitted with a basket for books to automated book trolleys that can even operate elevators autonomously. The main and service aisles should be dimensioned accordingly. In addition, maintenance and recharging areas for automated floor conveyors need to be provided.

5.4 Security and safety systems

5.4.1 Advisory services

The advisory services provided by the police and the appropriate fire safety authorities should be consulted as early as possible during the planning process.

5.4.2 Security and safety measures

5.4.2.1 General

Libraries can house items of great value. This is particularly the case if their collections include rare materials. In addition, computer systems and other electronic equipment are at risk of being stolen. The same applies to the data saved in the computer systems which can be of a sensitive nature and has to be protected against misuse and vandalism.

An appropriate voice alarm system should be installed to facilitate evacuation of buildings in an orderly manner in emergencies.

Library staff can be protected by hidden systems like panic buttons in furniture or keyboards. Staff locker rooms and staff lounges should not be accessible from the public areas of the library. In busy public and academic libraries the lending area should be located near the security or porter's lodge especially when it is manned in the evening. Staff entrances and parking lots should be located in visible areas.

5.4.2.2 Building security

Measures to protect buildings against burglars and vandalism should start at the building envelope with regard to the ground floor and any entrances to the basement. Experience has shown that windows and doors are weak points that need to be particularly well protected or monitored. Electronic security technology offers a wide variety of solutions to this problem. However, it should be taken into account that, once installed, video surveillance and alarm systems need to be monitored continuously, either by staff or a security company. Facades can also need to be secured against intruders up to a certain height. The same applies to light wells and ventilation shafts.

The simplest way to protect a building is to install mechanical systems such as bars on windows and burglar-proof laminated glass. All entrances should also be fitted with burglar-proof doors. Generally speaking, it will be necessary to monitor at least the doors by installing a burglar alarm which includes contact switches. Any groups of windows that are vulnerable to burglars should also be included in the alarm system and monitored by means of contact switches and glass break detectors. A further way of securing a building against intruders, in particular in the case of large continuous glass facades, is to install motion detectors inside the building immediately above interior facade.

5.4.2.3 Monitoring indoor spaces

In addition to protecting the building envelope, it is also advisable to monitor the spaces, or at least the public areas and the corridors connecting administrative areas, by means of motion detectors as persons have not infrequently been known to let themselves be locked into public buildings at the end of opening hours. The monitoring system can also include floor pad sensors.

Stacks for rare materials and server farms storing sensitive data should be designed as special secure areas for which the right of access should be defined. Rules for activating the security systems should also be developed.

When monitoring indoor spaces by using video surveillance for example in unmanned library branches or stacks outside the general user area, the privacy and freedom of information for users and staff should be considered.

5.4.2.4 Central control unit and forwarding of alarm signals

Security monitoring systems for buildings and indoor spaces require a master control unit which receives the various alarm signals and continuously checks the systems to ensure that they are working correctly. The master control unit is generally combined with other control systems (for lifts, fire safety, book-conveying facilities, vehicle access points, and locking systems) and/or building services control systems. It can be installed in the porter's or janitor's lodge or in a separate room manned by security staff. If installed inside the building the alarm sensors should be switched over to the local police station or to an external central control point when the building closes. The master control system can also be located in a central control room nearby as the various systems need to be monitored continuously.

5.4.2.5 Locking systems

Buildings with many locks like libraries generally need master key systems. In addition, special lock cylinders can monitor whether the individual sections of the building have been locked. Electronically controlled locks with card readers or operated by a PIN can be either connected directly to the data network or operate offline. They are particularly suitable for staff entrances, for transition points between public areas and administrative sections or stacks as well as for rooms used by many different members of staff and/or other parties (training rooms, staff cafeterias, etc.).

If libraries open at specified times without being manned (e.g. at night), they can use card readers to check electronically whether persons seeking entry are authorized to access the library. If the security requirements are particularly stringent, electronically controlled locks connected to the building security monitoring system via data links can be employed. Persons authorized to access the library have to prove their identity by means of a smartcard or PIN and in some cases by biometric data. This ensures that the stacks, the specialist reading rooms and so on are safeguarded against unauthorized entry and enables access to be monitored. The corresponding security monitoring system should also be connected to a central control unit (see 5.4.2.4).

5.4.2.6 Security of physical collections

The checks carried out by library staff in large reading rooms and open stacks or video surveillance of such areas are not generally sufficient to protect materials against theft. Electronic security systems should therefore be included from the outset in plans for important exits and security gates in stacks and reading rooms that are open to the public. The library should be designed in such a way that all users are automatically guided towards a central security gate fitted with a security system. It should not be possible to bypass the security gate.

All security systems for physical items basically comprise two components: an element (e.g. magnetic strip, label) that is concealed as well as possible inside each item and firmly affixed to it and a security gate to scan that element. Books or media secured in this way will activate an alarm if a user attempts to exit the library through the security gate with materials that have not been checked out properly.

There are currently two security systems available:

- magnetic strips;
- RFID labels.

Magnetic strips work with electromagnetic fields. An acoustic or optical alarm sounds when the field is interrupted at or near the corresponding security gate by media that have not been checked out properly and barriers or turnstiles can be blocked temporarily at the same time. The magnetic strip is not deactivated until the books have been checked out properly, after which the user is allowed to pass the security gate. In the case of RFID systems, the tag is deactivated when books are checked out properly and thus disabled.

5.4.3 Fire safety

5.4.3.1 General

The first principle of fire protection is to prevent the outbreak of a fire as not only the fire itself but also the water used for fire-fighting can have disastrous consequences for media collections in libraries. Structural means such as avoiding electrical installations and cable ducts as far as possible, switching off the mains electricity supply automatically at night or reducing the oxygen content of the air in the stacks are important, as are organisational measures.

When planning fire protection systems a distinction should be made between structural (passive) fire protection and active fire protection. Structural measures primarily include the planning of escape routes and fire rescue paths, the provision of water for fire-fighting and the installation of fire compartments. In addition, the properties of building materials and components as well as of equipment and furniture should be considered, as materials react differently in heat and fire.

Active fire protection includes the installation of fire extinguishing systems, smoke and heat exhaust systems as well as fire detection and alarm systems.

Fire safety requirements laid down in building and fire codes vary from country to country. Statutory regulations which lay down the requirements for the combustibility of building materials and the fire resistance rating of components are also of relevance.

5.4.3.2 Structural (passive) fire protection

Structural fire protection first and foremost includes all means of preventing the outbreak of a fire. Prevention should have top priority, especially in sensitive areas. Preventive measures include, for example, dispensing with any unnecessary electrical installations and the possibility of switching off the main electricity supply to complete sections of a building at certain times in order to minimize the risk of short circuits.

Fire compartments with fire-resistant walls should be provided in order to prevent the spread of fire to other areas of a building or to adjacent buildings. Internal fire-resistant walls should generally be placed not more than 40 m apart.

Two completely separate escape routes (primary and secondary escape routes) should be provided on each floor. The secondary escape route is not necessary if fire-fighting stairs have been installed in the building. The presence of fire loads in escape routes is not permitted at any time. Ducting and cables for building services and ventilation systems can be installed in service ducts with the required fire-resistance rating. Services and systems can be installed without ducts if the required fire-resistance rating is achieved by fire dampers placed at penetration points in building components.

5.4.3.3 Active fire protection

5.4.3.3.1 Detection systems

Fire detection and alarm systems should include smoke detectors. Apart from photoelectric smoke detectors, ionization smoke detectors and optical beam smoke detectors are also commonly used. Ionization smoke detectors should comply with regulations on radiation protection. Optical beam smoke detectors are particularly suitable for public areas, large, high rooms or for cable ducts (with poor accessibility). Highly sensitive smoke extraction systems can also be installed in rooms housing IT equipment and technical installations and in cable ducts. Multi-functional detectors can feature alarm functions (voice alarms, sirens, flashing lights) in addition to their fire-detection function.

5.4.3.3.2 Extinguishing systems

Sprinkler systems and fire extinguishing systems employing gaseous agents are suitable for fire suppression. Pre-controlled dry systems can be installed in areas with sensitive materials. Sprinkler systems should not be installed in stacks housing particularly valuable collections. Some sprinkler systems work with water mist

instead of water drops. Considerably less water is sprayed at a higher pressure through specially designed nozzles, thus limiting water damage.

The use of gaseous extinguishing agents is particularly recommended in sensitive areas (server farms and IT-departments, stacks with rare collections, etc.) owing to the low risk of damage. Carbon dioxide, argon, nitrogen or Inergen (a mixture of nitrogen, argon and carbon dioxide) are in use. Inergen is recommended in particular as it is not detrimental to human health. The use of carbon dioxide is no longer regarded as suitable except in non-occupied areas or systems. Enough space needs to be provided in order to store sufficient supplies of extinguishing agent. Low-pressure liquid tanks can also be installed for large rooms in order to save space. If a fire-extinguishing gas is used, pressure-relief vents and strengthened walls should be provided owing to the high pressures involved. Special safety cages that can be installed in existing buildings are commercially available for the protection of particularly sensitive IT areas (server farms, etc.).

In the case of smoke and heat exhaust systems, a distinction is made between mechanical systems (operating with suction or pressurization) and natural systems. Such systems are only suitable for installation in rooms in which gaseous extinguishing agents are used under certain circumstances.

Table 27 — Fire extinguishing systems

System	Recommended for	Not recommended for
Sprinkler system	Public areas	Sensitive materials
Water mist	Public areas, stacks	Rare collections
Gaseous agents	Rare collections, IT	Public areas, large spaces
Carbon dioxide	Not recommended for libraries	Areas accessed by humans

5.5 Light and lighting

5.5.1 General

Lighting deserves special attention, bearing in mind the positive or negative effects the chosen solution can have on the comfort and safety of users and staff and the protection of the collections.

The aim of this subclause is to lay down a series of technical aspects and recommended levels that can serve as a guide when planning lighting for a library.

There are two factors that determine the appropriate lighting comfort during the course of the day:

- the configuration of the building's facade and roof, which determines entry of daylight;
- artificial lighting.

An important aspect to bear in mind is the coefficient of reflection, which is the relationship between the amount of incident light and the amount reflected from a surface as a consequence of its colour. White has a coefficient of reflection of 80 %, but very dark colours such as dark brown and black can have a value between 3 % and 5 %.

Another important factor is the brightness of the finishing material of surfaces and furniture. Matte surfaces are recommended for greater comfort.

In addition to the influence of colours and finishes, the various surfaces in a room reflect light according to their location. The following reflection factors are recommended: more than 70 % for the ceiling, from 30 % to 70 % for the walls, from 20 % to 40 % for the floor and from 30 % to 40 % for the furniture.

5.5.2 Recommended lighting levels² according to the activities in an area

Table 28 — Recommended lighting levels for specified areas

Functional areas	Lighting level (lx)
User places, reception/loan desks and information points	500
IT-workplaces	150 to 300
Open and closed stacks	200 to 400 Minimum 200 on the lower shelf
Stacks and exhibition areas for rare books, unprotected graphic material in colour and other special documents	20 to 50 A specific study is required depending on the material stored.
Entrance area	250 to 400
Multipurpose hall (events, lectures and other activities)	300 ambient light Adjustable from 0 to 400 according to the activity taking place.
Exhibition area (except for rare materials)	300 to 700
Area/rooms for meetings and events	100 to 300
Learning centre and training rooms	500
Circulation spaces	150 to 300
Offices for administration	500 On the plane of the work surface
Open-plan offices for administration	750 to 1000 On the plane of the work surface.
Recreation/communication area for users	200
Store rooms and utility management space	150 to 200
Toilets	100 to 200

During the day, a combination of natural and artificial light could be used to achieve these levels.

² Lighting level: (Symbol: E (lx) - Unit: Lux. defined as unit per m² (lx=lm/m²)). This parameter is a characteristic of the object that is illuminated. It indicates the quantity of light falling per unit area of the surface of the object when it is illuminated by a light source.

Illumination is inversely proportional to the square of the height above the surface. In libraries, the quantity of light is usually calculated for the plane of a horizontal work surface, which is usually installed at a height of 70 to 80 cm.

5.5.3 Natural light

Natural light is understood as the light provided by the sun, which varies in position, colour and intensity in the course of the day, and varies according to the season, the weather conditions and the geographical location.

The control of natural light has three main aims:

- a) energy conservation;
- b) visual comfort;

The following points should be borne in mind in library buildings.

- Avoid letting direct sun fall on tables or shelving.
- Avoid glare, reflections and shadows.

- c) preservation of the collections.

Factors that condition the level of natural light:

- 1) climate;
- 2) geographic position of the building;
- 3) orientation of the facades;
- 4) shape of the building;
- 5) light openings (windows, skylights, etc.);
- 6) nearby buildings and other features that surround the library.

In most cases, fixed or movable mechanisms to modify the light of the sun should be installed (ledges, visors, blinds, curtains, screening films, etc.).

The chosen system should be robust and easy to clean and maintain. In the case of moveable protective elements, it is recommended they be electrically operated and controlled exclusively by the library staff.

5.5.4 Artificial light

5.5.4.1 General

Artificial lighting can provide illumination anywhere and at any time, but its energy cost is very different to the zero expenditure needed for natural light. Artificial lighting is, together with air conditioning, the greatest consumer of energy in a library.

According to the proportion of light that strikes objects directly, artificial light can be direct, diffused or indirect.

Direct light is recommended for lighting work areas, area/rooms for meetings and events, etc.

Indirect lighting, where light is projected onto a reflecting surface and is reflected from there, is characterised by a sensation of lightness and lack of glare. It is recommended for rooms where computers are used, to provide ambient light in study areas and wherever uniform lighting without shadows or bright spots is required.

One solution for obtaining visual comfort is to combine the two methods, using indirect light for general illumination and direct light in particular areas where it is most called for.

5.5.4.2 Requirements and recommendations

- Artificial lighting should facilitate the practice of all activities carried out in spaces of different dimensions and with varying ceiling heights.
- Care should be taken to provide light with the appropriate quality, intensity and direction, with balanced contrast. Lighting should provide visual comfort for users and staff, and ensure the conservation of the collections.
- A certain degree of uniformity is required (minimum illumination/medium illumination) with values close to 0,5 (Emin/Emed). Otherwise, flexibility in the use of spaces is reduced.
- Artificial lighting should provide light of an appropriate colour, which depends on the choice of lamp³. It is recommended that lighting should have an Ra (colour rendering index)⁴ of more than 80.
- Glare should be avoided, which depends on the specific design of the luminaire⁵. These should light the work surfaces, but not shine in the eyes of those who are working at them. Luminaires should have a UGR (Unified Glare Rating)⁶ of less than 19.
- Lamps and luminaires should be chosen depending on the initial and replacement cost, as well as on resistance and durability. Moreover, the design of the luminaires should facilitate replacing the lamps.
- To facilitate energy saving independent circuits should be established depending on the activities planned and also on the location of the areas relative to the natural light sources. In this case, it can also be useful to incorporate a sensor system to regulate the ignition. It is also recommended that presence detectors are installed in the toilets.
- According to the type of library and its characteristics, it can be convenient to locate light switches so that they are accessible only to library staff.
- External areas pertaining to the library (car parks, paths, ramps, etc.) should also be illuminated, as should residual spaces which might otherwise pose a security threat.

5.5.4.3 Placement of the luminaires

There are two options:

- a) locating the luminaire independently of the furniture;

this makes it possible to alter the distribution of the furniture, flexibility of use being the main advantage. A uniform illumination system can be chosen, or the installation of different types of light that offer a varied ambiance. Systems that are independent of the false ceiling are preferable, since they will make it easier to change the distribution of the lighting.

In some areas it can be recommendable to install a lighting track system. This makes it easy to change both the model and the location of the luminaires, with the consequent increase in flexibility and in the variety of lighting conditions.

³ Lamp: Manufactured source of optical radiation. generally visible.

⁴ Ra (colour rendering index): A measure of the ability of a light source to reproduce the colours of objects faithfully.

⁵ Luminaire: Device which distributes, filters or transforms the light emitted by one or more lamps. along with the accessories needed to support them. protect them and connect them to the electrical circuit. and which also contain. where necessary. the auxiliary components needed for operation.

⁶ UGR (Unified Glare Rating): An index of the unpleasant glare coming directly from luminaires in an interior lighting installation.

- b) incorporating lighting into the furniture.

This reduces flexibility, but creates sharply differentiated ambiances, which in the case of study tables assists concentration. It makes it possible to provide the level of lighting required on the work surface without also providing it in other spaces where it is not necessary, with consequent energy saving. On the other hand, as the furniture has to be connected to the electricity supply, it is more difficult to move it; also, maintenance costs will be higher because of malfunctions and vandalism.

Finally, a combination of the two options can be decided upon, the choice depending on the type of library.

5.5.4.4 Lighting conditions in the main functional areas of a library

5.5.4.4.1 Reading rooms

In reading rooms the possibility should be considered of enabling users to adjust the lighting themselves, in terms both of direction and intensity. This can be achieved either with a lighting system incorporated into the furniture or by means of more sophisticated mechanisms that make it possible to control lighting remotely. The first of these options has the disadvantages, as already noted, that flexibility is reduced and maintenance costs will be higher. The second option is preferable but is very costly at present. Hence, it would be viable for libraries where flexibility is not an issue, with firmly defined reading areas where change is not expected.

5.5.4.4.1.1 User places

In user places lighting should be concentrated on the work surfaces with the possibility of varying the intensity of the light according to need.

The position of the light source should be such that it does not cause shadows for left-handed people.

Continuous tables, in many cases installed with their back to perimetric architectural elements such as walls or partitions, require that the light source be located so as to avoid shadows being thrown by the users themselves.

5.5.4.4.1.2 IT-workplaces

In IT-workplaces no natural light should fall directly on the computer screens. Neither should artificial light be reflected in them. Therefore the light source should be behind the equipment and raised above it. Indirect light is the most effective solution.

5.5.4.4.2 Stacks

5.5.4.4.2.1 Open stacks

The most effective solution is a linear luminaire parallel with the shelving, so that the light falls on the vertical plane and clearly illuminates the spines of the books. This effect can be achieved with luminaires incorporated into the shelving or independent of it. The first option, which requires the shelf units to be connected to an electricity supply, makes it difficult to move the shelves and makes them more expensive. With the second option there is a danger that shelving could be badly sited in relation to the light source.

A more flexible solution might be an arrangement perpendicular to the shelving, with a distance between luminaires that will ensure an adequate level of lighting.

The reflected light generated by the material and colour of the flooring can help achieving the level of lighting required for the bottom shelves (minimum 200 lx).

5.5.4.4.2 Compact shelving areas

For the compact shelving, where the aisles between the shelving units are of variable width, an installation perpendicular to the shelving is recommended.

5.5.4.4.3 Stacks and exhibition areas for rare books, unprotected graphic material in colour and other special documents

See 5.1.2.2

5.5.4.4.3 Other spaces

5.5.4.4.3.1 Reception/loan desks and information points

Illumination should be concentrated on the work surface. The design and location of the luminaires can also make it easier for users to identify the service desks.

5.5.4.4.3.2 Multipurpose halls (events, lectures and other activities), exhibition areas and certain other spaces (young adults' library, music library, informal areas, etc.)

These areas need flexible, directional lighting adapted to current use, with a system for regulating lighting intensity that will enable the illumination levels mentioned above to be obtained.

In exhibition rooms it is desirable that the lighting should flood the walls.

5.5.4.5 Artificial light generation systems using electrical energy

Table 29 — Advantages and disadvantages of the light sources most used in libraries

Light source	Advantages	Disadvantages
Incandescent	Warm light Visual comfort Very good colour rendering Low purchase cost Immediate start-up and restart Able to operate in any position Easy installation and handling No auxiliary units required	High energy consumption Low luminous efficiency⁷ (8 to 25 lm/W) High heat generation Only a small proportion (less than 10 %) of electrical energy is converted into light. The rest produces heat. Short service life (1000 hours)
	Due to the low luminous efficiency, incandescent lights have been prohibited in some countries and are about to be prohibited in others.	
Halogen incandescent	Visual comfort Small size, enabling more precise control of the cone of light Perfect colour rendering Immediate start-up and restart Easy installation and handling No auxiliary units required, except in the case of low-voltage bulbs, which require a transformer	High energy consumption Low luminous efficiency (25 lm/W) High heat generation Somewhat short service life (2000 hours) Need for auxiliary transformers for the low-voltage version
Fluorescent	Provides uniform light (free of shadows) Low consumption High luminous efficiency (65 to 100 lm/W) Minimal heat generation Moderately long service life: greater than 6000 hours Available in a wide range of shapes and sizes Variety of light colours Easy replacement	Cold light, in spite of the range of available light colours Auxiliary units required (except for compact lamps, which have the auxiliary circuits incorporated) Unless an electronic reactance is used, a stroboscopic effect is produced and diffusers become necessary with consequent reduction of luminous efficiency
Metal halides	High luminous efficiency (70 to 95 lm/W) Medium-long service life: 2500 to 14000 hours	Start-up and restart are not immediate (about 10 minutes for the discharge to be established) Auxiliary units required Moderately high purchase and replacement costs

⁷ Luminous efficiency: (Symbol: lm/W - Unit: Lumen/Watt). The luminous flux emitted by a light source for each unit of energy consumed.

Table 29 (continued)

Light source	Advantages	Disadvantages
LED (Light Emitting Diode)	Can produce a specific colour without the need for filters Low consumption (depending on manufacturer) No heat emitted with the light (although the diode can overheat) Very resistant to impacts Long service life: between 50000 and 60000 hours	Variable luminous efficiency (up till now, 5 to 70 lm/W, depending on manufacturer) Difficult to create warm white light High initial cost
	At present, LEDs are already an alternative for general library illumination. It is a constantly-evolving technology, and it is possible that developments will resolve many of the disadvantages mentioned above, particularly with regard to luminous efficiency (up to 100 lm/W) and the quality of white light. Consequently, the data provided here can vary as research proceeds, and will need to be updated as it does so.	

5.6 Acoustic conditions

5.6.1 General

In order to provide suitable acoustic conditions for reading and working in libraries, the appropriate steps should be taken to control both the noise from outside and the noise produced within the building.

This subclause

- explains some technical aspects,
- specifies levels for acoustic comfort
- describes systems for insulation and acoustic correction that can be used as a guide for library projects.

5.6.2 Types of noise

In the architectural context there are two types of noise:

- a) airborne noise;
- b) impact noise.

5.6.2.1 Airborne noise

This is transmitted through air and can also be reproduced through solid elements. It is originated in the air and the noise source can be both outside and inside the building. External airborne noise comes from the noise sources around the building (traffic, schools, industries, etc.). Internal airborne noise is produced by users and staff, by equipment (photocopiers, computers, etc.) and by utilities management (lifts, air conditioning, etc.).

Airborne noise is measured in A-weighted decibels (dBA).

5.6.2.2 Impact noise

Impact noise is caused by object dropping, vibrations and bangs, by contact of shoes with flooring, etc. It is transmitted very quickly by solid elements.

Impact noise is normally caused on floor structures. It can be prevented by building floating floors, consistent in a rigid basis separated from the floor structure by elastic joints.

Impact noise is measured in decibels (dB).

5.6.3 Architectural acoustics

Architectural acoustics is the set of techniques that enables the control of acoustic characteristics and the attainment of the level of acoustic comfort desired in the premises.

There are two types:

- a) acoustic insulation (the capacity of the building elements to reduce noise transmission from one part to another and between the outside and the inside);
- b) acoustic absorption (the property of the building materials to absorb acoustic energy and diminish the reflection of sound waves produced inside the buildings).

When a sound wave reaches a surface, one part is reflected, another is absorbed by the surface, and the remainder is transmitted to the other side. If the sound source and the receiver are in different rooms, the reduction is made by acoustic insulation of the building elements that separate them. When the sound source and the receiver are in the same room, possible disturbing noises can be reduced by acoustic absorption.

5.6.4 Recommended acoustic comfort levels

In order to achieve acoustic comfort, a series of parameters should be controlled. The principal ones are:

- a) sound level;
For each type of space a sound level should be established, which permits to carry out a specific activity in a comfortable way. Sound level is measured in A-weighted decibels (dBA).
- b) reverberation time.
A sound originated in a place with reflective walls is still perceived during a fraction of time after it is produced. The ideal reverberation time is the value that limits the duration of noise to an acceptable length. It is directly proportional to the volume of the space and inversely proportional to the capacity of absorption of the covering.
Reverberation time is measured in seconds (s).

Table 30 — Recommended acoustic comfort levels for functional areas

Type of space	Sound level (dBA)	Reverberation time (s)
Entrance area and circulation spaces	< 50	1
Auditorium	A specific acoustic study should be done to establish the optimum values required for the activities planned.	
Recreation/communication area for users	< 50	0,9
Training rooms and area/rooms for meetings and events	< 40	0,8 to 1
Reading rooms, open stacks and reception/loan desks and information points	< 40	0,8
Quiet study areas	< 35	0,7
Children's library	< 40	0,8 to 1
Reprography space	< 45	1
Offices for administration	< 40	0,8 to 1

For offices there will often be local or national regulations as to noise limits.

To achieve these acoustic comfort levels, enclosures and dividing walls should be insulated against noise generated both in adjoining premises and external to the building.

5.6.5 Insulation and acoustic correction systems

The following recommendations should be considered already in the start of a building project, as they can facilitate the performance of the acoustic comfort levels stated before.

5.6.5.1 Location

It is very important to bear in mind the acoustic characteristics of the building plot and its surroundings (intense traffic, schools, industries, etc.). In some occasions it can be more effective to find another location than to adequately isolate a building placed in a difficult acoustic environment.

5.6.5.2 Distribution of functional areas

It is necessary to know the type of use of every room, as well as to localize and recognize the noise sources of the building. The different spaces should be distributed in a way that the sources of noise and the noisier areas are away from the quiet rooms.

It is advisable to place the areas where there is greater traffic and greater noise near to the entrance areas (reception/loan desk and information point, reprography space, children's library, etc.), in order to minimize acoustic interferences with areas which need silence (area for reading and studying, etc.).

Utilities management spaces for air conditioning, lift machinery, etc. are large noise generators, so they should be concentrated and separated from areas which need silence. This way it will not be necessary to design many heavily insulated partitions.

It is also important to pay attention to the volume of some areas. Staircases, entrance halls and, in general, areas with double or triple heights increase reverberation a lot. In these cases, coverings with a high coefficient of acoustic absorption should be used.

5.6.5.3 Facades and roofs

All facades should be insulated for sound, bearing in mind that the openings are the weakest and most difficult elements to insulate.

The interface of the openings with the facades should be done through hermetic joints and the opening mechanisms should not cause vibrations.

Roller blind boxes are an acoustic bridge which should be avoided. It is recommended that other types of solar protection be provided.

It is preferable that the access doors have an inner door (double door) to reduce the transmission of exterior noise. Likewise, automatic and revolving doors are preferred to folding doors.

Lightly constructed roofs cause acoustic problems, mainly due to impact noise caused by rain or hailstones. A double layer incorporating insulating materials is required.

5.6.5.4 Flooring (see also 5.7)

Impacts generated on the flooring are transmitted to the floor structure, causing airborne noise in the lateral and lower premises. Therefore, the chosen surface should minimize or eliminate this problem.

It can be solved by using light flooring and floating floors. Light floorings avoid impact noise. Floating floors, which consist of a rigid basis separated from the floor structure by elastic joints, separate the source point of impact noises from the building structure, decreasing in this way its transmission. Therefore, from the acoustics point of view, the ideal solution is the floating floor with a light flooring finish.

5.6.5.5 Ceilings

It is recommended that ceilings be covered with absorbent materials in order to reduce reverberation time. Bearing in mind that the majority of absorbent materials are soft and fragile, it is recommended that they are out of arms reach.

5.6.5.6 Vertical dividing walls

It is very important to achieve a continuity of enclosure insulation of the premises to avoid acoustic bridges. It is especially relevant in vertical walls which end at the false ceiling and do not reach to the upper floor structure, as well as in ducting for building services.

To improve insulation in entrances to some premises, inner doors (double doors) are recommended, as well as installing mechanisms that avoid noise produced by slamming, opening and closing doors.

5.6.5.7 Utilities management space

A very important aspect to bear in mind is the noise coming from utilities management space for air conditioning, lift machinery, etc. The majority of these utilities generate airborne noise and impact noise. Therefore, it is transmitted both through the air and the solid elements.

Premises which provide space for utilities management should be acoustically insulated and machine fulcrums should be separated from the building structure by bedplates, springs or elastic elements.

Installation routes, pipes and tubes should be fixed on the building elements (walls and floor structures) in an elastic way to avoid vibration transmission.

Machines and elements that are placed in or enter every room (motors, fans, air vents, etc.) should not cause disturbance (incorporation of silencers, control of fluid circulation velocity, etc.).

Installations related to the systems of automated transport and automated storage should also be well insulated.

5.7 Floor construction and covering

5.7.1 General

The horizontal separation between habitable floors of a building is made of the following elements:

- a) floor structure;
- b) lower covering (ceiling);
- c) upper covering (flooring).

The floor structure is the horizontal structural element that receives the load directly and transmits it to the other elements of the structure (columns and foundations).

Normally, a lower covering or ceiling is added to conceal the lower part of the floor structure; in some cases the decision can be not to cover this lower part. The type of material chosen usually depends on its aesthetic impact and acoustic features. There are two installation systems:

- in direct contact with the floor structure;
- separated from the floor structure allowing an intermediate air space (false ceiling). This option allows for the installation of services (lighting, air conditioning, wiring, etc.). It is essential that hatches are installed to give access to the services.

As for the upper covering, there are three ways of installing the flooring:

- 1) directly placed on the floor structure;
- 2) placed over an intermediate layer which is used both for levelling the flooring and for housing the services;
- 3) separated from the floor structure, leaving an intermediate air space (raised floor). This is a system of adjustable feet located on the floor structure. These support plates on which the flooring is placed. This option allows for the installation of services (air conditioning, wiring, etc.).

This subclause defines some requirements for flooring and types of flooring suitable for libraries.

5.7.2 Flooring requirements

The flooring, always visible because it is in our field of view, is an integral part of the architectural design. Different types of flooring could be used to visualize different functions in an open area. The choice of flooring can be based on different aspects: the functions of the particular library area, the traffic routes, aesthetics, durability, financing issues, etc.

Some of the requirements are:

- a) comfort and security for the public and staff;
Aspects to bear in mind:
 - 1) The flooring should be nonslip and non-inflammable.
 - 2) On the stairs and ramps there should not be any kind of relief.
 - 3) The height difference between the outdoor flooring and the indoor flooring should not exceed 2 cm, with a rounded edge or well cut at an angle of 45°.
- b) acoustic absorption and prevention of impact noise;
- c) resistance to intensive use and to specific live loads (shelving, wheeled furniture, etc.);
- d) durability;
- e) ease of cleaning and replacement;
- f) possibility of facilitating access to installations going underneath (both fitted ductworks in the filling layer on the floor structure and raised floor). Access hatches should be perfectly level with the rest of the flooring in order to avoid accidents.

Requirements for the raised floor:

- strength: The system of adjustable feet system supporting a raised floor should be adequate to support the weight of shelving and other items of furniture.
- cleaning: As the raised floor is not guaranteed to be waterproof, the recommended cleaning method is by vacuum cleaner. When the material employed for the finish requires liquid products, the cleaning should be carried out with great care in order not to damage the ductworks and connections beneath.

There might be local or national regulations concerning flooring that ought to be considered.

5.7.3 Types of flooring

The following types of floor covering are suitable for use in libraries:

- a) carpet;
- b) stone;
- c) artificial aggregate (e.g. terrazzo);
- d) ceramic tiles;
- e) light flooring (e.g. linoleum);
- f) wood;
- g) laminate and stratified flooring;
- h) continuous flooring in situ.

Table 31 — Types of flooring

Carpet	Types of carpet: a) natural Generally made of a single fabric which serves both the purposes of resistant support and surface finish. b) synthetic Made of a base of resistant fibres and a fabric layer of surface finish. Carpets are supplied in rolls or as floor tiles. Placing can be done without adhesives because it is a flooring of a floating kind that settles due to its own weight.	
	Positive aspects: — thermal insulation — soundproofing Carpets never isolate airborne sound because the mass is minimal. Their best acoustic features concentrate on absorption of inside noise and inhibition of impact noise, given that it is soft flooring. — safety of usage	Negative aspects: — Carpets retain large quantities of dust and can cause allergy problems. — limited service life: The busiest areas are easily damaged. Using floor tiles allows partial substitution of the most affected parts. — difficulty of maintenance: It is necessary to clean carpets repeatedly, generally with a vacuum cleaner. The presence of much furniture (shelving, service desks, tables, chairs, etc.) makes this operation more difficult.
	This flooring is recommended for the following areas: — auditoria — children's library	