Preservation: Buildings and Equipment

Wolf Buchmann
Bundesarchiv, Bundesrepublik Deutschland

PRESERVATION AS A BASIC AND GENERAL GUIDELINE FOR ARCHITECTS AND ARCHIVISTS IN CHARGE OF PLANNING AN ARCHIVES BUILDING

The theme of this paper: "Preservation: Buildings and Equipment" with the amendment in the preliminary program: "storage standards, security measures, disaster prevention, etc." might be misunderstood as an invitation to concentrate only on technical figures like temperature and humidity in the stack areas or on recommendations for the installation of a sprinkler system. To my view this would only cover a very limited part of the topic. Preservation is not only a technical matter, it has to be regarded also as a most important policy matter for archivists. In an article published in January 1996[1] George MacKenzie analyzed the establishment of a preservation program by defining three elements. (1) direct conservation, e.g. de-acidification of paper or repair of damaged documents, (2) indirect preservation, e.g. maintenance of a stable and adequate climate in the stacks and security against fire and other threats, and (3) preservation by substitution or reformatting, e.g. organizing a microfilm program and providing researchers with microfiche instead of the original documents.

It is evident that there are direct links from each of these three elements to decisions on archival buildings and equipment. Direct conservation means to carefully plan and build laboratories for the work of conservators. Indirect preservation includes all installations to ensure the proper storage and handling of archival materials. Preservation by substitution means to plan appropriate photo laboratories, to provide the equipment for scanning or microfilming of archival documents and to install the technical facilities for researchers in the search room in order to enable them to read microfiche, microfilm or electronic images. As can be seen already from these few examples, preservation has an impact on the planning and construction of all areas of an archives building, mainly of course on the stacks but also on the area for the public, the laboratories and offices.

When planning an archives building an analysis of the methods and procedures for preservation should be carefully executed. Two results are evident:

1 Whatever may be summarized in the column "indirect preservation" is obligatory and has to be done at the highest possible level. Some standards for indirect preservation especially for the planning and construction of stacks and to ensure security will be discussed later in this paper.
2 The archival technologies for "direct preservation" and "reformatting" are optional with different priorities. No archives will renounce planning and building the traditional conservation laboratory but in all other fields the question should be asked whether outsourcing is a possible solution. Criteria for such a decision and

solutions developed for the building of the Bundesarchiv at Koblenz will also be discussed briefly later in this paper.

Preservation		
Direct Preservation	Indirect Preservation	Reformatting
Decisions on technologies to be applied: - conservation laboratories for paper, parchment, seals, leather and other archival materials - bindery - fumigation chamber - de-acidification chamber - rooms and devices for the handling of machine-readable records	1 Security for the stack areas 2 Security for other parts of the building 3 Stable climate in the stacks depending on the archival materials 4 Adequate handling of archival materials: e.g. proper transportation, light in stacks, research and offices	Decision on technologies to be applied: - laboratories for microfilming, photocopying, duplication, printing and scanning - planning and equipping the research area to facilitate the use of reformatted materials - access to scanned archival materials in-house and via national or international networks

Many requirements for preservation in the process of planning and completing an archives building are not matters of controversy in the literature and in practice. All archivists will agree, for example, that smoke and heat detectors are absolutely necessary in the stacks as well as fire resistant doors, and that it must be possible to control the careful handling of archival materials by researchers in the research area. I would therefore like to concentrate in the following pages on matters which to my knowledge are controversial and for which different decisions have been taken in new or adapted archival buildings in the last few years. Security and climatic conditions especially in the stacks are the most important criteria for 'indirect preservation' to be followed when planning an archives building.

CLIMATIC CONDITIONS FOR THE STORAGE OF ARCHIVAL MATERIALS

Temperature, humidity and air pollution

Recommendations for temperature, humidity and the quality of filters for air vary in recent publications. Often the concept for the handling of archival materials on which the figures are based, is not defined, especially when dealing with audiovisual records. Colour film in the Bundesarchiv at Koblenz e.g. is stored at minus 6°C. This applies of course only for the security or archival copy which is kept frozen in the stacks. Researchers are provided with a consultation or working copy of that film which is produced from a master copy. The climatic conditions for storing the master copy and the consultation copy are different from those for the archival film which is only used whenever a new master copy has to be produced. Figures for storage conditions should always be given for specific archival materials and explanations too whether this material is available for research or kept largely untouched in the stacks as an archival copy. Even when the word 'archives' or 'long term storage' is used one has to be careful because sometimes this only means a stability for a very limited period of time which is promised by producers for their product.

Paper records are stored in the Bundesarchiv at 18°C ±3° and 50% relative humidity ±5%. For black and white silver film we use 13°C ±3° and 50% ±5% and for color film minus 6°C ±2° and 25% ±3%. We know that the humidity for black and white film

should be reduced but we are facing difficulties in achieving this with a temperature of 13°C.

It seems to be difficult for archivists to come to an agreement on precise figures. The British Standard Recommendation for Storage and Exhibition of Archival Documents BS 5454 is quoted very often. Some figures of this standard must be questioned: a relative humidity for paper records up to 65 % is not acceptable and the exchange of air in the stacks for paper records should be reduced to a minimum.[2] In the new building of the National Archives of the USA 21° ±2°C and 45% ± 5% relative humidity are ensured for textual and cartographic materials. There are arguments, quoted by Arnold den Teuling in an article of 1996, for not exceeding 18°C[3] for paper records, limiting the range of tolerable changes to a minimum and establishing a climate of minus 20°C for black and white acetate film and coloured photographic materials. Another recent publication refers to 13°C ±2° for the archival storage of black and white film with 15 to 40% relative humidity, for color film 2°C or below and 15% to 30% relative humidity[4]. French regulations are quoted in an article by Danièle Neirinck with 12° to 20°C and 45% ±5% for acetate black and white film[5]. Discussing our archival requirements for our new building at Koblenz with the Ministry for Finance, the Ministry in charge of Federal Buildings in Germany and the Ministry for the Interior I found it extremely difficult to convince the decision-makers for our budget that specific climatic conditions for paper, film and magnetic tapes with small ranges for temperature and humidity were absolutely necessary and had to be achieved to ensure the best possible preservation. They too had read standards and articles with diverging figures and of course always favoured low budget solutions. I do not want to add a new list of recommended figures for temperature and humidity to the existing proposals. As archivists we have to insist on some essentials: the climate should be stable (±3°C for the temperature and ±5% for the humidity should be the maximum tolerance for paper records). The humidity should not exceed 60% to avoid mould. Temperatures higher than 23°C should not be accepted. Film, and especially color film, should be kept as cold as possible (keeping in mind the problem of acclimatisation when the film is used).

Special attention has to be given to nitrate film. This film must be kept in a cold storage area, outside the archives building, and it can only be copied or reviewed in specially built and equipped working areas. Very often it is not known to the archivists that small portions of nitrate film are hidden among other films in their stacks. Each film produced before 1957 should be checked carefully - a heavy explosion of a small stack of nitrate film of the Bundesarchiv on the fortification Ehrenbreitstein in 1989 was an experience that should never be repeated. We are storing our nitrate films, which still comprise about 100,000 reels of movie film, in special stacks where it is taken in trucks with cooling facilities. These films are kept at 10°C ±2° and 50 % ± 5% relative humidity. The temperature might even be lower to further slow down the process of the detoriation. We did not identify the precise reason for the explosion of 1989. Probably a malfunction of a cooling device was its cause. Preservation of nitrate film causes problems for the design of stacks and laboratories where these films are kept and handled. The best solution for these specific building problems is copying this film onto polyester stock and disposing of the nitrate orginals. This is of course a procedure disliked by those archivists who favour the intrinsic value of nitrate film.

In the standard BS 5454, as well as in several publications, a regular exchange of air is stipulated for the stacks for paper based archival materials. I agree that the air has to

be circulated in a stack area, that technically it has to be possible to exchange the air if needed (e.g. in case of fumigation after an infestation with insects) and that a very limited quantity of outside air should be brought into the stacks, but by no means should this be done by simply opening the windows. According to the figures of so-called "Schadstoffkataster" (register of pollutants in the air of a defined region or city) in all regions of Germany the air should be filtered before it is taken into archival stacks as 'fresh air'. Dutch regulations and BS 5454 indicate the maximum level of air pollution[6] for sulphur dioxide and nitrogen oxides. Ozone and carbon monoxide are harmful for archival materials. Of course all kinds of particles, dust, and mould spores have to be eliminated from the outdoor air before taking this air inside the stacks. Having accepted that 'fresh air' today is not fresh according to the standards for the preservation of archival materials, but polluted, one has to agree with the statement of Den Teuling, that pollution in the repository may be restricted by letting in as little fresh air as possible. In some publications it is not clear what is meant by 'exchange of air'. An article published in Germany[7] calls for circulating the air six times an hour inside the stacks with only 10% outside air per hour to be brought into the stacks. I think that this is still too much. Outside air should not be taken in an ongoing process but only occasionally. I am not in a position to make precise proposals about quantities but some 'fresh air' every two to three weeks or even less should be sufficient. Having in mind that filter systems and especially their maintenance are expensive, it makes sense to install only the capacity really needed. I believe that some research is necessary to identify more precisely this capacity with regard to the quality and quantity of the process of air filtration.[8]

'Natural Air Conditioning' - a low energy concept for the stacks

The concept of achieving a stable climate in the stacks for paper records by means of construction without energy consuming electric devices, is not generally accepted by archivists in charge of planning new buildings. For the United Kingdom, Christopher Kitching reports on positive experiences in some newly built record offices in the United Kingdom but also points out that British architects prefer to rely on air-conditioning[9]. The new building for the National Archives at Washington is completely air-conditioned with impressive high-technology solutions for cleaning the air. The building for the Bundesarchiv at Koblenz was completed in 1986 as one of the largest archives applying the 'natural air-conditioning system' which means that a report can now be given on practical experiences over one decade.

At a very early stage of the planning of the Bundesarchiv, the decision was taken to follow the example of the city archives of Köln, but with important and decisive modifications: we refused to accept windows in the stacks and we could not see any reason why a 'natural air-conditioning system' should not be operated in the underground stack areas[10]. We first asked a firm specializing in air-conditioning technology to develop and propose a plan for a strong-room in which a stable climate of 50% ±5% of relative humidity and 18°C ±3° temperature could be reached by means of the construction, and as far as possible without the use of electric energy. On the data sheets below, the outdoor temperature and humidity are documented from the print-out of a computer system used as a monitoring device for the environment in all stack areas of the Bundesarchiv building. As can be seen (sheets. no. 1 to 4) the outdoor temperature and humidity changed considerably during the twenty-four hours of

March 13, 1997, December 30, 1992 and August 10, 1993. The indoor temperature and humidity remained quite stable. The data sheet from February 15, 1993 (sheet no. 4) is interesting. It indicates that at about two o'clock, somebody opened one of the doors of this strong room and, contrary to all regulations of the Bundesarchiv, left it open. The indoor temperature went up and correspondingly the relative humidity went down. It then took about half an hour until the climate stabilized again.

One of the arguments in favor of the this system is the fact that if, for whatever reason, electricity is not available for some days or even weeks, the climate in the stacks will remain stable. The concept was to be applied for about 10,000 square metres for stacks for paper records. It was not to be used for 5,000 square metres for black and white and color movie film in the Bundesarchiv at Koblenz due to the lower temperature which we need for film and which can only be achieved by cooling and dehumidifying the air. In these stack areas we had to install air-conditioning devices but the walls and the roof were built with the same structure as for paper records thus also reducing the energy costs for the air-conditioning for the film stacks. Special emphasis was given to the point that changes within these climate constraints were acceptable not as rapid changes but only as long-term fluctuations. This led to a technical recommendation[11] for construction of the walls above ground level with 0,49 m perforated brick masonry, with an attached vapor barrier to prevent steam diffusion, on top of which is a thermal insulation of 0,10 m mineral fibers. Finally at a distance of 0,05 m there is a granite facade. For the underground walls of the strong rooms the system had to be modified (con. the plan encl. no 6). Inside the walls we have 0,175 m of bricks as a buffer or storage medium to stabilize temperature and humidity, then 0,30 m of concrete with insulation (0,10 m). The whole block is surrounded by air above ground. As can be seen on the plan, air can pass up under the granite facade and through the space between the roof and the ceiling of the top floor. With this construction each of the towers for the strong rooms is insulated as much as possible against the outdoor climate and its changes. On the other hand a maximum capacity of indoor stability of the climate with only very slow changes is achieved by means of the "buffer capacity" of the brick walls.

Additional equipment had to be installed to achieve an adequate climate, i. e. for preventing the formation of areas of stagnant air in the rooms which are completely equipped with moveable shelves. Four ceiling-mounted devices with a capacity of 1,300 m^3/h were installed which can recirculate the air of one of the strong rooms with 500 m^2 approximately four times per hour. These machines are intended only to circulate the air, not to bring in outdoor air. In rooms with a high percentage of outdoor walls for which a heating demand had been calculated the recirculating fans were accordingly equipped with electrical heaters.

In the rooms of the 5th floor (i.e. the top floor directly under the roof) where due to the ceiling area, extraordinary heat could develop during longer heat periods in summer despite the thermal insulation of polystyrene boards 0,15 m thick, the recirculating fans were additionally equipped with a cooling facility.

In addition to these installations, it is of course possible to ventilate the room with outside air - if outside temperature and humidity allow for this - by using the existing smoke and heat exhaust system which has been separately installed in every store room for fire protection reasons. The flue gas ventilator will then be operated with half of its capacity i. e. with 6.250 m^3/h.

The temperature and humidity of the air taken in from outside and internal air is permanently controlled with a computerized operating and control system using the so-called "direct digital control" technology. With this system the exchange of air from inside to outside can be preprogrammed to take place under specific conditions, i. e. fresh air will only be brought into the strong rooms when temperature and humidity correspond to archival needs.

After several years of controlling the climate inside and outside the stacks we may conclude the "natural air-conditioning system" of the Bundesarchiv building has proved to be an effective method to stabilize temperature and humidity within a range acceptable for paper records. We have faced some problems in the last ten years which, though they do not challenge the success of the system on the whole, may lead to modifications in future planning of comparable systems.

1 Constructing huge walls with many cubic feet of bricks means using a large quantity of water. We had to move into the strong rooms almost immediately after they had been completed and other parts of the building were still under construction. It seems to take not only months but years for the underground walls to dry out. For several years the humidity was too high. We used movable devices for dehumidification especially of the underground strong rooms. The problem is now solved but it would of course been much better to dry the walls before moving in the records.
2 The insulation of the ceiling of the top floor must be improved to further minimize the influence of summer sun on the climate of this floor. The insulation is not sufficient if it is extremely hot over several days. This is the reason we installed a technical cooling facility in the top floor stack rooms as mentioned above. We are using this cooling device over very few days each year during very hot and humid periods. In some areas with many outdoor walls, heating cannot be avoided in winter after several days with extremely cold temperatures. Both heating and cooling have been necessary to a very limited extent, heating for example only during three to four days last winter to raise the temperature two to three degrees.
3 A problem we really could not foresee has to do with the organization of the work of the staff members in the Bundesarchiv. The entrance doors to the strong rooms are of course heavy because they must withstand a fire for a given time (F 90, i.e. 90 minutes). There is a tendency, which is very difficult to fight, to leave these doors open i.e. to block the door open with small pieces of wood or folded paper. Even if these doors are opened and closed quickly if they are opened frequently, the climate in the strong rooms is influenced by the climate of the corridors. It is recommended that two doors be installed as an air sluice to avoid the exchange of air between the stacks and the corridors.

To avoid misunderstanding I would like to point out that the details of our construction - with, for example, precisely 0,49 m thickness of our brick wall - cannot be regarded as a standard for archival strong room buildings in general. The concept as such is of course applicable everywhere but the quality of the wall and its insulation do depend on the local climate. The state archives of Schleswig-Holstein completed a strong room building at Schleswig, close to the coast of the Baltic Sea in 1991. In accordance with the results of an engineer's study, the walls of this building are different from those built at Koblenz: The outer walls are 860 mm thick, consisting of 510 mm of massive brickwork on the inside, with 180 mm mineral wool on the outside.

The insulation is protected by a facade of brickwork, separated from the insulation by a 60 mm air gap[12].

When planning a new stack building the additional costs for the construction of brick walls or other special installations have to be taken into consideration. There is no doubt that using the "concept of natural air-conditioning" will bring down or minimize the operating costs for air-conditioning. This of course also applies to the stacks for movie film (5,000 sq. in the Bundesarchiv building at Koblenz) in which we do use air-conditioning equipment. I agree with the statement of Christopher Kitching that for the analysis of measuring the energy efficiency in costs per square meter little comparative work has been done for archival buildings[13]. In the Bundesarchiv we have identified the costs for running an air-conditioning system for the movie film stacks (colour Film) at Berlin - Wilhelmshagen as7,20 DM per square meter per month (climate is minus 6°C ±2°, 25% ±3%). I have to admit that his system was installed several years ago and that it probably does not operate very economically.

When dealing with costs one has to consider that an airconditioning system has to be controlled. If the strong rooms are not too large or too numerous, a lot can be done manually using inexpensive equipment for measuring temperature and humidity in - and outdoors. On the other hand manual handling is not possible for an institution like the Bundesarchiv with more than 15.000 m² of strong rooms in the Koblenz building. The installation of the necessary computerized DDC-technology is expensive and requires at least one highly qualified staff member to run it and to maximize its potential. On the other hand a system like this offers the possibility of optimizing all the technical control procedures throughout the archives building. Decision on how to construct the strong rooms and how to control the climate in an archives building as a basic requirement for the preservation of the records should therefore be taken on the basis of professional technical expertise, with some attention to the costs of construction, and to operating costs of the building and to staff costs.

SECURITY

Separation of different functional areas

In general, three different areas can be distinguished in an archives building:

1 The stack areas always comprise most of the space of an archives building taking about 2/3 of the total of the square meterage.[14] These areas for example cover about 68 % of the overall space of the Bundesarchiv building. Access is strictly controlled and limited to those staff members who need to have access.

2 The public area, which includes the reading rooms, the exhibition area, rooms for lectures and meetings and the cafeteria, covers about 8% of the overall floor space of the Bundesarchiv building. Within the public area again two parts have to be kept separate: rooms which might be open for the public without any control (cafeteria, exhibition area, lecture rooms) and other rooms to which only controlled access is possible (reading rooms).

3 The workshops, laboratories and offices cover about 24 % of the overall space of the Bundesarchiv building. This area should be accessible only to staff members and individual visitors who of course should be checked when entering and leaving this area.

The basic problem for an architect when planning an archives building is on the one hand to ensure security by a clear separation of the different areas mentioned above and on the other hand to link these areas as closely as possible, so as to minimize distances for internal transportation and communication. Separation includes avoiding the planning of permanent working facilities in the stacks. Access by staff members should be limited as much as possible and they should enter stacks only to collect and return records. The climate should correspond to the needs of the archival materials and not the needs of the staff. Consequently no windows should be planned for stack areas. This window problem which I do not believe to be a problem at all has long been discussed in publications[15]. Michel Duchein proposes windows in order to provide natural ventilation and to allow a certain limited amount of sunlight[16], but outside air should not be brought into stacks without being filtered, which of course is not possible with windows used for ventilation. Christopher Kitching quotes the British Standard 5454 which favors windowless repositories; he also reports an interesting story about hunting and shooting a pigeon which entered a repository through an open window.[17] Several new archives buildings have been completed in Germany and in Europe recently with windows and permanent working facilities in the stacks. There is no common view on windows, or on mixing stacks and working areas among archivists today. I believe that due to the need for security, a stable climate and clean air, the stacks of an archives building should be used for the storage of records and for nothing else. There should be with no compromise for the benefit of staff or for a fast or easy service.

The Bundesarchiv building at Koblenz might be taken as an example of how the need to combine security and rapid and easy communication can be achieved:

- In the area open to the public the reading rooms, the exhibition area in the foyer, the film and lecture rooms and the cafeteria are grouped together on the ground floor. A visitor entering the foyer can turn right and reach the cafeteria which holds 250 persons as well as smaller lecture and seminar rooms for up to 70 persons. The foyer directly behind the main entrance is used for exhibitions. Crossing the foyer, the visitor reaches the reading room, which encloses an atrium in the center of the building complex, and is thus insulated against traffic and noise from the outside world. This enables undisturbed academic work to be carried out in a quiet inner zone. Special parts of this research area are devoted to the use of paper files, of maps, plans and drawings, posters and photographs, as well as documentary films, sound and video tapes. Very close to the reading rooms and on the same floor more than one thousand square meters of stacks are available to store archival materials which can be very easily produced for researchers. To ensure security these stacks are separated from the research area by a corridor which is accessible only to staff members.
- The stack areas are divided among three buildings with five floors and each has 5,000 m² of storage space. Two of these buildings are intended for paper files, and one for documentary and feature films. Their hexagonal shape with cut-off corners allows several repository buildings to be linked easily to a vertical access shaft. As mentioned above, each stack room is surrounded by a corridor on each floor, and this serves as a security zone and also allows access. Firstly, security for the stack areas must have a high priority. Secondly, the overall plan of the building should facilitate communication, but it should be emphasized that this is a lower priority.

Plans proposed by architects should be refused, unless the separation of the three areas mentioned above is ensured.

Fire prevention and extinction

Special attention should be given to the protection of archival materials against fire. In the light of the experience with fire in the National Personnel Records Center in St. Louis in the United States[18] and the research conducted after the fire, no archivist should rely only on passive fire protection. Alarm systems, and small compartments to limit the damage in case of a fire are not sufficient. The installation of an automated system to extinguish the fire as soon as possible is necessary. The argument is used again and again that packed paper will not burn.[19] It has to be emphasised that practical experiences with fire prove that this is wrong. In the past, recommendations have been for the installation of gas systems. Carbon dioxide is poisonous and dangerous to human beings. The use of Halon is now illegal in many countries e.g. in Germany. Nor is it effective with burning books and records. The fire will not be extinguished but damped down, and might start to flame up again after doors are opened. Records are very often heavily damaged by the water used by the fire-brigade to extinguish a fire. An automated system should react very soon after a fire starts to burn, as close as possible to the fire and limited to the area where the fire occurs. It is essential that the firebrigade does not have to fight the fire with large quantities of water under high pressure. The activities of the firebrigade might in some cases be very harmful for records, and in most cases the damage to records will be more serious than that from a sprinkler system. For paper records therefore my recommendation is to install a water-sprinkler system with dry pipes in the stacks, with double security against unnecessary and incorrect operation of this system (sprinkler heads covered by a glass element which has to melt before water is released, water filling the pipes only in the case of an alarm after three smoke and/or heat detectors have indicated a fire, discharge limited to the vicinity of the fire and the lowest shelf being 0,18 m above the floor). Water as such is not necessarily harmful to paper - it is used in large quantities during the production of paper. With a sprinkler system it is used in small quantities and only in defined areas where it is really needed. Using a sprinkler system does not damage records kept in and protected by proper boxes. The installation of such a system of course has an impact on other decisions, e.g. special requirements for the moveable shelf system, the use of boxes and labels, the height of the stack area with 0,45 m space between the top shelf board and the sprinkler head, the availability of vacuum freeze-drying possibilities, outlets for the water in the floor, and the establishment of a disaster plan.[20]

When discussing the installation of the sprinkler system possible problems with moveable shelves had to be taken into consideration. For the Bundesarchiv building we came to the conclusion that a minor loss of the storage capacity was acceptable because we requested the enlargement of the rubber stops between the moveable rows of shelves. When moved to a block there is a distance of six centimeters between the shelves so that water from the sprinkler system may flow from the top shelf board down to reach the burning paper, at least to prevent the spread from one shelf row to the next. Another solution was found for the National Archives at Washington. In case of a fire and at all times when the building is closed, the computer will automatically arrange the rows of shelves to distances of several centimeters between each one. For

the Bundesarchiv building we decided not to install electric drives for the shelves because we wished to limit all installations in the stacks as much as possible for security reasons, and also because of the costs (such a system only seems economical for frequently used records where there is a corresponding need for very frequent access to the shelves) and because we were not sure about the insulation of the cables and motors during the operation of the sprinkler system.[21]

I disagree with proposals for the partition of the stack area into very small compartments with only 100 to 200 sq.[22] in cases where a sprinkler system has been installed. Bearing in mind that this system will most probably extinguish a fire very quickly after a certain temperature or a certain density of smoke has been detected, it is acceptable for one compartment to be four hundred or even five hundred square metres. The construction of too many fire-resistant walls and doors is not only more expensive, it also makes the installation of moveable shelves more difficult and requires additional facilities for the exchange of air in the stacks.

I have no reliable figures for the costs of the installation of a gas system. The costs for the installation of our water sprinkler system including all elements like the tank, pumps and pipe work amounted to 354,000 DM for 10,340 square metres in the stacks for the paper records. This corresponds to 33,85 DM per square metres. Adjusting the price for inflation in recent last years in accordance with the official figures published annually, the costs would have been 48,75 DM per square meter in November 1995. This does not include the costs for additional cubicmeters which have to be built to accomodate the height of stacks equipped with sprinklers. This price on the other hand should be seen against the background of the overall costs for building a stack for an archives: in the case of the Bundesarchiv it is only 1,1 % of the price for a square meter of the stack area.

Outsourcing or internal operation of archival technologies

For 'direct preservation' and 'reformatting', decisions have to be taken concerning which methods and procedures are to be applied in the planned archival building. In my view archivists should not try to install all the devices and technical facilities for the preservation of archival materials that they can think of. Questions should be asked first as to how often these facilities are used in daily practise, whether co-operation with other institutions is possible or whether it may be less expensive to contract out certain operations.

When planning the Bundesarchiv building we discussed the need for a fumigation chamber. Our policy is not to fumigate all records which we transfer from the Federal Record Center at Bonn to Koblenz but to fumigate only files which are infected and have to be cleaned. This is a very limited quantity and it is done by a commercial firm at Frankfurt at extremely low costs. A second reason for not installing a fumigation chamber was the risk of handling toxic materials by staff members and the fact that the Bundesarchiv is located in a residential area where protests were expected if we had started to burn the gas from a fumigation chamber with an open flame on the roof of our building. We also discussed the option of installing the technology to develop color film in our laboratories. Due to legislation to protect the environment this installation would have been very expensive so we rely on the service of commercial firms in that field. The quality of their work of course has to be controlled with regard to archival standards.

Besides outsourcing another option is co-operation between archival institutions or the co-ordination of archival tasks. Some of the State Archives of the German Länder have concentrated their capacity for conservation i.e. their laboratories in one place, in the case of Baden-Württember at Ludwigsburg close to the Staatsarchiv Ludwigsburg. De-acidification is done for all State Archives of Lower-Saxony at Bückeburg. Co-operation in these cases is an excellent tool to rationalize the work. As for co-ordination the Bundesarchiv might be taken as an example. We operate at several places in Germany from Freiburg to Berlin and from Aachen to Bayreuth. We decided on priorities for the work of our laboratories at these locations: e.g. filming of large formats is done in the Bundesarchiv-Militärarchiv at Freiburg, restoration is carried out at our Berlin laboratories. We are out-sourcing the production of microfiches (which are replacing the originals for research) and the production of electrostatic copies, of photos and of film ordered by researchers. De-acidification of our records will be done by firms at Frankfurt and Leipzig.

When planning an archives building with regard to preservation the options for outsourcing, for co-operation and for co-ordination should be carefully studied. These are policy decisions which have an expensive impact on the programme for the building and its equipment. On the other hand the archivist has to be careful: the construction of a new building very often offers the chance to acquire new devices and to install new technologies which would be very difficult to achieve with a normal budget. It might not be possible to later revise a decision to renounce technical possibilities in a new building. All details and consequences should therefore be discussed and thought over carefully.

BUDGET PRIORITIES

Costs of an archives building

Archivists in many or perhaps most countries share the experience of shrinking resources, cuts in budget and the reduction of staff capacity. We are obliged to use our financial resources as effectively as possible. When we look at preservation and at the different options of direct and indirect preservation or of reformatting, the question of what can be achieved by setting priorities is legitimate. It can easily be seen that financing the best possible quality of archives building i.e. investing in 'indirect preservation' is the most promising. Comparing the costs of reformatting, direct and indirect preservation should not lead to the misunderstanding that all financial means should be invested in only one or in two of these fields - none can be neglected, but an analysis of the costs might help to decide on priorities. The archivist in charge of planning an archives building should take it as a real challenge to achieve the best possible quality for the building. A comparatively small amount of money invested in the walls of a stack building might be more helpful for the preservation of the records than a much more expensive microfilm program. The figures mentioned below of course only reflect the situation in Germany, they certainly cannot be simply transferred and applied to a similar building project in other countries.

When looking at costs reliable figures can be calculated on the basis of the costs for the new building for the Bundesarchiv at Koblenz which was completed in 1986. The annual increase in costs for the construction of buildings in Germany for the period

from 1986 until the end of 1994, which is determined officially by federal agencies, has already been added to the figures below for the costs of the building from 1986[23]. Assuming therefore that the new building for the Bundesarchiv was completed at the end of 1994 the costs for one cubic meter in gross, i. e. from outdoor wall to outdoor wall would amount to:

stack area for paper records	631 DM per cubic meter
stack area for movie film	649 DM per cubic meter
offices and laboratories	750 DM per cubic meter.

A similar calculation is possible for the square meters. The *Hauptnutzfläche* which is the space for offices, laboratories and stack areas (without the space for corridors, elevators, toilets) of the Bundesarchiv building covers 23.210 m². The *Bruttogeschoßfläche* which is the space within the building including corridors, staircases etc. amounts to 41.147 sq. A calculation of the costs, assuming completion of the building in 1994 gives the following results:

Hauptnutzfläche - 23.210 sq. - :	4382 DM / sq.
Bruttogeschoßfläche - 41.147 sq. - :	2472 DM / sq.

The above costs do not include those for the building site or for equipment such as furniture or laboratory facilities. The costs of shelving are included. With a moveable shelf system we have installed 77,244 shelf meters in 10,340 sq. This means that the costs of a high quality construction of a stack building for paper records amounts to less than 600 DM per shelf meter. Costs are not mentioned very often in reports or articles on archives buildings. In his excellent publication on Archives Buildings Michel Duchein has not touched upon that topic. Christopher Kitching has published some figures in part 2: Case Studies of his publication about new archival buildings in the United Kingdom[24].

Cost of direct preservation and reformatting

De-acidification is an example of direct preservation. The costs for this procedure carried out by a research institute at Frankfurt are about 2,300 DM per shelf meter. A different technology for de-acidification has been developed by the state archives of Lower Saxony at costs of about 950 DM per shelf meter (applicable only to separated sheets of paper, not to bound files). The production of microfiche is an example of indirect preservation, the costs for the filming of one shelf meter of records are more than 2,000 DM. The Bundesarchiv would of course never be able to de-acidify or to microfilm all the 244,000 meters of our paper records. We have to concentrate our effort on heavily used or extremely fragile records. This is another reason that the figures cannot be compared realistically but they at least indicate that money invested in the building of an archives is well spent.

This of course does not mean that all other requirements and methods for the preservation of archival materials are of secondary importance. All the technologies and procedures for preservation may be likened to a chain. Security of the stacks, adequate climate in the stacks, use of microfiche instead of originals by researchers, co-operation with agencies to improve the quality of paper of current records that will become archival or any other step to preserve documents are chain links: the archivist must

meet a minimum standard in all these fields. If one of the links in the chain is too weak the results on the whole will be insufficient.

SUMMARY

"Form follows function" is a well-known and famous statement of American architects and a guideline for modern architecture in other countries. An archivist should never try to discuss the form of an archives building with the architect but should convey the function. The architect should design the building from inside out, not from outside in[25]. We have an example of a modern library building in Berlin which is regarded as a milestone in the history of architecture from its outer appearance and its public areas. It is disfunctional from the point of view of the internal working procedures. The architect should be told as precisly as possible what "function" means in the context of archival or library tasks. There might be a problem that archivists do not agree on the "function" of an archives. Should we for example take up the "House of History" concept which was presented by Eckhardt G. Franz at the 4th European Conference on Archives in Lancaster on September 15, 1994 ? As for the Bundesarchiv the function is defined by the Federal Archives Law § 1[26]: Federal archival documents are to be permanently preserved and made available for use and scholarly exploitation by the Federal Archives. According to the law and to the policy of the Bundesarchiv preservation is the number one priority. I believe that an archives building should reflect this priority from its outside appearance and from its internal structure. All elements of direct and indirect preservation and of reformatting should be taken as the basis for the policy of an archival institution. Last but not least they are to my view the most important part of the architectural programme for an archives building.

NOTES

1 George MacKenzie: 'Establishing a preservation programme', *Janus* 1996.1, p.86-99.
2 *British Standard Institution. British standard recommendations for storage and exhibition of archival documents* (BS 5454: 1989). A survey on temperatures and relative humidities as recommended by BS 5454 is published by Christopher Kitching: *Archive Buildings in the United Kingdom 1977 - 1992*, London 1993, p.46.
3 Arnold den Teuling: 'Environmental conditions for the storage of archival materials', *Janus* 1996.2, p.110-118.
4 Börje Justrell, Michael Roper, Herbert White: *Guidelines for the Preservation of Microforms, International Council on Archives, Studies 2*, Revised Edition, Paris 1996. In this publication a concise list of the relevant ISO standards can be found.
5 Danièle Neirinck: 'La conservation des Microfilm et des Photographie', *Atlanti*, vol. no. 5, Maribor 1995, p.17-24.
6 Arnold den Teuling, p.115. Anna Haberditzl: 'Kleine Mühen - große Wirkung, Maß nahmen der passiven Konservierung bei der Lagerung, Verpackung und Nutzung von Archiv- und Bibliotheksgut', in: *Bestandserhaltung in Archiven und Bibliotheken*, ed, by Hartmut Weber, Stuttgart, 1992, p.74.
7 Anna Haberditzl, p.74.
8 I agree with the statement of Arnold den Teuling: "There is no need for much fresh air in storage rooms, which were not designed to house people except for taking papers out and bringing them back again.", p.110.
9 Christopher Kitching, p.20-22

10 The so-called Kölner Model is only operational in the stack floors above ground, for the underground stacks an air-conditioning systems is installed. Hugo Stehkämper: 'Der Neubau des Historischen Archivs der Stadt Köln', *Archivalische Zeitschrift 1972*, vol. 68, pp.99- 116.

11 The technical study was carried out in 1980 by the engineers Dipl. Ing. Wilhelm und Sälzer (Gutachtliche Stellungnahme zur bauphysikalischen Ausbildung von Magazingebäuden unter dem Aspekt optimaler Temperatur- und Feuchtekonstanz im geplanten Bundesarchiv Koblenz). The study has not been published.
A detailed documentation with many technical figures, plans and photos has been compiled in a booklet by the architect of the Bundesarchiv building, Mr. Rose, Director of the Staatsbauamt Koblenz Nord, and his staff members. This booklet is available on request (for 22,50 DM + postage) from the Bundesarchiv (D-56003 Koblenz, Postfach 3 20, Fax 0261 505 226). I want to express my gratitude to Mr. Rose, Mr. Schöning and Mr. Walther, Staatsbauamt Koblenz Nord, for their assistance providing me with the technical figures and details mentioned in this paper and for the permission to publish the plans in the annex.

12 A study on the climate in the strongroom of the Landesarchiv Schleswig Holstein has been published by Lars D. Christoffersen (Birch and Krogboe A/S, Consultants and Planers), *ZEPHYR Passive Climate Controlled Repositories*, Department of Building Physics, Lund University, Sweden, June 1995, ISBN 91-88722-06 6. For a description of the walls and roofs of the archives at Schleswig see p.52 and 53.

13 Christopher Kitching, p.23

14 These figures correspond to experiences in France, see Michel Duchein: *Archives Buildings and Equipment, ICA Handbook Series Volume 6*, 1988, p.139: Stack areas 70%, offices, laboratories 19%, public area 11%.

15 Bernhard Zittel: 'Belichtung und Belüftung von Archivmagazinen', *Archivalische Zeitschrift*, 1968, vol. 64, p.79 - 116.

16 Michel Duchein, p.48

17 Christopher Kitching:, p.28.

18 'The National Personnel Records Center Fire: A study in Disaster', *American Archivist*, vol. 37, no 4, October 1974, p.521-548

19 The latest report I found dealt with a fire in Great Britain: Jean Kennedy: 'Norfolk Record Office Fire: an initial report', *Journal of the Society of Archivists*, Vol. 16, No. 1, 1995, p. 3-6.

20 Irina Shepilova and Adrienne Thomas: *Main Principles of fire protection in libraries and archives, RAMP study General Information Programme and UNISIST*, Paris. 1992, (PGI-92/WS/14), p. 17. I.G. Shepilova: The basic requirements for security, Janus 1992.1 p.89-100.

21 In the Preliminary Sketch Design Report for the Public Record Office Extension, Stage 1, July 1989, p.23 to25 a very precise recommendation is given for a sprinkler system. "The recommendations of this report are that all repositories in the extension should be protected with a pre-action dry-type auto-sprinkler system initiated by operation of one or more POC detectors." The sprinkler system was not installed later "because it was not felt to be effective in extinguishing fire in mobile racking." See David Thomas 'Security at the new Public Record Office', *Janus* 1992.1, p.111. The new building of the Scottish Record Office has been equipped with a water sprinkler system. See George MacKenzie, p.90.

22 Michel Duchein, page143.

23 I have to express my gratitude to architects and engineers of the Staatsbauamt Koblenz, especially Mr. Detlef Schöning who provided me with the figures for the anual increase of costs for planning and construction of buildings in Germany.

24 Christopher Kitching, p.79-140. Because it is not clear what is included (building side, equipment, shelves) these figures may only be used with caution. The costs for six archives range from 232 DM/shelf meter (Public Record Office), 274 DM/shelf meter, 290 DM/shelf meter to 652 DM/shelf meter, 725 DM/shelf meter and 775 DM/shelf meter. The Bundesarchiv would be in the middle of the more expensive group of archival buildings at600 DM/shelf meter.

25 Victor Gondos: 'Archival Buildings - Programming and Planning', *The American Archivist*, vol. 27, 1964, no. 4, p.477.

26 Law on the Preservation and Use of Federal Archival Documents (Bundesarchivgesetz) of January 6, 1988 (BGBl. I S. 62) as amended on March 13, 1992 (BGBl. I S. 506)