Air-conditioning for Archives

Timothy Walsh
Australian Archives

Introduction

Most archivists must by now know something about the self-destructing nature of the paper records in their custody. The problems of poor quality, highly acidic paper have been well publicised.[1] So too, have the problems facing all librarians, whether they know it or not. For instance:

> At least 1.5 million books in [the University of] Columbia's collection of five million are "falling apart". At the Library of Congress, an estimated six million books are unusuable out of 13 million. Half the New York Public Library's research collection of five million is disabled.[2]

Archivists face the same and probably worse problems than librarians. I say probably worse because generally paper records have been created on poorer quality papers than library books, especially in this century and during wartime in particular.

One way archivists can slow this decay, perhaps until mass methods of deacidification and consolidation can be developed, is by the correct use of air-conditioning. A ten degree fahrenheit (5.6°C) drop in temperature will double the life expectancy of a book.[3] The same can be assumed for paper records.

However for far too long, it seems to me, archivists, and others with cultural material in their custody such as museum curators, have neglected air-conditioning. By neglecting I mean that in the design stages of building a repository they have assumed that the architect will take care of this aspect; and in the operating of a completed building they have been prepared to let the maintenance people assure them that all is running smoothly. The result of this neglect is that when one really investigates the environmental conditions in which records and museum items are being stored, they are rarely, if ever, as laid down in the original specifications and as the text books say they should be.

The purpose of this article is to impress on archivists the need to specify fully to architects and mechanical engineers the exact environmental conditions they require in their storage areas and then,

once the building is commissioned, to make sure the environment is monitored regularly and that they are aware immediately of any changes or malfunctions that occur. When one reads that the life expectancy of an archive is determined very largely by the environment in which it is stored it makes sense for the archivist to be as concerned about this aspect of the job as about the perhaps more glamorous aspects such as reference work, disposal schedules and access problems.

Specific requirements

Air-conditioning as an essential part of an archivist's interests was first brought to my attention by Mr Neville Corbett, at that time Regional Conservator for the N.S.W. Branch of Australian Archives. In 1979 he and I, with the considerable help of Mr Phil Hamill (O.I.C. Engineering Services, Villawood Repository) visited a number of large buildings in Sydney where air-conditioning was vital to the successful carrying out of those buildings' functions. These included the Overseas Terminal at Kingsford Smith Airport, Royal North Shore Hospital and the C.S.I.R.O.'s National Measurement Laboratory at Lindfield. We spoke, not to the administrative heads of these organisations, but to the mechanical foremen who had to control the day to day running of the air-conditioning plants and rectify mistakes in design and operation. The views formed in this survey have been reinforced by the many questions I have put to archivists, librarians, museum curators etc. in recent years. Almost without exception they are either unaware of the exact environment in which their collections are being housed or if they are, they complain bitterly about poorly designed and badly operating air-conditioning.

All archivists should by now be aware that permanent records must be stored in an even environment, both in regard to temperature and relative humidity, if their useful life is to be prolonged as long as possible. For paper records, Cunha puts it succinctly when he says

> In terms of conservation, nothing will give greater return than an investment in air-conditioning. Cellulose [from which paper is made] is subject to deterioration by hydrolysis, oxidation and photo degradation. Each is accelerated by heat. Paper degradation is minimised by low temperatures between 60°-70° F [15.6-21°C] and relative humidities between 50%-60% are optimum for preservation [of paper].[4]

Most archivists for some years to come will have as their main concern the preservation of paper records. Film, computer tape and other audio-visual materials require specific environmental storage conditions. This article, however, will concentrate mainly on the needs of paper records.

Technical Aspects

Usually most, if not all, archives buildings will be completely air-conditioned. The exception to this will be where records of a temporary

nature are to be stored and in this case clean dry air circulation is generally adequate. However, certain areas within a repository will require conditions differing from the main storage, staff and public areas. These areas include the conservation laboratory and the low temperature audio-visual storage vault.

The environmental conditions required in that part of the building in which paper records are stored are:
Temperature: 20°C ± 1.5°C
Relative Humidity: 50% ± 5%

These conditions must be retained constantly in the following areas:

- General storage
- Security vault
- Control records room
- Conservation laboratory
- Microfilming
- Audio-visual processing

It is important to install a system that maintains a constant environment as fluctuations, even relatively small ones, adversely effect the long term preservation of archives.

Filtering

The air inside a building must not only be at the specified temperature and relative humidity but it must also be filtered. The British Standards Institute's *Recommendation for the Storage and exhibition of archival documents* states that:

> The incoming air should be filtered to eliminate 95% of the dust particles of 2μm diameter or more, but an electrostatic dust precipitator should not be used for this because of the risk to documents from the ozone generated. The sulphur dioxide content of the inlet air should be reduced by washing, or other appropriate means, to a level not exceeding 50μg/m³. The air should be kept in continuous motion day and night, being recirculated to all parts of the repository six times an hour, with a 10% intake of fresh air.[5]

This warning against the use of electrostatic precipitators is repeated by Thomson who says "Electrostatic precipitators (electrofilters) produce small quantitites of ozone and are therefore entirely unsuitable as air cleaners for Museums".[6] In another paper Thomson goes on to say:

> *Removal of pollutant gases.* Two methods are currently available:
> (a) Washing with plain or alkaline water. (In some plants humidity control is by continuous water spray at variable temperature. This can be an effective wash).
> (b) Absorption, usually on activated charcoal. Water-washing with recirculation of air can be effective for the acid gases sulphur dioxide and nitrogen dioxide. Activated charcoal (with recirculation) can be effective for all three of the dangerous pollutants, the above two and also ozone. Suggested specification for these systems are: (a) sulphur dioxide and nitrogen dioxide — each not more than 10μg/m³ (b) ozone — reduce to trace levels (0-2 μg/m³).

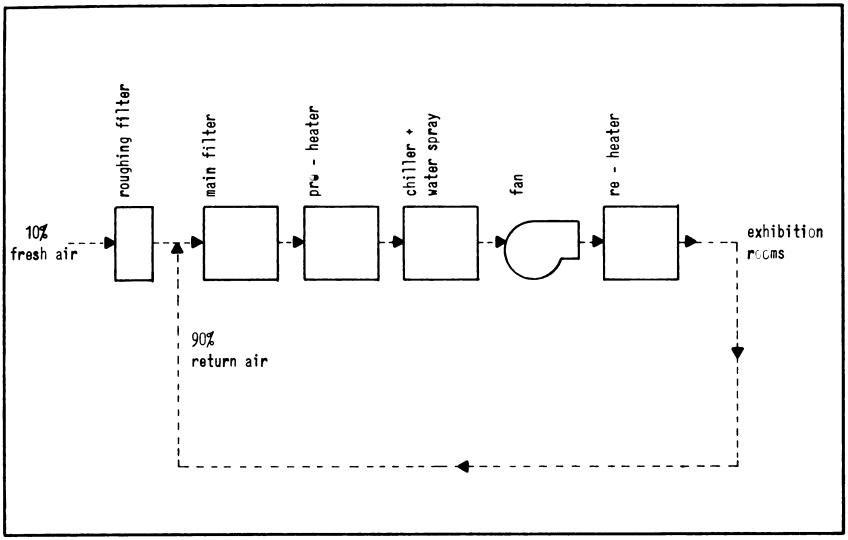

Figure 11. Diagram of an air - conditioning system.[7]

A typical air-conditioning plant in diagrammatic form (Fig. 11) shows 90% recirculation of air. Fresh air is drawn through a roughing filter which need only be of moderate quality, its main purpose being to increase the lifetime of the main filter and keep the entrance duct clean. The main filter is according to specification above. Both humidity control and purification from gaseous pollutants is by continuous water spray. A more usual system today would require the addition of activated carbon filters.[7]

From the investigations undertaken in 1979, mentioned above, it is felt that the long term successful air-conditioning of an archives building will depend on the use of pneumatic controls, centrifugal refrigeration compressors, a separate services building and several other factors. In more detail:

Pneumatic controls

Pneumatic controls alone are required. Electronic controls are not considered suitable and this is emphasised by the long term problems created by their use at the Australian Archives' Villawood, N.S.W. repository.

The reasons for insisting on pneumatic controls are as follows:

- they are easier to service and maintain
- faults are more easily diagnosed
- manual override is possible
- they present less fire hazard

- they are more fail-safe
- they are used successfully at Kingsford Smith Airport, Commonwealth Government Centre, Sydney and the Royal North Shore Hospital, Sydney.

Centrifugal Refrigerator Compressors

It is recommended that centrifugal refrigerator compressors be used. Reciprocating compressors are used at the Villawood N.S.W repository and are unsatisfactory because it is difficult to achieve temperature control with them.

Plant building

It is recommended that a services building separate from the main archives building be designed. This would be connected by a service tunnel to the air handling plant room for the far chambers. By this means it will be possible to keep all maintenance and service outside the main security area of the building and will thus allow 24 hour access by service personnel.

Heat transference

The control of environmental conditions within an archives building will be easier to maintain if double concrete walls with a cavity, and double glazing are used.

Air-conditioning in the Conservation Laboratory

Dangerous fume-producing chemicals and archives covered with mould spores will be present in the conservation laboratory. For this reason the air-conditioning system in the laboratory must be separate from that of the rest of the building.

Toilets, washrooms and cleaners' stores

These are a common source of mould growth in museums, libraries and archives. The air-conditioning system must be designed so that there is no possibility of mould spores travelling from these areas to other parts of the building.

Shelving Considerations

When designing the air circulation system for an archives building due consideration must be given to the effect mass shelving will have. Pockets of stagnant air must be avoided. All storage areas must undergo regular changes in their air mass.

Alarms

Malfunctions in the air-conditioning system must be monitored in the Conservation area as well as in the plant room. The alarms installed should be visual as well as auditory.

Vaults

Fans must be installed in all storage vaults to allow air to be circulated during periods of downtime.

Balancing

Once an air-conditioning system has been installed in a building it will require "balancing". This is best explained by describing what is actually involved in circulating air throughout a building.

An air-conditioning plant is required to deliver a flow of conditioned air to a wide variety of locations ranging from toilet blocks to offices and repository areas. This is accomplished by means of ducting. At the outlet of each segment of ducting is an adjustable louvre. These louvres have to be fine tuned to make sure that the flow is checked after installation by means of a vane anemometer. Changes in the louvres will affect the air-flow, which can also be affected by shelving and partitioning.

Balancing is generally done by means of random spot checks. This is not at all satisfactory for an archival storage area. Balancing is an expert and lengthy process and can be done by companies specialising in this work. Archivists should insist that every outlet be balanced and that the actual air flow be recorded on the building plans supplied. Balancing should only be carried out after all shelving and partitioning has been installed. Once correct, louvres must not be altered except when re-balancing is required following changes in partitioning or shelving.

Monitoring

Monitoring the environment created by the air-conditioning plant must not be overlooked. In large buildings, say those provided for state archives, there will usually be a sophisticated system to monitor access security and fire protection. This system can be extended to include a continuous record of the storage environment. Sensors are placed throughout the building and these trigger an alarm should the set environmental parameters be exceeded. This is especially important in audio-visual record storage areas where even a change in temperature for a short period may lead to considerable damage.

Although it will inevitably create discord between conservation and maintenance staff environmental monitoring should be seen as the conservator's duty and therefore the data monitoring collection point should be in the conservation laboratory.

In less sophisticated repositories monitoring is just as important and should be done by means of thermohygrographs. These should be placed in all storage areas. In large areas more than one may be necessary.

A thermohygrograph will record on a chart a continuous reading for the temperature and relative humidity of the area in which it is placed. In this way the air-conditioned environment can be monitored and the plant altered if the specifications are not being adhered to. Plenderleith and Werner have a useful appendix on the use of thermohygrographs.[8]

A point often overlooked in the use of thermohygrographs is their need for regular calibration — about once a week. Calibration is reasonably simple to do and is done with a whirling or sling psychrometer or hygrometer (an electric powered type is now available). Without regular calibration there is no purpose whatsoever in using a thermohygrograph as the readings will be false.

Conclusion

The literature on this subject is voluminous. I have compiled a very selective bibliography. The articles by Gary Thomson are particularly lucid. Most of the standard conservation textbooks have sections on air-conditioning. It can obviously be a highly technical subject but archivists should not ignore it because of this. They should not be afraid to ask simple direct questions of architects and engineers. A favourite one should be: "What will the temperature and relative humidity be in the far left hand corner of the top floor at 2.00 am". It is important to make the experts realize that they are not merely designing an office area with air-conditioning system to match but that they are creating a storage environment in which unique records will have to be stored for a very long time.

Other questions which should be asked are:

> What will be the environmental conditions (temperature and relative humidity) in all major segments of the building after two, twelve and twenty-four hours of plant down-time"?
> "What will be the maintenance requirements of the plant after ten years? What parts will need replacement after ten years and what is the cost of these at present day prices"?
> "How frequently can the plant be expected to be out of action and how long, on average, will these periods last"?

If forced to undertake detailed calculations to provide answers to these questions before architectural drawings are completed then architects may design the building with air-conditioning in mind from the very start. This could lead to a more appropriate design and air-conditioning being used merely to "fine-tune" the internal environment. The energy conservation advantages of this could be considerable.

I owe a tremendous debt to Neville Corbett for stimulating my interest in this subject and as he will realise I have borrowed much of what I say from him.

FOOTNOTES

1. See for instance Watson, A. J., "Manufacturing and Environmental Factors affecting the permanence of paper", *Archives and Manuscripts* Vol. 6 No. 7 (Aug 1976) 285-291 and Russell, Carol "Preventive Medicine and the Treatment of Socially Deprived Records", *Archives and Manuscripts* Vol. 7 No. 4 (April 1979) 172-178.
2. *Paper,* Vol. 189, No. 10 1978, 595
3. *ibid.*
4. Cunha, George Martin and Dorothy Grant Cunha, *Conservation of Library Materials,* 2nd ed., Vol. 1., Scarecrow Press, Metuchen 1971, p. 96. Another useful reference on this subject is Wessell, Carl J., "Environmental factors affecting the permanence of library materials" in *Deterioration and Preservation of Library Materials,* ed. Howard W. Winger and Richard Daniel Smith, University of Chicago Press, Chicago 1970, pp. 39-84.
5. BS 5454: 1977 §9.3
6. Thomson, G., "Effects of the Environment" in *Conservation in Australia: Proceedings of the I.C.C.M. National Conference,* Canberra May 1976, (Sydney 1977) p. 53.
7. Thomson, G. "Control and Monitoring of the Environment" in *I.C.C.M. 1977 Conference Proceedings* pp. 97-98. I have selected only a small extract from Thomson's most useful articles. They are well worth reading by all archivists — a lot of Museum technology is relevant to archives; for example, Thomson has useful information on methods of dehumidifying storage and display areas. This is especially useful where full scale air-conditioning is not available — see page 95, 97 of *I.C.C.M. Conference Proceedings 1977.* Thomson's comments on air filtration are also relevant to an archivist specifying air-conditioning — see p. 97 of previous reference.
8. Plenderleith, H. J. and A. E. A. Werner, *The Conservation of Antiquities and Works of Art,* 2nd ed., O.U.P., London 1971, p. 366-367.

SELECT BIBLIOGRAPHY

"Airconditioning and lighting from the point of view of conservation", *Museum Journal,* Vol. 63 Nos. 1, 2, 1963.

BRITISH STANDARDS INSTITUTION, BS 5454: 1977, Recommendations for the storage and exhibition of archival documents.

COOK, IAN, "Air Pollution and Aspects of Polymer Degradation", *ICCM Bulletin,* Vol. 2 No. 4, Dec. 1976.

CUNHA, George Martin and Dorothy Grant, *Conservation of Library Materials,* 2nd ed., Vol. 1, The Scarecrow Press, Metuchen 1971 (pp 96-98), Vol. 2 Bibliography, pp 203-209).

DANIELS, V., "Air Pollution and the Archivist", *J Soc. Archivists,* Vol. 6 No. 8, April 1979.

GARVER, Thomas H., "Control of Atmospheric Pollutants and Maintenance of Stable Climatic Conditions within Museum Buildings", I.I.C. 1967 London Conference on Museum Climatology, *Proceedings.*

HOWORTH, F. Hugh, "An Approach to Airconditioning" I.I.C. 1967 London Conference on Museum Climatology, *Proceedings.*

KATHPALIA, Yash Pal, *Conservation and restoration of archival materials,* UNESCO, Paris 1973 (pp. 186-188).

LAFONTAINE, Raymond H., *Environmental Norms for Canadian Museums, Art Galleries and Archives* Canadian Conservation Institute, Technical Bulletin 5, November 1979.

LAFONTAINE, R. H., *Recommended Environmental Monitors for Museums, Archives and Art Galleries,* Canadian Conservation Institute, Technical Bulletin 5, November 1979.
LAFONTAINE, R. H., *Recommended Environmental Monitors for Museums, Archives and Art Galleries,* Canadian Conservation Institute, Technical Bulletin 3, July 1978.
PLENDERLEITH, H. J. and A. E. A. Werner, *The Conservation of Antiquities and Works of Art,* Second Edition, O.U.P. London 1971 (Appendix IX: Methods of Recording Relative Humidity).
THOMSON, Garry, "Air Pollution — A Review for Conservation Chemists", *Studies in Conservation,* Vol. 10 No. 4 (November 1965).
THOMSON, Garry, *The Museum Environment,* Butterworth, London 1978.
THOMSON, Garry, ed., Contributions to the London Conference on Museum Climatology, 18-23 September 1967, International Institute for the Conservation of Historic and Artistic Works, London 1968.
WALSTON, S., ed., *Proceedings* of the ICCM National Conference, Canberra, May 1976, (Sydney 1977), especially "Effects of the Environment — Notes of a Lecture", "Control and Monitoring of the Environment — Notes of a Lecture" by G. Thomson.