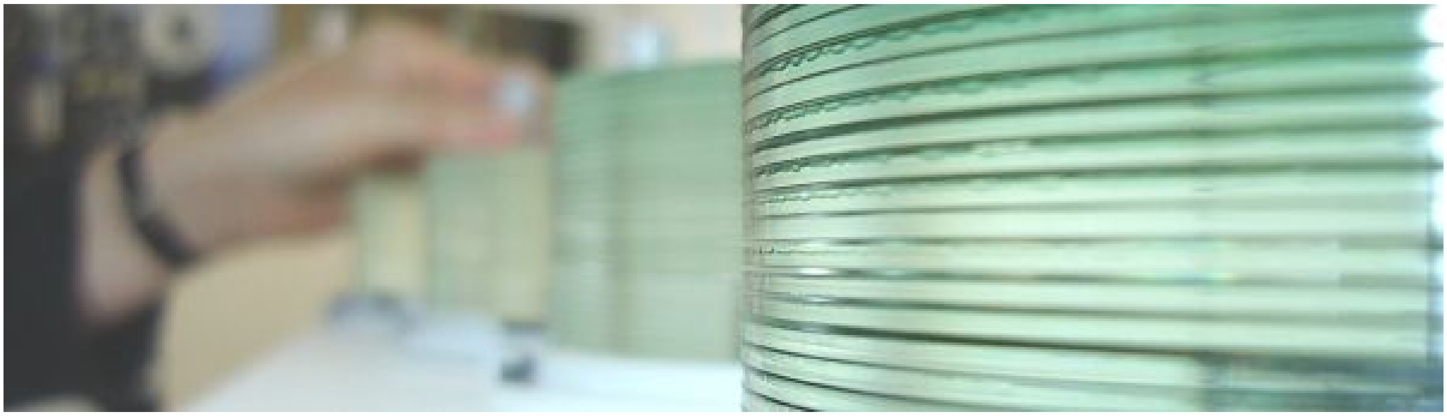
Technical Document for the Vault



A Low Cost, Low Humidity Vault for the Storage of Sound and Moving Image Documents

- Technical Paper by Carolyn Gimian

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Introduction

It would seem that many of the archivists who end up caring for sound and moving image documents come to their profession, not out of a technical background, but out of a love for film, a love for history, or a love for some form of human communication. I didn't have a film or a media background: I got into this area from book publishing and editing.

From 1976 until 1987, I was involved in several contexts with the editing and publication of a number of books about Buddhist philosophy and meditation. A number of the publications that I worked on were based on edited transcriptions of lectures that were recorded on reel-to-reel and cassette audio tapes.

At a certain point, in the early 1980's, I became curious about these tapes. I discovered out that there were thousands of audio tapes, both reel-to-reel and cassette, representing lectures by about 100 individuals. In the collection, there were also several hundred open reel black-and-white video tapes, VHS and 3/4″ colour video and some film. The tapes were well organized, having all been accessioned and labelled. However, they were in an uncontrolled humidity and temperature environment. They belonged to a Buddhist organization called Vajradhatu, for whom I was working, which was then located in Boulder, Colorado.

In 1987, all of the tapes were moved to Nova Scotia, Canada, where the organization now had its headquarters. At this point, I noticed a major difference between the environment where I had lived in the States and where I had moved: Colorado was a very dry climate; Nova Scotia was extremely damp. I began to wonder what effect all of this humidity would have on the tapes.

Obviously, as soon as I started researching the effects of high humidity on magnetic tape, I discovered that high temperatures and high humidity are very damaging, although it certainly was not all that easy to find out what an ideal relative humidity for magnetic materials would be.

There has been and continues to be debate on what is the ideal relative humidity, but most people would agree that RH above 40% is not good; everyone, I think, would agree that humidity above 50-55% percent is detrimental and RH above 55% has disastrous effects in a relatively short period of time. In Nova Scotia in the summer months and during certain parts of the Fall and Spring, the relative humidity is well above 55%.

Armed with a little bit of knowledge, I was eventually able to convince the Board of Directors for the Shambhala Community that an archives should be established. In 1990 we initiated a fund raising campaign to pay for a temperature and humidity controlled space for a collection that included the tapes, as well as a number of paper documents and photographs. By early 1991 we had about $12,000, and we thought that this should be enough to get us started.

At that point, we put together a team of people to plan the renovations. This included myself, as the newly appointed Director of the Vajradhatu Archives and James Hoagland, who was interested in working with the Archives and eventually became our technical director. We found an architect, David Garrett, who volunteered his time, and through a circuitous route we found two consultants: John Perkins and Rob Stevenson, who had a small company, who agreed to help us with the project.

Definition of our Goal

A simple, economical, low-tech way to provide a clean, cool, and dry environment for the contents of the Archives. Wherever possible, we wanted to use passive means to achieve stability in the vault.

<u>Desired Conditions</u>
What we want to achieve in the vault is a low, stable temperature and humidity. By low temperature we mean 60-65 degrees Fahrenheit, never exceeding 70 degrees; by low humidity we mean 25-30% RH, never exceeding 55% RH. Some seasonal variation is to be expected; sharp variations within a short period of time (daily or weekly) are more problematic than small variations between summer and winter. By small variations, we mean 5 degrees F and 10 degrees RH.

<u>Passive Components in Implementing the goal:</u>
A. The Room
We took a space in the basement that is 45’6″ x 14’6″ x 9’3″ (lxwxh) and walled it across the middle making two equal size rooms. We defined one room for vault storage; one as a work room.

We increased the insulation in the exterior walls and bricked up two windows in the vault. We redid the vapour barrier in the exterior wall. The rooms are partially below grade, therefore the earth on the exterior wall provides some insulation.

We added insulation in the ceiling, as well as a plastic membrane to help prevent water leakage. Insulation in the ceiling was partly for noise; partly for stabilizing the environment.

We insulated the interior wall for soundproofing, as well as to help stabilize temp/humidity. Overall, insulation was increased to R20.

We used fire retardant materials throughout and put a fire door into the vault.

We kept the existing carpeting, partly because of budget, partly because we were concerned about not having time to allow for offgassing of materials that would be used if we put in a linoleum floor. Also, the existing carpet was in good condition, cleanable, very low pile. (Not an ideal decision)

We kept the fluorescent lighting in the vault, again partly because of budget but also because fluorescents give off less heat.

We installed an “air lock entry” into the two room suite. This creates positive air pressure from the archival space into the rest of the building, which helps to keep dirt/outside air out.

B. People/Use of Space

As part of our strategy for the control of temperature and humidity, we decided to restrict the use of the vault, whenever possible, to storage and retrieval only. Our reasoning was that we could then keep the temperature lower (not being so worried about human comfort) and could keep the lights off most of the time–resulting in less heat from the lights and less damage to materials from overexposure to light. We also felt that this would provide a more stable temperature and relative humidity, since people tend to introduce heat and moisture into an environment. Less use of the vault also meant less concerns about air exchange.

We have found that July and August are the two hottest, most humid months. We benefit from people taking their vacations during these months, which means that less work is going on in the space.

C. Final Point:

It is not uncommon for people to focus on the mechanical aspects of controlling temperature and humidity. If you are trying to keep your heating bills down at home, you would think about insulating, new windows and other measures that are basically a “passive” approach to conditioning the space. This makes sense also in the design and implementation of a system for the control of the environment in archival institutions.

<u>The Mechanical System</u>

A. Approach

The strategy for the mechanical system was to use residential quality equipment with control for RH without getting overly complicated or expensive. Simple, stand-alone controls were used where appropriate, but integrated control of the RH was implemented– to the extent that budget and simplistic design allowed.

What this means is that we didn’t try to integrate all the functions with one control system. This becomes very complicated and expensive. So RH and cooling are on our system, but heat is on a separate manually controlled thermostat. We very rarely have to adjust the heat; it remains quite constant, but at times both the heat and the A/C operate — in the early part of the winter when it is very humid. When the humidity drops, the A/C shuts off.

In the Workroom

The environment is conditioned primarily in the workroom. A 4″ transfer fan moves air to the vault. The fan was sized for continuous duty with a manual switch. Primary heat is provided by electric baseboard, dehumidification by stand-alone units and A/C, and cooling by an 8,600 BTU split system A/C unit. This unit is unusual –or different from a standard residential unit — in that it can run down to 0 degrees Centigrade. Most air conditioners shut off around 15 degrees Centigrade.

Humidification

Originally stand-alone humidification was considered but has never been introduced. We are still considering a stand-alone humidifier with a manual switch or on a controller for use in the winter. There was concern about the possibility of introducing fungus or mould from humidification, if we didn’t keep up religiously with maintenance. We don’t tend to be overly fussy about the system, so I have hesitated to introduce humidification until we get more consistent with about maintenance.

In the Vault

Supplementary de-humidification (residential quality 110 VAC stand-alone unit) is the only mechanical system located in the vault. The archival materials in the vault are somewhat buffered by boxing, which helps to moderate T and RH fluctuations expected in a control system of this type.

Heat and Air-filtering
Three 500 W baseboard electric heaters are provided in each room on two thermostatic controlled zones. The work room also has a stand alone residential quality air-filtering device under its own control running constantly. We originally were going to purchase a Casco stand-alone device, but budget did not permit.

Make-Up Air
We originally installed a make-up air system (Braun 360 high-end residential bathroom type exhaust fan) bringing 0-100 CFM of outside air directly into the workroom. We were concerned that there would not be sufficient air exchange and fresh air in our work space. Control was manual. It turned out that there was not a problem with the room being too airtight and the make-up air just introduced a very cold draft. It has since been covered over with insulation. The make-up air feature might be useful for someone with a truly airtight space–we could have used the money better elsewhere in our design!

B. Control System Design
In the Workroom
Since RH control is primary, three progressive dehumidification control steps are used. The control system first switches the supplementary dehumidifier in the workroom via a solid state relay. If further dehumidification is called for, the A/C unit will provide that. This minimizes the temperature reducing impact of relying on the A/C unit for primary de-humidification. These two units are controlled by an integrated controller (on/off or PID capability) taking readings from a combination T and RH General Eastern sensor. Switching is accomplished by Solid State relays. At some point, we could add humidification with its own control system. When the A/C unit is running to provide dehumidification, the heat can also be on — which means that we are simultaneously cooling and heating for periods of time. Although this sounds strange, it hasn't really been a problem and is rarely the case.

In the Vault
In the vault, a second humidity sensor/controller system can call for additional dehumidification localized in the vault. This is the only system located in the vault area. We have had some problems with the dehumidifier in the vault putting out too much heat. The humidity is brought down, but the temperature rises above 70 degree fahrenheit. We may want to modify the vault design in the future and consider adding a second air conditioner — but this would be expensive now that we have bricked in the windows!

C. Monitoring Protocol
We were advised to install monitoring to confirm the system was performing as desired and to provide an archival record of the conditions in the archive. For the equipment and software that we wanted, this would have cost an additional $2,000 — not including a computer (which we didn't have at this time). We were already quite over budget, so we delayed purchasing dataloggers — and still don't have them. We have borrowed monitoring equipment sporadically and have used it to confirm that our instruments are taking accurate readings. However, this is not really sufficient, and our next equipment purchase for the vault will be monitoring equipment!

The control panel in our workroom is constantly showing readings for humidity and temperature in the workroom and humidity in the vault. The temperature in the vault can only be read off a separate thermostat in the vault itself, which is inconvenient and means that we lose track of the temperature there for periods of time. I would like to add a temperature sensor in the vault which gives us readings on the same control panel. We have manually logged readings off of the controls once or twice a day for the past four years. At the beginning, we were quite religious about this; in the past year or so, we have been less conscientious about taking the readings.

Budget

We spent approximately 18,000, all figures Canadian dollars, on the basic renovation. This included the construction costs, and the air conditioner was included in that bid. The architect who drew up plans and consulted with us throughout the project, David Garrett, donated his time.

We paid approximately $2,000 to consultants for their design of the climate control system and overall help. This was invaluable.

The two Sears Kenmore dehumidifiers together cost about $750.

The control system was in US dollars. It included two General Eastern sensors, 2 Deltron power supplies, 4 solid state relays, three Eliwel controllers and two reducers (whatever those are), plus 8 hours of engineering time. The total was just under $1,600 US, which at the time was around $2,000 CAN.

We also paid an engineer a fee and electricians, plus miscellaneous items such as shipping equipment, long distance, etc.

By the end of the project, we had spent close to $25,000 CAN, which was about $10,000 more than we set out to spend. In retrospect, however, this was a very small amount of money to accomplish what we did.

Relatively speaking, we put a high percentage of our funds into the design and equipment for the environmental control system. I would do exactly the same thing again. I can't overstress the value of the consultants we worked with. Also, we went for extremely good sensors and excellent controllers. Any system for controlling temperature and humidity is only as good as the sensor that is reading the T and RH in the environment — which comes down to a little hair in a little piece of equipment.

Findings

A. Recorded Fluctuations in Temperature and Humidity
The lowest humidity we have recorded is 17% for a few weeks in January or February each year. The highest humidity readings we have recorded are 44% for a few days in August one year. When we saw readings this high, we were able to bring the humidity below 40% within a day by adjusting the transfer fan and the controls.
We set out never to exceed 55% RH. We have never even come close to 55%. However, we set out to have a fluctuation of only 10% RH total. Our maximum yearly variation has been 27%, several years it has been about 20%. With humidification, I think that we could keep the RH variation within 15%. In other words, if we want to introduce moisture in the winter, we could keep the RH between 25 and 40% year round. But I still have questions about introducing humidity.

The temperature has varied between 66 – 72 degrees F. We set out never to exceed 70 degrees F. We have exceeded that occasionally by a few degrees.

Most of the year the humidity is between 25 and 35%. We have found that the humidity fluctuates during the day by a maximum of 5-7%. Often the humidity fluctuation between the beginning and the end of the day is only 1-2%. The exception is when we have a lot of people in the space — generally for tours for short periods of time. Then the humidity can rise 4-5% in 30 minutes or so. It generally also goes back down in the same period of time after people leave the vault. (We have no readings from later than about 10 p.m. or earlier than about 8 a.m.)

In summary, we have avoided extremes of temperature and high humidity. We have a very stable environment on a day to day basis, but there is seasonal fluctuation, which parallels what is happening in the environment out of doors. Avoiding sharp variations during the day was one goal, which has been met.

B. Problems with the system

Dehumidifiers are noisy and distracting when they are running continuously during the summer! Staff have shut off one of the dehumidifiers for several hours at a time, when doing work that requires quiet and concentration. This leaves us to rely on the air conditioner and the back-up dehumidifier in the vault. (We never turn off any equipment in the summer when it's really wet and hot–) This is not ideal and has once or twice resulted in someone leaving a dehumidifier off overnight.

Heat from the dehumidifier in the vault pushes up the temperature there — this is not good. To compensate for this, it is sometimes necessary to adjust the dehumidifier in the vault so that it is running at a lower level.

Sunlight from a window and hot air coming from the dehumidifier fall on the same wall as the sensor in the work room, so we believe that the sensor registers a higher temperature than the actual ambient temperature in the rest of the room–which often feels quite chilly when the controls register 70 degrees. Cooler is good for the contents of the archives, but not necessarily for human comfort. Nevertheless, this appears to be a flaw in the design.

The fact that our system relies on limiting the human use of the spaces that are being conditioned is a limitation. The system is not powerful enough to keep the humidity in the acceptable range when many people are in the space. Our workroom is about 14″x23″, which is enough space to accommodate 4 or 5 people working in it at any one time. The system seems able to handle that many people — provided they are not doing calisthenics! The vault generally has no one in it most of the day; during periods of time that we needed to do cataloguing or triage in the vault, one or two people have worked there five days a week for several months. This does not seem to have overly stressed the system.

We have no back-up power system. We have never been without power for more than a few hours and, during those times, the increase in humidity and increase or drop in temperature has been quite small. One two occasions when the dehumidifier was left off overnight due to human error, an increase in humidity overnight of 7 to 9% was noticed.

Even though our system has been repeatedly described here as "low tech," nevertheless the sensors and controllers seem to be very high tech for Halifax. We purchased them in the U.S., and our local consultants used consultants in the US to help spec the system. We had difficulty finding people in Halifax to install the system, and we find that ongoing adjustment of the system is not easy. This would be important to take into account if a system such as this were going into a truly remote area.

There can be problems with having a system, like ours, that can be manually adjusted by anyone with the inclination to fiddle with the controls. If someone gets a little chilly in the space or doesn't like the noise or just gets an idea, they can start changing things — which could be disastrous. The control system should be designed so that access to it is limited.

Already noted above is the problem of not having a monitoring system in place.

Conclusion

This economical system for control of temperature and humidity would seem to hold promise, especially for small institutions operating with limited funds. The simplicity of the system means that it can be maintained by staff with limited technical background.

I hesitate to draw dramatic conclusions about the success of this approach, because of the lack of consistent monitoring to establish the stability of the system. Nevertheless, it seems apparent that this is a promising approach to the low cost control of extremes of temperature and humidity, and that further investigation of this approach and application of these principles would prove extremely valuable.

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