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Airflow and Humidity Control in a Two-Room Cold Storage Box: A Design Flaw Uncovered

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In February 1994, following twelve years of intermittent but earnest campaigning, I obtained a modest budget with which to design, purchase and install a small cold storage box at our Washington, DC, headquarters.

The proposal approved by management was for a small cold storage vault designed for storage of primarily 35mm original color transparencies, our most plentiful archival format and medium. Ironically, I was able to obtain approval for this project not on the strength of my arguments for the extending the life of our culturally, artistically, and historically valuable originals, but because we had recently begun selling reproduction rights for some rather handsome fees, and management was suddenly impressed with the monetary value of these originals.

With the assistance of Jim Wallace of the Smithsonian Institution, Office of Printing and Photographic Services, and Steve Weintraub, Art Preservation Services, I had slogged my way through the science of heating, ventilation and air conditioning, and had come up with a general design and set of specifications for the box: a simple Bally box with a vestibule located in an open storage area below the first floor, the main room to be kept at 40° F. and 35% RH and the vestibule to be cooled with air blown out from the back room until it reached 60° F. Both the cooling and dehumidifying equipment would be backed up with identical systems.

I obtained estimates for the job from three major refrigeration companies, and settled on G & H Insulation, Inc., a company that had done a lot of work for Jim Wallace. I submitted their estimate of about $38,000 for construction and installation, in addition to which I asked for some $7,000 for wiring, plumbing, and furniture. The storage space inside the box is about 9′ by 8′, and 9.5′ tall, with a vestibule about 4′ by 8′, just big enough to handle the door swing and put up a couple of shelves. A storage capacity of around 400,000 35mm slides is estimated using a system of storage we have used for decades, which makes use of metal cabinets with 2.5″-deep drawers divided into ten two-foot rows. Each cabinet holds seventeen drawers and stands about five feet high.

(I want to stress very strongly at this point, before any readers jump to the conclusion that the design flaw alluded to in the title is going to lead me into a critical tirade against G & H Insulation, that this is not the case. We are very pleased with the job they did, and for a great number of reasons would and have recommended them to other interested institutions.)

Installation of the box went smoothly, with full support and participation of the National Geographic engineering staff, to whom I am deeply indebted for their help. Anticipating the eventual need for the NGS engineers to take over maintenance of the box, I asked that G & H call them instead of me to make all

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arrangements for installation, and so, while it demanded more of their time, it meant that our engineers were able to have a hand in the entire installation and were that much more familiar with the equipment and systems.

The box was installed and the two compressors and two dehumidifiers were fully tested by May 1994. However, I decided to put off transferring material into the box until November or December to give us a chance to observe it in operation through all the tough weather.

Only one major problem arose during the summer. This problem could have spelled disaster for any film that might have been stored inside had we not opted for this long engagement prior to the marriage.

The theory of refrigeration with dehumidification is that once the box is cooled and the air dried, very little more needs to be done to keep it that way as long as the doors are kept closed. However, as spring changed to summer and the moisture in the outside air increased, our system seemed to have a difficult time keeping the relative humidity near the set point of 35%. This was inexplicable, and resulted in our having to pipe water away from the dehumidifier because it was working so hard.

We became aware that we had a serious problem when we discovered water leaking from the back-up dehumidifier into the cold room, which first occurred soon after the furniture was delivered. This was especially perplexing in that this unit was not even operating, and it was difficult to understand how it was generating excess moisture. Even stranger, when we switched systems, the dehumidifier that had been leaking was running perfectly, and the other one—now turned off—was leaking. For weeks, G & H and our own engineers combed the systems trying to solve this problem.

After much tweaking and adjusting, including trying to re-synchronize the limits set in the engineers' Delta monitoring system (which was continually going to alarm) with the set points in the refrigeration system, G & H determined that the problem was not in the dehumidifiers, or any of the equipment, but was actually being caused by the vestibule. We were blowing air from the back room to the vestibule to cool it to 60° (which it needed frequently when the furniture was being loaded in, hence the sudden eruption of the problem), but we had neglected to provide a way to replenish the air in the back room. We were creating a low-pressure situation that was being relieved by sucking air through the only crevices available, the unused dehumidifier. This 74°+ outside air had a high summer humidity, and on meeting the cold equipment inside, was giving up its moisture content in the form of condensation, which was then running out of the unit and into the cold room.

We easily solved the problem by installing a small one-way vent or transfer grill between the rooms. This vent is covered by gravity dampers that blow open when the pressure in the vestibule is higher than the pressure in the cold room, and close when the pressure is equalized; thus, it is always open when the fan is blowing cold air from the back room into the vestibule. Although this introduces some outside air into the back room, the system handles it easily with only a momentary increase in temperature and humidity.

Clearly, this was a problem that should have been uncovered in the design phase, and we were all more than a little embarrassed that we hadn't caught it. But what kept it from being a disaster was (1) that we had delayed putting film in the box so that we could observe it over the summer, and (2) that the designers stuck with us until the problem was solved.

At this writing there have been no further problems. I have been conducting real-time delamination tests with adhesives and glass negatives, and so far have no detectable results. We have changed from one system to the other without a perceptible rise in temperature or humidity and we have started putting film in. The engineers have the box on a regular maintenance program, and check it twice a day.

Resources

Art Preservation Services	539 East 81st Street, New York, NY 10028	(212)988-3869
G & H Insulation	11424 Cronhill Drive, Suite A, Owings Mills MD 21117	(410)581-1641