

**Relative Humidity** 

compared to a typical museum exhibition environment. When conditions allow gelatin to go above its glass transition (Tg), rapid image degradation can occur.

The sealed cabinet method takes advantage of the natural thermodynamic

properties of hygroscopic materials such as gelatin and paper to keep the

climate inside the cabinets within the safe, allowable range as shown in the

figure above. For more information about this topic please read the paper

entitled: "The Allowable Temperature and Relative Humidity Range for the

Safe Use and Storage of Photographic Materials," Journal of the Society

of Archivists, Vol. 17, No. 1, 1996. It is available for free on our website:

## The Design and Operation of a Passive Humidity-Controlled Cold Storage Vault Using Conventional Freezer Technology and Moisture-Sealed Cabinets

Mark McCormick-Goodhart and Henry Wilhelm Wilhelm Imaging Research, Inc., Grinnell, Iowa/USA Presented at the IS&T Archiving Conference, San Antonio, Texas, April 22, 2004

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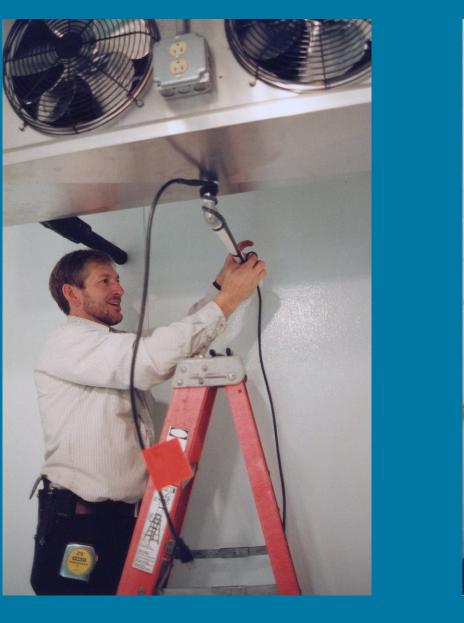
Begin Construction...

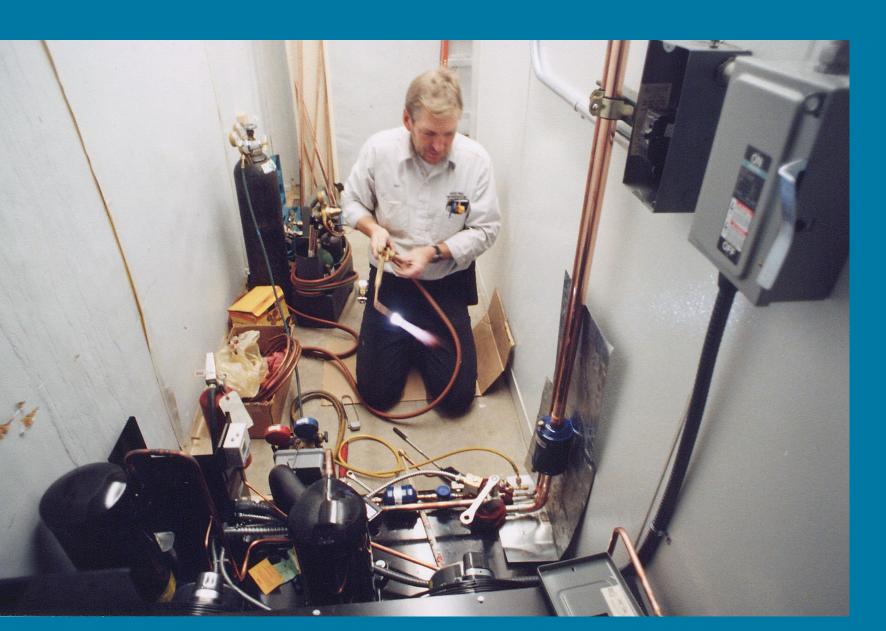








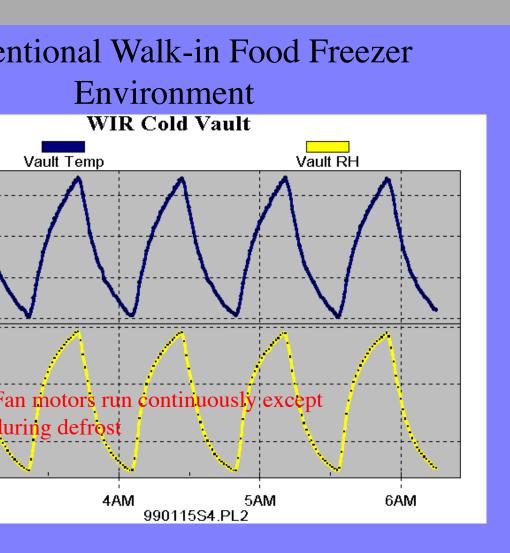


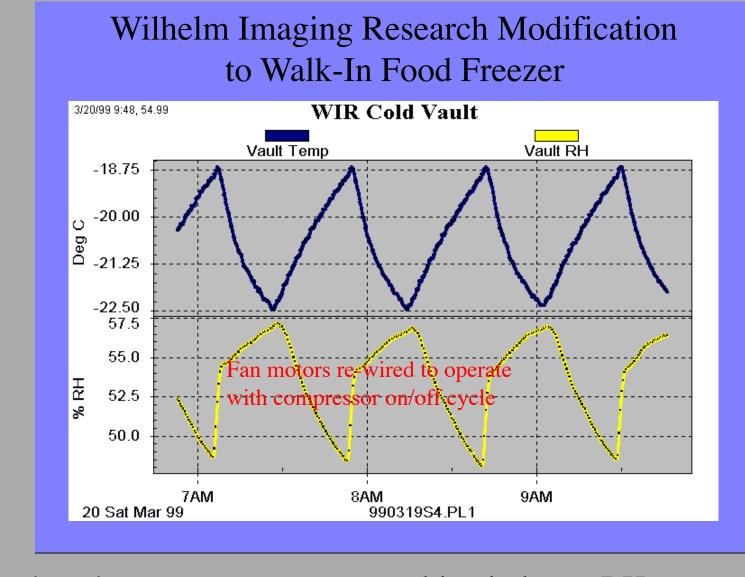






Construction...





A minor wiring change enabled the fans to run only when the compressor runs, resulting in lower RH.

Freezer modifications...







the heated slab was not necessary.



Walk-in freezers are readily available due to their wide-spread use in the food

industry. Modular construction allows quick assembly. Site preparation for our

project was minimal. We checked with the contractor to determine whether a

heated slab would be needed under the freezer to prevent frost heaving. Because

our vault was located in a fully heated building and away from the outer walls,





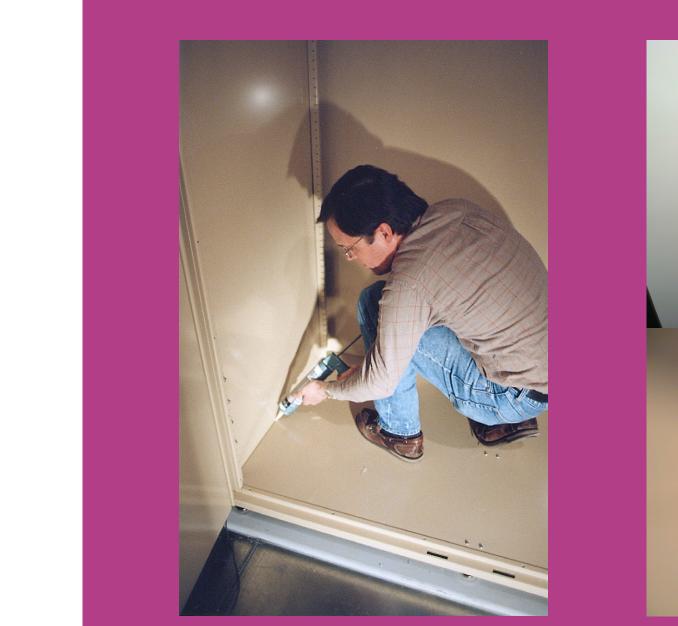
Time to Complete — 4 days



Cabinet Installation...

The dimensions of the vault were planned so that cabinets would fit through the door, and equally important, could be erected vertically once inside the vault. Note the 4 to 6 inch clearance left between the cabinets and the inside wall of the vault (see photo on the far right). This gap improved air circulation and cabinet temperature uniformity.

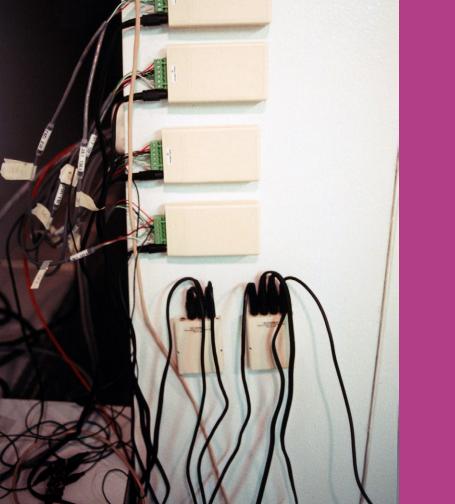
... Time to Complete — 1 day







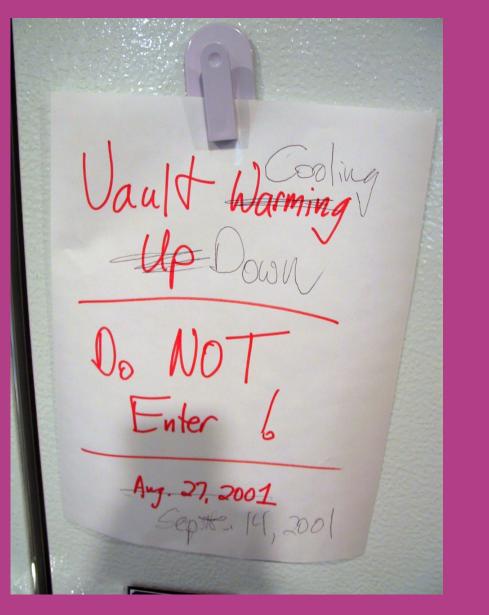
















Cabinet modifications, methods, and experiments...

Only minor changes were needed to use the cabinets manufactured by Viking Metal Cabinet Company. Moisture vapor transmission studies showed that the key holes were a significant leak! They were easily covered using metal foil tape or readily obtainable vinyl magnetic signage material. The other cabinets required extensive modifications including silicone caulking, replacement of door gaskets, and covering vent holes. We installed cobaltous chloride indicator plugs in each cabinet for simple and quick observation of cabinet interior relative humidity. We also installed electronic temperature and RH sensors in each cabinet with wiring routed to data loggers

located on the outer wall of the vault. This setup allowed real time precision monitoring of cabinet performance. Additionally, we lined the cabinets with conservation mat board to create a satisfactory moisture buffer for cabinets which contain only a small amount of collection material.

Bringing objects safely in and out of the vault was accomplished by thermally insulated transfer boxes. Shown above is one that was made from an ordinary picnic cooler. A radio transmitting temperature sensor (available at RadioShack® for less than \$40.00) is a simple way to determine when the box may be safely opened. We con-

ducted thermal staging experiments to prove the safety and efficacy of the method.

Lastly, we conducted a simulated power or equipment failure test to prove that the cabinets will protect the collection and will warm safely in the event of a vault failure. This test demonstrated that over time, small amounts of moisture accumulating in the panel seams will condense and cause some water droplets to fall from the ceiling. The cabinets easily protected the collection from this failure mode. The problem can likely be eliminated or greatly reduced by sealing the panel seams with metal foil tape on the outer surface of the walls.

Over four years of trouble-free operation, \$1.46/day energy costs!