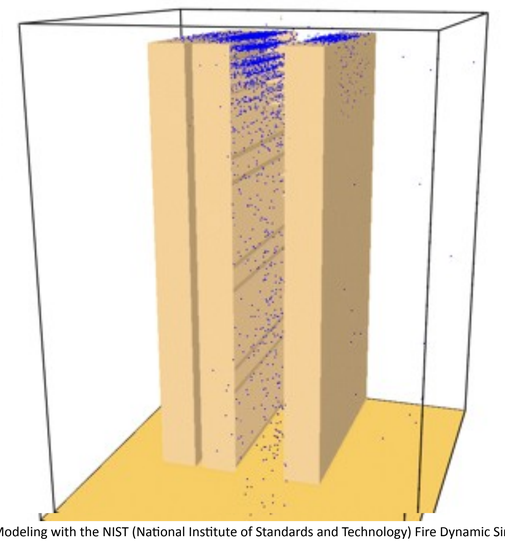
Planning for Disasters in High Bay Library Storage Facilities in the United States

The Problem

Disaster Planning…. It's an area familiar to all in cultural heritage preservation, but how should our plan differ when dealing with library and archive materials stored in high-density library storage? In this sort of facility, materials are stored compactly by size in cardboard trays on shelving up to 40 feet (12 meters) high (*see image at right*)? The University of Illinois at Urbana-Champaign (UIUC) quickly realized that our standard disaster plan would not function should a disaster strike. Beginning in 2009, the Preservation and Conservation staff at the UIUC Library began to write a new disaster plan to enable us to react to a disaster in just such a facility. But first we had a few questions…

- What should we expect?
- What types of events should we plan for?
- In the case of an event, how do we move up to several million books quickly and efficiently?
- Can we identify where special collections materials and other top priorities for retrieval and salvage are within the ranges?



Modeling with the NIST (National Institute of Standards and Technology) Fire Dynamic Simulator showed significant pooling of water at the upper range (top 5-7 feet) of the shelving array followed by a cascading effect along the remainder of the 40 foot tower with discharge of one 94 K-22 Early Suppression Fast Response (ESFR) Reliable sprinklers head as installed in the UIUC storage facility.

To better prepare ourselves and answer these questions, we set about to:

- gather experimental data
- gather statistical data to determine disaster probabilities and economic losses
- Recommend facility improvements to aid in recovery and reduce risk
- Create a new disaster plan specific to this type of facility that would consider the unique layout, retrieval and recovery needs.

Testing Sprinkler Head Deployment

Gathering Necessary Data involved partnering with the UIUC Department of Industrial and Enterprise Systems Engineering to develop a series of tests and figures. Although it was determined that the risk to such a facility was very low (new construction, ample fire suppression, limited staff entry and no public access, etc.), the potential economic loss with the discharge of even one sprinkler head was *VERY* high (thousands of wetted books). To better test the effects of a sprinkler head deployment, a live test was employed using discarded library and archival materials in trays used for shelving in the facility and a similar sprinkler head and water pressure. The test was run for a period of

Figures 1-4 (clockwise from top, left): Observable damage caused to the books and trays after a 30 minute sprinkler deployment. Figures 1 &2 show both the maceration of the book text blocks and the shearing of the labels from the front of the book trays. Figure 3 shows the loss of books from the failed special collection s tray that was located on the topmost shelf of the array. Figure 4 shows the effects of book swell upon the general collection trays. While this may appear to be a failure, the tray was able to be extract-

- **Average Dimensional Expansion for a Book: 17%**
- **Average Overall Weight Increase for a Book**
  - **With enclosure: 40%**
  - **Without enclosure: 85%**
- **Distribution of Damage**
  - **Front trays held an average of 16% more water than back trays**

RESULTS OF TEST ONE

- The shearing effects of the downward water motion can be seen in figures 1 & 2, where the text-blocks have been macerated (leaving, in some instances, paper pulp in place of books) and the tray barcode labels have been delaminated from the front face of the trays
- The label that was placed onto the front of the record storage box was lost and the water-soluble paper tape that held the box together was compromised during the test (see figure 3)
- Book swell was observed throughout the trays – but all trays maintained their core physical integrity (see figure 4)

Facility Improvements

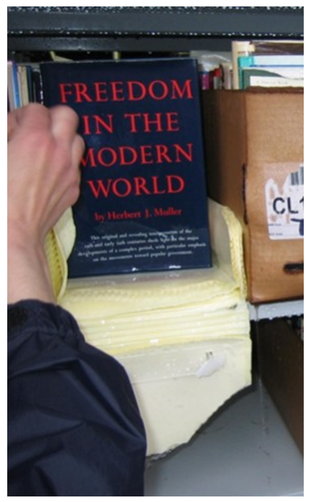
	L24	L25	L26	L27	L28	L29	L30	L31	L32	L33	L34	L35	L36	L37	L38	L39	L40	L41	L42	L43	L44	L45	L46
S19	TOP																						
S18	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"
S17	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
S16	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
S15	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
S14	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"
S13	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"
S12	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"
S11	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"
S10	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"
S9	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"
S8	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"	7"
S7	9"	9"	9"	9"	9"	9"	9"	9"	6T-21	9"	6T-44	5T-22	5T-52	9"	9"	6T-46	9"	9"	9"	9"	9"	9"	9"
S6	10"	1T-10	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"
S5	6T-47	9T-131	10"	2T-27	10"	10"	10"	10"	10"	10"	10"	2T-15	10"	10"	10"	3T-42	10"	10"	10"	10"	10"	10"	10"
S4	13T-182	4T-11	1T-11	5T-88	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	4T-188	6T-15	10"	10"	10"	10"	10"	10"	10"
S3	3T-24	2T-24	10"	11T-159	10T-110	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	4T-58
S2	9T-134	9"	9"	9"	9"	4T-14	13T-146	9T-88	9"	9"	9"	3T-34	1T-10	1T-12	9"	10T-57	6T-269	9"	12T-19	6T-252	9T-163	9"	9"
S1	2T-13	10"	10"	15T-282	10"	10"	10"	10"	10"	10"	10"	10"	2T-11	10"	4T-18	10"	10"	10"	10"	10"	10"	10"	10"

Locating Special Collections Materials

Although the first vault of the Library Storage Facility had was already filled to capacity, a second vault had just been opened and plans were being drafted for the construction of a third.

For Vault One, a modified Greedy algorithm was created which ran off the shelf locations of materials held in the vault and their material type or sending library. This identified special collections and other high-priority items dispersed throughout the vault space. Concentrations of high-priority collection materials were then mapped for each range of shelving to aid in fast identification and retrieval. (*left* where red = high concentration, yellow medium concentration, green low concentration and white no concentration).

For future vaults, Preservation staff recommended that future placement of special collections and other high-priority materials be limited to the bottom twelve feet (3.6 meters) of shelving (beginning at least 3 feet above the floor) to reduce risk of damage and allow for manual retrieval. This has been practiced in the filing of Vault Two and will continue in Vault Three upon the completion of construction.



Improvements in Storage Materials

After the sprinkler test, it was obvious that some of our chosen storage materials do not stand up to the high water saturation levels. Post-testing it was decided to cease the use of any buffered, lignin free storage containers as the wet strength of the board was far inferior to that of regular cardboard stock. A subsequent test using trays made of acrylic coated buffered, lignin free board stock resulted in similar tray failure.

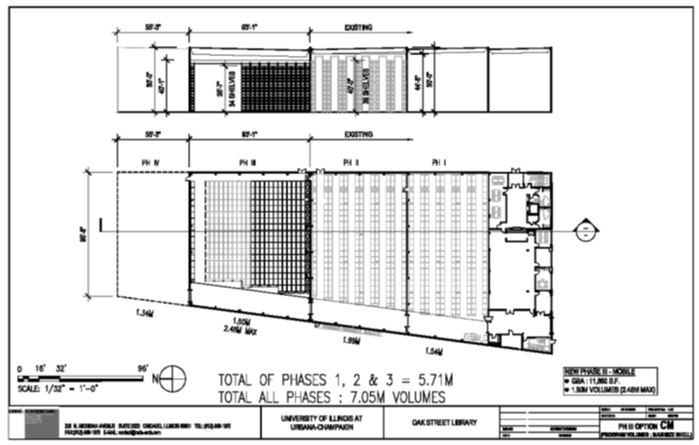
Additionally, archival boxes held together by gummed tape, rather than staples or glue, were no longer recommended for storage.

Changes In Disaster Planning

A Whole New Plan...

After all of our findings, the UIUC Preservation and Conservation staff set about to write a new disaster plan for our high-density storage facility incorporating what we had learned about the dispersion of water, integrity of the storage trays and access to high-priority items. The key to the disaster plan is understanding and interpreting the scale of the disaster. While a disaster of under 1,000 books is still possible, it is much less likely. Almost all disaster scenarios involve the assistance of a disaster recovery vendor and the large-scale cleaning, freezing or discard of tens of thousands, or possibly more, of library materials. Recovery efforts were developed keeping massive extraction efforts in mind, while also tracking the flow of materials and developing mechanisms to track the final disposition of trays, boxes, and pallets of materials so that short(er) term inventories can be developed post-disaster. Extraction has been proposed to take place through three teams: hand removal (up to 10 feet assisted by a ladder), scissor lift removal (up to 24 feet) and lift removal (up to 40 feet). The Library Administration, after consultation with staff also agreed that if materials are to be in a temporary location for less than one year (assuming no major structural damage to the building or shelves), then it is not necessary to provide access to materials during the interim – a decision which greatly simplified the necessary level of tracking of materials being pulled from the facility during recovery.

In the end, the UIUC Library hopes to never have to use our new disaster plan, but feel that after our research we are much better prepared should we be faced with such a disaster, whatever the scale.



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