White Paper Report

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Project Director: Janet Gertz (gertz@columbia.edu)

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WHITE PAPER

Sustaining the Rare and Special Collections of Burke Theological Library

Project Director, Janet Gertz
Columbia University Libraries

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[This White Paper is identical to the final report submitted for Project PF-50011-10.]

SUMMARY

Project Goals

In 2010 the Columbia University Libraries (CUL) received a one-year planning and evaluation grant from the Endowment to diagnose the causes of damaging temperature and humidity fluctuations in the rare book and special collections stacks of Burke Theological Library. The goal of the project was to develop realistic, achievable, customized solutions to bring conditions more closely in line with preservation recommendations for prolonging the useful life of unique and valuable books and manuscripts.[1] The project focused on Burke Library's Brown Tower, which houses ca. 200,700 rare items and over 4,500 linear feet of archives, one of the largest theological collections in the western hemisphere, rich in moisture-sensitive vellum and similar sensitive materials.

The preservation goal for Columbia in storing this valuable collections is to ensure its survival well into the future. While the stacks are protected against water by alarms that give alerts in case of leaks and against fire by a sprinkler system, they are not adequately protected against the long- and short-term effects of environmental conditions. Heat affects all organic materials, including paper, vellum, and leather; therefore, the lower the temperatures, the slower the rate of chemical reactions responsible for deterioration of the materials. A range of 60-65° F is nationally recommended for spaces where people are not normally present. This is the applicable target for Brown Tower, since staff are routinely in the stacks only briefly to retrieve and reshelve materials.

Relative humidity (RH) is an equally important factor, first because moisture amplifies the effects of temperature. Second, materials that are too dry desiccate and become brittle, split, or warp, while materials that are too damp can suffer mold growth. Keeping RH within a range of 30-50% is therefore recommended nationally. In the case of Brown Tower, however, the decision has been made to target a somewhat higher range: 40-55% RH. This decision is based on the presence of a relatively high proportion of vellum and wood in the rare book collection, two materials that suffer damage particularly when exposed to lower RH. This type of damage to early volumes is particularly unfortunate for the Burke collections, given that 63% of the incunables at Burke are in original bindings, a higher percent than in many American collections.

Library materials constantly absorb and release moisture to achieve equilibrium with the air around them. As this happens, they swell and shrink slightly, causing damage where two

[1] Although there is no officially adopted national standard for storage conditions, the technical report *Environmental Guidelines for the Storage of Paper Records*, by William Wilson, has served in an unofficial capacity (NISO Technical Report NISO-TR01-1995; Bethesda, MD: NISO Press, 1995). National Archives & Records Administration Directive 1571 sets a model for other repositories based on the *Guidelines* (NARA 1571 *Archival Storage Standards*, 2002).

different materials move at different rates, for instance paper attached to vellum covers. Even relatively small changes can adversely affect sensitive materials like vellum and wood. To minimize damage from such movement, RH in the stacks should be kept as steady as possible, while allowing for gradual seasonal change. Extremes and frequent, rapid fluctuations of temperature are harmful; however, reasonable temperature changes make little difference to the long-term survival of library objects and stand in clear contrast to the harmful effects of even moderate RH shifts. Stabilizing RH is thus more important than stabilizing temperature. Deliberate changes in temperature can be used to keep RH levels steady, as long as infiltration of external air can be limited and the HVAC system is designed and managed properly. The goal of this project was to find out if there are methods to achieve such a situation for Brown Tower.

Project Outcome

The outcome of this project has been positive. The expert consultants' report on the Tower analyzes its construction and operation and details the causes of temperature and humidity deviations from the set points, as well as conditions that lead to mold growth. The report presents a preliminary design for a new air-handling unit and rough cost estimates sufficient to serve as the basis for future planning and implementation to achieve reasonable improvements. We recognize that the Library can never sustain tight controls holding temperature and humidity to a fixed point year-round without unachievable fundamental construction work tantamount to re-building. Rather, the report will help us find implementable measures that are mindful of energy consumption and that will enable us to keep temperature and humidity within a range that allows for seasonal adjustments without reaching potentially dangerous levels.

We remain conscious of the importance of cost containment and reduction of energy usage, and we look to find an appropriate balance between action to prolong the useful life of the collections and economic and ecological concerns.

The report has also identified a number of interim changes to equipment and behaviors that will mitigate conditions somewhat while we undertake the major effort of planning for a new system.

PROJECT DETAILS

Burke Library

Burke Library was established in 1838 to serve Union Theological Seminary (UTS). Founded in 1836, UTS broke its initial ties with the Presbyterian Church in 1892; in 1910 it became an affiliate of Columbia University. The Seminary administered Burke directly until 2004, when CUL assumed management of the staff and ownership of the collections. UTS continues to own and manage the buildings. This project was conducted as a cooperative effort involving staff from the CUL Preservation & Digital Conversion Division, which has responsibility for conservation of the collections; Burke Library, which has responsibility for managing the collections and serving the library's users; and UTS Facilities, which has responsibility for maintaining the buildings that house the collections. All three groups share concern for the longevity of the collections and are committed to improving the environmental conditions.

Project Activities

Upon announcement of the award, a project team with representatives of the three participating groups was established.

CUL central services
- Janet Gertz, project manager
  Director, Preservation & Digital Conversion Division, CUL
- Alexis Hagadorn
  Head of Conservation, CUL
- Vasare Rastonis
  Rare Books Conservator, CUL
- Aline Locascio
  Facilities Coordinator, CUL

Burke Library
- John Weaver
  Director, Burke Library, CUL
- Joseph Lemelin
  Collection Services Assistant, Burke Library, CUL
- Matthew Baker
  Collection Services Librarian, Burke Library, CUL

UTS
- Michael Maloney
  Deputy Vice President of Buildings and Grounds, UTS
- Xavier Orengo
  Assistant Director of Facilities, UTS

CUL engaged Garrison & Lull Inc., respected experts on library and archival facilities. Details about the company are available at http://garrisonlull.com. The company's role was to analyze the current situation – construction of the building, maintenance practices, and equipment for heating, ventilating, air-conditioning (HVAC), and humidity control – and to make recommendations for improvements specific to the nature of the collections' materials. Garrison & Lull collaborated with Altieri Sebor Wieber Engineers (ASW) on design of the proposed new system. Information about ASW is available at http://www.altieriseborwieber.com. In preparation for the analysis of the existing situation, CUL provided Garrison & Lull with datalogger reports for past years and other relevant information.

William Lull and Andrew Sebor made site visits to Burke Library on January 25-26 and March 11, 2011, to examine Brown Tower and the UTS air-handling equipment, and to meet with staff from Burke Library, CUL, and UTS Facilities. Lull and Sebor returned to campus on April 27 to present their draft report and discuss its recommendations with the project team. The official report was submitted subsequently after final edits based on the discussions.

Current Brown Tower Conditions

Burke Library's archives and special collections are located in Brown Tower, which stands at the southeast corner of the two-block-long building that houses UTS at the intersection of Broadway and 120th Street. The main part of the Library (public stacks, reading rooms, and offices) is located just to the north of Brown Tower on the Broadway side of the building and is connected to it by an entry rotunda.

Photo courtesy of William Austin, 2010.

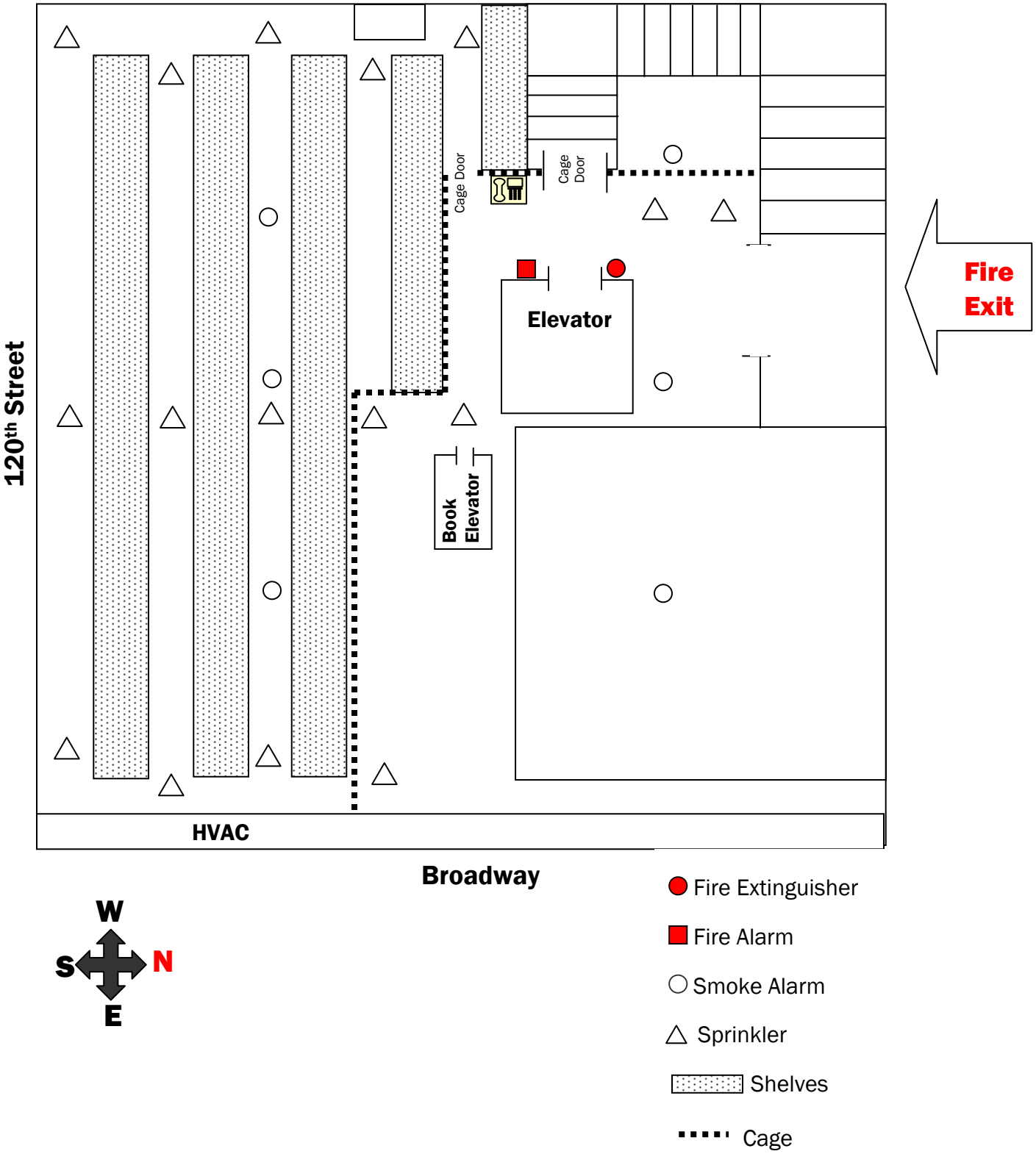
Constructed in 1910, Brown Tower has exterior walls that consist largely of windows. Rare books and special collections are stored on levels 14 through 20 (the floors whose windows appear yellow in the picture). Level 20 is the attic located immediately below the roof. Levels 4 and 5 house the Archives, while the intervening floors house the entry rotunda and UTS offices that are not part of the Library.

Heating and cooling for levels 4 and 5 are provided from the same air-handling unit that serves the general stacks and offices of Burke Library. Levels 14-20 are served by a dedicated air-handling unit located on level 14, within the stacks. Because the central UTS boilers do not provide steam during the warmer months or chilled water during the colder months, it is not possible to achieve dehumidification through chilling the air to cause moister to condense out and then reheating it. Stand-alone, manually-operated dehumidifiers are located on each level, with hoses leading to an otherwise unused sink for drainage and bringing with them definite risk of leaks. The air-handling unit is represented on the floor plan of level 14 (shown on the following page) by the large square located below – i.e. to the east of – the elevator.

In 1994 an environmental report for all of Burke Library was prepared by Garrison & Lull. The sections devoted to Brown Tower identified the major problems as:

- relative humidity ranging from 20% in winter to 70% in summer due to lack of functioning controls;
- condensation and mold growth stemming from the design of the HVAC system;
- water infiltration due to unsealed windows and cracks and leaks in the building fabric.

Brown Tower Deck 14



A subsequent grant from the Lilly Endowment awarded to UTS at the beginning of the last decade, before Burke became part of CUL, enabled the Library to undertake important first-line preventive activities throughout the entire library (general stacks, offices and reading rooms, several storage areas in other parts of UTS, as well as Brown Tower). Funds were used to stabilize the general environment by upgrading temperature and humidity controls and adding air conditioning; repairing the physical plant to minimize the risk of leaks and other damage caused by natural events; installing sprinklers and smoke detectors; and installing a new security system, including security cameras and alarms, to prevent human depredation. The Tower windows were re-sealed to prevent entry of water or polluted outside air.

While these upgrades improved environmental conditions in Brown Tower to a degree, the main impact of the Lilly grant was on Burke Library as a whole. That grant was not focused on special collections storage, especially for collections rich in moisture-sensitive vellum, leather, and wooden boards.

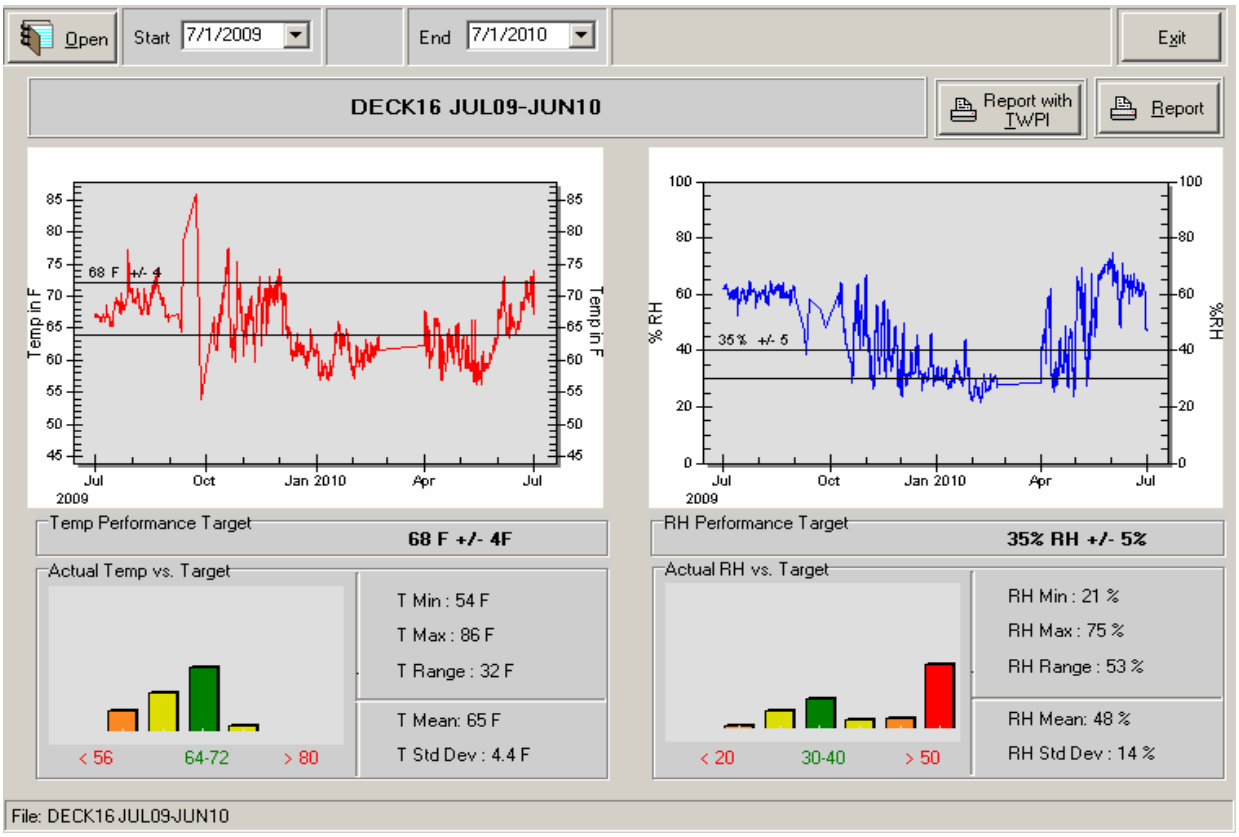
Since the time of the Lilly Endowment renovation, all staff from Burke Library and the UTS Facilities management team who were involved in that effort have left, as people retired or moved to new positions elsewhere. As a result, no one participating in the current project has first-hand knowledge of the renovation, and unfortunately documentation was scattered and incomplete. Lack of engineering drawings and specifications on the Brown Tower air-handling system make operating the system particularly difficult, since the manufacturer has also changed hands in the interim.

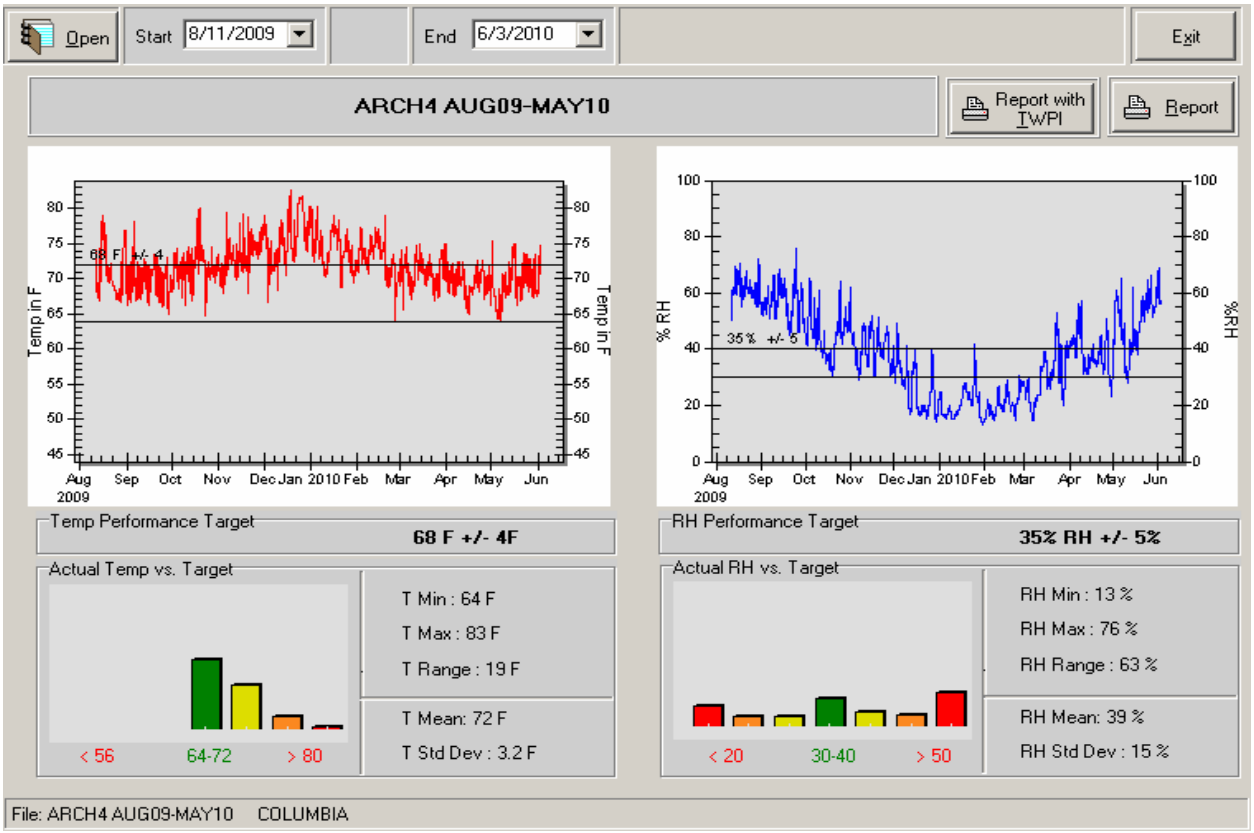
In addition to inadequate performance of the HVAC system, another major concern is the location of pipes and ducts in close proximity to valuable collections in cramped spaces, leading to mold outbreaks when condensation forms due to temperature differences between the air in the duct and the surrounding space. Books have also been damaged by condensation running down the elevator shaft, again due to temperature differences between the storage area and the top of the shaft, which is on the roof.

Staff of the CUL Conservation Lab monitor temperature and relative humidity on levels 14, 16, 17, 19, and 20, and in the Archives Rooms. The charts for levels 4 and 16 on the following page provide examples of the extreme conditions all of the spaces suffer.

Existing HVAC Equipment

Brown Tower is served by piping and ducted air systems shared with the rest of the UTS buildings; chilled water and low-pressure steam are provided to the campus from a central boiler room. The boilers for heating are turned off when outside air rises above 50º, after which a single boiler provides hot water to bathrooms and kitchens. Similarly, the chillers are turned off when outside air temperatures are below 70º. This situation is problematic for dehumidification, which is achieved by chilling air to the point where sufficient water condenses out, then reheating the air to the desired room temperature. Since the chillers and boilers do not normally operate at the same time, the UTS plant cannot support dehumidification. The unit located in Brown Tower therefore cannot meet our RH requirements, since it could only provide dehumidification through a re-heat process dependant on a steady supply of both chilled and hot water from the central UTS plant. It


Open
Start 7/1/2009
End 7/1/2010
Exit
DECK16 JUL09-JUN10
Report with TWPI
Report
Temp in F
68 F +/- 4
Jul 2009
Oct
Jan 2010
Apr
Jul
% RH
35% +/- 5
%RH
Temp Performance Target
68 F +/- 4F
Actual Temp vs. Target
T Min : 54 F
T Max : 86 F
T Range : 32 F
T Mean: 65 F
T Std Dev : 4.4 F
< 56
64-72
> 80
RH Performance Target
35% RH +/- 5%
Actual RH vs. Target
RH Min : 21 %
RH Max : 75 %
RH Range : 53 %
RH Mean: 48 %
RH Std Dev : 14 %
< 20
30-40
> 50
File: DECK16 JUL09-JUN10


Open
Start 8/11/2009
End 6/3/2010
Exit
ARCH4 AUG09-MAY10
Report with TWPI
Report
Temp in F
68 F +/- 4
Aug 2009
Sep
Oct
Nov
Dec
Jan 2010
Feb
Mar
Apr
May
Jun
% RH
35% +/- 5
%RH
Temp Performance Target
68 F +/- 4F
Actual Temp vs. Target
T Min : 64 F
T Max : 83 F
T Range : 19 F
T Mean: 72 F
T Std Dev : 3.2 F
< 56
64-72
> 80
RH Performance Target
35% RH +/- 5%
Actual RH vs. Target
RH Min : 13 %
RH Max : 76 %
RH Range : 63 %
RH Mean: 39 %
RH Std Dev : 15 %
< 20
30-40
> 50
File: ARCH4 AUG09-MAY10 COLUMBIA

is not cost effective for UTS to maintain boilers and chillers year round, since there are no other areas on the campus that have the same urgent need for closely controlled RH.

The spaces included in this study fall into two HVAC zones.

- The Archives rooms on levels 4-5 are served as a small zone of the variable-air-volume system that serves the rest of Burke Library aside from Tower levels 14-20. As described above, this system has no re-heat capacity, and dehumidification of the Archives space is handled through stand-alone room units. Due to malfunctions in the VAV boxes, the two rooms receive high temperature air constantly, and run window air-conditioning units supplemented by fans to bring temperatures down to the mid 70^{o}s.

- Tower levels 14-20 are served by the dedicated air-handler located on deck 14. This is a constant-volume terminal reheat system, with a parallel-flow cooling coil and manually-closed outside air damper. Zone reheat coils and humidifiers are located on each deck level. The humidifiers are limited in capacity because they are located near duct turns. Limited dehumidification is provided by stand-alone units on each level. Free-standing fans have also been installed on each level to improve air circulation. The air-handler apparently brings in increased amounts of outside air to assist in cooling when outdoor temperatures are lower than indoor, and this adds significant amounts of air that are not controlled for humidity, leading to frequent and sizable swings in RH. Clearly, all of these features take together mean that it is impossible to achieve uniform conditions across the stacks.

Major Areas of Concern

The report identifies three main areas of concern.

- Fluctuation of RH between very dry winters when vellum and other materials suffer mechanical damage, and humid summers when mold outbreaks can occur. This is the highest concern.
- Temperatures that are frequently above the recommended maximum for closed stack areas, especially in the Archives rooms on levels 4-5.
- Soot and other particulate pollution infiltrating from outdoors.

In addition to the inadequate HVAC equipment described above, several other factors contribute to these conditions.

- A roof vent is kept open constantly to allow a large coaxial cable to run up to the roof. This enables entry of pollutants as well as air that has not been controlled for temperature and humidity.
- The type of filter used with the air-handler is inadequate.
- In order to keep the roof-level elevator equipment room warm, the access door from level 20 is left open, leading to chronic condensation that results in mold when RH is high.
- A restroom located on level 6 outside of the Library's space periodically suffers plumbing problems that result in leaks into the Archives spaces.

Recommended Long-term Solution

The conditions desired for Brown Tower are:

- Temperature between 60-65° F, preferably as close to 60° as equipment design and economical operations allow.
- Humidity between 40-55% RH, with minimal change day-to-day while allowing for gradual seasonal adjustment.

We recognize that the Library can never sustain tight controls holding temperature and humidity to a fixed point year-round without unachievable fundamental construction work tantamount to re-building. Rather, we asked Garrison & Lull to find implementable measures that are mindful of energy consumption while enabling us to keep temperature and humidity within a range that allows for seasonal adjustments without reaching potentially dangerous levels.

The key features of an appropriate HVAC system are:

- Constant volume ducted air distribution with forced air heating.
- Cooling.
- Humidification, usually with clean steam.
- Dehumidification, usually through reheat capacity.
- Particulate and gaseous contaminate control.

Based on their examination of the site and discussions with UTS Facilities, Lull and Sebor recommend a single new air-handling unit to provide treated air to both the Archives rooms and Tower levels 14-20. A convenient shaft through which ducts could carry air to all of the relevant spaces is available in the form of a defunct book lift that runs from level 4 to level 20 (shown on the level 14 floor plan as a small rectangle below and to the left of the elevator).

The new unit would be connected to and make use of the central UTS steam and chilled water system whenever they are available, in order to minimize energy costs, but would include new capacities appropriate for special collections. Features of the recommended new system are:

- Heating running off of the central steam system.
- Cooling running off of the central chilled water system when available. When the chillers are shut off or not cold enough, then a water-to-water heat pump will add chilled water. This pump only operates when chilled water is inadequate or not available from the campus.
- Humidification provided by a single electrode humidifier incorporated in the air-handling unit to permit year-round humidification even when the central steam system is shut down. This eliminates the current level-by-level humidifiers and simplifies maintenance.
- Dehumidification provided by a passive, two-pass desiccant wheel. Central chilled water will be used when it is available, otherwise the heat pump will operate. Heat from the pump will go into a hot water loop to provide reheat capacity at times when the central steam is turned off. No new energy is required for this re-heat because it uses the heat generated in the process of chilling the water.
- Filtration of both outside air and recirculated air before temperature/humidity treatment

through a MERV7 prefilter and a MERV14 final filter for particulates on either side of a vertical tube media filter for gaseous pollutants.

Recommended Interim Actions

While the existing Brown Tower air-handling unit is not capable of producing the recommended conditions, it can do better than it has in past. The new UTS Facilities managers have been working hard to improve its operations. In addition, they immediately began following up on several specific actions identified by the project report that can be taken in the short term to ameliorate the Tower and Archives situation.

- Brown Tower
  - Close the outside air dampers to reduce extremes of temperature and humidity. Achieving this will require further work on the air-handler controls.
  - Close the level 20 roof penetrations for the same reason. This will require patching around cables and other equipment that must run out onto the roof.
  - Renovate the equipment space above the book elevator to prevent condensation and mold. This is likely to require insulating the space.
- Archives storage rooms on levels 4-5
  - Add an isolation damper to the air ducts on each level of Archives to eliminate unneeded heat. This is in the planning stage.
  - Remove unused/unneeded equipment to reduce fire hazards. Burke staff are planning for this.
  - Reduce the risk of leaks from the restroom on level 6. Since the restroom cannot be closed, installing a water monitor is under consideration.
- General
  - Improve filtration to reduce the incidence of soot and dirt through use of better filters. This has already been accomplished.
  - Expand use of the existing HEPA vacuum cleaners to control soot and dirt.
  - Reduce the risk of leaks by inspecting all water pipes, gutters, and drains regularly.

Location of the New Air-Handling Unit

There are two options for placement of the new unit, and the choice will affect the cost not only of construction and installation, but also ongoing maintenance in future.

- Place the new air-handling unit on level 14 where the old unit now stands.
  - Maintains the status quo of space use, although the footprint of the new unit is larger, and some stack space would be lost.
  - Would require a custom-built, more expensive unit in order to fit the tight, oddly-shaped space.
  - Maintenance would be awkward due to the tight fit.
  - Machinery in the stacks is always a fire and leak hazard.

- Build the new air-handling unit in a room on level 6 currently used by Burke Library for storage and staff activities.
  - Less expensive because equipment will be easier to install and there is no need for custom construction.
  - Easy access for maintenance.
  - All of level 14 would be restored to shelving.
  - Safer for the collections.
  - Loss of the level 6 room's current functions.
  - Noise and vibration from the unit's operation could disturb UTS faculty with offices on levels 5 and 6.

Next Steps

Implementing the recommendations from Garrison & Lull will not be a minor effort. In addition to fees for hiring architects and engineers to produce detailed drawings and specifications, a parallel set of costs must be calculated for moving the collections out of level 14, temporarily storing them elsewhere during the demolition and construction work, and then reshelving them. The estimated cost of demolishing the old air-handler, purchasing the components and constructing the new one, and then testing, balancing, and commissioning amounts to $1,015,000. When all aspects of the effort are accounted for, including collections relocation, it is likely that the new system could cost $1,500,000 or more. Design of a fund-raising campaign will obviously be an important part of planning for the new system.

The timing of this project to analyze Brown Tower was particularly opportune because UTS is now entering into a year of strategic planning that includes thorough consideration of the physical plant and use of all of the campus buildings. It is within this context that the administrations of UTS and CUL must determine whether to implement the new HVAC system, which options to choose for location and other variables, and how all of this will fit into a larger plan for possible renovations and repurposing of spaces throughout the campus. The unusual arrangement whereby ownership of the collections that will benefit from the HVAC improvements is separate from ownership of the building adds a level of complexity to all aspects of the planning and implementation. This project has already benefited us by promoting closer ties between the CUL Preservation and Digital Conversion staff and the UTS Facilities staff. We hope that this signals an ongoing stronger relationship among all of us responsible for the future of the Burke collections and their Brown Tower home.