

White Paper
for the
National Endowment for the Humanities

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**Improving Energy Efficiency in Collection Storage in
Spencer Research Library, University of Kansas**

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Project Summary

The National Endowment for the Humanities (NEH) awarded the University of Kansas (KU) Libraries a Sustaining Cultural Heritage Collections Implementation Grant to complete the second phase of a multi-phased approach to update the heating, ventilation, and air conditioning system (HVAC) in the [Kenneth Spencer Research Library](#), which houses the University's archival and special collections. The current award allowed KU Libraries to implement some of the energy-saving recommendations proposed by the Image Permanence Institute, previously hired by KU Libraries with funds from a NEH Sustaining Cultural Heritage Collections Planning Grant.

The focus of the current Implementation Grant was to replace pneumatically controlled reheats in collection areas of the building (approximately two-thirds of the building's area) with modern electric reheats, variable air volume (VAV) dampers, and new direct digital controls (DDC) as a first step in eventually replacing the entire air handling system that dates to 1968. While the AHU in Spencer Library provides cooled, filtered, and some degree of humidity-controlled air to the building, all heating and dehumidification comes from the electric reheats installed in ducts throughout the building.

Testing and balancing of the system was completed before installation in order to garner a more complete picture of airflow throughout the building, as well as detailed information about the functionality of each heater. Collected data informed the installation of thirty-five heaters in collection storage areas, which took place after some delays due to the pandemic. After installation, a second testing and balancing operation was conducted to test the efficacy of the new heaters. Environmental monitoring for temperature and relative humidity was conducted throughout the granting period and continues. The ultimate goal of the long-term project was to better preserve our collections while also finding ways to save energy.

Project Origin and Goals

State-of-the-art in 1968, the Spencer Research Library building and its mechanical systems are aging. Spencer Library's HVAC system is original to the building, with the exception of minor repairs and adjustments over the years. The single-zone HVAC distribution system does not provide the option of separate control of temperature and relative humidity in collection storage areas. Originally designed with set points at 60-65°F and a 50% relative humidity (RH), the system and the facility have degraded to the point that temperature and relative humidity are harder to control. Average temperatures have

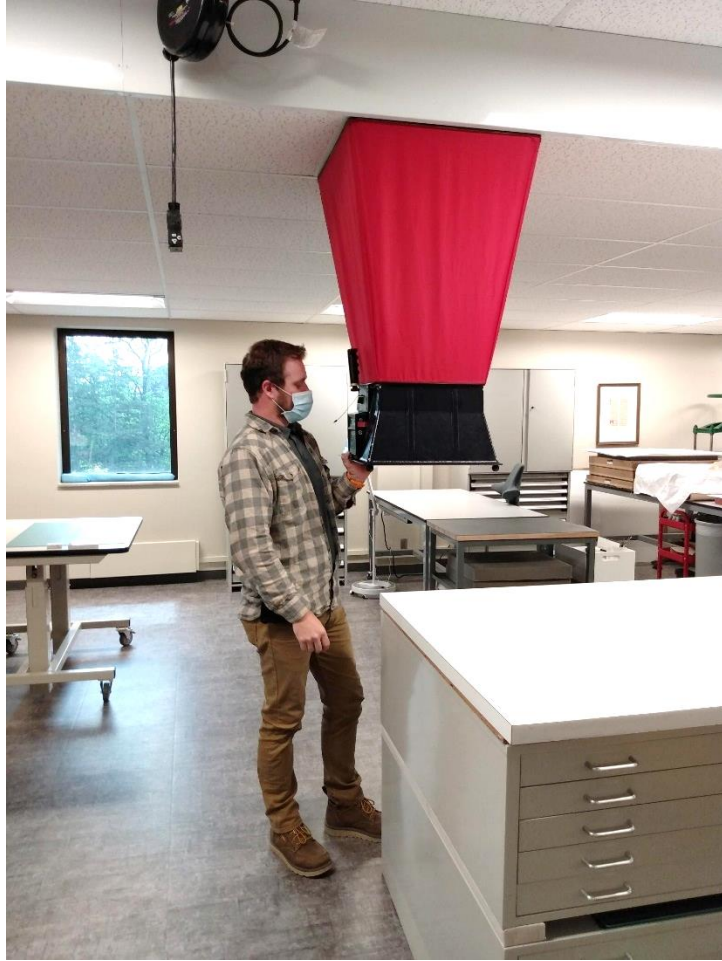
inched up over the years by at least 5 degrees F and wide humidity variances exist within the different floors of the building.

The major goals of the project were:

- 1) Test and balance the HVAC system, evaluate the air and water flow to equipment, and check all ceiling diffusers; test and document the total air supply for the air handling unit and its distribution system; and test the temperature controls for the automatic control dampers, the reheats, and airflow totals.
- 2) Replace select pneumatic reheats with electric ones in collection areas, upgrading the electrical panels with three-phase circuit breakers to accommodate the new, more energy-efficient reheat devices.
- 3) Conduct a final testing and balancing to ensure that the new reheats are working properly.
- 4) Monitor the temperature and relative humidity over various seasons to ensure that upgrades are successful.

Project Activities, Team & Participants

Doyle Field Services of Leawood, Kansas, was contracted to test and balance the building in spring 2021. During that process, technicians found that some duct heaters, baseboard heaters, and thermostats in the building were not functioning properly. In addition, they determined that no pneumatically-produced air was circulating in the stacks on the fourth floor, thanks to a malfunctioning supply fan. KU Facilities replaced the actuators on the outside air dampers on the air handling unit to fix this problem. Doyle Field Services also discovered that fire dampers were closed on some supply ducts on the third floor, which were opened by Facilities. These small fixes along the way improved airflow throughout the building; Doyle Field Services reported up to a 40% increase in airflow on the fourth floor of the building and up to a 100% increase in some parts of the third floor.



Doyle Field Services technician testing building airflow with a flow hood.



Doyle Field Service staff checking airflow in Spencer Library stacks.

Doyle Field Services provided a final report, highlighting commissioning issues and benefits. Technicians found that a number of electric reheats were not functioning (not all of which were in collections area, which was the focus of this grant). As noted earlier, the report also indicated issues with the airflow, in particular on the top floors of the building. KU Facilities staff were able to adjust building pressure before Doyle Field Services finished its work; they also addressed a few easy fixes brought up by the report. Once the report was received, Doyle Field Services met with KU Libraries and Facilities staff to discuss next steps and determine what might be achievable under this grant.

A personnel change in the KU Facilities, Planning, and Development Department overseeing operations (from George Werth to Jacob Lee) and global shipping delays led us to petition NEH for a twelve-month extension, which was approved on 10/12/2021. We met with NEH in spring 2022 to discuss a small change of request, reflecting rising equipment costs and supply chain delays. In further analysis of the heaters, we learned that some of the reheat locations were difficult to access and others

would require electrical modifications. NEH approved the change of including these necessary electrical upgrades into the scope of the project on May 4, 2022.

Over summer 2022, Whitney Baker (Head of Conservation Services, KU Libraries), Miller (Associate Dean, KU Libraries), and Lee (University Engineer, KU Facilities, Planning, and Development) met multiple times to walk through the building and gather data for Lee to write the bid proposal, with a target of 21 heater replacements. Lee held a pre-bid meeting for potential contractors on September 2, 2022 to determine the scope of the project and walk throughout the building with bidders. Bids were due September 16, 2022. We had previously discussed also replacing the outside air damper, but with rising pandemic supply costs and shipping delays, we decided to focus on our original plan of only upgrading the reheats in the collections areas to improve air circulation and environmental control in the stacks areas of Spencer Research Library.

U.S. Engineering Service was selected as the successful (low-bid) contractor for installation of the reheat boxes. Because the bid for parts and installation of 21 heaters was lower than expected, we were able to ask for an addition of 14 heaters to the project scope, for a total of 35 heaters. These additional heaters were selected based on data gathered by Doyle Field Services and in locations easiest to access. This good news allowed us to more closely meet the original grant goals of replacing all 44 heaters in collections area.

Before the installation occurred, staff from Conservation and Public Services met with the contractor to walk through the building and identify the locations of the heaters. Some collections were moved and stacks were draped with plastic before installation occurred to minimize collections risk during installation. Sometimes getting into the ceiling and removing equipment can result in emergent dust, so we wanted to preemptively protect the collections. We appreciated the chance to get to know the contractors, as personal connections always make projects run more smoothly. After preparation, heaters were replaced on all four and a half floors of collections areas, with all but nine original heaters replaced in collections areas in the final analysis.



Collections in the stacks covered with plastic, in preparation for new heater installation in the ductwork.



With collections relocated, stacks were draped and heater locations identified with signage.

Shipping delays moved installation right up against the end of the grant period, with heater installations in February and March 2023. The contractors first removed ceiling tiles under the heating units to be upgraded in order to have the best clearance to de-install the old heaters and install the new.



1968-era heating unit in the ceiling of a collections storage area.



Old heater removed; new one still to be installed.

U.S. Engineering partnered with electricians to hook up the new heaters and update circuitry where necessary.



Contractor installing a new heating unit in the ambulatory area of the second floor North Gallery stacks.



New heater installed in ductwork.

Project Outcomes

The project served as a real-world learning opportunity for graduate students in KU's Museum Studies program. While this grant project did not have a particular outreach component, the project was discussed in co-PI Baker's fall 2021 graduate class in Museum Studies, *Conservation Principles and Practice*, during discussions on control of temperature and relative humidity in collections spaces. It was also discussed with two KU Libraries Conservation Services students (one undergraduate, one graduate) who collect temperature and relative humidity data from loggers across the library system. They regularly analyze the graphs with the co-PI Baker (Head of Conservation Services).

In addition we featured the project in a post on the Kenneth Spencer Research Library's blog on February 21, 2023 titled, "[Improving Energy Efficiency in Collection Storage in Spencer Research Library.](#)" Now that the project has concluded, we hope to publicize it further in conjunction with the Libraries' Office of Communication and Advancement.

Project Evaluation and Impact

Unfortunately, with the various delays we ran out of time for Doyle Field Services to perform the final testing and balancing within the grant timeline, as previously proposed. However, we decided to use KU Libraries funds to pay for this testing, to ensure that the new heaters were functioning properly. Doyle Field Services tested each electric reheat coil's cooling and heating airflow between a range of 55°F to 85°F, and found that no airflow adjustments were required, indicating that all of the new reheats were functioning properly. The report's author noted that "no issues were found in the performance of the electric reheat coils as they operated as expected" and that "the ambient condition of the spaces were [sic] immediately noticeable compared to our previous testing... The improvements should provide a better preservation environment for the collections and staffers working in the spaces."¹

Throughout the project Conservation staff monitored temperature and relative humidity to catch any possible anomalies quickly. During the course of the project temperature and relative humidity in the collection spaces stayed within acceptable ranges. We had hoped to have almost a year of the grant timeline after installation for environmental monitoring and assessment, but since the heater installation was moved to the very end of the grant period, we have not yet finished our analysis

¹ Doyle Field Services. 2023 (June 13). *Executive Summary/Report Remarks*, 1.

of potential energy savings. We will continue to work with KU Facilities, Planning, and Development to analyze the data.

Project Continuation and Long-Term Impact

Thanks to the NEH Implementation Grant, Phase 2 of our project is complete. As noted above, we will continue to monitor temperature and relative humidity in collection areas to gather longer-term data over various seasons on the effects of having fully functioning heaters in collection spaces. This coming winter we will once again experiment with overnight setbacks to lower our environmental footprint.

Looking further afield, we may consider the following building upgrades to the building, as Phase 3, if time and resources allow:

Identify water issues in the tunnels

Consultant Findings (from the Planning Grant): The two tunnels under Spencer Library that supply conditioned air to the building are not properly sealed, allowing for water intrusion at certain times of the year.

Actions: KU Libraries will work with Facilities staff to determine the causes related to this issue, as they have time and resources to address it.

Replace mechanical system

Consultant Findings: The current air handling unit is 55 years old and struggles to maintain an appropriate preservation environment for the collection, especially in the summer.

Actions: This recommendation is the ultimate goal, Phase 2 of which was covered in the Implementation Grant. At this time, replacing the back-end of the system, the AHU, is cost-prohibitive, but now that we have replaced much of the front-end (digital controls and reheats), we will achieve a faster turnaround time when the AHU is replaced, placing the collections at lower risk when that happens. In the meantime, the upgraded heaters will provide greater control of individual spaces, using the existing AHU.

Install building management system (BMS)

Consultant Findings: Facilities will have more control over the Spencer system when a BMS is installed.

Actions: We have taken the first steps toward this recommendation by replacing the pneumatic controls

with digital, replacing original reheats, and undertaking air balancing at the end of this project. A final BMS would be an end-product of Phase 3, when the air handling unit is replaced.

The University of Kansas is grateful to the National Endowment for the Humanities for support of our efforts to protect some of our most treasured campus resources by upgrading the building's mechanical system in collection areas.