NATIONAL ENDOWMENT FOR THE Humanities

DIVISION OF **PRESERVATION AND ACCESS**

Narrative Section of a Successful Application

The attached document contains the grant narrative and selected portions of a previously funded grant application. It is not intended to serve as a model, but to give you a sense of how a successful application may be crafted. Every successful application is different, and each applicant is urged to prepare a proposal that reflects its unique project and aspirations. Prospective applicants should consult the Preservation and Access Programs application guidelines at http://www.neh.gov/grants/preservation/sustaining-cultural-heritage-collections for instructions. Applicants are also strongly encouraged to consult with the NEH Division of Preservation and Access Programs staff well before a grant deadline.

Note: The attachment only contains the grant narrative and selected portions, not the entire funded application. In addition, certain portions may have been redacted to protect the privacy interests of an individual and/or to protect confidential commercial and financial information and/or to protect copyrighted materials.

Project Title: Folger Sustainable Preservation Environment Project

Institution: Folger Shakespeare Library

Project Director: Stephen C. Enniss

Grant Program: Preservation and Access Sustaining Cultural Heritage Collections

Folger Shakespeare Library
Application to the National Endowment for the Humanities
Preservation and Access: Sustaining Cultural Heritage Collections
Implementation Grant

Folger Sustainable Preservation Environment Project
Description of the Project and its Significance

The Folger Shakespeare Library requests an implementation grant of $350,000 from the National Endowment for the Humanities to fund Phase 2 of the Folger Sustainable Preservation Environment Project (FSPEP), capital improvements to three critical air handler units to help create a sustainable preservation environment for the long-term storage of the Folger's unparalleled collection of Shakespeare and early modern European resources by 2017. These capital improvements (and the operational changes dependent on them) will ensure that lower summer dew points can be maintained in the Folger vaults and New Reading Room, and follow the recommended actions of Phase 1 of FSPEP, a one-year in-depth study of mechanical system optimization and environmental data in critical storage areas made possible by a National Endowment for the Humanities Sustaining Cultural Heritage Collections planning grant.

Preserving the collection is a critical priority of the Folger Shakespeare Library. Phase 2 of FSPEP focuses on the Folger's primary long-term storage areas. The Library has a peerless collection of over 256,000 books; more than 75,000 manuscripts; 250,000 playbills; 50,000 prints, photographs, and drawings; plus audio and video recordings, and other special collections. The only comparable collections for studying Shakespeare and Early Modern England are the British Library, the Bodleian Library, and the Birmingham Shakespeare Library, all in Britain.

The Folger's collections are actively used by nearly 1,000 on-site researchers each year and made accessible online through a digital image database of over 48,000 images as well as through an ongoing series of public exhibitions. Folger Education pairs primary source material from the collections with web-accessible lesson plans to bring the best in Shakespeare education to K-12 teachers nationwide. Further, the collections serve as the springboard for the Folger's award-winning publications, theater, music, and poetry programs.

This project will be a collaborative effort of Folger facilities staff, curators, and conservators, guided by the expertise of preservation technology and energy consultants with the Image Permanence Institute (IPI) and professional engineering consultants with Mueller Associates, Inc.

Folger Shakespeare Library
Application to the National Endowment for the Humanities
Preservation and Access: Sustaining Cultural Heritage Collections
Implementation Grant

Folger Sustainable Preservation Environment Project

Narrative

Introduction

The Folger Shakespeare Library requests an implementation grant of $350,000 from the National Endowment for the Humanities to fund Phase 2 of the Folger Sustainable Preservation Environment Project (FSPEP), capital improvements to three critical air handler units to help create a sustainable preservation environment for the long-term storage of the Folger's unparalleled collection of Shakespeare and early modern European resources by 2017. These capital improvements (and the operational changes dependent on them) will ensure that lower summer dew points can be maintained in the Folger vaults and New Reading Room, and follow the recommended actions of Phase 1 of FSPEP, a one-year in-depth study of mechanical system optimization and environmental data in critical storage areas made possible by a National Endowment for the Humanities Sustaining Cultural Heritage Collections planning grant.

Preserving the collection is a critical priority of the Folger Shakespeare Library; "to preserve and enhance its collections" is the opening clause of our mission statement. The Folger's collections are actively used by nearly 1,000 on-site researchers each year and made accessible online through a digital image database of over 48,000 images as well as through an ongoing series of public exhibitions. Folger Education pairs primary source material from the collections with web-accessible lesson plans to bring the best in Shakespeare education to K-12 teachers nationwide. Further, the collections serve as the springboard for the Folger's award-winning publications, theater, music, and poetry programs.

While preservation planning often focuses on the risk of catastrophic destruction, a sustainable preservation environment is an equally important factor in long-term collection preservation. Managing collection environments over time requires an understanding of the forms of deterioration, how those forms of deterioration relate to each other, and how institutional best practices can reduce the overall decay rate of various kinds of collection materials. Based on the detailed analysis of observed environmental conditions in areas where collections are stored, displayed, and used by researchers, and detailed documentation, analysis, and preliminary optimization of four key air handler units, we are in a position to greatly increase the life-span of the collection while actually decreasing energy consumption.

Organizational Profile

The Folger Shakespeare Library is a world-class center for scholarship, learning, culture, and the arts. It is home to the world's largest Shakespeare collection and a primary repository for rare materials from the early modern period (1500–1750). The Folger is an internationally-recognized research library offering advanced scholarly programs in the humanities; an innovator in the preservation of rare materials; a national leader in how Shakespeare is taught in grades K–12; and an award-winning producer of cultural and arts programs—theater, music, poetry, exhibitions, lectures, and family programs. By promoting understanding of Shakespeare and his world, the Folger reminds us of the enduring influence of his works, the formative effects of the Renaissance on our own time, and the power of the written and spoken word. The mission of the Folger Shakespeare Library is to preserve and enhance its collections; to render

the collections, in appropriate formats, accessible to scholars; and to advance understanding and appreciation of Shakespeare's writings and of the culture of early modern Europe more generally through various programs designed for all students and for the general public.

The Folger opened in 1932 as a gift to the American people from Henry Clay Folger and Emily Jordan Folger, husband and wife. The original physical facilities consisted of a large reading room, book stacks, secure vaults for rare books, a theater, an exhibition hall, a small garden, and an administrative wing. Major renovations to the original building between 1979 and 1982 created an additional reading room—the New Reading Room—and extensive below-ground vaults. In 2000, the library expanded to include a renovated building across the street, the Wyatt R. and Susan N. Haskell Center for Education and Public Programs.

The Folger Shakespeare Library is governed by an independent Board of Governors and administered by the Trustees of Amherst College, Henry Folger's alma mater, in accordance with Mr. Folger's bequest. The current annual operating budget is $15.6 million. Last year, visitors to the Folger included 776 readers (for a total of 8,585 reader days); approximately 15,500 exhibition attendees; and nearly 40,000 attendees to the Folger's theater, music, poetry, and lectures programs. More than 12,000 elementary, middle, and high school students and teachers participated in the Folger's education programs, which were held at the Folger, in local schools, and at conferences and workshops across the country. Reference inquiries topped 2,000, and the Folger's website, www.folger.edu, logged millions of visitors. The Folger's staff (including Divisions of Central Library, Education, Public Programs, and Research, as well as Offices of Administrative Services and Development) includes 100 regular full-time, six grant-funded full-time, and thirty-four part-time employees.

The Folger Shakespeare Library's collections include rare printed books, manuscripts, works of art, audiovisual materials, and modern scholarship. These materials extend beyond Shakespeare to include a wide range of disciplines—e.g. history, politics, theology, exploration, law, and the arts—from the early modern period. New acquisitions of rare and modern materials are made regularly through purchases and the generosity of donors. Collection development policy focuses on building existing strengths in order to enhance the collection's value for in-depth research. It is guided by a team consisting of the Folger's Librarian, Head of Acquisitions, Curator of Rare Books, Curator of Manuscripts, Curator of Art & Special Collections, and Head of Reference. The current acquisitions budget is (b) (4) , and includes funds generated by the Folger's endowment as a whole, funds generated by 28 restricted endowments for acquisitions, and other private gifts supporting current acquisitions initiatives. The Folger has a dedicated book and paper conservation lab with three conservators and two advanced interns. Conservators collaborate closely with curators to determine how to treat particular items, seeking the delicate balance in each case between treating material and preserving its historic integrity.

Significance of collections

Phase 2 of FSPEP focuses on the preservation environment of the vaults and the New Reading Room, the primary long-term storage areas. The Library has a peerless collection of over 256,000 books; more than 75,000 manuscripts; 250,000 playbills; 50,000 prints, photographs, and drawings; plus audio and video recordings, and other special collections.

Printed Books

The Folger's large collection of printed books includes about 116,000 rare books. Although the Folger is renowned for the size and scope of its Shakespeare collections, its rare holdings encompass all aspects of British and European literary, cultural, political, religious, and social history from the fifteenth through

the eighteenth centuries, with particular strength in the sixteenth and seventeenth centuries. The collection also includes 250,000 printed playbills, primarily from the nineteenth century, offering an invaluable resource for research into British and American stage history.

The Folger has one of the largest collections of early English printed books in the world. It houses some 85,000 such volumes, including about 55,000 printed before 1700 and about 30,000 from between 1701 and 1800. Famously, the Folger holds 82 copies of the first edition of Shakespeare's collected plays, published in 1623 and known as the First Folio. Other material includes ephemeral 17th-century newsbooks such as *A Brief Narrative of A Strange and Wonderful Old Woman that hath A Pair of Horns Growing upon her Head* (London,1670), devotional books like the *Book of Hours* from 1533 that Anne of Cleves inscribed to Henry VIII, and literature such as the only known copy of the first state of Edmund Spenser's *The Shepheardes Calender* (London, 1589). Scholars generally divide English books from before 1700 into two categories, STC and Wing, after the titles of important catalogs. STC books take their name from the *Short-Title Catalogue of Books printed in England, Scotland, & Ireland and of English Books Printed Abroad, 1475-1640,* a reference work listing all such books and broadsides. The Folger has the world's third largest collection of these very early volumes, after the British Library and the Bodleian Library at Oxford University (it holds copies of almost half of the volumes listed in the STC). Early English books printed between 1641 and 1700 are known as Wing volumes, for Donald Wing's short-title catalog of works from the period. The Folger has about 25,600 Wing titles, a figure that includes almost 34,000 separate volumes including multiple copies. The Folger's Wing holdings place it among the top four such collections in the United States. For a number of STC and Wing publications, the example at the Folger is the only copy known to have survived. The first edition of Shakespeare's *Titus Andronicus* (1594) is probably the most famous of these "uniques."

Manuscripts

Manuscripts form a critical part of the Folger's holdings. The Folger collection of ca. 75,000 manuscripts ranges in date from the late thirteenth century to the present day and includes a vast range of handwritten documents, including original literary, poetic, and dramatic works, correspondence, diaries, commonplace books, musical manuscripts, books of heraldry, religious works (devotional writings, sermons, polemical pieces), account books, political writings, warrants, and deeds. Research interest in these unique holdings has grown significantly as cataloging initiatives have expanded access to them. In 2010 the Folger completed a three-year Mellon-funded project to provide online catalog records for the entire manuscript collection, which has noticeably increased its use among scholars. Highlights of the manuscript collection include important letters by John Donne, Shakespeare's own copy of the deed for his purchase of the Blackfriars Gatehouse, and a promptbook for the 1930 Savoy Theatre production of *Othello* starring Paul Robeson.

Works of Art and other materials

The Folger Shakespeare Library's collection of paintings, prints, drawings, and photographs consists of approximately 50,000 items. Unlike an art museum, where collections are aesthetics-driven and artist-driven, the Folger's mission as a research library mandates a subject-driven visual materials collection. The Folger's prints and drawings collection focuses exclusively on Shakespeare, Shakespeare's era, and the theater. The Library has portraits of actors and actresses ranging from the likes of David Garrick, Edwin Booth, and Ellen Terry—still famous today—to character actors who were barely noticed in their own time periods. It holds thousands of depictions of Shakespeare's plays—some representing actual stage performances, others purely imaginary. As a result, the Folger provides images not typically found in other repositories, since the subject matter is not of primary interest to art museums, and since libraries often exclude visual material. Humanities and other subject strengths in the Folger's art collection include

allegorical imagery (e.g. Ages of Man, Five Senses, Nine Muses), architecture, costume illustrations, current events of the early modern period (e.g. festivals, Protestant Reformation, English Civil War, French and Dutch politics), daily life (including visual representations of the "good woman," the "happy husband," and other complements to social conduct literature), memento mori, and portraits.

Like the rare book collection, the art collection includes prints where the Folger copy is the only one known to survive, e.g. *The Ambiguous Confessor*, an English engraving from ca. 1650 in which one man appears to re-build a church (but might be destroying it) while another definitely destroys it. The dual meaning is repeated in the verses superimposed on the church, which can either be read in two columns or straight across. Non-textual material in the Folger collection also includes such things as porcelain figurines, audio recordings, theatrical costumes, and Shakespeare souvenirs.

Art from the Folger is routinely requested for major exhibitions in the United States and abroad. Recent examples include lending the mid-18th-century terracotta modello for Louis-Francois Roubiliac's sculpture of Shakespeare to the Louvre and the Metropolitan Museum of Art, and lending Henry Fuseli's 1793 oil painting *Macbeth consulting the vision of the armed head* to the Kunsthaus Zürich, Tate Britain, and the Smart Museum of Art at the University of Chicago.

Acquisitions continue for all parts of the collection, which complements rather than competes with the Library of Congress, the National Gallery of Art, the Smithsonian Institution, and the National Library of Medicine, all easily accessible in the area. The only comparable collections for studying Shakespeare and Early Modern England are the British Library, the Bodleian Library, and the Birmingham Shakespeare Library, all in Britain.

Use of the Collections

As a national and international resource, the Folger shares the wealth of its collection with everyone from Shakespearean scholars to actors, conservators, undergraduates, and K-12 students and teachers. Last year, scholars from more than 20 countries and 242 colleges and universities came to study and take part in a diverse array of conferences, seminars, and symposia. Researchers from across the globe can access the Library's bibliographic information through our online database, Hamnet (http://shakespeare.folger.edu). Over 48,000 images of collection materials are available online in the Folger's digital image database (http://luna.folger.edu). Additional content is provided through the Library's website (http://www.folger.edu), which includes online exhibitions, lesson plans, and subject- themed resources.

The Library also offers over thirty fellowships annually in support of advanced research. This year's projects include such topics as "Treacherous Faith: Heresy and Demonization in Early Modern English Literature," "Shakespeare and East Asia," and "Race and Bound Labour in the British Atlantic World." The Folger Institute, a consortium of over forty member universities from the United States, Canada, and Great Britain, provides conferences and seminars in advanced studies in the humanities (e.g., "A New World of Secrets: The Hermeneutics of Discovery in the Early Americas" and "Introduction to Early Modern English Paleography"). The New Folger Library Shakespeare, co-edited by Barbara Mowat (Emerita Folger Director of Research) and Paul Werstine (University of Western Ontario), is the authoritative school edition of Shakespeare's work. These editions are standard in high school classrooms nationwide, with more than 2 million copies sold since 1992. The Library publishes award-winning exhibition catalogs and publications including the journal *Shakespeare Quarterly*.

The Folger collection also stimulates an active schedule of public and educational programs designed to bring the text and time period alive for diverse audiences. Programs include exhibitions, theater

productions, poetry readings, music performance by the Folger Consort, and educational programs for K-12 students and teachers such as "Shakespeare Steps Out" (aimed at grades three through six) and the NEH-funded "Teaching Shakespeare" summer institute. The current exhibition, *Manifold Greatness: The Creation and Afterlife of the King James Bible*, is part of a project led by the Folger and jointly produced by the Folger and the Bodleian Library, University of Oxford, with assistance from the Harry Ransom Center at the University of Texas at Austin, and made possible by a grant from the National Endowment for the Humanities. The exhibition explores how the translation came to be, and what made this particular translation so influential. *Manifold Greatness* includes a website (http://www.manifoldgreatness.org); major exhibitions at the Bodleian, the Folger, and the Harry Ransom Center; a traveling panel exhibition in partnership with the American Library Association; a publication from Bodleian Library Publishing; a blog (http://manifoldgreatness.wordpress.com); and social media outreach. All of these scholarly and outreach activities depend in large part on the Folger's rare and historic collections.

Current conditions

All collection material at the Folger is permanently housed on-site (see Appendix A for floor plans with illustrations). Reference works are located in the Paster Reading Room ("Old Reading Room"), the New Reading Room, and in underground book stacks that (b) (4) . Most rare material is located in limited-access underground vaults. (b) (4) the Art Vault (containing paintings, photographs, art on paper, and objects) and STC Vault (containing works listed in *A Short-Title Catalogue of Books printed in England, Scotland, & Ireland and of English Books Printed Abroad, 1475-1640*); and (b) (4) , the Deck C Vault (containing manuscripts from the late 13th century to the present; Continental books from 1468 through 1830; English books from 1641 to 1830, Shakespeare editions from the 17th century to the present; playbills, programs, scrapbooks, and other theatrical ephemera; the Folger archives; sound recordings; and more paintings). (b) (4)

(b) (4)

When not being used in the reading rooms, material stays in the Service Vault for the duration of a researcher's project. The Exhibition Hall, Conservation Lab, Photography and Digital Imaging Department, and the processing areas where Acquisitions, Cataloging, and Curatorial staff work also temporarily house collection material.

Unlike the rare books, manuscripts, and works of art on paper, much of the Folger's collection of paintings is permanently stored outside the vault area, where it can be seen and appreciated for its artistic and historic value. The largest group—forty-two oil paintings—hangs in the New Reading Room, a space created during the 1979 to 1982 renovation.

Temperatures and relative humidity levels in these areas are monitored and controlled by Johnson Controls sensors through FX Server software. Since December 2008, we have been collecting temperature and relative humidity data with PEM2 dataloggers from the Image Permanence Institute in order to have a machine-readable dataset. The PEM2 loggers have proven to be accurate and convenient, so additional loggers have been added and the recording hygrothermographs previously in use have all been phased out. We now have thirty-one PEM2 loggers deployed in collection areas throughout the building. Most recently, we started monitoring conditions both inside and outside display cases in the Exhibition Hall in order to learn how the temperature and humidity within the cases differ from the

temperature and humidity in the room. Certain loggers have been identified for daily uploads to PEMdata.org, a free online data analysis tool provided by IPI, the other loggers are uploaded monthly or quarterly. If a daily upload shows anomalous data, the remaining loggers in rooms served by the same air handler are checked for confirmation. See Appendix B for the full list of PEM2 dataloggers in use.

Metrics from the PEM2 dataloggers collected to date in areas where collection materials are permanently stored indicate that current environmental conditions are not optimal for long-term collection preservation (see Appendix C for data covering December 2008 through October 2011). The metrics are quantitative numerical estimates of the rate of environmentally-induced decay in collections, broken down into specific numbers for the risk of natural aging, metal corrosion, mechanical damage, and mold growth (see below and Appendix D and E for more information about preservation metrics). In terms of damage to collection material from natural aging, mechanical damage, and metal corrosion, all major long-term collection storage areas are in the "risk" zone or at the low end of "OK" (of three possible ratings: Good, OK, and Risk). In addition, the east end of the Deck C vault earns a "risk" ranking for mold growth.

Natural aging is quantified by Time Weighted Preservation Index (TWPI) values. These single figures represent the rate of spontaneous chemical change in organic materials (the paper, textiles, leather, etc. that make up the collection) as estimated from the cumulative effect of temperature and relative humidity as they change over time. TWPI is calculated from the Preservation Index (PI) points recorded every half hour by the PEM2 data loggers (each recorded PI point is an average of six temperature and relative humidity readings taken at 5-minute intervals during the previous half hour). TWPI is "time weighted" because the more time an object spends in a space with a higher PI, the better. TWPI values in the vaults and New Reading Room range from 35 to 52, which is not very good. The preservation index number can be thought of as the number of years a theoretical very-sensitive object could be stored in that space before significant damage. A TWPI of 45 or lower ranks as "risk," 45 to 75 as "OK" and 75 or higher as "Good." All organic materials decay over time. Our goal is to slow the decay rate as much as possible.

The risk of mechanical damage is determined by three different aspects of moisture content: Maximum Equilibrium Moisture Content (i.e., Is it too damp? Will paper curl? Will emulsions soften? Will wood warp?), Minimum Equilibrium Moisture Content (Is it too dry? Will paper become brittle? Will emulsions crack? Will wood chip?), and Dimensional Change (How great are the fluctuations between the most damp and the most dry? Has expansion and contraction from absorption/desorption of water put physical stress on the collection materials?). Seven of the eight dataloggers installed in critical areas in December 2008 document mechanical damage at "risk" level: all five loggers in the underground vaults, the logger in the Service Vault, and one of the two in the New Reading Room. The New Reading Room logger shows "OK" for mechanical damage risk. Note that the source of these poor ratings has been traced to a combination of excessive humidity in summer (which will be corrected by the capital improvements described in this proposal) and excessive dryness in winter. The winter dryness was caused by malfunctioning humidifiers which have now been repaired, ready for this winter.

Metal corrosion risk is determined by the Maximum Equilibrium Moisture Content (EMC Max), a representation of how much moisture is present in the air. The lower the number, the better. Seven of the eight long-term dataloggers in critical areas report EMC Max in the "risk" zone for metal corrosion. The other only rates "OK". In addition to obvious examples of metal in the collection (e.g., steel swords used by famous 19th-century Shakespearian actors, Renaissance bindings with metal clasps) the high iron content of writing and drawing ink in the early modern period puts large sections of the manuscript and art collections at risk from corrosion.

One area earns a "Risk" rating for Mold Growth: the east end of the Deck C vault shows a Mold Risk Factor of 0.71. Mold spores exist everywhere, but only under certain temperature and humidity conditions

will the spores be able to germinate. The Mold Risk Factor of 0.71 indicates that mold spores were more than half way to germination (a Mold Risk Factor greater than 1.0 would indicate mold spores have germinated, and visible mold could be actively growing).

This project will address the preservation environment in the vaults and New Reading Room – the areas where collection material is stored long-term – by implementing recommendations for capital improvements from the *Mechanical System Optimization and Environmental Data Analysis Consultation* produced in August 2011. These capital improvements will permit lower summer dew points in the vault and New Reading Room. A lower summer dew point will greatly slow the natural aging of collection material, reduce mechanical damage from excess humidity, and eliminate the mold and metal corrosion risks. (The mechanical damage from excess dryness has already been addressed by repairs to the humidifiers).

History of the project

Overview

Preservation actions undertaken since 2005 laid the foundation for FSPEP by stabilizing the building envelope. In August 2002, water seeped through the walls of Deck C (b) (4) , and the New Reading Room experienced leaks in the flashing around the skylights. After a thorough analysis of the building envelope by Hoffman Architects, the faulty drainage field around the underground vault was replaced and a new waterproof membrane installed (the two-year "Vault Repair Project"). The New Reading Room roof was replaced, and the exterior wall was repointed.

Once the acute issues with the leaking building envelope had been resolved, one of the major variables in our preservation environment had been eliminated. We were ready for the next step: moving away from responses to emergencies towards an understanding of existing mechanical systems in the context of an overall preservation quality and risk assessment in order to plan a sustainable preservation environment, i.e., the first phase of the *Folger Sustainable Preservation Environment Project* (FSPEP). Phase 1 of FSPEP took place from August 2010 to August 2011, and the results can be seen in the *Mechanical System Optimization and Environmental Data Analysis Consultation* prepared by the Image Permanence Institute (IPI) and Herzog/Wheeler & Associates LLP, referred to hereafter as the IPI–Herzog/Wheeler report, and attached as Appendix F.

In Phase 1 of FSPEP, IPI and Herzog/Wheeler studied four of the Folger's twenty-three air handler units (AHUs) in depth. These four were chosen because they serve core areas where rare material is permanently stored, and because they have "twins" serving other areas, so the information learned can be applied elsewhere. See Appendix A for floor plans and Appendix G for a full list of which AHU serves which area. Air Handler Unit 1 (AHU 1) serves Deck C, the (b) (4) Air Handler Unit 5 (AHU 5) serves the (b) (4) , which is made up of two smaller spaces (the Art Vault and the STC Vault). As mentioned in greater detail under "Current Conditions" above, Deck C contains manuscripts, rare books, ephemera, and paintings, the Art Vault contains most of the art collection, and the STC Vault contains works listed in *A Short-Title Catalogue of Books printed in England, Scotland, & Ireland and of English Books Printed Abroad, 1475-1640*). Air Handler Unit 4 (AHU 4) pre-conditions outside air reaching the already-mentioned AHUs 1 and 5 (as well as AHUs 2 and 11, serving modern reference stacks, not studied). Air Handler Unit 15 (and its twin, AHU 14, not studied) serves the New Reading Room (housing the largest and most important group of paintings at the Folger) and the adjoining Service Vault (housing material from the underground vault while it is in active use by individual readers).

Phase 1 of FSPEP provided the following:

- a thorough understanding of the four key mechanical systems named above: AHU 4 (pre-conditions air for the underground vaults and modern reference stacks), AHUs 1 and 5 (condition air for the underground vaults), and AHU 15 (conditions air for the New Reading Room and Service Vault); the study revealed both what they are currently doing, and what they are capable of doing (and under what conditions) in order to achieve optimal performance
- a thorough understanding of how the climate relates to the long-term preservation needs of the different materials in the collection, allowing us to see where seasonal adjustments can reduce energy consumption with little or no effect on the collection
- recommendations leading to a decrease in energy consumption, without additional expenses, by optimizing current equipment and practices
- reccommended next steps: capital improvements and full implementation of recommendations

Details of Phase 1

We began preparing for Phase 1 by installing twenty PEM2 dataloggers from IPI in November, 2008. The PEM2 datalogger is a refinement of the original Preservation Environment Monitor (PEM), a datalogger IPI developed specifically for libraries and museums in the late 1990s, with funding from the National Endowment for the Humanities (NEH). These twenty PEM2 dataloggers allowed us to monitor preservation conditions in various spaces over the course of all a full year in order to identify the most critical areas for improvement.

Phase 1 of FSPEP added another layer of environmental monitoring and data gathering by positioning sixteen additional dataloggers directly inside the four air handler units that were studied. The resulting environmental conditions analysis compared data results in collection areas with data results in air handlers and duct work in order to assess how those conditions changed with modifications to management, maintenance, and adjustment of air handlers. The loggers inside the air handlers also revealed instances of excessive energy consumption: some systems were sub-cooling and reheating air year-round instead of only in summer (when sub-cool and reheat is needed for dehumidification).

At the time most of our air handlers were installed in the early 1980s, it was hoped that they would meet the then-standard year-round preservation targets of 68°F temperature and 50% relative humidity, with minimal daily fluctuations. In practice, this has not been possible, and more recent research shows that the old conventional wisdom is not so wise after all. Preservation metrics derived from complex data analysis not possible earlier show that these fixed, narrow targets are overly strict, not necessarily appropriate for library materials, and thus needlessly wasteful of energy and resources (see Appendix E for *Understanding Preservation Metrics* by Doug Nishimura). Accordingly, in Phase 1 of FSPEP, we developed new recommendations appropriate to the Folger collection and its use, the building envelope, the local climate, and the mechanical systems servicing collection storage areas in consultation with the Image Permanence Institute and Herzog/Wheeler & Associates. Instead of striving for a year-round fixed temperature and humidity target, as was done in the past, we will improve the preservation environment and reduce energy consumption through the gradual adjustment of temperature and humidity set-points twice a year, in November and May (the historic transition points between DC's winter "humidification season" and summer "dehumidification season" when outdoor dew points are approximately 40°F, see Appendix H). Previously, it was thought that avoiding temperature and humidity fluctuation was paramount because of the risk of mechanical damage from expansion and contraction. IPI's own research and literature surveys have shown that gradual change twice a year in order to provide excellent conditions in winter, and so-so conditions in summer, is less damaging to the health of library materials over the decades than keeping constant so-so conditions year-round (furthermore, it saves energy by

taking advantage of the naturally cooler and drier outdoor air in DC between November and April). The risk of mechanical damage from the twice-yearly shift is more than compensated for by the greatly slowed chemical damage of natural aging. Similarly, although we cannot make the reading rooms considerably colder because of human comfort needs, it is preferable to occasionally move a small number of items from the colder, drier vault to the warmer, more humid reading rooms for use than to keep the entire collection in warmer, more humid conditions all the time (note that because material will never be used in a drier environment than it is stored, risk of physical damage from handling is not a serious issue).

Phase 1 revealed that through a combination of operational changes and targeted capital improvements, it is possible to greatly improve the preservation climate in the Deck C Vault, Art Vault, and STC Vault, and more moderately improve the preservation climate in the New Reading Room and adjoining Service Vault, while decreasing overall energy use. (Note that greater improvement is not possible in the New Reading Room because it must accommodate sedentary workers, so cannot be kept colder than 68-70°F).

Methods and standards

Background

The Image Permanence Institute (IPI), a nonprofit, university-based laboratory devoted to preservation research led by James Reilly, is well-known among conservators and curators as a leader in preservation research. We at the Folger became better aware of how this research is being applied to sustainable practices for the preservation of images and cultural property during the summer of 2008, when we made site visits to various local institutions to learn about their climate monitoring systems. Climate Notebook, IPI's Windows-based environmental analysis software, was unanimously praised. Moreover, we learned that IPI, in collaboration with energy cost management consulting firm Herzog/Wheeler & Associates, has been working with the Library of Congress, across the street from us, to monitor and improve its preservation environments in a sustainable way. Although the Folger operates on a much smaller scale than the Library of Congress, we hold similar materials, engage in a similar variety of activities, and purchase our chilled water from the same source, the Architect of the Capitol (AOC).[1] Their experience with the Library of Congress, plus the respect they command in the field, made working with IPI and Herzog/Wheeler the obvious choice for Phase 1 of the *Folger Sustainable Preservation Environment Project* (FSPEP), which produced the *Mechanical System Optimization and Environmental Data Analysis Consultation*, or "IPI–Herzog/Wheeler report," attached as Appendix F.

Quoting from the Executive Summary of the IPI–Herzog/Wheeler report:

> The options and recommendations listed are meant to achieve a dual purpose – the improvement of environmental conditions for the collections, and the savings of both energy and money. Operational recommendations, or adjustments in how the mechanical systems are run, should be able to be implemented with no additional capital expenditure to the systems beyond normal maintenance issues. If all specific recommended actions are taken, Folger could see a potential savings of $22,000 in the first year alone...as well as the improvement of the preservation

[1] The Architect of the Capitol (AOC) is the federal agency responsible for maintenance, operation, development, and preservation the Capitol complex. Although the Folger is a private institution, our location on Capitol Hill means that the building is served by the same chilled water system as the Supreme Court, Library of Congress, US Capitol, and other near-by federal buildings.

environment through adjusted setpoints in winter. If the recommended additional experimentation is performed, the savings, and cost recovery rate, will likely be even greater.

We are implementing all the operational changes in the report (again, see Appendix F for the full report):

- AHU 4 (supplies pre-conditioned air to the AHUs serving the underground vaults)
  - restrict winter (November–April) heating to the minimum necessary to avoid freezing of the coils in the unit
- AHU 1 (sends pre-conditioned air from AHU 4 to the Deck C vault, which houses the bulk of the Folger's rare material)
  - correct the year-round sub-cool/reheat operation to only sub-cooling when dehumidification is necessary (May–October)
  - run an 8-hour shutdown of the system nightly
  - enact winter, non-dehumidification season (November–April) setpoints of 60°F and 35–40% RH (reducing the temperature to 50°F in winter, as recommended, depends on capital improvements)
- AHU 5 (sends pre-conditioned air from AHU4 to the Art Vault and STC Vault)
  - correct the excessive winter sub-cooling and reheating to do only necessary sensible cooling (roughly November–April)
  - run an 8-hour shutdown of the system nightly
  - enact winter, non-dehumidification season (November–April) setpoints of 60°F and 35–40% RH (reducing the temperature to 50°F in winter, as recommended, depends on capital improvements)
  - leave the total bypass damper closed

The nightly shut-downs of AHU 1 and AHU 5 began as a closely-monitored energy-saving experiment on May 2, 2011, approximately three-quarters of the way through Phase 1. The decision to experiment was not taken lightly, as these units serve the spaces that house the bulk of the library's rare materials: the Deck C Vault, the Art Vault, and the STC Vault. Several factors convinced us the experiment was likely to succeed. As explained in the IPI–Herzog/Wheeler report (Appendix F):

(b) (4)

During normal daily operation, Deck C showed relatively little temperature gain: air pulled back into the return was 4 to 5°F warmer than air supplied to the room, indicating there was little heat load during the day, when the space is semi-occupied, with one or two computers running, and additional lights on; overnight, the space is unoccupied, computers are off, and only emergency lights are on

The Art and STC vaults showed even less temperature gain during normal daily operation: less than 2°F

The experiment showed promising results. Again quoting from the IPI–Herzog/Wheeler report (Appendix F):

> ...temperature variation ... during the shutdown has shown, on average, a temperature increase of between 0.5°F and 1°F, which the system is able to recover, the space returning to setpoint temperature, the following day within two hours. There has been no cumulative temperature increase in the space during the experiment due to the shutdown process.... Achieving these results during the high heat and moisture summer season of the Washington, DC, metro region indicates that this operation adjustment should be able to be run on a year-round basis, with no meaningful impact on the preservation environment, while saving on energy costs. ... RH levels fluctuated by up to 5% ... during the nightly shutdown experiment. This is due to two factors – the change in dew point in the space during the shutdown and, to a lesser extent, the slight fluctuation in temperature. Both the dew point and the temperature are recovered within the first two hours of the system coming back on, and the RH adjusts with that recovery. This fluctuation actually has very little bearing on the overall preservation of the collection. Past IPI research has shown that it can take up to 30 days for collections materials to fully equilibrate to a change in moisture content in the environment – in other words, that 5% change in RH would have to stay constant for 30 days before collections materials completely equilibrated to the new condition. These fluctuations, occurring over the period of eight hour shutdown and then recovering, are not of a long enough duration to cause change in the material. In essence, due to the slow rate of moisture equilibration, these small, short-term fluctuations are not felt by the collection.

Based on the experiment, we have continued the nightly shut-downs, and of course continue to monitor the spaces with PEM2 dataloggers. As it is only November, we have yet to collect data from the winter season. We will be particularly alert for large, cumulative, or unrecoverable drops in relative humidity over the coming months.

Note that there were no operational changes recommended for AHU 15 (serves the New Reading Room and Service Vault) as it is incapable of providing an “OK” or “Good” preservation environment without capital improvements.

The report recommends four capital improvements:

1. Install a booster chiller with glycol and redesign the cooling coil at AHU 4 to allow for lower summer dew points in the underground vaults.
2. Redesign AHU 15 [and AHU 14, its twin and partner] to allow for better summer dew point control based on a sub-cool and reheat system.
3. Explore cost of creating steam on-site.
4. Upgrade and calibrate control system temperature/relative humidity sensors in all collections areas and air handling units serving collections areas.

Recommendations #1 and #2 are the subject of this grant proposal, and are described in more detail below.

Recommendation #3 has already been implemented in as much as our brief exploration of creating steam on-site quickly revealed that it was preferable to continue purchasing steam from the Architect of the Capitol. Leaving aside the cost of equipment and personnel, our property simply does not have the necessary space for the equipment that would be required.

Recommendation #4, to upgrade and calibrate control system temperature/relative humidity sensors, is already underway, independent of this grant application. In addition, we plan to install airflow sensors, to alert us if a filter goes bad sooner than expected. We determined that upgrading and calibrating the

sensors in all collections areas and air handling units serving collections areas was critical to implementing the operational changes recommended in the report, and that for the sake of the collection we could not delay.

Recommendation #1: upgrade AHU 4 to greatly improve conditions in the Deck C, Art, and STC Vaults

The IPI–Herzog/Wheeler report recommended installing a booster chiller with glycol and redesigning the cooling coil at AHU 4, which pre-conditions the air sent to AHU 1 and AHU 5 (serving the underground vaults that house rare material) and AHU 2 and AHU 11 (serving the underground book stacks that house most of the reference collection):

> High summer dew points are the most significant limiting factor when it comes to creating appropriate preservation environments at Folger. The key collections storage areas studied – Deck C and the STC and Art Vaults – have distinct potential advantages in environment, namely as mostly unoccupied spaces with little heat load. Those factors cannot be fully taken advantage of due to limitations at the cooling coils on AHU #'s 1 and 5, which were only designed to achieve dew points of 48°F at best. As a result, Folger is limited in terms of just how cold of a preservation environment they can create for collections.
>
> If we define the environmental goals for these spaces with the set of seasonal set points, one set of options would be:
>
> - Summer: 50°F, 55% RH, PI = 137
> - Winter: 50°F, 35% RH, PI = 244
>
> This model would require a summer dew point of 34°F, would reduce the current chemical decay rate by nearly two-thirds, and the RH seasonal setpoint range between 35% and 55% would provide mechanical stability.
>
> Achieving a 34°F dew point means providing adequate moisture control at some point in the system. Most of the moisture in an enclosed space or system is introduced through the outside air, which is brought in chiefly to meet code for human occupancy. The system then has to remove this moisture at the cooling coil in order to achieve a dew point that will allow for an appropriate temperature and relative humidity setpoint. Because AHU #'s 1, 2, 5, and 11 all receive their outside air from AHU #4, the easiest solution to moisture control and the lowering of dew point, is to achieve it at AHU #4.
>
> Installing a booster chilled-water/glycol system at AHU #4 and redesigning the coil would make a 34–35°F dew point attainable. The entering volume would remain at 3,000 CFM. Once sub-cooled at AHU #4, that air would then be supplied at 35°F to AHU #'s 1, 2, 5, and 11. We would foresee no capital changes to equipment at AHU #'s 1, 2, 5, and 11. This change would not change winter operation of the units, aside from the recommendations already made for winter operation.
>
> By dehumidifying the outside air as it enters the system, the dehumidification (latent cooling) load is removed from the downstream units, leaving them with only the sensible cooling load to contend with. In the case of AHU #1, rather than having to sub-cool 12°F, it would now only have to cool enough to overcome the 3°F load in the space.

As explained below under "Mueller design for recommendation #1," condensation problems not anticipated in the IPI–Herzog/Wheeler report mean that Recommendation #1 was overly optimistic, but sound in principle. While it is possible to reduce the summer dew point to 35°F as recommended, it is not possible to supply air with a summer temperature of 35°F from AHU 4. The best that can be achieved is a dew point of 35°F and a temperature of 50°F. Nevertheless, this will still be a large and worthwhile

improvement over current conditions, cutting the rate of natural aging in summer by almost two-thirds (from a PI of 43 to a PI of 117) while still consuming less energy overall than in the past by taking advantage of naturally cold outdoor air in winter.

Recommendation #2: upgrade AHUs 14 and 15 to improve summer conditions in the New Reading Room and adjoining Service Vault

The IPI–Herzog/Wheeler report recommends redesigning AHU 15 (and by extension, its twin, AHU 14) to allow for better summer dew point control in the New Reading Room and Service Vault based on a sub-cool and reheat system:

> While certain challenges of creating a preservation environment in the New Reading Room will always be present – the balancing of human comfort versus preservation conditions, the significant load in the space from windows and exterior exposure – a redesign of AHU #15 to provide a better dew point would solve a number of the current problems.
>
> Currently, the challenges are as follows:
>
> - Best possible dew point is around 51°F (this is with no outside air – with outside air, it would probably rise closer to the 54°F design condition)
> - Inability to sub-cool and reheat at unit necessitates the use of the perimeter radiation for reheat in summer, to the detriment of the paintings (an IR thermometer showed surface temperatures on the paintings that were close to the discharge temperature of the radiators, located directly below), and at the sacrifice of temperature and RH control in the space
> - The Service Vault is currently a small "microclimate", with lower temperatures and higher RHs than in the New Reading Room due to the lack of sufficient reheat, potential placing materials at risk for mechanical damage if stored in the Vault for extended periods of time.
>
> A redesign of AHU #15 to a similar system as AHU #1 would be quite practical – the ability to sub-cool and reheat, particularly if the coil were sized to provide a lower dew point, even based on the 42–43°F water that Folger is likely receiving, would be capable of providing a dew point as low as 45°F.

Consulting engineers

In preparation for implementing recommendations #1 and #2 of the IPI–Herzog/Wheeler report, the Folger sought recommendations for consulting engineers through the website of the International Association of Museum Facility Administrators (IAMFA). We then issued a Request for Proposals for Mechanical Design Services (see Appendix I) to four recommended firms. We received three proposals for consideration. After reviewing the proposals and checking references we selected Mueller Associates, Inc., of Baltimore, MD, to prepare a schematic design and cost estimates. Their experience with cultural heritage institutions similar to the Folger and the recommendations we sought independently gave us confidence that they would be able to produce a schematic design to meet our needs. See Appendix J for the full schematic design, which is summarized below.

Mueller design for Recommendation #1 (improvements to AHU 4 to greatly improve conditions in the Deck C, Art, and STC Vaults)

As briefly mentioned above, IPI–Herzog/Wheeler's recommendation #1 is correct in theory: installing a booster chiller with glycol at AHU 4 and re-designing its cooling coil would make it possible to discharge

air with a 35°F dew point and a 35°F temperature. In practice, though, supplying air with a 35°F dew point and a 35°F temperature would cause damaging condensation on and inside AHU 4 and the ducts leading from it because they are located within a machine room with an ambient summer dew point of up to 71.8°F. Instead, after being cooled to 35°F in order to wring out the moisture and achieve a dew point of 35°F, the dry air must be reheated to 50°F to prevent condensation. This will require not only installing the booster chiller with glycol recommended in the IPI–Herzog/Wheeler report (to lower the temperature, and thus reduce the moisture) but also replacing the current AHU 4 entirely because is not capable of providing the necessary reheat. Its configuration makes it impossible to retrofit it with a heating coil; a new unit with built-in reheat capability is needed.

Furthermore, having to reheat AHU 4's air to 50°F in order to avoid damage from condensation means that achieving the IPI–Herzog/Wheeler report's recommended set points of 50°F/55% RH in summer (Preservation Index = 137) and 50°F / 35% RH (Preservation Index = 244) in winter would, in fact, require not only the replacement of AHU 4, but also the replacement of AHU 1 and AHU 5. Mueller did not provide designs or cost estimates for replacing AHUs 1 and 5, since that was beyond the scope of our request, and is a larger project than we can contemplate at the moment. Such replacement remains a possibility for the future, with the currently-proposed replacement of AHU 4 as the necessary first step. While it was disappointing to learn that capital improvements to AHU 4 alone cannot improve the summer Preservation Index as much as forecast, we are still in a position to almost triple it.

Supplying air from AHU 4 with a summer temperature of 50°F will allow us to achieve 58°F / 42%RH in summer and 58°F / 35%RH in the underground vaults. The risk of mechanical damage from gradual humidity fluctuations of 7% is negligible compared to the cumulative effect of faster natural aging through chemical decay from higher temperatures which, unlike mechanical damage, cannot be repaired. See the chart below operational changes only:

Deck C Vault	*Summer*	*Winter*
Operational changes only	65°F / 60% RH (PI 43)	60°F / 35% RH (PI 125)
Capital improvements plus operational changes, larger temperature shift	58°F / 42% RH (PI 117)	58°F / 35% RH (PI 143)

Mueller has indicated that it may even be possible to obtain winter temperatures as low as 52°F (PI of 214), but because the airflow in the units is currently unknown, this can only be determined later in the project, and will depend on successful testing and balancing of the equipment.

Having to reheat the supply air to 50°F partially negates the energy savings forecast in the IPI–Herzog/Wheeler report (which based winter savings on supply air of 35°F, meaning that on cold days the air would already be the right temperature). Accordingly, Mueller looked for other ways to increase energy efficiency. Using a more efficient desiccant process instead of the booster chiller with glycol was explored, but both liquid desiccant and solid desiccant equipment proved too big to fit in the space we have (the space cannot be enlarged). Wrap-around heat pipes for AHU 4 were explored. This passive system would transfer heat, but not moisture, from the warm side of the cooling coil to the cold side, providing a certain amount of "free" reheat to supplement the reheat coil. Unfortunately, the tight space again made this impossible. We will, however, be able to see energy savings thanks to re-purposing heat generated by the compressor on the booster chiller. This heat recovery chiller will transfer heat from the

condenser to the building's heating water, pre-heating the water as it returns to the steam-to-water converter and thereby reducing steam consumption for the generation of building heating water. Most of the existing heating coils in the Folger's system cannot yet take advantage of this free energy because they were designed for higher temperature water. The new heating coil for AHU 4 (and also the new heating coils for AHUs 14 and 15, described below) will be low-temperature heating coils, able to make use of the heat recovery water. As other heating coils are replaced over time, they will also be the new low-temperature kind. Furthermore, as described under "Booster Chiller" in the Mueller schematic design submission, re-setting the heating water supply temperature in the summer could allow use of the heat recovery water with existing high-temperature coils.

Mueller design for Recommendation #2 (upgrade AHUs 14 and 15 to improve summer conditions in the New Reading Room and adjoining Service Vault)

Recommendation #2, to re-design AHUs 14 and 15 to allow for a better summer dew point based on a sub-cool and reheat system, can be implemented as described in the IPI–Herzog/Wheeler report. Existing cooling coils in AHUs 14 and 15 will be replaced, and reheat coils added. Options with and without new humidifiers were considered, as described below. Note that the New Reading Room is largely open to the Paster Reading Room (" Old Reading Room"), which is conditioned by AHU 6 (not part of this grant application). Mueller's design submission states:

> redesign of AHU 6 to allow for better summer dew point control based on a sub-cool and reheat system will minimize the potential for AHU 6 to adversely impact the environment in the New Reading Room. Modifications to AHU 6 are not included under this project, but AHU 6 should be modified similar to AHU 14 and AHU 15 under a separate project.

We have received a schematic design and cost estimate from Mueller for improvements to AHU 6, and are proceeding with that work as a separate project, independent from this implementation grant.

As can be seen in the schematic design submission, there are two options for reheat coils in AHUs 14 and 15. Option 1 adds reheat without otherwise changing the configuration of each air handler unit. However, space limitations mean that each existing humidifier would have to be removed and replaced by a new one with short vapor trails (to minimize the potential for condensed vapor droplets collecting in the fan). Option 2 removes the need for new humidifiers (an equipment cost savings of $19,500) because it would naturally place each unit's reheat coil far enough from the existing humidifier. This would be accomplished by eliminating the preheat coil, installing the new cooling coil where the preheat used to be, and installing the new reheat coil where the existing cooling cool is. This can be visualized as follows:

Existing:	Preheat coil >	Cooling coil >	Humidifier >		Fan
Option1:	Preheat coil >	New cooling coil >	New reheat coil >	New humidifier >	Fan
Option 2:	New cooling coil >	New reheat coil >	Humidifier >		Fan

The preheat coil's only purpose is to protect the cooling coil from freezing should the air temperature inside the unit drop below 32°F, but given the relatively mild winter climate of Washington, DC (average January low of 29°F), and the fact that 85– 93% of the air reaching the cooling coil will always be return

air from a space kept at 68–70°F, the preheat is an unnecessary precaution. The existing system is overbuilt for DC's winters. Accordingly, we will proceed with option 2.

Protecting the collection during construction

Because the air handler units targeted for capital improvements are physically located outside vault spaces, we do not anticipate needing to take extraordinary security measures during construction. Our standard procedures include: contractors must sign in at the Security Desk; contractors must be accompanied by a Folger staff member when working in staff-only areas of the building; steps must be taken to prevent construction dust from entering collection areas; no smoking is allowed within the building.

The environmental security of the collection during construction is a particular concern, as the capital improvements will take each of the three air handler units involved out of service for a time. Most significantly, complete replacement of AHU 4 will mean being without it for up to five months. Based on the relatively short time period involved and on our previous experience shifting the collection during the two-year Vault Repair Project, we determined that the physical handling associated with moving the entire collection to off-site storage would put it at greater risk than leaving it with only partial climate control for up to five months (provided that the work not take place in summer, when DC's climate is naturally more difficult to cope with). Moreover, moving the collection off-site would make it logistically impossible to remain open to researchers.

At no time would all air handlers serving a given area be off line. AHU 4 (to be completely replaced) pre-treats outside air going to AHU 1 (Deck C Vault) and AHU 5 (Art and STC Vaults). While AHU 4 is off line, both AHU 1 and AHU 5 will continue to operate, though overnight shut-downs will be suspended as a precaution. As demonstrated by the successful overnight shut-downs, the Deck C, Art, and STC Vaults are little influenced by the outside environment because they have no contact with outdoor weather. Nevertheless, we will schedule work for winter, when we can be sure the ground temperature and natural humidity will remain low. Additional heat and humidity can be provided by AHU 1 and 5 without the help of AHU 4, and the spaces do not contain permanent work stations, so the amount of fresh air that circulates naturally through the opening and closing of doors will be sufficient.

AHU 14 and AHU 15 will be replaced one at a time, so at any given point the New Reading Room will have one fully-operational air handler, supplemented by the moisture migration and thermal exchange with the Paster Reading Room, which is connected by three large openings and served by a completely separate air handler unit. Again, work would not be done during the extreme heat and humidity of a DC summer. Additional heat, if needed, can be provided by the perimeter radiators. (b) (4)

) is served only by AHU 15, but its door is open during the work day, so it will receive ambient conditioned air from AHU 14 and the Paster Reading Room while AHU 15 is offline. We will closely monitor the PEM2 data from the Service Vault to see if having the door closed while AHU 15 is offline creates a serious risk. If it does, we can keep the material on wheeled book trucks instead of shelves, and move the trucks to a conditioned space when the Reading Rooms are closed. We do not expect there to be a serious risk, though, as the space is small, and none of its six sides are exposed to the outdoor environment.

Effect on the building

The proposed capital improvements to AHU 4, 14, and 15 will not have an effect on the building envelope because the design changes can be accommodated within existing mechanical rooms, and

equipment will be broken down and re-assembled as necessary to accommodate existing doorways and other access routes. The riskiest part will be bringing equipment for AHU 14 and AHU 15 into the Paster Reading Room and up to the mechanical rooms on its balcony. The wall panels, book shelf moldings, door frames, and railings are all hand-carved white oak original to the building's 1932 construction. As noted in the Mueller Schematic Design Submission, "the superb quality of the finished space through which this pathway runs will require careful rigging." Past experience has shown that slow, careful, movement combined with protective blankets should get the job done safely.

Capacity to maintain and monitor systems

Immediately after each improved system is brought online during the grant period, dataloggers will be placed inside the mechanical systems so that consultants from the Image Permanence Institute (IPI) can replicate the monitoring and calculations done during Phase 1 of the Folger Sustainable Preservation Environment. We want to make sure that the equipment functions as expected, has the expected beneficial effects on the preservation environment, and consumes less energy overall than the previous, un- optimized systems.

Operating, maintaining, and monitoring the improved environmental systems over the long term will be accommodated within existing workflows:

- operation: managed by David Conine and Mitchell Norman through Johnson Controls FX Server
- maintenance: inspection, cleaning, calibration, and replacement of consumable parts (e.g. filters) of AHUs and booster chiller system managed by David Conine and Mitchell Norman; inspection, calibration, and replacement when needed of PEM2 monitors managed by Erin Blake
- monitoring: managed at the AHU end by David Conine and Mitchell Norman using Johnson Controls FX Server software; managed at the collection spaces end by Erin Blake using PEMdata software. In addition, David, Mitchell, and Erin have read-only access to each other's monitoring systems. Both systems provide point data and historic information graphs.
- twice-yearly set point changes: David Conine, Erin Blake, and Stephen Enniss will confer each November and April to agree on the target date for the switch

Workplan

October 2012 – June 2013: Design Package Development for Construction Drawings		
10/2012 – 4/2013	Preparation of construction documents for both recommendations #1 and #2	Librarian, Dir. of Finance & Admin., Facilities Manager, Curator of Art, Head of Conservation, Mueller Assoc., IPI
5/2013 – 6/2013	Bidding and award	Dir. of Finance & Admin., Facilities Manager, Curator of Art, Librarian,
July 2013 – December 2013: Order New Equipment with Appropriate Lead Times Each equipment purchase to include submission of the approvals (shop drawings), engineer review, responses by contractor / manufacturer, engineer approval, fabrication / assembly (16 weeks minimum), disassembling for shipping and installation, and delivery		
7/2013 – 12/2013	Order new custom AHU 4 – 3,000 CFM	Dir. of Finance & Admin., Facilities Manager, subcontractor, IPI
10/2013 – 12/2013	Order 40-ton heat recovery chiller for AHU 4	Dir. of Finance & Admin., Facilities Manager, subcontractor, IPI
11/2013 – 12/2013	Order new cooling and heating coils for AHU 15 and AHU 15	Dir. of Finance & Admin., Facilities Manager, subcontractor, IPI

January 2014 – April 2016: Construction No construction is to start until firm delivery confirmation of all ordered equipment		
1/2014 – 9/2014	Start-up, prep, staging for all work	Dir. of Finance & Admin., Facilities Manager, Curator of Art
October 2014 – August 2015: AHU 4 AHU 4 out of service Oct 2013 through April 2013 (during period of low humidity) as collection will not be moved and that area will be on 100% re-circulated air.		
10/2014 – 11/2014	Space preparation, demolition of existing AHU 4	Librarian, Dir. of Finance & Admin., Curator of Art, Facilities Manager, Chief Engineer, subcontractor
12/2014	Rigging	Facilities Manager, Chief Engineer subcontractor
1/2015 – 4/2015	Installation of new AHU 4, new chilled water (glycol) system, new piping, valves, appurtenances, new pump for reheat coil; modification of new pump for reheat coil; installation of new wiring, controls and other electrical.	Facilities Manager, Chief Engineer, subcontractor
5/2015 – 6/2015	Environmental stabilization/testing & balancing	Facilities Manager, Chief Engineer, subcontractor
7/2015	Commissioning to ensure requirements are met	Facilities Manager, Chief Engineer
October 2014 – April 2016 AHU 14 & AHU 15		
10/2014 – 42015	AHU 14 out of service	
10/2014	Rigging AHU 14	Facilities Manager, Chief Engineer, subcontractor
10/2014 – 11/2014	Preparation of AHU 14 to receive new equipment: remove existing heating and cooling coils, electrical preparation	Facilities Manager, Chief Engineer, subcontractor
12/2014 – 2/2015	Installation of new heating and cooling coils, new coil piping, valves, and appurtenances, new electrics, and controls	Facilities Manager, Chief Engineer, subcontractor
3/2015 – 4/2015	Environmental stabilization/testing & balancing	Facilities Manager, Chief Engineer, subcontractor
5/2015	Commissioning to ensure requirements are met	Facilities Manager, Chief Engineer, subcontractor
10/2015 – 4/2016	AHU 15 out of service	
10/2105	Rigging AHU 15	Facilities Manager, Chief Engineer, subcontractor
10/2015 – 11/2015	Preparation of AHU 15 to receive new equipment: remove existing heating and cooling coils, electrical preparation	Facilities Manager, Chief Engineer, subcontractor
12/2015 – 2/2016	Installation of new heating and cooling coils, new coil piping, valves, and appurtenances, new electrics, and controls	Facilities Manager, Chief Engineer, subcontractor
3/2016 – 4/2016	Environmental stabilization/testing & balancing	Facilities Manager, Chief Engineer, subcontractor
5/2016	Commissioning to ensure requirements are met	Facilities Manager, Chief Engineer

Fall 2012 – Winter 2016: Evaluation and Review by IPI		
10/2012 – 8/2016	Evaluation preparation and site visits from IPI	Librarian, Dir. of Finance & Admin., Facilities Manager, Curator of Art, IPI
11/2016	Final report from IPI	IPI

Project team

Stephen Enniss, Eric Weinmann Librarian, will serve as project director, managing the budget and serving as the main point of contact with NEH. Dr. Enniss began his tenure at the Folger Shakespeare Library in January 2009 after serving as the Director of Emory University's Manuscript, Archives, and Rare Book Library, where he led the significant growth of the Library's collections. He earned a Ph.D. in English literature from the University of Georgia and an MLS from Emory University.

Melody Fetske, Director of Finance and Administration, will serve as project co-director, with Dr. Enniss. Ms. Fetske is responsible for overseeing the financial life of the institution. She directs all finance and administrative functions of the Library, and is responsible for the day-to-day operation of the buildings and grounds maintenance, business office, housekeeping, human resources, information systems and technology, and gift shop. Ms. Fetske has overseen many construction and renovation projects at the Folger over the past fifteen years, including: Fire Suppression and Security Systems Upgrade, Emergency Vault Membrane Repair, Conservation Laboratory Construction, Renovation of West Building Offices, Renovation of 301 East Capitol St., SE to become the Haskell Center for Education and Public Programs.

David Conine, Facilities Manager, will be the project manager, facilitating ongoing tasks and collaborative decision-making, while managing operations, maintenance, and monitoring and evaluation. He will accompany Mueller and Associates and IPI during onsite visits, providing access to the air handlers and other relevant mechanical systems and equipment, and he will be the key contact for any queries related to these systems during the project period. He has seven years of experience in management of maintenance and construction environments. Prior to that position, he was Chief Engineer for Combustioneer.

Dr. Enniss, Ms. Fetske, and Mr. Conine will be supported by a team of Folger staff members, all of whom have responsibilities and expertise in aspects of the project, including:

Erin Blake, Curator of Art and Special Collections. Dr. Blake holds a Ph.D. in Art History from Stanford University. Her experience in humanities research and education includes published papers, invited lectures, exhibitions, and a teaching appointment at Rare Book School at the University of Virginia. She served as project manager on Phase 1 of FSPEP, and acts as the "climate liason" between collections staff and facilities staff.

Renate Mesmer, Eric Weinmann Head of Conservation. Ms. Mesmer oversees the Folger's internationally renowned conservation laboratory and in this capacity will consult with the project team and contractors. Ms. Mesmer is the former Director of the Book and Paper Conservation Program at the Centro del bel Libro in Ascona, Switzerland. She has a Master's degree in bookbinding from the Chamber of Crafts of Palatinate in Germany and gained experience in conservation during ten years of work as head of the conservation department at the Speyer's State Archives in Germany.

Mitchell Norman, Chief Engineer. Mr. Norman oversees daily operations of engineering staff and mechanical systems at the Folger. In this capacity he supervisors engineers and contractors, repairs and maintains building electrical, mechanical, plumbing, doors, floors, and carpentry, and works with the Folger's energy management system.

The Folger will also tap leading experts in preservation technology and energy efficiency to join the project team, as third-party contractors:

Mueller Associates, established in 1966, provides mechanical, electrical, and plumbing engineering services for facilities throughout the Northeast and Mid-Atlantic. The firm specializes in engineering for academic buildings, museums, performing arts centers, and other complex environments involving advanced technology, stringent environmental controls, and challenging sustainability requirements. Mueller will provide the design services for the implementation of the two HVAC modifications; a new AHU and booster chiller to provide better dehumidification to incoming outdoor air provided to the art vault, STC vault, Deck C vault, and service vaults, and design modifications to AHU 14/15. Mueller engineers Paul Czajkowski, Todd Garing, Robert Marino, and Kenneth Rock will work with Folger staff on this project.

Image Permanence Institute (IPI) is a university-based, non-profit research laboratory founded in 1985 as a department of the College of Imaging Arts and Sciences at Rochester Institute of Technology, in Rochester, New York. Devoted to scientific research in preservation technology for library, museum, and archives materials, IPI supports the preservation field through research, publication, educational activities, products, and services. We will work with IPI's Director, Professor James M. Reilly, who is also the co-director of the Advanced Residency Program in Photograph Conservation at George Eastman House, a consultant to numerous museums and government agencies, and a widely sought-after teacher and seminar speaker, and with Jeremy Linden, Preservation Environment Specialist at IPI, Formerly the Head of Archives and Special Collections at the State University of New York at Fredonia, he is deeply familiar with the use of IPI's research tools in special collections settings.

Project results and dissemination

We expect that Phase 2 of FSPEP will extend the life of the collection by slowing chemical damage (natural aging), and eliminating the risk of mechanical damage, mold, and metal corrosion. In the case of the underground vaults (Deck C Vault, Art Vault, and STC Vault) that house the vast majority of the Folger's collection of rare books, manuscripts, and works of art, the rate of natural aging should be cut by almost two-thirds. We will continue to monitor the spaces as we have been since December 2008, with daily data uploads from some PEM2 loggers and monthly uploads from the rest, to ensure that project goals are being met.

We also expect that Phase 2 will reduce energy consumption compared to the operation as-found in the IPI–Herzog/Wheeler report, though not as much as initially hoped because of the need to reheat supply air from AHU 4 to 50°F instead of leaving it at 35°F. Implementing overnight shut-downs of AHUs 1 and 5 (serving the well-insulated underground vaults, which are unoccupied overnight), correcting the year-round sub-cool and reheat that needlessly cooled already-dry winter air, keeping lower winter temperatures in the underground vaults, and taking advantage of the heat recovery possible from the new booster chiller, will undoubtedly have an effect. With help from IPI consultants, we will verify that the implementation is working as expected, and quantify the change in energy consumption.

Approximately one year after the project's completion (i.e. after we have experienced all four seasons with new equipment and operating procedures) we will create a white paper to share with the larger community. We also anticipate presenting the project at conferences. The white paper and conference presentations will cover why we made the changes, what the costs and benefits were, and how we continue to monitor and maintain the improvements. We believe that our work will provide a model for others, and thanks to the internationally-recognized importance of our collection, people will be open to listening to us.