

Historic New England

HVAC Systems in Historic House Museums Roundtable Meeting Notes

April 6th 2011

Codman Carriage Barn, Lincoln, MA

Participants included:

John Childs, Chair (Art Preservation Services)	Michaela Neiro (Historic New England)	Tim Walsh (Historic New England)
Ben Haavik, Chair (Historic New England)	Bill Remsen (William Remsen Architects)	Ben Wilson (New Hampshire Bureau of Historic Sites)
Colleen Chapin (Historic New England)	Caroline Roberts (Winterthur Fellow)	Mark Wilson (The Trustees of Reservations)
Neil Ellwein (Colonial Williamsburg Foundation)	Rodney Rowland (Strawbery Banke)	Bill Wladyka (WJ Wladyka Systems Consulting)
Gretchen Guidess (Historic New England)	Jim Shea (Longfellow House, National Park Service)	Laura Word (National Endowment for the Humanities)
Richard Kershner (Shelburne Museum)	Patricia Silence (Colonial Williamsburg Foundation)	Josh Wright (Historic New England)
Erin Knerr (Historic New England)	Brigid Sullivan (National Park Service Northeast)	
Charles J Moore (Preservation Society of Newport County)	Kerry Vautrot (Historic New England)	

Statement of Purpose: The roundtable has been organized as part of Historic New England's IMLS grant-funded two year project to implement an improved environmental monitoring system for its historic house museums and upgrade the environmental control systems in four of its house museums. The goal is to share Historic New England's findings and to foster a dialogue with other peer organizations about the different approaches that have been taken to improve Relative Humidity (RH) control in historic house museums in the region.

Historic New England Project Overview (1990-Present)

Mr. Haavik presented on Historic New England's attempts since the early 1990s to improve RH control in the collection of historic house museums.

- In the 1990s Historic New England received a grant from the National Endowment of the Humanities (NEH) to fund a project to better control the environment in eight of Historic New England's principal properties. The goal was to improve the environment to benefit the collections in the properties,

Historic New England

without harming the building structures. At each property, the project consisted of three phases:

- Monitoring to identify sources of moisture
- Action to eliminate the sources of moisture
- The introduction of humidistatic techniques to reduce humidity and control climate year round
- In recognition of the unique conditions of each house, and in an effort to learn as much as possible during the implementation of the project, seven different systems were installed in the eight houses after analysis and mitigation of water infiltration.
- Problems with the systems began to develop almost immediately. Historic New England was plagued by staff turnover, a lack of sophisticated infrastructure, poor design and implementation of the systems, and was unprepared for their high maintenance costs. Communication with the systems was difficult at best and the DOS based operating system was quickly outdated and upgrades were not affordable.
- Approximately 10 years later Historic New England secured a Kress Fellowship to focus on the environmental issues at the sites. The environmental fellow would analyze the success of the 1990s project by reviewing the data and collecting new environmental data. The fellow was the first full-time staff person dedicated to analyzing the environmental conditions at the sites and her analysis provided the following lessons learned:
 - Water mitigation efforts were apparently productive, but a general lack of specific data (ie monitoring of RH) makes it difficult to analyze results
 - Environmental data collection needs to be consistent and reliable.
 - High-end HVAC equipment and controls require a substantial allocation of funds to maintain.
 - Pressurizing different sections of the buildings proved very tricky and technically demanding.
 - The introduction of glycol into many of the systems was very destructive in the long term.
- A four point approach was developed by staff to help guide our actions with the systems:
 - Collect temperature and RH data in the museums before, during, and after any work is implemented.
 - Understand that the majority of the objects within the structure can survive within parameters of 30-60% RH.
 - Perform corrective repairs to elements that are allowing water to infiltrate the building and use the environmental data to measure the results.
 - Install mechanical systems using simple controls and equipment in a phased approach and evaluate the environmental data after each phase.
- Next steps (2008-2011): At the conclusion of the Kress project Historic New England had gathered information on its systems from the past and developed

Historic New England

lessons from those projects. The next step was to start implementing those lessons and secured IMLS funding over two years to:

- Continue the staff position.
- Improve our environmental monitoring and analysis of data.
- Continue our experimentation with simpler systems by adjusting and modifying the 1990s systems by adding basement heat and humidification

What RH Number is the Right One (Historic New England Approach)

Mr. Childs presented on the development of the so-called museum standard for collections environments; 70° F and 50% RH ± 5%, and how Historic New England is moving toward a more realistic and achievable range.

- During WWII, the National Gallery relocated its art to caves in Wales that were easily regulated to a constant temperature of 68° F with RH levels of 50% ±5. Condition problems which the collection routinely developed over time in the Gallery disappeared during the relocation, and this became powerful anecdotal evidence for the importance of environmental control. Environmental guidelines of 70° F and 50% RH ± 5% began to be widely instituted. What developed as guidelines gradually tightened into “standards” which were more and more rigidly applied.
- In the 1980s it was increasingly recognized that maintaining these “standards” would negatively affect un-insulated buildings without vapor barriers in cold-weather climates, like New England. This was explicitly recognized in the New Orleans Charter of 1991.
- In “A Practical Approach to Environmental Requirements for Collections” JAIC 1992, Richard Kerschner recommended a range of 35%-60% as being more practical for historic houses.
- Historic New England’s environmental project in the 1990s took the new Orleans Charter and Kerschner’s work into account and set a range of 40%-60% RH as a goal, along with moisture mitigation and installation of Direct Digital Controls (DDC) to operate the new mechanical systems.
- Analysis of the 1990s project in 2007 confirmed what had become clear to Historic New England staff: in many cases the systems no longer worked properly, and in some cases conditions were actually worse than before the 1990s project.
 - Hamilton House, South Berwick, Me
 - Suffered from delimitation of wallpaper, flaking paint, mold and shrinking, all apparently the result of the 1990s work and a system that was operating much on its own.
 - Review of retained data reveals that environmental conditions after drainage remediation in the 1990s might not have merited installation of system.
 - Cogswell’s Grant, Essex, MA
 - The 1990s system was poorly installed and there were multiple problems with the ductwork, causing the RH to increase and mold to develop and bloom on both the collections and the building interiors.

Historic New England

- Anecdotally the house never had mold issues before the system was installed.
- Historic New England is now trying to implement simplified systems to maintain a range of 30%-60% RH, with set points allowing for the appropriate seasonal drift.
- For collecting and monitoring environmental data Historic New England currently uses dataloggers by Onset with analysis software by the Image Permanence Institute.

APT DC Conference Update

Ms. Silence, Mr. Kershner and Mr. Remsen updated the group on the Association of Preservation Technology (APT) conference in Washington DC in March, 2011.

- The meeting covered many of the issues being discussed at the round table.
- The Lancaster Resolution, the product of a “Round Table Discussion: The Introduction of Modern Mechanical Systems Into Historic Buildings In New England”, sponsored by the Getty Grant Program and held in Lancaster, MA in 2009 was introduced at the meeting in DC.
 - Many of the attendees at today’s roundtable were participants in the Lancaster Resolution
 - It was agreed that the Lancaster Resolution was an excellent document that needs to be shared with a wider audience.
 - It was further agreed that a 2-day conference or roundtable should be organized to continue to hash out the details of the Resolution. The more parties there are in the room, the more the final document will be widely accepted.

Simplified Systems (What Does That Mean?)

Mr. Haavik presented on Historic New England’s experiences with trying to simplify the HVAC systems installed in the 1990s.

- The 1990s project installed Direct Digital Control (DDC) panels that became known as the “black boxes” because only a few years after their installation no one knew how they were set up or what they should be doing.
 - Because of infrastructure and modem issues the control panels never effectively communicated out to the main computer at our headquarters.
 - The control company also could not communicate with the systems.
 - Trouble shooting ended up being very expensive service calls that reset the system,
 - Ten years later the systems were being re-set with a series of floppy disks that had survived over the years. Unfortunately whether these were the correct disks to use and whether the set points contained on the disks were the most accurate remained undetermined.
- The lack of control over the “black box” caused Historic New England to take a step back and move toward simpler controls:
 - Simple meant basic thermostats for the heating systems and the built-in humidistats on dehumidifiers.

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- But then the desire to gain more control and get better efficiency out of the system took over.
 - Next step was to install a simple control panel consolidating separate controls into one location. A humidistat, high temperature thermostat and a low temperature thermostat were mounted on a board together.
 - The different controls are wired together to provide finer level control over the heating system and dehumidifiers.
 - The control panel is for the heating plant and to squeeze efficiency out of the system by only having it operational when necessary (ie heat is only on when RH is high or if the ambient temp gets too low and is shut off when ambient temp is too high).
 - This system seems simple with low tech thermostats, etc, however there is a lot of wiring required and requires an electrician to troubleshoot.
- Realizing the above mentioned controls really are not that simple Historic New England advanced the idea one step further and has recently installed a proprietary DDC control panel that can take care of all of these different needs.
 - Replacing one of these panels, in theory, will be easier than replacing the two thermostats, a humidistat and then resetting all of the set points. The choice of the DDC was predicated on the control company being regional, having these panels “off the shelf” and that they have easy access to our programming in order to replace set points.
 - When you look past the modern on-site interface, the new control box behind the interface looks very similar to the “black box” control panel of the 1990s.
- Is Historic New England headed back down the same road?.
 - Simple keeps getting more complicated because we want the systems to be effective and to be efficient.
 - Today we need to balance a number of issues as it relates to the control of our systems:
 - Is it easy even for untrained staff to understand what is going on
 - Is it easy to fix? What is the least number of contractors required to fix a system.
 - Is there quick turnaround for when parts are needed

Heat and Dehumidification Systems

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Mr. Haavik reiterated Historic England’s new four point approach (listed above) when installing new systems, and discussed some of the recent systems.

- Historic New England has been focusing on a bottom up approach to focus the efforts in the basement where the conditions are the worst and are also not concerned with “human comfort”
 - Focusing in the basement will help with mitigation of the basement air to the upper floors
 - Seek to resolve drainage issues

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- Close basement from outside
 - Treat basement air
- Experiment 1: Castle Tucker, Wiscasset, ME
 - The basement was notorious for having high RH readings. The basement walls were continually covering in a green mold.
 - The new system consisted of two basement heating zones, one with a modine heater and cast iron radiators while the other only had the radiators.
 - Two dehumidifiers were need to further help control the RH
 - After the installation the RH numbers did return to a more acceptable reading.
 - The swings of data have reduced.
 - The risk of mold germination has decreased significantly.
- Experiment 2: Marrett House, Standish, ME
 - The basement was so wet that at times water would drip off the floor joists and there was typically standing water.
 - Minor drainage improvements were carried out to help reduce the water along with a trench drain with a sump pump to help remove the excess water.
 - A hydronic heating system was installed using two electric hot water heater with free standing cast iron radiators
 - Since the work the RH numbers have fallen into the approved range of 30%-60% all the while reducing the standard deviation to more acceptable numbers.
- The IMLS Grant Funded Project (2009-2011)
 - Was created with the previous two experimental systems in mind focusing on modifying heating, ventilating, and air conditioning systems to improve the environment.
 - The project focused on new or modified systems at four houses.
- Hamilton House, South Berwick, ME
 - The goal was to reestablish control of the system to achieve levels within 30%-60% range because the 1990s system had been malfunction causing the house to be over heated.
 - The old system was dismantled and removed
 - The basement was completely closed off from the upper floors. A new boiler was installed with radiators to help heat the space.
 - Dehumidifiers were also added to further help remove moisture.
 - This work had a tremendous effect on the space.
 - The RH readings for both the basement and parlor have flat lined.
- Cogswell's Grant, Essex, MA
 - The first floor was experiencing large amounts of mold growth mostly in the dining room. The cause was later found out to be that the ductwork was faulty, allowing for basement air to migrate into the dining room causing the large mold blooms
 - The 1990s system was completely shut down and all ductwork to the first floor was closed up.

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- Basement heat like that of Hamilton House was added with the use of radiators however, dehumidifiers were not added until after it was found that heat wasn't enough to reduce the RH.
- Don't have any congruent data because there was a problem with the system being in the wrong season.
- Spencer Peirce Little Farm, Newbury, MA
 - The goal was to reduce the high RH in the house, eliminate mold growth on the objects and the interiors.
 - The underlying drainage issue was analyzed and remediation required is quite significant. Planning and fundraising is underway.
 - To help with museum mold a dehumidifier was added to the museum air handler and a basement heat loop and dehumidifiers were added..
 - The data doesn't show a great improvement because the basement has had measurable amounts of standing water and still needs to be mitigated.
- Sayward-Wheeler House, York Harbor, ME
 - This house has never had a heating plant because it was only ever used as a summer house.
 - The goal became to design a system to reduce the RH more effectively, eliminating mold growth in the house interior and on the collections. the design would be easy to understand and not require a specialized expertise.
 - The underlying moisture issue is related to the building being situated on ledge.
 - Basement heating was accomplished by installing a hydronic radiant floor in a concrete floor that needed to be re-poured. New drainage planes were created as part of the floor process to keep ledge run off contained and transported out of the basement.
 - This system was the last to be installed and although early data shows positive results not enough time has elapsed for an accurate understanding.
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- Next steps
 - To look at the sites that have no heating and see what the effects are when using passive techniques.
 - Analyze the different systems and set points in conjunction with moisture migration in the different buildings in our collection.
 - Does it matter the type of heat we use (radiators, hot air, radiant floor, etc) and which one is most cost effective?

Strawbery Banke

Mr Rowland discussed an IMLS Climate Grant to study and improve environmental conditions in ten of the furnished house museums at Strawberry Banke., Rowland's presentation focused on the Thomas Barley Aldrich House.

- The project was divided into two phases
 - Phase 1: Climate Data Collection/Consultant review and improvement plan
 - Phase 2: Install humidity controls and light filters

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- The public entrance to the Thomas Bailey Aldrich House c. 1797 is through the back of the house via the gardens.
- Converted a servant's space into an entry exhibit space to keep outside air from accessing the actual museum space.
- All closet doors are fixed open, and the closet spaces are used to house ductwork and supply vents. Black curtains are used to help conceal as much as possible. The basement door is fixed open and used as the return air supply.
- The system is controlled by a humidistat with a temperature range control.
- The data loggers and modem are all located in the basement with all monitoring being carried out from the basement.

Shelburne Village, Shelburne, VT

Mr. Kershner presented on a newer type of heating and cooling option, which is a ductless system that requires very little space and has been used for years in Europe.

- A 525 foot long horseshoe-shaped building was built to house a miniature version of a circus parade. Because of the design it was difficult and expensive to configure a traditional heating system; a decision was made to look into the Mr. Slim split-ductless system.
- The split-ductless system is newer to the US but has been used in Europe for years. This ductless air conditioner and heat pump has been able to keep the RH below 60% in the summers, despite no insulation in the building and just tight construction.
- The system takes up little space but does require a few holes in the building for the coolant lines to attach to the condensing coil, which is placed outside the building. The coil can be placed up to 50 feet away from the building.
- The system works best in a large open space and the filters need to be cleaned once a month.

Colonial Williamsburg

Ms. Silence and Mr. Ellwein discussed issues at Colonial Williamsburg (CW) dealing with their historic area and heating systems. Their presentation focused on the Peyton Randolph House.

- The Peyton Randolph House, c. 1715, is used as exhibition space. But because the house is located in an historic area no modern mechanical systems can be visible. All system components are therefore confined to the basement.
- In order to keep noise levels to a minimum and not interfere with the visitors' experience, an insulated box-within-a-box was built in the basement to house the mechanical system.
- Because of high summer temperatures and RH, CW's systems must have air conditioning in order to provide for visitor comfort. This adds to the complexity of their systems.
- At CW, most of the HVAC systems are run by DDC. Overall, there are three different DDC systems, provided by three different vendors. This adds considerably to the complexity.
- CW has personnel monitoring the systems 24/7 in a central location.

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Wrap up

The combined experiences and lessons learned by the attendees to the roundtable lead to some basic guidelines for historic house museums:

- Design systems that are understood by those responsible for the day-to-day site management.
- Keep it simple, especially the controls.
- Use local contractors who understand the proposed systems.
- Require as-builts from all contractors, equipment as-builts and control as-builts and create a system manual.
- Review and update system documents at least annually.
- Do not install any systems unless there is staff expertise available to monitor and troubleshoot the systems after the project is completed, and funds are available to maintain and update software as required. Staff turnover can be very costly unless the new staff member is well versed in the systems.
- Continue reliable temperature and RH monitoring after the systems are installed.
- Design systems to fail to a safe mode (i.e. heat turn off instead of overheat).
- Include minimum and maximum set safety points for T and RH with fail-safe mechanical cut-offs.