28 December 2007

By H Jay Enck
Commissioning & Green Building Solutions, Inc.

Hind Sight of a LEED Silver Museum Two Years after Completion

Museums have very special requirements for maintaining indoor temperature and humidity conditions to maintain historic artifacts. The “Little White House” was built by Franklin Delano Roosevelt in 1932 in Warm Springs, Georgia where he retreated for rest and physical therapy for the paralysis caused by polio. During FDR’s presidency and the Great Depression, he developed many New Deal Programs (such as the Rural Electrification Administration) based upon his experiences in this small town. While posing for a portrait on April 12, 1945, FDR suffered a stroke and died a short while later. After his death on April 12, 1945, thousands of visitors sought to visit President Roosevelt’s Little White House.

The trustees of the Georgia Warm Springs Foundation, to which FDR willed the Little White House, were not organized to provide the special administration necessary and decided to donate the properties to the State of Georgia on the condition that the Little White House is suitably administered as a memorial. The State of Georgia established the Franklin D. Roosevelt Warm Springs Memorial Commission in January 1946. In July 1980, administration of the memorial was transferred to the Parks, Recreation, and Historic Sites Division of the Georgia Department of Natural Resources. In May 2003 years of planning and fundraising came to fruition allowing a many new improvements to this historic site which included a new 10,500 sq ft building addition to the 3,305 sq ft existing gatehouse completing the new museum complex in April 2004. The gatehouse originally served as the ticket office, gift shop and administrative office on a small portion of the historic site.

The new addition which now houses the “Unfinished Portrait” and showcases many exhibits, including FDR’s 1938 Ford convertible with hand controls, his Fireside Chats playing over a 1930s radio, his stagecoach and a theater that shows a brief newsreel-type film, "A Warm Springs Memoir of Franklin D. Roosevelt," compiled of footage from home movies of FDR filmed at the Little White House in the 1920s and 1930s.. The existing museum building was renovated and converted to a gift shop and admission center, the existing maintenance barn was deconstructed and replaced with a new maintenance barn, the water system was upgraded, and the existing administrative offices received interior renovations. The project was accomplished through a design build delivery method within a $5 Million dollar budget.

The new museum and renovated gatehouse are conditioned by central chilled water plant and rainwater fed cooling tower supplied by roof area storm water collection system and supplemented by the updated water system when necessary. Two variable air volume air handlers with electric reheat and return air humidifiers maintain interior temperatures between 68 and 78 °F and relative humidity between 45 and 55%. One of the main constraints in temperature and humidity control in a museum occurs in the winter when indoor humidity levels could typically drop to 20 to 30% relative humidity without humidification. Raising the indoor relative humidity to the desired 50% requires significant energy and limits setback temperatures during unoccupied periods. Exhibit 1 illustrates the difficulties associated with lowering space temperature.

As shown in Exhibit 1 lowering the room temperature from 72 °F at 50% RH to 65 °F raises relative humidity levels to 75%RH. It is essential to understand this phenomenon when operating the museum because the higher humidity levels will damage artifacts unless it is dehumidified. During the commissioning process after the controls contractor had completed their programming, we observed this problem while conducting system performance testing as well as observing condensation forming in the artifact storage area. Working with the building operator, the controls contractor, and the designers, changes in sequences of operation and establishment of operating parameters were implemented to protect the artifacts within FDR's Little White House. Understanding how wall and HVAC systems work was critical to correctly operating the facility after commissioning.

The importance of maintaining strict temperature and relative humidity levels to protecting the artifacts hinges on controlling the moisture content of the interior air year round. Lowering the space temperature from 72 F to 65 F as a conservation measure would raise the moisture levels in the building causing excess moisture buildup and mold growth. Mold growth, which is a symptom of high moisture levels in a building, occurs when all of the following conditions are present:

- Temperature between 45 and 95 degrees Fahrenheit (°F)
- Oxygen
- Organic nutrients (many building materials provide food for mold growth)
- Moisture (water or RH above 70 percent)

The only one of these conditions that is easily controlled indoors is moisture.

EXHIBIT 1
Relationship Among Dew Point, Humidity Ratio, and Relative Humidity at Various Temperatures
At a given dew point and humidity ratio, a slight increase in temperature results in a significant decrease in RH.

Dew Point (°F)	Humidity Ratio (grains/lb)	Relative Humidity at 65 °F (%)	Relative Humidity at 72 °F (%)
57	69.5	75	50

The commissioning process identified and helped correct issues that would have affected the buildings intent and performance including moisture control, correct operation of demand based ventilation, accessibility to equipment for routine maintenance, incomplete work and missing equipment required for correct operation of the facility. Some examples are the misunderstanding by both designers and contractors of how demand based ventilation control should be designed and installed. Designers not specifying a clear sequence of operation leaves open to contractor interpretation how to set damper positions and implement control sequences.

FDR's Little White House museum is such a case in point where the control contractor called for the outside air damper to modulate between open and closed based on carbon dioxide concentrations in the building's interior. This would have resulted in causing the building to fluctuate between positive and negative pressurization and introducing to much outside air during periods of high visitor occupancy. The commissioning process identified the correct minimum outside air (OSA) damper position during occupied periods to maintain positive pressurization and maximum OSA damper position need to meet ventilation requirements specified by the designer which did not exceed the HVAC systems capacity to properly condition the OSA.

Energy Efficiency

FDR's Little White House was designed to reduce operating energy costs by 36.89% over a building constructed to ASHRAE Energy Standard 90.1 – 1999. Some of the energy efficiency features employed included the following:

- R-20 continuous insulation on roof and R-19 continuous insulation on the exterior wall with 6" metal studs (new building addition);
- High performance windows;
- General lighting power density reduced by 45%
- Dimmable display lighting;
- CO_2-controlled ventilation;

An energy analysis for the Little White House Museum (Warm Spring, GA) was performed using eQuest and calculation protocol from the US Green Building Council's Leadership in Energy and Environmental Design (LEED®) version 2.1 Energy Modeling Protocol (EMP) illustrated in LEED-NC Reference Guide, which is derived from ASHRAE 90.1-1999 Chapter 11 Energy Cost Budget (ECB) Method. The original model completed in 2003 predicted that the regulated load which includes heating and cooling, general lighting, and service hot water heating would be 14.43 kWh/sq ft · yr. The unregulated loads, which include exhibits, exhibit lighting, rain water make-up water pump, plug loads, operation of exhibits, theater, etc. were estimated to be 17.05 kWh/sq ft · yr resulting in predicted energy usage for the museum and renovated guard house to be 31.48 kWh/sq ft · yr.

The 1999 ASHRAE Energy Standard 90.1 does include process loads such as the exhibits, exhibit lighting, theater operation, etc within the regulated energy cost budget calculations. Table 1 shows the original lighting power density assumptions for the Little White House museum. It is easy to see that moving the exhibit lighting alone into the unregulated column significantly reduces the regulated lighting load and is a major contributor to the buildings calculated energy efficiency.

Table 1

Little White House Museum			
Building Area Method - Lighting Power Density			
VA Total	Square Feet	Actual VA/SF	Allowable VA/SF
(Non Exhibit Lighting)			
9796	11262	0.87	1.60
(Exhibit Lighting)			
22411	11262	N/A	N/A
Totals			
32207	11262	2.86	N/A
Per Section 9.3.1 Exhibit Lighting is exempt from the Lighting Power Density Restrictions			

Based on 2005 actual energy usage the facility consumed 42.46 kWh/sq ft · yr which is approximately 25% more than the original energy model predicted. To correlate between actual energy usage and calculated energy usage predicted in the original energy model requires that the actual weather data for the area during the same period. This weather information has several problems including being 40 miles north of the closet weather station and missing hourly information. Other reasons for this discrepancy which are unknown by the author at the time of this article include:

- Actual weather conditions vs. historic averaged annual data used by energy modeling software programs
- Variations between actual conditions and ones assumed by the energy modeler
- Additional equipment installed not included in the original contract documents
- Changes by building operators

In general the building appears to be operating as intended. Operators and occupants are pleased with the facilities operation. However, with actual energy usage 25% greater than predicted, efforts are currently underway to analyze and understand why the predicted performance is not closer to actual. The actual energy consumption of a well commissioned building is the best benchmark for establishing energy performance. The commissioning process verifies that the building systems are operating as intended. Fluctuations in energy consumption need to be identified and analyzed so that operators and owners can maintain buildings at peak performance for the life of the facility.