



Museums: Unique Commissioning Challenges

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George Bourassa





Why Museums Are Unique

- Collections are most often irreplaceable and priceless
- Artificial and natural lighting can impact collection integrity
- Pollutants in outside air can be damaging to collections
- Artworks are particularly sensitive to changes in environmental conditions – especially relative humidity
- Stabilization of interior conditions within narrow limitations is critical to long term care of collections, especially artworks
- Art galleries have high traffic flow – challenge to maintaining environmental conditions
- Balance between protection of collections and display for public appreciation
- Many normally successful energy efficiency strategies are counter-productive in museum environments
- High level of security in museums complicates normal commissioning activities







Environmental Conditions – Majority Of Buildings

- Most commissioned buildings have people as main “occupants”
- ASHRAE comfort envelope for people defines acceptable temperature/relative humidity combinations for summer and winter seasons
- Based on energy conservation concerns, summer temperatures for “people” comfort envelope are higher than winter
- Comfort envelope has relatively broad RH boundaries



-  Normal winter comfort zone for people
-  Normal summer comfort zone for people

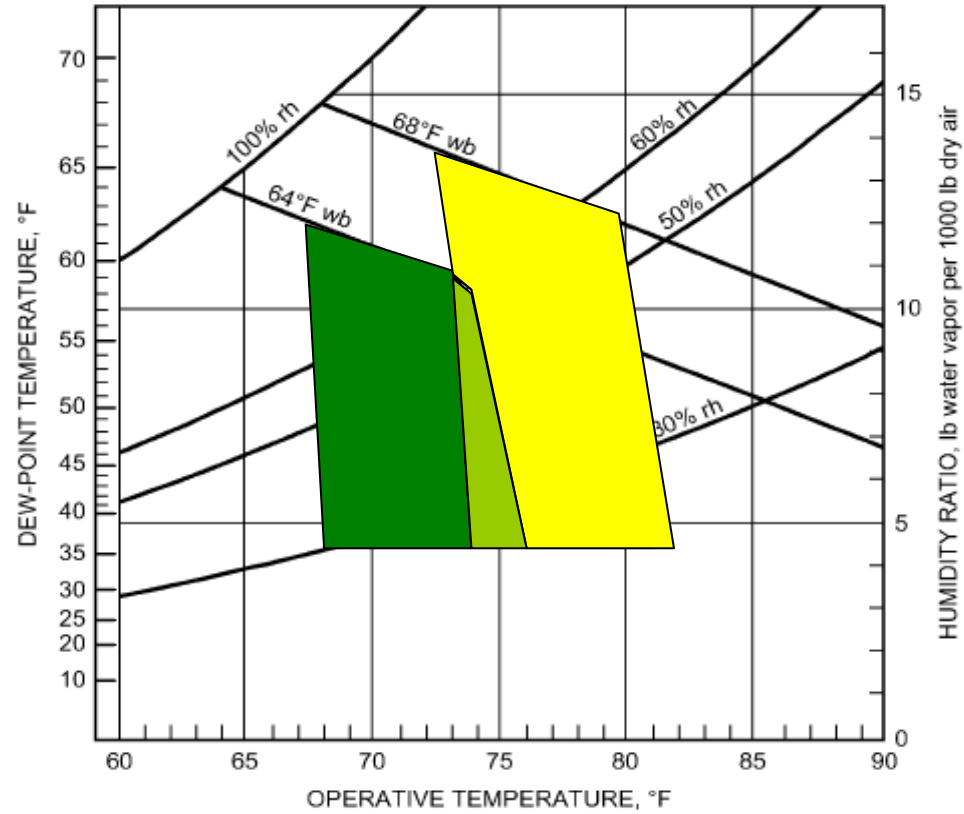


Fig. 5 ASHRAE Summer and Winter Comfort Zones
 (Acceptable ranges of operative temperature and humidity for people in typical summer and winter clothing during primarily sedentary activity.)

Graph from the ASHRAE 2005 Fundamentals Handbook





Environmental Conditions – Museum Buildings

- Museum buildings have collections as main “occupants” in galleries and storage spaces
- Equivalent “comfort” envelope for collections, especially artworks, defines acceptable temperature/relative humidity combinations for summer and winter seasons
- Comparison of collections and people comfort envelopes demonstrates demanding limits on temperature and relative humidity combinations for museums



-  Normal winter comfort zone for people
-  Normal summer comfort zone for people
-  Museum winter comfort zone
-  Museum summer comfort zone

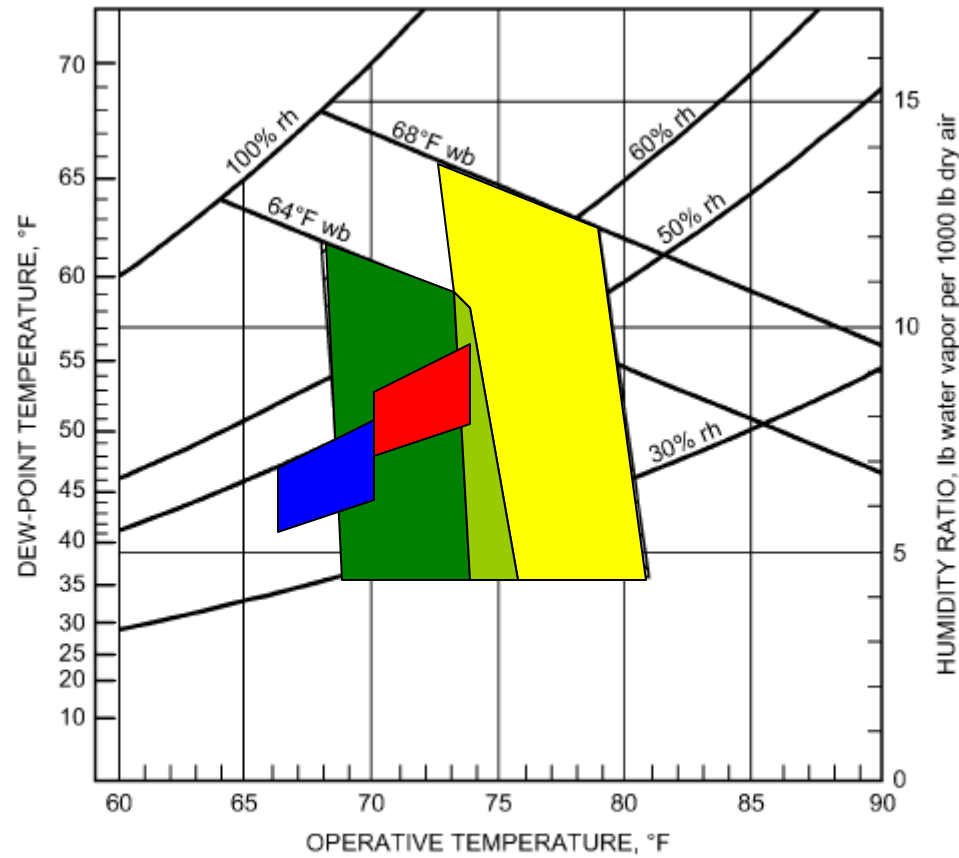


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Environmental Conditions – Museum Buildings

- Beyond narrow limits of temperature/relative humidity conditions, collections are sensitive to change, especially relative humidity – added restriction of not more than 5% RH change in 24 hour period
- Highest quality of commercial RH sensor has accuracy of +/- 2%, such that maintenance of stable RH conditions is highly demanding





Environmental Conditions – Museum Buildings

- Traveling exhibits require verification of stable maintenance of environmental conditions as prerequisite to collections assignment for display
- Reliability of components and systems becomes critical to ongoing operations for museums – higher level of expectation
- Effective training of system operators is also fundamental to successful stabilization of environment





Environmental Conditions – Museum Buildings

- “Standard” variable air volume air distribution based on temperature control of air volume modulation plays havoc with RH control in museums – hybrid strategy based on RH as dominant parameter and minimum air volume set point is potential strategy; ASHRAE conflict?
- Normal energy efficiency strategy of outside air economizer operation is counter productive for museums, because of RH load imposed by introduction of significant outside air – water side economizer is superior approach
- Museums inherently are significant energy consumers because of RH requirements and 24/7 operation of HVAC systems





Environmental Conditions – Museum Buildings: Complexity of Commissioning

- Many non-museum buildings not humidified in winter; temperature control is primary Cx focus
- Summer dehumidification sets maximum RH level; temperature control predominates
- Typical non-museum building has “occupied” and “unoccupied” sequences and short transition cycles – contrast to museum facilities
- Most non-museum facilities are not severely impacted by normal power or equipment failure – contrast to museum facilities





Environmental Conditions – Museum Buildings

- “Standard” objective to maximize daylighting in high performance buildings not appropriate for museums, especially direct sun impingement on artwork
- Lighting control for museums highly sophisticated, as artificial lighting is modulated to balance fluctuations in daylighting to maintain target light levels in galleries





“After” Commissioning for Museums

- Commissioning process has no “ending”
- Environmental stabilization period following performance verification testing
- Transition to permanent facility management
- Electronic “smart file cabinet” database
- CMMS programs
- Re-Commissioning
- Continuous commissioning
- Persistence of training
- Track performance
- Demonstrate persistence of commissioning benefits





Recommended Stabilization Period

- Normal functional performance testing verifies that systems meet design criteria at time when test results are recorded
- Seasonal testing addresses performance at opposite climactic conditions
- What about the seasonal variations between “design days”? Fall and spring “shoulder” conditions can be greatest challenge for HVAC systems
- Example: Chicago temperature can change 35 degrees F, with associated RH, in 2-3 hours
- “Standard” commissioning program must be extended to establish stabilization of environmental conditions over reasonable expectation of annual climactic variations





Stabilization Program Highlights

- Program timing is important - follows functional performance verification testing, substantial completion and prior to loading art into galleries
- Construction in all spaces must be complete, including punch list items, and all building systems operating in design sequences
- Hygrothermograph equipment must be calibrated and confirmation acknowledged
- Traffic movement in subject spaces must be controlled





Stabilization Program Highlights

- Involvement of museum constituencies is essential to success of initiative
- Communication protocols and assignment of specific responsibilities are important
- Program must address minimum number of temperature/RH sensing/recording points in each space – integrity of results
- Establish outside conditions over time period that satisfactorily simulate “average” seasonal climactic variations and extremes
- Agreement by all constituencies to satisfactory duration of stable conditions within “comfort envelope” is key to acceptance of results





Case Study Project

The Art Institute of Chicago Modern Wing

Chicago, IL

- Comprises art gallery/art storage, public and education spaces
- Architectural design of building takes advantage of outside vistas with extensive glazing in building envelope
- Innovative roof structure allows daylighting without direct sunlight
- Building envelope outperforms ASHRAE standard
- Water side economizer reduces humidification requirements
- LEED® certification applied for and demonstrated: compatible objectives of aesthetics and sustainable design features









Case Study Project

The Art Institute of Chicago Replacement of Existing Air Handling Units

- Commissioning of air handling unit replacement complicated by restricted spaces; impact on demolition and delivery of new equipment
- Scheduling of contractor and associated work difficult because of ongoing museum operation; units located above gallery spaces
- Performance of new equipment impacted by downstream distribution component condition
- Commissioning process identified numerous performance deficiencies; resolution achieved
- Value of commissioning demonstrated principally in design reviews, regulated site inspections with perspective of operator, performance verification testing, and record documentation









Commissioning Lessons Learned

- Involvement of all museum constituencies
- Clarity of specification documents
- Schedule coordination
- Client management support
- Availability of O & M personnel
- Schedule of values in construction contract
- Ongoing museum operations cannot be interrupted
- Maintaining momentum
- Importance of effective and ongoing communication
- Partnership focus
- Quality objective
- Anticipate functional performance verification test failures
- Issues log
- Resolution of deficiencies
- Maintenance of gallery environmental conditions



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Questions/Discussion

george.bourassa@c-b.com

(312) 466-5522

