Existing Building Commissioning for Improved Building Operation

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Agenda

- Motivation for Energy Management
- Existing Building Commissioning Process
- Typical Energy Conservation Measures
- Keys to Success
Where does Our Energy Go?

- Buildings use 76% of all electrical consumption
- Buildings responsible for 12% of water consumption

“Credible scientists give us 10 years to be well on our way toward global greenhouse gas emission reductions in order to avoid catastrophic climate change.”

-AIA Sustainable Design Factsheet (architecture2030.org)
Reasons for Existing Buildings Commissioning (N=85)

- Ensure system performance (energy and non-energy-related systems): 69%
- Obtain energy savings: 94%
- Ensure or improve thermal comfort: 65%
- Extended equipment life:
- Train and increase awareness of building operators: 24%
- Smoother process and turnover (new construction):
- Increase occupant productivity: 47%
- Ensure adequate indoor air quality: 59%
- Comply with LEED or other sustainability rating system: 1%
- Reduce liability:
- Qualify for rebate, financing, or other services: 8%
- Research/demonstration/pilot: 13%
- Participation in utility program: 28%
Existing Building Commissioning

- Existing Building Commissioning is a systematic process for investigating, analyzing, and optimizing the performance of building systems through the identification and implementation of low/no cost and capital intensive Facility Improvement Measures and ensuring their continued performance over time.

- The Existing Building Commissioning process assists in making the building systems perform interactively to meet the Current Facility Requirements.

- As defined by BCA “Best Practices”

Process Variations include: Retro-Commissioning, Re-Commissioning, Monitoring Based Commissioning, Ongoing Commissioning, Continuous Commissioning™
What is Existing Building Commissioning (EBCx)?

- Applying commissioning process for improving the current conditions/operations of an existing building
- Typically focuses on:
  - HVAC Systems
  - HVAC Controls (mostly)
  - Lighting Controls
- Evaluates building operation (Current facility requirements):
  1. What were the building systems designed to do?
  2. What are the building systems doing now?
  3. How can the building systems be optimized?

THINK ABOUT IT AS A BUILDING “TUNE-UP!!”
Existing Building Cx Phases

Planning Phase
- Establish Goals, Owner Needs & EBCx Plan

Investigation Phase
- Evaluate Current System Performance with Owner Needs & Identify Improvements

Implementation Phase
- Implement Recommended Improvements and Verify Performance

Turnover Phase
- Establish Smooth Transition and Hand Over to O&M Staff

Persistence Phase
- Ensure Continuous System Performance Improvement

As defined by BCA “Best Practices”
1. Quickly identify if opportunities exist
   - Interview key maintenance personnel
   - Inspect mechanical systems
   - Spot check/implement system trends
2. To convince building owner to proceed
   - Benchmarking
   - Produce range of economic costs/benefits
3. Create specific approach to identify deficiencies and resolve (scope of work, schedule, CFR)
Benchmarking – Energy Use Index

EUI =
Annual Energy Use (kBtu/yr)

Facility Total Floor Area (sf)
Benchmarking – Monthly History

Monthly Natural Gas Use - NRRC A

Natural Gas Use (Decatherms)

Jul, Aug, Sep, Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun

05-06, 06-07, 07-08
Investigation Phase

1. Documentation/Site Review
2. Facility Performance Analysis
3. Systems Diagnostic Monitoring
4. Test Development
5. System Testing
6. Master List of Findings
7. Economic Analysis

Evaluate Current System Performance with Owner Needs & Identify Improvements
Investigation Phase - System Testing

- Data trending
- Point to point controls checkout
- Test and balance measurements
- Maintenance assessments
- Loads analysis
Space Temperature Control

CSU Technical Audit - NESB
Third Floor - A & B Wings - Room Temperature Data (DDC 1/24/09 - 1/30/09)
**Problem: Chiller Operates During Low Outside Temperatures and Unoccupied Periods**

Below 55°F outside air, building could cool using economizer only and chiller should be turned off.

Chilled Water Supply Temperature of 42°F at midnight indicates chiller remains on during unoccupied hours.

**Recommended Solution:** Disable chiller at low outside temperature and unoccupied periods using existing DDC.
## Functional Testing Control Sequences

### Test Procedures

<table>
<thead>
<tr>
<th>Task #</th>
<th>Action Item</th>
<th>Expected Response</th>
<th>Passed (Yes/No)</th>
<th>Verified By</th>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Occupied Heating Mode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Set system to normal occupied mode</td>
<td>RTU Supply Fan runs</td>
<td>Yes</td>
<td>TCP</td>
<td>12/30/04</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RTU Supply Fan S/S = ON</td>
<td>Yes</td>
<td>TCP</td>
<td>12/30/04</td>
<td>Operating mode = Run</td>
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<tr>
<td></td>
<td></td>
<td>RTU Supply Fan Status = ON</td>
<td>Yes</td>
<td>TCP</td>
<td>12/30/04</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify DAT setpoint, based on zone temp</td>
<td>DAT setpoint follows intended setback strategy</td>
<td>Yes</td>
<td></td>
<td>Zone</td>
<td>SP-DAT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>66</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Override zone temp. below setpoint</td>
<td>Hot water circulation pump runs</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td>Overrode HW reset schedule to change DAT-SP to 110°F.</td>
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<tr>
<td></td>
<td>Zone temp: 67.4°F</td>
<td>Hot water valve modulates open</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td>HW IAO = 100%.</td>
</tr>
<tr>
<td></td>
<td>DAT temp: 88.7°F; DAT setpoint: 90.1°F</td>
<td>MA damper modulates to minimum</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Override zone temp. above setpoint</td>
<td>Hot water circulation pump runs</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td>Overrode HW reset schedule to change DAT-SP to 50°F.</td>
</tr>
<tr>
<td></td>
<td>Zone temp: 67.4°F</td>
<td>Hot water valve modulates closed</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td>HW IAO = 0%.</td>
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<tr>
<td></td>
<td>DAT temp. was above DAT setpoint</td>
<td>MA damper remains at minimum</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Set OAT &gt; 60°F to disable HW pump</td>
<td>Hot water circulation pump off</td>
<td>Yes</td>
<td>TCP</td>
<td>1/12/05</td>
<td>HWP Output Status = Off</td>
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<tr>
<td></td>
<td>OSA Lockout changed to Above 60°F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Override CO2 level above CO2 setpoint</td>
<td>MA damper modulates open</td>
<td>Yes</td>
<td>TCP</td>
<td>1/12/05</td>
<td>CO2 setpoint = 1200 ppm</td>
</tr>
<tr>
<td>7</td>
<td>Override CO2 level below CO2 setpoint</td>
<td>MA damper modulates to minimum</td>
<td>Yes</td>
<td>TCP</td>
<td>1/11/05</td>
<td>CO2 setpoint = 1200 ppm</td>
</tr>
</tbody>
</table>
“Top 10” HVAC Opportunities Found

10. Sensors out of calibration
9. Repair inoperable controls hardware (dampers & valves)
“Top 10” HVAC Opportunities Found

8. Improve cooling tower sequencing/lower cond. water temps
7. Improve chiller sequencing (including lockout control)
“Top 10” HVAC Opportunities Found

6. Return VFDs to variable speed operation
5. Optimize supply air static pressure set points
4. Ensure proper ventilation airflow rate (min. OA, DCV)
3. Optimize/restore economizer operation
2. Implement reset schedules to eliminate simultaneous heating and cooling
1. Turn off equipment when not needed (Scheduled S/S)
“Top 5” Gas Opportunities

5. Optimize lockout control strategy

4. Implement aggressive air and water temperature reset strategies (HWS vs OA, MAT vs RAT, night setbacks, space temperatures)

3. Tune-up terminal units to eliminate simultaneous heating and cooling (valve leakage)

2. Optimum start/stop vs. scheduled start/stop (close OSA!! – let Building “coast” to end of day)

1. Turn off heating plant when not needed (Scheduled S/S)
EBCx Process Challenges

- Lack of building documentation
- Ability of BAS to accomplish req’d trending
- Access to site or building
- Coordination of system testing with existing building user operations and staff
- Asbestos or other environmental issues
- Lack of funding for implementation
- Not enough O&M staff training on Training or Persistence phases
- Lack of internal “champion” to assist the process
Keys to Success

EBCx will Save Energy and Solve Operational Problems

1. Financial Requirements and Implementation Commitment Before Investigation
2. Qualified EBCx Service Provider
3. Robust Building Automation System (BAS)
4. Emphasize O&M Staff Involvement and Buy In
5. Training for O&M Staff & Documentation
6. Establish Benchmarks and Ongoing Monitoring and Verification
Thank You!

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