Preparing for an Evolving World
Southeastern Tri-Regional JETS

“Saving Big $” through the Retro-Commissioning (RCx) Process

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What is RCx?
RCx is a Series of Processes

Processes need to be:

- Collaborative
- Systematic
- Adaptive
The **collaborative** process requires the selection of an **RCx** team, working together, investigating *how* building systems are operated and maintained, with the objective of identifying ways to improve overall building performance.
The RCx team must develop a systematic process to fully assess the architectural, mechanical, electrical, and operational control systems. Efforts to improve and optimize an existing building’s comfort, operation, and energy consumption profile is contingent on a systematic approach.
The **RCx** process must be *adaptive*.

- As facility operational needs change, the **RCx** process must also be flexible, meeting the current operational needs as closely as possible.
- The process *may* also include remedial design and construction activities to accomplish this goal.
- ASHRAE, BCA, NEBB
RCx Process = Teamwork!

What happens when ONE RCx team member drops the baton in the race?
RCx Implementation
RCx Project Phases

Implementing and conducting a RCx project involves multiple phases, including:

• Contract Phase
• Pre-Site Investigation Phase
• Site Investigation Phase
• Assessment Analysis Phase
• Corrective Action Phase
• Follow Up Phase
• O&M Training
What are the Benefits?
The RCx Processes

A properly scripted RCx process will identify:

- Poor and/or lack of system documentation
- Post occupancy design modifications/changes
- Improper equipment or system installations
- Original design errors
- Failed or malfunctioning equipment
- Poorly tuned controls/improper sequences
- Deferred maintenance issues
- Training requirements for the O&M staff
RCx Improves...

Occupant Comfort

Occupant Productivity

Indoor Air Quality

- Airborne Particulates
- Volatile Organics
- CO₂ Levels
RCx Improves…

Facility Staff Training
(informal & formal)

Operations and Maintenance

… Which Extends Equipment Life
RCx Improves…

Energy Performance

Owner Profitability

…And Helps Protect Our Environment
RCx Projects Typically…

• Achieve Energy Savings of 5 - 20% of total building energy costs
• Has a payback from energy savings averaging 2 years or less
• Reduces operating expenses

Source: PECI
RCx Case Studies
University - Old Medical School

Original Construction – 1920’s

Total Area: 244,000 Ft²

Major renovations/additions: 1960’s – current
  • Over 120 major HVAC revisions since 1960’s!

RCx activities completed June 2011
Site Investigation Ph. - Sample Issue

VFD running in “hand” mode.
Site Investigation Ph. - Sample Issue

CW valve pneumatic tubing not connected
Damper actuator travel limited by copper tubing
- Economizer enabled
- Concurrent Heating/Cooling
- OA conditions adequate to meet building needs
Sample of ECMs Implemented

**Retrofits:**
- Lighting Upgrades
- VFD Installations
- Occupancy Sensors

**Scheduling:**
- Occupancy

**Maintenance and Repairs:**
- Repair/Replace Inoperative Steam Traps
- Functional Testing of System Devices and Controls

**Control Modifications:**
- Mechanical System Operational Set Point Modification
- VAV Flow Sensor Calibration
- Temperature Sensor Calibration
- Building Pressurization Set Points and Control Modification
- Economizer Cycle Control Modification
Old Medical School - Results

ECM Implementation Cost = $255,698

1st Year Energy Cost Savings = $349,283

Simple Pay-Back = 8.7 Months
RCx Case Study # 2
Ft. Bragg
Energy Consumption
Data Analysis
Ft. Bragg, NC - Sample ECM Savings

Administration/Headquarters/Gym/Dining/Fitness
(Total of 20 buildings @ approx. 400,000 s.f.)

<table>
<thead>
<tr>
<th>ECM</th>
<th>Est. Annual Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Occupancy Schedules/Sensors</td>
<td>$ 1,045,900</td>
</tr>
<tr>
<td>• Demand Control Ventilation</td>
<td>$418,000</td>
</tr>
<tr>
<td>• Chilled Water Reset on OAT</td>
<td>$333,300</td>
</tr>
</tbody>
</table>
Normalized Mechanical Load Analysis

Fort Bragg
Bldg. D-3915
Heating Water Demand Changeover

Typical Changeover = 65°F
D-3915 Changeover = 45°F

Heating/Cooling Changeover
Energy Modeling and ECM Analysis

Annual Energy Cost

- **Baseline**: $19,296
- **Return to Design Conditions**: $15,265
- **ECM 1: Occupancy Schedule**: $8,718
- **ECM 2: Occupancy Schedule and Remove Inlet Vanes**: $7,801

Annual Energy Cost ($/year)
Annual Savings From Baseline ($/year)
Pre and Post RCx Trending Results

Pre-RCX

Erratic Indoor Temperature and Humidity Control

Stabilized Indoor Temperature and Humidity Control

Post-RCX
Compare Results of RCx Process

![Graph showing RA Temperature Range and AHU Return Air Temperature Variability]
Compare Results of RCx Process
RCx Case Study # 3
Elementary School
Operational Issue Identification

86,645 Square Foot Elementary School

The RCx process identified 135 Issues

- Calibration.............................................................. 9
- Failed Equipment...................................................... 9
- BAS Graphics........................................................... 12
- Maintenance and Repair......................................... 66
- Control Programming............................................. 12
- Test, Adjust, and Balance...................................... 27
Sampling of Issues

Calibration Issues:
- Stat serving DHC-11 (2.4°F higher than BAS reading)

Failed Equipment and Controls:
- **80% of VAV reheat valves have issues** (either failed or BAS not responding)
- AHU-9 filter alarm inoperable
- AHU-8 preheat valve inoperable
- AHU-11 return damper actuator inoperable, stuck in closed position; unit operating at 100% OA
- AHU-12 Low Limit Stat not operational
BAS GRAPHIC ISSUES:

- Graphic for AHU-13 is showing the relief dampers on the screen for AHU-12 and AHU-14
- Graphic does not show the thermostat associated with DHC-84. This thermostat serves the Art room along with DHC-83
- Graphic for DHC-6 displays a damper but this duct heating coil does not actually have a damper serving it
Sampling of Issues

MAINTENANCE ISSUES:

• Recommend cleaning all pre-heat coils at AHUs (gym)
• Recommend cleaning all strainers

WATER FLOW ISSUES

• Only 54% of the chilled water coils are within the +10%/-10% tolerance range.
• Only 56% of the preheat and reheat coils are within the +10%/-10% tolerance range.

DAMAGED EQUIPMENT:

• DHC-76 damaged
VALVES LEAKING:

• 30 Issues documented related to various control valves with ‘leak-by’ – wasting energy

  o Example: DHC-28 Leak-by (Control valve is allowing a small amount of water to leak-by and flow through the coil (0.2 psi). This is causing an approximate increase of 1.5 degrees F at the discharge of the coil.)

• Others include: AHU-1, AHU-2, AHU-3, AHU-4, AHU-5, AHU-6, AHU-10, AHU-11, AHU-12
Sampling of Issues

**BAS PROGRAMMING:**

- Economizer Cycle Not Functioning – Chiller running during low OA temperatures
  - AHU-10, AHU-12, AHU-13

- AHU-13 Preheat & Reheat Coil Control Valves – valves 100% open when programmed closed

- Several reheat valve names on BAS graphic do not match the drawings, however BAS locations do match actual locations
Results to Date: 14% reduction in Energy!

Electrical Usage

- 2013-2015
- 2016
Results to Date: 35% reduction in Energy!

Gas Usage

- 2013-2015
- 2016
RCx Process & Benefits Recap
RCx Process

• The RCx process involves steps that are integrated into your existing building:
  – Contract Phase
  – Pre-Site Investigation Phase
  – Site Investigation Phase
  – Problem Analysis Phase
  – Corrective Action Phase
  – Follow Up Phase
  – Training
Results of RCx Effort!

- Comfort
- Indoor Air Quality
- Occupant productivity
- Facility staff training (informal & formal)
- Operations and Maintenance
- Equipment life
- Energy performance
- Owner profitability = monthly savings!
- Our environment
Winning the Gold Through Teamwork

What happens when the entire team works together?
Questions?
Thank You!

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