Retro-Commissioning

AEE NORTHERN OHIO CHAPTER

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- Over 25 years of focused experience
- Served as commissioning agent on 100+ projects throughout career
- Certified Energy Manager
- NCEES Model Engineer
- ASHRAE Commissioning Process Management Professional
- Proven troubleshooter
- Vast experience with both public sector and private clients throughout the world

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Agenda

1. Learning Objectives
2. Overview
3. Goals
4. Benefits
5. Challenges / Obstacles
6. Process
7. What to Look For
8. Q&A

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Learning Objectives

1. What will you learn?
   - Benefits
   - Challenges
   - Typical Process
2. Why is this important?
   - Improve Comfort
   - Reduce Energy Consumption
   - Improve Operation and Maintenance

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Overview

- Many buildings, particularly those that have never gone through any type of commissioning or quality assurance process, are typically performing well below their potential.
- This is especially true when a group of buildings are multi-use and aged, usually they have been constructed at various times.
- Retro-commissioning applies a systematic investigative process for improving and optimizing a building's operation and maintenance (O&M).
- Retro-commissioning occurs after construction, as an independent process and is typically applied to buildings that have not previously been commissioned.
- It may or may not emphasize bringing the building back to its original intended design. In fact, original design documentation may no longer exist or may be irrelevant based on current operating needs.

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Goals

- The goal of retro-commissioning is to maximize system functionality.
- It is a holistic and systematic process intended not only to optimize how equipment and systems operate, but also to optimize how the systems function together.
- Although retro-commissioning may result in recommendations to investigate further capital improvements, O&M tune-up activities and diagnostic testing are primarily used to optimize the building systems.
- The goals and objectives for applying the process, as well as the level of rigor, may vary depending on the current needs of the owner, the budget, and the condition of the equipment.
- Typically, the level of effort is consistent with an ASHRAE Level 2 energy audit and most often focuses on dynamic energy-consuming systems, with the goal of reducing energy waste, obtaining energy cost savings, and identifying and addressing existing problems.

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Benefits

- Identification of system operating, control, and maintenance issues
- Reduction of maintenance cost and premature equipment failure
- Reduction of energy cost and waste
- Documentation of building systems
- Training of operating staff
- Collecting data for long-term planning and maintenance budgeting.
- Can be used as a continuous advanced training tool to educate maintenance staff on various control strategies and the logic behind them, as well as educating staff in identifying energy conservation opportunities.
- Retro-Commissioning typically reduces energy consumption by at least 3 to 5 percent where implemented with a 6-month to 2-year Simple Payback.

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Challenges Obstacles

- The energy savings from retro-commissioning programs varies widely.
- The total operational and maintenance cost savings can be difficult to quantify before any investigative work has started.
- Difficult to quantify savings even after some due diligence has been performed.
- Can be challenging to identify portion of savings due mainly to RCx even with 12 months of post-project data.
- Although some savings can typically be realized through low cost / no cost measures, often repairs and upgrades are a requirement to realize significant savings and correct other issues.
- Some measures will Increase energy consumption
- A comprehensive approach incorporates multiple steps, processes and entities / stakeholders

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Process

Often Has Elements of:

- Condition Assessment
- Energy Audit
- Capital / O&M Repair Project
- Commissioning
- Measurement & Verification

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Process

- Data Collection
- Site Survey
- Analysis
- Develop Functional Test Procedures
- Initial Functional Testing
- Implementation of Repairs / Upgrades
- Final Testing

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Data Collection

- Kickoff Meeting
  - Meet with the appropriate Owner personnel to coordinate site visits and meetings with key project team members and stakeholders.
  - The kickoff meeting will introduce the team and process, establish goals, collect valuable input and provide an understanding of the priorities and needs of the Owner.
  - Additionally, initial data requests, access issues and schedules will be coordinated.
  - Initial data requests typically include (where available):

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Data Collection

- Maintenance history / list of issues / wish lists with respect to HVAC, building envelope and lighting
- Recent energy, deferred maintenance and building condition studies
- Historical energy data (3 years of utility bills: electricity, natural gas, water)
- One (1) copy of a recent actual utility bill for each utility
- Capital and master plans
- AutoCAD floor plans
- Architectural, Mechanical, Plumbing and Electrical drawings
- Protocol for access to each building
- Protocol for access to Building Automation Systems (BAS)
- HVAC equipment inventories

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Site Survey

- Review existing control sequences, set points, set up trends thru BAS / Web Browser.
- Evaluate building mechanical and control systems to identify potential opportunities to conserve energy, improve comfort and operations.
- Observe and note the operational and usage characteristics of the facility to identify low-cost / no-cost and behavioral based opportunities.
- Document existing conditions to provide the basis for post-RCx energy and water savings calculations, analysis and a consistent record of baseline data for future use.

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Analysis (Pre-Site Survey)

- Tabulate utility data
- Benchmark energy use intensity
- Target & prioritize opportunities
- Review drawings and past studies
- Identify issues and opportunities
- Perform initial energy savings calculations

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Analysis (Post-Site Survey)

- Compare drawings and past studies to confirm their level of accuracy compared to data collected during walkthroughs of the buildings.
- Identify issues and opportunities
- Provide preliminary findings, obtain feedback
- Perform initial energy savings calculations

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Develop Initial Test Procedures

- Develop pre-functional checklists
- Develop functional testing procedures incorporating adjustments / optimization.
- Perform initial testing
- Maintain issues log
- Identify recommended repairs and upgrades with estimated cost, savings and potential disruption / phasing required

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Implementation of Repairs Upgrades

- Develop repair / upgrade documentation for implementation
  - ESPC Program
  - Design, Bid & Construction
  - Owner directed repair / upgrade
- Oversee the Implementation process
  - Owner's Rep role
  - Traditional Construction Administration role
  - Construction Manager role
- Often incorporates metering / submetering

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Perform Final Testing

- Conduct Retro-Commissioning meetings.
- Functionally test selected HVAC equipment, other systems
- Develop corrective action plan (CAP).
- Assist Owner in implementing CAP.
- Perform follow up functional testing of systems after repair.
- Develop commissioning report containing functional test results
- Functional test procedures for Continuous Commissioning
- Recommendations for additional enhancements.

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10-Month Post-Project Follow Up

- Analyze utility data
- Field Survey
- Identify Issues:
  - Warranty
  - Operation & Maintenance
  - Building Operation / Usage Deltas
- Adjust energy savings baseline as appropriate
- Make recommendations for future
- Perform functional testing of systems after Corrections / Adjustments

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What to Look For

1. Common Opportunities
2. Opportunities with Complexity / Cost
3. Building Type Specific Opportunities
   - Laboratories
   - Operating Rooms
   - Data Centers

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Common Opportunities

- Unoccupied setback of HVAC & Lights
- Space temperature set points
- BAS / Manual Overrides
- BAS set point optimization
- Failed air-side economizer
- Over / Under ventilation
- VAV Box minimum airflow settings
- Simultaneous heating and cooling
- Low Chilled Water Delta-T Syndrome
- Failed Mechanical / Electro-Mechanical Components
  - Actuators / Linkages
  - Dampers / Damper Blades
  - Sensors

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Opportunities with Complexity / Cost

- Design / Installation issues causing operational issues – cascading affect
- Change of use / floor plan changes – cascading affect
- Pneumatic Controls
- Conversion of constant air / water to variable flow
- Occupancy sensor-based set back of HVAC and lights
- Building Envelope / Infiltration
- Interior / Exterior Lighting / Lighting Control
- Demand Control

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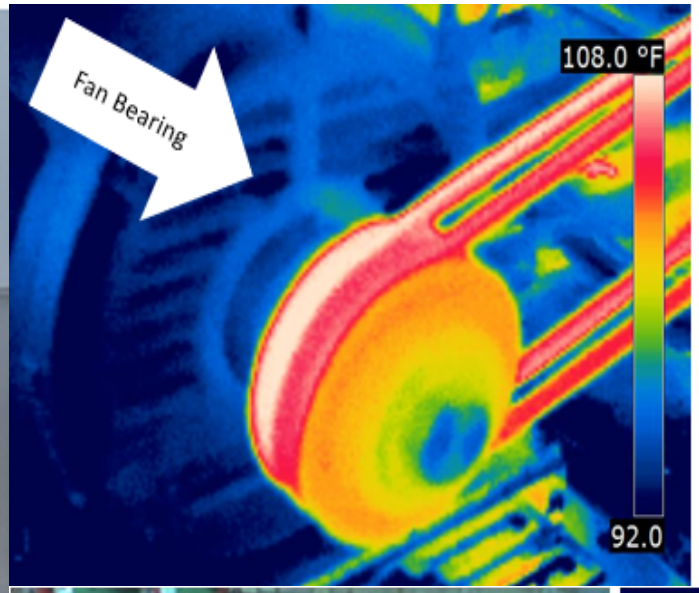
Fan Bearing
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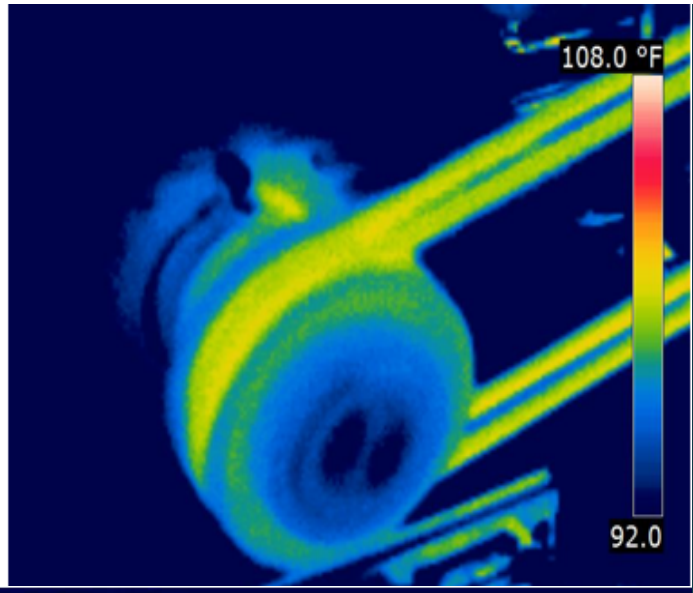
108.0 °F
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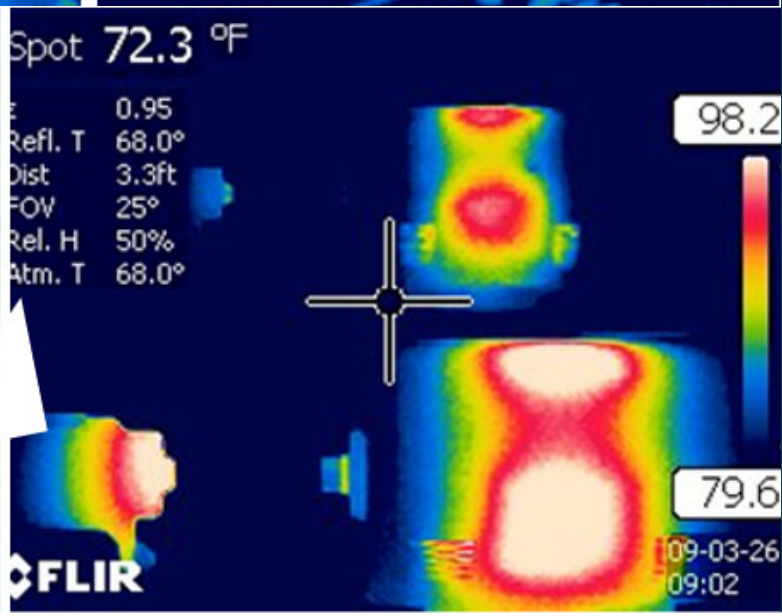
Pump shaft not properly aligned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Dist 3.3ft
FOV 25°
Rel. H 50%
Atm. T 68.0°
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79.6
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Laboratories

- Balance between Energy Efficiency and Safety (Labs 21)
- Complexity of Control, Setback Strategies
- Interface between Lab Controls and BAS
- Sash position Sensor Mechanism Operation
- Setback strategies
- Training Facilities Staff and Users on Proper Lab and Fume Hood Protocols
  - Chemical storage
  - Using Fume Hoods as a Chemical Storage Cabinet
  - Keeping Fume Hood Sashes Closed

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Operating Rooms

- Space Temperature Set Point
- Relative Humidity Set Points
- Proper Air Change Rates
- Exfiltration / OR Leaks
- Pressurization
- Air Change Rate Set Back
- Chilled Water Plant Impacts

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Data Centers

- Electrical Infrastructure
- IT Infrastructure
- Decommission Legacy Equipment
- Airflow Management
- Computer Room Air Handlers
- Central Plant (If Applicable)
- Humidification
- Lighting – Use Active Sensors to Shutoff Lights When Data Center is Unoccupied

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Data Centers – Airflow Management

- The efficiency and effectiveness of a datacenter conditioning system is heavily influenced by the path, temperature and quantity of cooling air delivered to the IT equipment and waste hot air removed from the equipment.
- Eliminate Mixing and Recirculation of Hot Equipment Exhaust Air
  - Optimize Hot Aisle/Cold Aisle Layout
  - Blank off area above server racks & utilize ceiling plenum for return air in lieu of the room itself to minimize potential for re-entrainment of server heat
  - Arrange equipment with side to side or top to bottom airflow configurations so they discharge heat away from other server intakes
  - Select Racks with Good Internal Airflow
  - Seal raised floor and optimize perforated tile locations
  - Relocate cable from floor plenum to exposed overhead cable trays and remove abandoned cable in order to improve air flow in raised floors.

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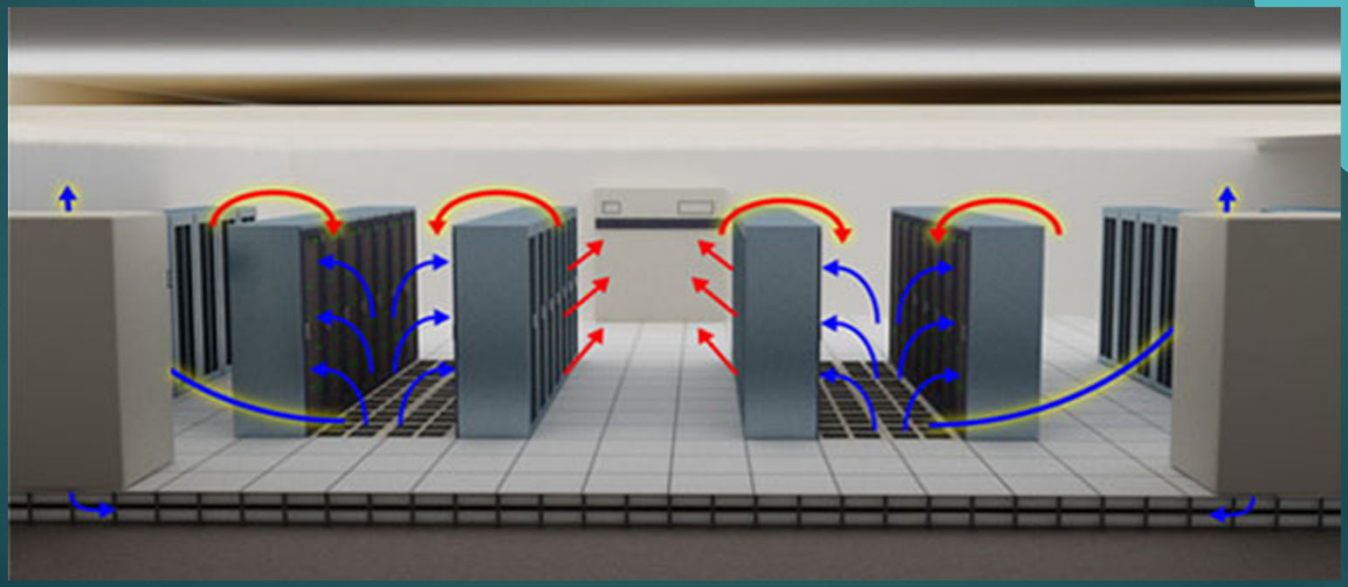
Data Centers – Airflow Management

- Maximize Return Air Temperature by Supplying Air Directly to the Loads
  - Position Supply and Returns to Minimize Mixing and Short Circuiting
  - Optimize Location of Computer Room Air Conditioners
  - Provide Adequately Sized Supply & Return Ducts and/or Plenums
  - Use an Appropriate Pressure in Underfloor Supply Plenums



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Data Centers - Humidification

Humidification specifications and systems are often been excessive and/or wasteful in data center facilities. A site-specific design approach to these energy-intensive systems is needed to avoid energy waste.

- Adjust System to Actual Equipment Requirements
  - ***Use Widest Suitable Humidity Control Band***
  - ***Calibrate / Replace Humidity Sensors***
  - Provide Appropriate Sensor Redundancy
  - Control Humidity with Dedicated Outdoor Air Unit
- Eliminate Over Humidification and/or Dehumidification
  - ***Ensure Proper Economizer Lockout***
  - Maintain Coil Temperature Above 55F
  - Centralize Humidity Control
- Use Efficient Humidification Technology
  - Use Waste Return Air Heat to Humidify
  - ***Use Adiabatic Humidifiers for Humidity and Evaporative Cooling***
  - Use Lower Power Humidification Technology

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- Architecture, Engineering, Interior Design & Asset Management
- Primary Markets: Criminal Justice, Civic, Hospitality, Senior Living and Retail
- Sub-Markets: Higher Education, Commercial and Industrial
- 9 locations throughout the US
- Nearly 80 professionals
- Forward thinking – planning for the future of design
- Building Relationships Based on Trust and Results

K2M Design – Recent Projects

- Marriott Key Center

- Ohio Reformatory for Women – LEED Housing Unit

K2M Design – Recent Projects

- Westminster Village – Senior Living Community

- College of Florida Keys – Key Largo Campus

For Additional Information:

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