Benefits of Incorporating Retro-Commissioning In An ESPC Project

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Overview of Presentation

- **What is Retro-Commissioning (RCx)?**
- **What are the goals of RCx?**
- **Planning the Process**
- **Selecting the Systems to be Retro-Commissioned**
- **Reporting and Training**
- **Typical Findings**
- **Cost Versus Savings**
- **Conclusions and Lessons Learned**
- **Path Forward**

Overview

- **Retro-commissioning: A second generation activity of institutionalizing energy programs;**

- **The first generation activity being facility energy audits and construction of energy conservation measures (ECM).**

- **ECM Examples: Installation of variable frequency drives, direct digital controls, and replacement of inefficient chillers and boilers.**

Overview (Cont.)

Retro-Commissioning: Revisiting (upgraded or original building) HVAC systems to enhance their effectiveness based on current conditions.

- **Retro-commissioning is the comprehensive and systematic testing, validating, and further enhancement of HVAC systems;**
- **It includes reporting of activities and findings, training, and providing recommendations for further capital intensive improvements.**
- **Retro-Commissioning is carefully planned (i.e., it is not sporadic)**

Goals of Retro-Commissioning

Reduce energy consumption, and operation and maintenance costs through:

1. **Control adjustments and calibration;**
2. **No cost/low cost system modifications; and**
3. **Preventative maintenance improvements**;

Goals (Cont.)

Improve comfort level, indoor environment, safety, and health by:

1. **Systematic checkout and optimization of automatic temperature controls and HVAC system operation, and**

2. **Rebalancing of ventilation systems and air circulation rates, consistent with current occupancy requirements**

Goals (Cont.)

Advance maintenance personnel's skills and awareness through training;

Enhance O&M documentation;

Establish ground work to facilitate continuous commissioning by Owner's staff well beyond the warranty period.

Document baseline operating conditions using performance trend logs and metered data

Design Energy Survey Versus Retro-Commissioning

- **Common Elements:**
  - Reviewing engineering documentation and performing on-site inspections;
  - Development of a calibrated energy simulation model;
  - Identification of low cost/no cost energy saving measures;
  - Identification and evaluation of capital intensive energy saving projects;
  - Preparation of a formal report.
- **In Addition to the Above, Retro-Commissioning Normally Includes:**
  - Establishing a formal project team with more active owner participation;
  - Re-evaluation/updating of design intent and preparation of a formal design intent document (DID) consistent with current occupancy;
  - Calibration and optimization of automatic temperature controls;
  - More extensive trend logging, sub-metering, and follow-on site visits;
  - Modification of system operation to enhance indoor air environment, safety, health, and comfort level;
  - Development of an O & M manual and a training program, and establishing groundwork for continuous commissioning;

Planning The Process

- **Organize a project team that will define building requirements and design criteria; the team may include:**

  1. Facility owner administrative, Operating & Maintenance, and safety personnel;

  2. ESCO;

  3. Commissioning professionals;

  4. Controls contractor;

Planning The Process (Cont.)

- **Verify/update design intent of energy systems and design intent document (DID);**

- **Gather documentation including:**
    1. **Record and as-built drawings,**
    2. **Temperature control submittals,**
    3. **Test and Balance reports,**
    4. **Performance trend logs,**

Planning The Process (Cont.)

- Plan and implement field tests using on-line and portable instrumentation;
- Review current sequence of operation;
- Compare actual performance with intended design performance;
- Perform calibration of control loops;
- Review findings with project team;

Planning The Process (Cont.)

- **Identify opportunities for operational enhancements and energy savings; present recommendations to the project team;**
- **Implement no cost/low cost corrective adjustments and modifications and coordinate work with controls contractor;**
- **Calculate savings expected to be realized from operational improvements;**

Planning The Process (Cont.)

- **Conduct follow-up site visits to validate effectiveness of operational changes;**
- **Plan for long term regular activities for measurement and verification;**

Planning The Process (Cont.)

- **Prepare and submit recommendations for cost effective capital improvements, include estimate of capital costs and energy savings;**
- **If an energy model is used, it should be calibrated against collected trend logs and metered energy consumption data;**
- **Obtain field test data after adjustments and improvements have been made in order to substantiate the calculated savings;**

Planning The Process (Cont.)

- **Develop and deliver a retro-commissioning report, delineating elements of the process**;
- **Capital intensive measures are in addition to other opportunities identified in the design energy survey (DES) phase of the project;**
- **Verified savings from retro-commissioning will be credited to the ESPC project, even if the measures are partially accomplished by in-house staff.**

Systems To Be Retro-Commissioning

- **Supply Air-handling Systems;**
- **Air exhaust systems and fume hoods;**
- **Building/zone pressurization controls;**
- **Automatic temperature controls;**
- **Steam, condensate, and hot water distribution;**
- **Chilled water distribution;**
- **Central heating plants;**
- **Central cooling plants;**
- **Illumination systems and controls.**

Reporting/Training

- **Report format will generally include:**
  - **Outline of the retro-commissioning process;**
  - **Details of low cost/no cost system improvements;**
  - **Estimate of energy and O & M savings,**
  - **A discussion of comfort and indoor air quality enhancement as a result of retro-commissioning;**
  - **Details of recommended capital intensive projects;**
  - **Outline of lessons learned and path forward;**
- **Prepare an operating manual to supplement report;**
- **Establish an O & M training program to facilitate transitioning to continuous commissioning**

Making The Case For Retro-Commissioning

- **Building HVAC systems have never been commissioned;**
- **Building occupancy has changed;**
- **Comfort levels have been compromised;**
- **Occupant complaints have increased (noise, odors, stuffiness, indoor air quality problems, etc.) ;**
- **High O & M cost per square foot;**
- **High energy cost per square foot;**
- **Too frequent equipment cycling;**
- **Building is under too much negative or too much positive pressure;**

Sample Findings – General

- **There is a need for follow-up site visits to confirm the effectiveness of system modifications;**
- **It is critical that all field changes be thoroughly documented and given to the facility staff;**
- **Control strategy changes, requiring re-programming should be implemented and documented by the controls contractor and coordinated by project team;**
- **Control documents often need updating.**

Sample Findings – Supply Air-handlers

- **There is a need to re-evaluate supply fan system performance, including discharge air static pressure set-point and current supply air volume quantities;**
- **Opportunity to realize substantial fan electric energy savings often exist by making simple adjustments;**
- **There is often an opportunity to minimize demand for heating and cooling by air rebalancing and by implementing straightforward changes in control strategy;**

Sample Findings – Exhaust & Return Air Systems

- **Exhaust systems are often found to be:**

  - Substantially out of balance;
  - Either inadequately sized, or
  - Significantly over-sized for the current application;

- **Controls of variable air volume exhaust and return/exhaust fans are poorly synchronized with the air supply fans;**

- **Re-programming of controls is often necessary to correct operational deficiencies;**

- **Correcting deficiencies will result in realizing substantial fan energy savings as well as improvement in indoor environment;**

Sample Findings – Automatic Temperature Controls

- **Control of terminal units (fan-coils, perimeter radiation, and reheat coils) are often in need of calibration;**
- **Transducers used for heating and cooling control are easily damaged by moisture in the pneumatic control lines;**
- **Current space temperature control strategies may afford opportunity to minimize simultaneous heating and cooling by relatively simple changes in control strategy;**

Example – AHU S.P. Adjustments

FAN SYSTEM	ACTUAL CFM	AS FOUND SUPPLY STATIC	FINAL SUPPLY STATIC	AS FOUND TOTAL STATIC	FINAL TOTAL STATIC	AS FOUND POWER, KW	FINAL POWER, KW
A	25500	4	1.5	5.2	2.7	28.2	14.4
B	23500	3.75	1.5	5	2.8	25.0	13.7
C	25900	3	1.2	4.75	3	26.2	16.2
D	30000	2.85	1.5	4.5	3.1	28.7	19.4
TOTALS	104,900					108.0	63.8
NUMBER OF HOURS OF OPERATION = 5840 PER YEAR							
AT $0.084/KWH, SAVING = (108-64)*5840*$0.084 =					$21,704	PER YEAR	

Example – Chiller Condenser Water Temperature

- **200-ton, York Chiller, with VFD, operates year-round, with an average load of 110 ton during off-peak;**
- **Maintenance personnel like to keep condenser water inlet temperature at 85 F and no lower;**
- **Panel indicates compressor power at o.58 kW per ton during non-summer months (tower fan has a VFD);**
- **Recommendation: Reduce condenser set-point to 70 F;**
- **Panel now indicates 0.45 kW/ton;**
- **Estimated savings = $3400 per year**

Example – Implement Dual Space Temperature Set-point Control Strategy

- **An air-handling unit, converted to dual duct VAV with DDC controls, serves a 40,000 square foot office space on two floors;**
- **BAS shows that a single temperature set-point has been programmed to control each VAV dual duct box;**
- **Recommendation: Re-configure the program to assign a heating temperature set-point (70 F) for the hot deck and a cooling temperature set-point (75 F) for the cold deck, for each dual duct VAV box;**
- **Re-programming of DDC controls to be accomplished by facility in-house staff;**
- **Computer model shows the anticipated energy cost saving, from this measure, to be $7,600/year.**

Retro-Commissioning Cost Versus Benefits

- **The cost of retro-commissioning services will normally range between $0.10 and $0.30 per square foot depending on HVAC system size, age, and portfolio of services offered;**
- **Energy cost saving from no cost/ low cost modifications will normally range from $0.20 to $0.4 per square foot per year;**
- **Older systems generally offer less energy saving opportunities from low cost modifications than newer systems;**
- **Newer systems with DDC and variable speed drives, often yield the highest ratio of annual energy savings from low cost modifications to the initial cost of retro-commissioning;**
- **While older systems offer less opportunity for immediate energy cost savings from low cost modifications, opportunities for lucrative energy cost saving capital projects often emerge.**

Conclusions

- **Retro-commissioning offers opportunity for significant energy savings and operational enhancements;**
- **Follow-up site visits are essential to sustain and validate savings and operational enhancements;**
- **All operational changes must be thoroughly documented;**
- **Training the O&M staff is critical to sustain long term optimal performance and to implement continuous commissioning;**
- **Low cost corrective measures must be implemented in a timely manner to maximize savings and benefits;**
- **The EMCS is a critical tool for retro-commissioning;**
- **Active participation of operating personnel in the field process is critical for the benefit of both ESCO and owner.**

Path Forward

- **Delineate the transition from retro-commissioning to continuous commissioning, including prescription of follow-up field inspection and testing;**
- **Establish resources for continuous commissioning and for implementation of a measurement and verification process to validate and confirm the success of the implemented changes;**
- **Document findings and shortcomings noted after completion;**
- **Define scope of capital intensive opportunities and quantify savings preferably using a calibrated energy model;**
- **Establish an on-going operator training program defining scope and format, and update project operating manual;**
- **Reformulate details of the process, as necessary, based on project findings and lessons learned;**

THANK YOU

Questions or Comments??

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