

Retrocommissioning

Achieving Excellence in Facilities Management and Sustainability Workshop
Energy Track

Albuquerque, New Mexico

August 31, 2011

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Presentation Outline

- About Argonne
- RCx – What Is it and Types
- RCx Phases
- RCx at Argonne
- Identified Opportunities
- Discussion



About Argonne



- Located on 1,500 acres 25 miles southwest of Chicago, Illinois
- Employs ~ 3,200 people
- Annual budget ~\$630M (FY 2010)
- 200+ research projects
- Research centers around three principal areas:
 - Energy (energy storage, alternative energy and efficiency, nuclear energy)
 - Biological and Environmental Systems (computational models to enable regionally focused ecological and climate assessments); and
 - National Security (security technologies that prevent and mitigate events with potential for mass disruption).



RCx - What Is it and Types

- Retrocommissioning (RCx) is a systematic process for improving and optimizing building performance.
 - Applies to existing buildings that have never gone through any type of commissioning or quality assurance process.
 - Focuses on the verification of the proper controls strategies, sequences of operation, control component functionality, operations and maintenance procedures and strategies.
 - Concerned with how equipment, systems, and subsystems function together, but it does not generally take a whole-building approach.
 - The original design intent documentation may be lost or no longer relevant.
- Types:
 1. Commissioning of new buildings;
 2. Retrocommissioning;
 3. Recommissioning; and
 4. Continuous commissioning.



RCx Phases

1. Planning

- Identifying project objectives; deciding which building systems should be analyzed for improvements; defining tasks and assigning responsibilities;

2. Investigation

- Determine how the selected systems could operate more efficiently; performing tests to measure how the targeted systems currently operate; preparing a prioritized list of the operating deficiencies found and recommended corrective actions;

3. Implementation

- Correcting operational deficiencies; performing tests to verify proper and/or improved operation; and

4. Hand-off

- Preparing a report of improvements made; providing training and documentation on how to sustain proper and/or improved operation.



RCx at Argonne

- In May 2011, a five-member team contracted by FEMP performed elements of RCx as part of Energy Efficiency Expert Evaluation (E4) audits triggered by SSPP:
 - Five (5) buildings with large energy consumption were chosen, as well as steam plant;
 - Idea was that large and old buildings with significant energy and water consumption would offer the highest number of improvement opportunities;
 - All the buildings have both labs and offices;
 - Total area about 1.4 million GSF;
 - Total annual cost of utilities (electricity, natural gas, steam, and water) for these buildings was about \$5.7 million (FY 2010).
- The process started with a kick-off meeting and half-day RCx training based on the *Commissioning for Federal Facilities* publication.
- The team escorted by maintenance personnel, started a 5-day audit of the buildings.
 - Five-member team worked together all the time (no splitting).
 - People specialized in different areas.
- Last day, 52 preliminary findings were presented.
- Of them, **15** became recommended **ECMs**. Sorted from shortest to longest SPP in RCx report Draft.



ECM #1 - Lighting Upgrades

- Currently, Bld 362 corridors are lit at 30-45 fc, instead of 5 fc.
- Action items:
 - De-lamp (remove light fixtures and ballasts), and
 - Reduce lamp wattage.
- Follow [Illuminating Engineering Society of North America Lighting Handbook](#) recommendations for illuminance (3-1,000 fc).
- Can be combined with occupancy sensors & daylight harvesting devices.
- Done by in-house personnel.
- Energy savings: 2,220 MBtu/yr
- Cost savings: \$35k/yr
- Implementation cost: None
- SPP: immediate



ECM #2 - Replace Weather Stripping on Exterior Windows

- Currently, estimated 1% of HVAC load is gained/lost through 200 operating windows at Bld 205
- Done by in-house personnel
- Energy savings: 220 MBtu/yr
- Cost savings: \$3k/yr
- Implementation cost: \$4k (\$1.6/lf)
- SPP: 1.5 year
- References: ASHRAE; NIST; EIA Energy Model; *HVAC Equations* by Bell.



ECM #3 - Install Water-efficient Plumbing Fixtures

- Currently, great majority of toilets, urinals, and faucets in 5 buildings are not water-efficient.
- Action item: Replace existing 300 faucets, 120 urinals, and 240 toilets with water-efficient ones.
- Done by in-house personnel
- Water savings: 23MGal/yr of domestic water
- Cost savings: \$51k/yr
- Implementation cost: \$155k
- SPP: 3 years
- Requirements:
 - Showerheads: 2.5 GPM @ 60 psi
 - Public lavatory faucets with aereator: 0.5 GPM @ 60 psi
 - Urinals: 1 GPM/flush
 - Water closets: 1.6 GPM/flush
- References: National Water Efficiency Standards; LEED.



ECM #4 - Install Ground Brushes for AHU Motors

- Currently, el. motors' bearings at Bld 362 are failing prematurely due to a lack of / damaged motor brushes.
- Action item: Retrofit eight AHU motors by providing a low-impedance path to ground, so that VFD is not by-passed.
- Done by in-house personnel
- Energy savings: 220 MBtu/yr
- Cost savings: \$8k/yr
- Implementation cost: \$28k (\$3.5k/ea.)
- SPP: 3.5 years
- Assumed: 70HP motors each



ECM #5 - Install Fuel Cells

- Action item: Install four 400 kW/ea. natural gas-fired fuel cells for electricity and heat generation:
 - Electricity used primarily for HVAC, and
 - Steam used primarily for absorber chiller.
- Process: Natural gas \rightarrow H_2 \rightarrow $(H_2 + \text{Air} + H_3PO_4) \rightarrow (H_2 + O_2) \rightarrow$ DC \rightarrow (AC + waste heat)
- Energy savings: 50,727 MBtu/yr (less electricity purchased, more nat. gas used)
- Cost savings: \$800k/yr
- Implementation cost: \$5M
- SPP: 6+ yrs
- Assumed:
 - $\eta = .80$ efficiency
 - \$0.054/therm



ECM #6 - Use Two-speed Electric Motors

- Currently, 95 exhaust fan motors (370 HP total) operate at full speed at Blds 203 and 362.
- Action item: install PLC and dual starter on each motor, and connect them via software in order to start utilizing lower speed one third of a time.
- Energy savings: 1,100 MBtu/yr
- Cost savings: \$18k/yr (excl. HVAC savings)
- Implementation cost: \$114k (\$1.2k/motor, incl. software)
- SPP: 6.5 yrs



ECM #7 - Modulating Heating Water Perimeter

- Currently, existing JCI Metasys Energy Management and Control System (EMCS) does not allow for precise control and advanced energy savings strategies.
- Action item: Upgrade existing EMCS by programming new points; points would be able to trigger alarm.
- Energy savings: 82,000 MBtu/yr (~10% of HVAC energy consumption)
- Cost savings: \$500k/yr
- Implementation cost: \$3.5M (commissioning, programming, software update, training, hardware, replacement parts)
- SPP: 7 yrs
- More expensive alternative: Move to an open-protocol PLC-based SCADA.



ECM #8 - Modulating Heating Water Perimeter

- Currently, heat water flow loop in Blds 203, 205, and 362 is fixed (valves are 100% open all the time), and five pumps are running at full speed. This causes energy waste and discomfort in case of overheating.
- Action item: Upgrade existing system to variable flow by:
 - Installing VFDs on five heat water supply pumps;
 - Install sensors and program pumps to operate based on return water temperature.
- Energy savings: 84 MBtu/yr
- Cost savings: \$1k+/yr
- Implementation cost: \$12k (for all five pumps)
- SPP: 9 yrs



ECM #10 - Replace/Upgrade AHUs

- Currently, AHUs in Bldg 205 (A&B) and 203 are aged, and some without VFDs.
- Action item: Replace 12 AHUs, and upgrade another 8 AHUs with VFDs.
 - Demand-controlled ventilation (DCV) usually provides 20%-30% savings through less power used by motors and less air conditioned.
 - DCV combines CO2 sensors readings and AHUs to deliver only necessary amount of air
- Energy savings: 2,100 MBtu/yr
- Cost savings: \$29k/yr
- Implementation cost: \$280k
- SPP: 10 yrs



ECM #11 - Upgrade Fume Hood Controls

- Currently, fume hood exhaust fans serving Bldg 200 and 205 run constantly at full speed.
- Action item: Upgrade (1) existing 200 electric motors (2 HP/ea.) with VFDs, and (2) fume hood controls.
 - VFD would adjust the speed based on need to maintain static pressure
 - Less air would be exhausted & conditioned.
- Energy savings: 2,900 MBtu/yr
- Cost savings: \$46k/yr (excl. HVAC savings)
- Implementation cost: \$500k
- SPP: 11 yrs



ECM #12 - Replace HID Exterior Light Fixtures with LED

- Currently, HID (HPS and MH) light fixture lit exterior areas site-wide.
- Action item: Replace 50 (test phase) existing HID light fixtures with LED fixtures and install photocells for automatic operation
 - LED fixtures provide same illumination while consuming less power, and last longer
- Energy savings: 170 MBtu/yr
- Cost savings: \$3k/yr
- Implementation cost: \$41k (incl. material – LED fixtures and photocells, and labor)
- SPP: 15 yrs



ECM #13 - Install ATLAS-dedicated Chiller

- Currently, chilled water from central chilled water (CCW) system is cooled from 46°F additionally to 40°F for the whole Bld 203 because of accelerator needs.
- Action item: Install high efficiency 100-ton ATLAS-dedicated chiller.
- Energy savings: 300 MBtu/yr
- Cost savings: \$5k/yr
- Implementation cost: \$75k
- SPP: 15 yrs



ECM #14 - Replace Standard Motors with Premium Efficiency Motors

- Currently, great majority of AHU, fan, and pump electric motors are standard.
- Action item: Establish a comprehensive motor inventory and gradually replace standard motors with premium efficiency motors.
 - Over 10-yr operating life, value of electricity greatly exceeds initial cost
- Energy savings: 1,070 MBtu/yr
- Cost savings: \$17k/yr
- Implementation cost: \$300k (\$1.5/ea.)
- SPP: 18 yrs
- Assumptions:
 - 200 motors;
 - 3 HP/ea.;
 - (2 to) 8% savings over standard.



ECM #15 - Replace Valves for Chilled Water at AHUs

- Currently, 3-way valves are used on AHUs at Bldg 203 and 205. When load is lower, unused chilled water is returned to central chilled water (CCW) plant. Chilled water pumps are running at constant speed.
- Action items: Replace (1) 30 existing 3-way valves on AHUs with modulating 2-way valves, and (2) upgrade 20 pump motors with VFDs
 - Cooling load met → Valves start to close → Pressure builds-up → Pumps slow down → Pumps and chiller run less
- Energy savings: 340 MBtu/yr
- Cost savings: \$5k/yr
- Implementation cost: \$100k
- SPP: 19 yrs



Discussion

- In summary, it is estimated that 15 ECMs **would save about:**
 - 145,000 MBtu/yr,
 - 23 MGal/yr of potable water,
 - \$1.5M/yr.
- Would cost \$10M+ to implement.
- Overall, performing first two of four RCx phases was beneficial – a different set of eyes pointed out ECMs that were not actively discussed before.
 - Upon review, some projects will likely be included in Argonne FY12 and beyond list of projects
- Although majority of ideas were considered in-house before, some were new (use of 2-way valves at AHUs, for example).
 - Calculations were prepared for some “old” ideas (like fuel cells)
- In-depth assessment of 1.4 million GSF in five days was impossible to achieve.



Discussion cont.

- It was time consuming for escort – often time two people were with the RCx team: from building maintenance and engineering.
- Review of Report Draft in progress
- Some implementation costs seemed low.
- No data-logging was performed.
- Calculations were based on assumptions and interviews with building maintenance personnel.

- Any Questions?
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Thank You!