



O&M *First!*

A product of the FEMP O&M Center of Excellence

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A Case Study on In-house Retro-commissioning at a DOE National Laboratory



The U.S. Department of Energy's Federal Energy Management Program (FEMP) is pleased to present the series O&M First! as a way to promote energy efficiency by first applying O&M best practices. It is our hope that the experiences shared will provide Federal facility managers with strategies they can apply to their own facilities, as well as introduce the FEMP O&M program to federal site staff.

A copy of the FEMP O&M Best Practices Guide can be downloaded at www.eere.energy.gov/femp/operations_maintenance/om_best_practices_guidebook.cfm. This Guide, which covers a full range of facilities O&M topics, provides the rationale for a proactive O&M program; identifies O&M management issues and their importance; explains the various O&M program approaches; introduces maintenance technologies; and explores O&M procedures for the predominant equipment found at most federal sites.



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The building retro-commissioning (Retro-Cx) efforts at the Pacific Northwest National Laboratory (PNNL) facilities in Richland, Washington, were internally initiated to improve equipment and building operations by identifying and implementing low- and no-cost improvement opportunities. The selected building was the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL)—a 200,000 square foot national scientific user facility (pictured on next page). Estimated savings realized in FY02 were \$173,725, a 27% reduction in BTUs consumed and a 35% reduction in cost versus expected consumption and cost in FY02.

Best Practices Connection: O&M and Retro-commissioning

Retro-Cx refers to efforts aimed at ensuring existing buildings and their components are operating as intended or needed. Retro-Cx focuses on adjusting and tuning-up of building equipment to optimize building and equipment performance and efficiency, thus impacting both operations (e.g., control settings) and maintenance performance (e.g., potential identification of degrading components). Also, Retro-Cx activities usually result in low- and no-cost repairs and adjustments that can be addressed and maintained by facilities operations staff.

Numerous case studies of Retro-Cx activities have been completed over the years with resulting O&M-related energy efficiency improvements on the order of 5–30% covering a wide range of building uses. Further, most of these Retro-Cx efforts have reported simple payback periods of less than 2 years with many less than 0.5 years.

The Retro-commissioning Process

The PNNL Retro-Cx team followed a four-step approach of planning, investigation, implementation, and continuation. **Step 1** is the planning step that included assembling the in-house Retro-Cx Core Team composed of building management staff with skills in equipment operation, energy management, and engineering. During this step the overall program objectives and strategy were agreed upon.

Step 2, the investigation step, included several significant activities. During a typical Retro-Cx effort the providers become familiar with the building and its systems via walk-throughs, gathering and reviewing equipment and design documentation, and evaluating O&M practices. Since in-house staff were used for this effort, a significant degree of building, equipment, and process familiarity existed already. As part of the investigation step, a list of potential energy efficiency measures (EEMs) for the building was developed. The foundational checklist for PNNL's internal Retro-Cx is the database of the DOE Industrial Assessment Center at www.iac.rutgers.edu/database. PNNL's current master checklist contains more than 2,300 building-specific EEMs identified as low- and no-cost

actions (costing less than \$500 to complete), ranging from innovative free-cooling technologies to equipment scheduling to turning off lights. The master checklist is a living document and is updated as new EEMs are identified. Armed with this information the Retro-Cx Core Team was able to identify applicable EEMs, develop cost estimates, and prioritize the opportunities.

The **third step** in the Retro-Cx process is the implementation of EEMs. Once the implementation budget was finalized and necessary occupant approvals were obtained, the PNNL Retro-Cx team proceeded to put the changes in place. EEMs determined to be easy to complete, measure, and most likely to succeed were the first to be addressed. The results of these EEMs were then used to build-up credibility for the Retro-Cx approach and gain support to accomplish the full range of EEMs. Completed EEMs are tested and monitored for results with readjustments made as necessary.

The **fourth step** in the PNNL Retro-Cx effort is that of continuing the onsite Retro-Cx effort with activities such as monitoring building energy data, periodic review of operational changes, occupant and operator feedback, and monthly update reports. Ongoing monitoring of building performance helps to ensure that the retro-commissioned building systems continue to operate in their optimized state and energy savings continue to be realized.

Completed EEMs

PNNL has put into place roughly 200 low- and no-cost EEMs at EMSL. Note that all building occupant operational requirements continued to be satisfied even after these changes were made. Examples of the completed EEMs include

- HVAC systems fine-tuning, including modifying chilled water temperature set points, ensuring that heating and cooling control valves operate appropriately, optimizing chiller operations for efficiency, checking and correcting supply fan return dampers, optimizing selected supply fan heating/cooling strategies, reducing dead band limits on digital controls, and resetting building air flows as appropriate.
- Adjusting temperatures by modifying heat recovery system operational temperatures, modifying supply fan air discharge temperatures, resetting zonal thermostats to better match the conditions of the space (occupied or unoccupied), and applying additional night setbacks—adding some systems not previously set back and increasing the time for other systems.



William R. Wiley Environmental Molecular Sciences Laboratory

The 1997 E Source Tech Update “Commissioning Existing Buildings” reported retro-commissioning costs in a 44-building study varying from \$0.05 to \$0.40 per square foot with resulting energy savings usually between 5% and 15% and paybacks of less than 2 years.

“Some level of retro-commissioning is usually appropriate if you are considering any type of energy savings agreement such as energy savings performance contract (ESPC).” Haas and Sharp, A Practical Guide for Commissioning Existing Buildings ORNL/TM-1999/34.

In addition to saving energy, retro-commissioning of mechanical equipment can also result in

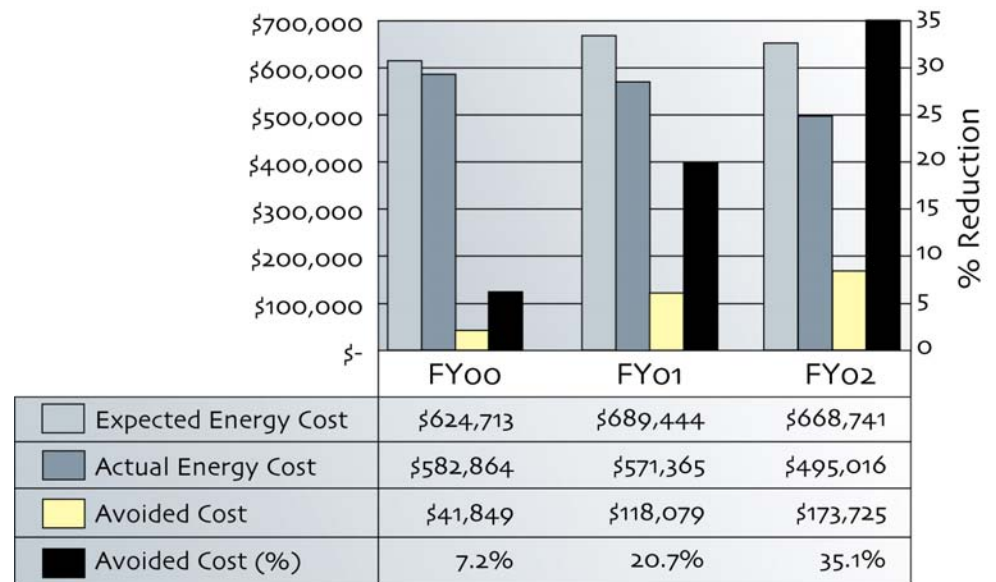
- extended equipment life
- safer and more reliable equipment operations
- increased occupant comfort

- Adding holiday schedules to building controls.
- Shutting down unneeded computers at night and performing light checks during off-hour tours.
- Monitoring fume hood positions with e-mail status reminders/updates to building occupants, and closure of open fume hoods by building operators during off hours.
- Designating staff members to review operational strategies for facility systems for operational efficiency improvement opportunities.

Results

The total investment cost to complete the EMSL Retro-Cx effort at PNNL was approximately \$125,000. As summarized in the figure below, the simple payback for this project is slightly more than 1 year based on the FY01 estimated avoided cost. Further, the EMSL RCx team now meets on a monthly basis to look for new opportunities and continued refining of the PNNL master checklist. Because of this success at EMSL, PNNL's facility management staff have expanded their O&M Retro-Cx efforts to other buildings on the PNNL campus, applying many of the lessons learned from the EMSL project to subsequent projects. It's all part of building and maintaining an effective O&M program at your federal facility, and it works!

PNNL EMSL Building Energy Performance by Fiscal Year (FY)



Additional Information

Retro-commissioning of existing building systems and equipment, along with commissioning of new buildings and/or new equipment, is a relatively new building management practice that has yielded compelling results at EMSL and other buildings. Additional studies to better quantify the costs and benefits of commissioning are underway, as are studies and demonstrations to refine commissioning practices.

The recently released *FEMP Continuous Commissioning Guidebook for Federal Energy Managers* (www.eere.energy.gov/femp/operations_maintenance/commissioning_guidebook.cfm) was developed for FEMP by the Energy Systems Laboratory at Texas A&M University. This guidebook presents a description of the continuous commissioning process, a summary of results at some commissioned buildings, and continuous commissioning measures for air handler systems, central chiller plants, central heating plants, distribution systems (chilled water, hot water, and steam), and thermal energy storage systems.

The PECI (Portland Energy Conservation Inc.) homepage (www.peci.org) makes available guidebooks, presentations, technical papers, and case studies on retro-commissioning and O&M practices.

Your Next Step

Realizing the efficiency improvement opportunities available through retro-commissioning requires an ongoing commitment on the part of the entire facility management staff with continuing attention given to the various O&M best practices. Federal agencies with questions regarding energy efficiency through improved O&M should contact FEMP for more information.

Leading by example, saving energy and taxpayer dollars in federal facilities



FEMP O&M Resources

FEMP is committed to providing federal facility staff tools and knowledge to help optimize their O&M programs. Visit the FEMP homepage for information on O&M and other FEMP programs and activities at www.eere.energy.gov/femp.

FEMP also offers the workshop Operations and Maintenance Management. To find out more about this course, visit www.eere.energy.gov/femp/services/training_om.cfm.

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