

The Right Stuff: Preparing the Facilities Engineering Group for the Sustainable Workplace

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Synopsis

Facility management departments have historically taken a quiet role in the company infrastructure. Today, with rising energy costs, indoor air quality concerns, and the greening of the workplace, companies are realizing how much FM affects the bottom line and the overall well-being of employees. This affords the FM department an opportunity to have a larger role in helping the organization achieve its goals. The FM department's engineering group is key to making this role effective. Consider this example -- a skilled and motivated engineering staff can reduce energy and water utility costs by 15 percent or more, with little or no capital investment -- simply through changes in the practice of operating and maintaining increasingly complex building systems and equipment.

This paper is for middle and upper level managers seeking to prepare their FM department's engineering group to effectively operate and maintain the green building. Topics include an FM operating plan for the green building, workforce competencies for operating and maintaining the green building, and a process for "greening" the O&M workforce. This paper will use the term "green building" to represent a range of high performance building types. High performance buildings utilize integrated design, construction, commissioning, and O&M practices that ensure energy and resource efficiency over the lifetime of the building.

Introduction

Buildings are where Americans spend about 90 percent of their time. They use one-third of our total energy and two-thirds of our electricity. Their construction consumes one-fourth of all harvested wood; 3 billion tons of raw materials are used annually to construct buildings worldwide. Buildings consume 17 percent of water and 50 percent of chlorofluorocarbons (CFCs). They also produce indirectly, 33 percent of carbon dioxide (a global warming gas) and 40 percent of landfill waste (GSA, 2000).

How does an organization build, operate and maintain sustainably? Definitions for sustainable development come from many sources including the development, design and engineering community, and more recently the facility management profession. The Hannover Principles, developed in 1992 by architects William McDonough and Michael Braungart, were among the first to address the fundamental ideas of sustainability and the built environment by asking organizations to remember three essential principles in their decision making processes: to recognize interdependence between the built and natural worlds, to eliminate the concept of waste, and to understand the limitations of design by treating nature as a model, not as an inconvenience to be evaded or controlled.

Since then, a number of design and engineering tools have been developed to help planners, architects and engineers design and build green buildings. The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) Green Building Rating System™ provides guidance in the areas of building development and design which results in a more sustainable project. (USGBC) LEED has been adopted by a number of Federal, state and municipal governments across the country requiring LEED

certification for their new construction projects. Several states also offer green building tax credits tied to LEED certification.

In 1999, the Federal government issued Executive Order (EO) 13123, Greening the Government through Efficient Energy Management, which established sustainable design principles for application to Federal projects in order to reduce pollution and other environmental costs associated with construction, operation and eventual decommissioning. Other guidelines have been developed such as the Whole Building Design Guide prepared by U.S. DOE Federal Energy Management Program, Advanced Building Guidelines prepared by the New Buildings Institute, and U.S. EPA's EnergyStar Buildings rating system.

Common to all of these documents is the role and responsibility of the facility management department in reducing energy consumption and costs, improving working environments, and reducing the environmental impacts of their operations. These guides are good first steps for putting principles into practice, and many FM departments are on their way to adapting their O&M programs to ensure successful performance of green buildings.

O&M Programs for the Green Building

The performance of the green building is a result of the integration of the work of the architect, mechanical system designer, contractor(s), and commissioning authority. The design intent of the green building is to produce a structure which is energy and resource efficient and offers both financial and productivity rewards for the property owners, managers and building occupants. The on-going realization of this intent is the responsibility of the FM department and requires a facility O&M program that differs from standard practice.

Traditionally, the term O&M (shorthand for Operations and Maintenance) has been viewed as a single unified process. For many in the field, the activity was expressed as a maintenance and repair (M&R) function. Maintenance has been defined as "...the work necessary to maintain the original anticipated useful life of a fixed asset" (Cotts, 1999). Repair relates to "...work to restore damaged or worn-out property to a normal operating condition" (Cotts, 1999). These are excellent definitions to describe the necessary maintenance work for a facility. They do not, however, address the "O" in O&M.

Operations is, of course, more than just the expression of the cost of operating a facility. Good operations within a building serve as a fundamental component of a best practices preventive maintenance program. Without attention to operations, "...even when the staff meticulously maintains equipment, operation that relies on inadequate control strategies or improper scheduling can result in a significant energy waste, higher energy bills, reduction in the useful life of equipment, and poor indoor environmental quality" (PECI, 1999). Clearly, a green building's intent to use resources efficiently and provide an indoor environment that spurs higher levels of worker productivity can be subverted without a conscientious approach to the maintenance and operations of the building.

A best practices operation of the facility provides persistence of the design intent of the building over its lifetime. The design intent of the green building is for energy and resource efficiency and an indoor environment that is conducive to high worker productivity. FM departments must redefine their approach to O&M to include operational activities that sustain the benefits of green design.

On the Way to Best Practices

The FM professional can turn to a number of resources to discern a "best practices" approach for managing the green building. Of course, any building benefits from adopting a sound O&M approach to facility management. As a baseline, the Federal Energy Management Program lists 10 steps for maintaining operational efficiency in an existing building.

10 Steps for Maintaining Operational Efficiency in an Existing Building (FEMP, 2002)

Step 1: Strive to increase management awareness and appreciation of the operations and maintenance program/department.

Step 2: Commit to begin tracking Operations and Maintenance activities.

Step 3: Through tracking begin to identify your troubled equipment and systems.

Step 4: Commit to addressing at least one of these troubled systems.

Step 5: Commit to striving for Operational Efficiency of this system.

Step 6: Commit to purchasing or contracting for some form(s) of diagnostic, metering, or monitoring equipment.

Step 7: Commit to trending the collected tracking and diagnostic data.

Step 8: Select, request funding for, and complete first "Operational Efficiency" project.

Step 9: Strive to highlight this success – capitalize on visibility opportunities.

Step 10: Commit to choosing the next piece of equipment.

Best Practices for the Green Building

Beyond this baseline of good practices O&M, a number of recent reports outline for FM departments a heightened commitment to operational practices appropriate to the green building. Research sponsored by the California Energy Commission in the persistence of benefits from retrocommissioning (Friedman et al, 2003) concluded that the persistence of the value of commissioning activities within a facility was enhanced by:

- Providing operators with training and support
- Providing a complete systems manual at the end of the commissioning process
- Tracking building performance
- Starting commissioning in the design phase to prevent nagging design problems

U.S. EPA and U.S. DOE sponsored the development of a report series on O&M best practices that summarized a number of specific O&M goals for the facility manager.

O&M Goals for the Facility Manager (PECI, 1999)

Goal 1: Incorporate goals for energy efficient building operation into the strategic business plan.

Goal 2: Require an energy management plan with energy efficient operation as a primary component.

Goal 3: Use an energy accounting system to locate savings opportunities and to track and measure the success of energy efficient strategies.

Goal 4: Hire or appoint an energy manager.

Goal 5: Train building operators in energy efficient O&M activities.

Goal 6: Require service contracts that support energy efficient building operation.

Goal 7: acknowledge energy efficient operation as a cross functional activity.

Goal 8: Maintain continuity and reduce troubleshooting costs.

Goal 9: Equip O&M staff with state of the art diagnostic tools.

Goal 10: Perform a comprehensive O&M site assessment.

Goal 11: Perform O&M tune-up actions.

Goal 12: Make full use of automatic controls to optimize efficient operation.

Goal 13: Operate equipment only when needed.

Goal 14: Track actual performance against expected performance for major equipment.

Goal 15: Redefine preventive maintenance to include activities critical to energy efficient building operation.

Even more specific to green buildings, the U.S. Green Building Council's LEED Green Building Rating System™ for Improving Building Performance through Upgrades and Operations (working draft) provides guidance for the FM department. In this rating system, buildings receive credits for "ensur[ing] that the building systems are continuously commissioned and maintained appropriately so that they go on delivering target building performance goals over the long term" (USGBC, 2002). To meet this intent, buildings must:

- Establish/maintain continuous commissioning program that monitors indoor environmental parameters (CO², temperature, humidity) on a daily basis to ensure building systems are operating properly to meet standards for indoor environmental quality and optimal levels of energy efficiency as specified by manufacturers, service contractors.
- Establish/maintain contracts or in-house resources in place for post warranty equipment maintenance.
- Implement/maintain a comprehensive best practice and continuous preventive maintenance program.

Green buildings clearly require a well developed, best practices approach to facility management. To achieve the high performance potential of the building, the design, construction, and commissioning process must connect to the FM department whose financial and human resources realize that potential over the life of the building.

Assessment of the O&M Workforce

Workforce assessment is part of the larger field of human resource development and comes with established standards and guidelines for assessing personnel needs. Yet workforce assessment is also recognized as an important responsibility for the facility manager. For the purpose of this paper, we will focus on assessment of the O&M workforce with the goal of understanding and enhancing the department's capacity to operate and maintain green buildings in accordance with design intent. Three assessment steps will be discussed including competencies necessary for operating and maintaining green buildings, staffing practices for operating and maintaining buildings, and a process for "greening" the O&M workforce.

Competencies for operating and maintaining green buildings

The term competency is defined as "an area of knowledge or skill that is critical for producing key products or services to others. They are internal capabilities that people bring to their jobs, capabilities which may be expressed in a broad, infinite array of on-the-job behaviors" (Craig, 1996). The field of HR defines competencies in four broad categories -- technical, business, interpersonal and intellectual -- for all job positions from CEO to building custodian. For the discussion of green buildings, we will focus on the technical competency area only and work to define a set of functional knowledge and skills necessary for operations and maintenance personnel including in-house staff and contractors.

The attributes of the best practices operations discussed in the section above form the basis for identifying the technical competencies of operation and maintenance competencies. It draws on research in persistence of benefits from building commissioning (Friedman et al, 2003), research on benefits of trained building operators (Peters et al, 2002), and guidelines proposed in the LEED™ Existing Buildings standards.

Working from this data, we compiled the following competencies for operations and maintenance personnel.

- ***Familiarity with the systems manual and baseline performance of the building.***

The systems manual is completed at the time the building is commissioned. Building commissioning, including retro-commissioning, is a detailed analysis of a building's mechanical system, lighting, and controls to insure that the building operates at its design intent. The systems manual is a product of the commissioning project and includes the design intent, system descriptions, sequences of operation, and a commissioning report. Operators should be familiar with the building systems knowledge and documentation. Examples include knowing location of HVAC and lighting system documentation, and keeping a maintenance log for HVAC equipment and lighting equipment.

- ***Track building performance.***

Operators should be able work from the documented baseline operation identified in the commissioning report to develop a method for tracking performance. Tracking should include consumption of energy, water, and waste. When deviations are detected, operators should be able to troubleshoot. LEED™ Existing Buildings calls for use of the U.S. EPA's EnergyStar Portfolio Manager. Other tracking tools are also available.

- ***Monitor and maintain equipment efficiency.***

Operators should be able to perform diagnostic tests to ensure equipment is operating at designed efficiencies and to incorporate diagnostics into the PM plan. Examples include cleaning heating/cooling coils regularly, confirming economizer operation, detecting sensor failure and replacing as needed, repair gaskets on doors for air handler, check condition of dampers and seals regularly, and conduct preventive maintenance on the cooling tower.

- ***Optimize building and equipment operations.***

No matter how well the building equipment is maintained, if it is operated poorly or operated when it could be shut down, the result is energy waste. Operators should be able to periodically check schedules to ensure that equipment is operating only as needed to fulfill its intended function and to diagnose operating problems by measuring and tracking the various parameters that indicate proper operation. For example, they should be able to review and determine that deadbands or lockout temperatures are properly set to keep cooling and heating from occurring simultaneously, and that sensors critical to efficient operation are calibrated more than once a year. They should record occupant complaints and comments and record new and changed control settings. They should provide supervisors with ideas for energy savings and comfort improvement opportunities.

- ***Specify energy and environmental goals with suppliers and contractors associated with the use of their products and services.***

Equipment suppliers and contractors are an important part of the O&M team. Begin by setting goals for operating and maintaining the green building using elements of the best practices operations plan. For example, explore with the contractor how they might upgrade standard service contracts to move beyond basic maintenance and focus on optimizing equipment operations. When working with contractors, it's important to establish clear lines of communication, review and document work, and conduct spot checks. Guidelines for obtaining a best-practice service contract are available in the resources section below.

- ***Familiarity with local utility energy and water efficiency programs.***

Facility managers in most regions of the country will find excellent technical assistance and training resources through their local electric, gas and water utility companies. Utility conservation staff are well versed in new technologies and equipment such as high efficiency lighting, heating and cooling systems. Many utilities also offer training programs for building managers and operators on operation and maintenance of energy and water efficient equipment. Finally, utilities may also be a resource for financial incentives to retrofit outdated equipment with new energy efficient alternatives.

Process for "greening" the O&M workforce

Improving the skills of the O&M workforce begins with an assessment of existing talent and expertise. Each department is different making generic approaches to professional development less effective. An assessment is conducted by having the manager and operator independently review and assess skills necessary to support the best practices approach, then meet to compare notes and identify skill areas for development. The final outcome should be a professional development plan for each operator that provides the skills to perform best practices operation and maintenance.

The professional development plan can draw from the following commonly used approaches for skill building in the workplace.

- ***Provide operators with training and support.***

Training and motivating building operators can reduce utility costs at facilities by at least 5 to 15 percent (Schueler, 1995). Savings reported in a 1995 review of over thirty studies of O&M improvements ranged from 5 to 30 percent. Building operator certification is one means to provide this training. In a comparison of BOC-trained and non-trained operators, BOC-trained operators were 30 percent more likely to engage energy efficiency practices and preventive maintenance (Peters et al, 2002). Building operator certification is available in seventeen states with sponsorship from local electric and gas utilities.

Other training resources include seminars and conferences offered by the U.S. Green Buildings Council, the U.S. Department of Energy FEMP, U.S. EPA EnergyStar and through local energy and water utility training programs. Certificate programs in energy management and sustainable building advisor are available in many local communities. Topics of benefit to operators of green buildings should address the building diagnostics, fundamentals and advanced control systems, optimizing operation of energy-intensive systems such as lighting and HVAC, and preventive maintenance.

Funds for training should be budgeted amply on an annual basis to allow each operator to attend training during the year. If training budgets are limited, the resourceful facility manager can explore training scholarships through their local utility, energy service provider (e.g., Energy Service Company (ESCO), service contractor, and through professional membership associations such as IFMA.

- ***Involve operators in the design phase of green building to prevent design problems that make the building difficult to operate and maintain overtime.***

Operators have experience working with systems, equipment, and manufacturers that can be valuable to the design team. Systems and equipment that are easy to access and maintain by the O&M staff have a greater likelihood of receiving proper care over their life. Involvement in the design phase also offers operators lead time to prepare an O&M plan for new equipment and systems integrated into the building design.

- ***Involve operators in new initiatives such as retrocommissioning, energy conservation, and pollution prevention.***

New work assignments for operators such as assisting as a team member on commissioning projects and energy efficiency initiatives such as lighting system upgrades and building management systems can provide excellent learning opportunities for operating and maintaining the green building. O&M staff at Pacific Northwest National Laboratories (PNNL) partnered with building scientists to demonstrate and test innovative FM technologies (Leibowitz, 2003). Pairing operators with veteran operators or project consultants is another strategy for skill-building and cross-training in the department. During the California energy crisis, PNNL staff paired with researchers to perform an assessment of load and energy reductions techniques (ALERT) which identify energy efficiencies at Federal facilities.

- ***Explore department re-structuring.***

Re-thinking the structure of the FM Department can also be useful in creating and maintaining a sound operations and maintenance approach. Hiring or appointing an energy manager can assist the facility manager in maintaining a focus within the department on a preventive maintenance approach that persists the benefits of the green building. Alternatively, some facilities may find the use of a Resource Efficiency Manager or Resource Conservation Manager (REM/RCM) as an effective way to achieve the consistent attention to resource efficient operations in the building. REMs track utility bills and energy and water consumption in the facility with the goal of identifying efficiency improvements (including billing errors) substantial enough to pay for the REM's salary annually.

- **Look to contractors as a resource.**

Outside contractors may also work as a part of the FM department's "team" commitment to resource efficient operations. Discussing a contractor's knowledge of and commitment to resource efficient operations may assist the FM in making selections for outside contractor assistance that will work to persist the value of the green building. Contract terms may want to reflect a set of expectations that the FM holds on the commitment of the contractor to these O&M practices.

Resources

The path to greening the O&M workforce begins with small steps and a whole host of resources for support. This paper has referenced a number of resources from best practices lists to utility efficiency programs to training and tools. The table below provides a summary of key resources for facility managers ready to get to work.

Chart 1. Resources for Greening the Facilities Engineering Group

Professional Development & Training for Building Engineers	<ul style="list-style-type: none"> ▪ Building Operator Certification™: www.theBOC.info ▪ BOMA's System Maintenance Administrator: www.boma.org ▪ Federal Energy Management Program O&M Management Workshops: www.eren.doe.gov/femp ▪ Association of Energy Engineers: www.aeecenter.org ▪ Energy Management Certificate Program: www.nweei.org ▪ University of Wisconsin Extension Program. http://epdwww.engr.wisc.edu/ ▪ Texas A&M: www.tamu.edu
Utility Efficiency Programs	<ul style="list-style-type: none"> ▪ Resource Efficiency Manager (REM): www.energy.wsu.edu/ten ▪ Northeast Energy Efficiency Partnerships: www.neep.org ▪ Northwest Energy Efficiency Alliance: www.nwalliance.org ▪ Midwest Energy Efficiency Alliance: www.mwalliance.org ▪ Local electric, gas, and water utility conservation offices
Guidelines & Tools	<ul style="list-style-type: none"> ▪ LEED™ for New and Existing Buildings: www.usgbc.org ▪ U.S. EPA EnergyStar Benchmarking Tool: www.energystar.gov ▪ Advanced Building Guidelines: www.newbuildings.org
Associations	Building Commissioning Association: www.bcxa.org Northwest Energy Efficiency Council: www.neec.net

Summary

The green building offers the potential for energy and resource efficiency, lower operating costs for owners and managers, and an indoor environment that enhances worker productivity and comfort. The FM department's approach to the operations and maintenance of the green building determines how and whether that potential is realized. A set of best practices O&M activities is critical to maintaining the design intent of the green building. The facility manager must approach this task with a thoughtful and strategic assessment of the workforce of the FM department and a commitment to an O&M approach that achieves the goals of the green building.

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