

APPENDIX D: CASE STUDIES

D.1 Building Operator Certification

The Building Operator Certification (BOC) Program, funded by the California Investor Owned Utilities (IOUs) and administered by the Northwest Energy Efficiency Council (NEEC), provides in-depth and hands-on experience to professionals in the building operations and maintenance (O&M) field. The program provides two levels of training and certification both of which are designed to improve job skills and lead to improved comfort and energy efficiency at the participant's facility or facilities. The Level I course series focuses on expanding knowledge of building systems and equipment while Level II students gain experience in equipment maintenance and troubleshooting.

BOC Level I training consists of seven courses and covers topics related to energy transfer, air movement, heating systems and maintenance, motors, cooling, ventilation and control systems, lighting, electrical safety, environmental health, and safety and indoor air quality. One course is held per month and each is structured to allow for lecture, work in small groups, the completion of tests and assignments, and the performance of work at one's own facility.

Course observation suggests that assignments and examinations are key factors in encouraging student engagement and active participation during the course sessions. Participants in the observed session paid close attention to the material presented, took notes and asked questions of the instructor, an indication of interest in the material and its applicability to their position. Instructors also highlight the importance of hands-on facility projects in reinforcing the information conveyed in the classroom.

Figure 23: Level I and II Curriculum

Course Name
Level I
BOC 101: Building Systems Overview
BOC 102: Energy Conservation Techniques
BOC 103: HVAC Systems and Controls
BOC 104: Efficient Lighting Fundamentals
BOC 105: Environmental Health and Safety Regulations
BOC 106: Indoor Air Quality
BOC 107: Facility Electrical Systems
Level II
BOC 201: Preventative Maintenance and Troubleshooting Principles (core)
BOC 202: Advanced Electrical Systems Diagnostics (core)
BOC 203: HVAC Systems Troubleshooting & Maintenance (core)
BOC 204: HVAC Controls & Optimization (core)
BOC 210: Advanced Indoor Air Quality
BOC 211: Motors in Facilities
BOC 212: Water Efficiency for Building Operators
BOC 213: Mastering the Fundamentals of Electric Control Circuits
BOC 214: Introduction to Building Commissioning
BOC 215: Electric Motor Management

In addition to attending classes and passing all tests, students must complete a series of facility specific projects. Level I projects include developing an energy management plan and conservation goals, the review of HVAC operations and maintenance procedures, and a lighting survey. For Level II students, projects require them to describe a power quality upgrade plan for their facility (or a part of it), compare original HVAC design and operating conditions to current conditions at the facility, and create an AC controls diagram, as well as a maintenance checklist for the facility fan system.

Participants who pass an exam at the end each course and complete all coursework are eligible for certification. Certification must then be renewed each year by completing at least five hours of additional training for Level I and ten for Level II. The certification and renewal processes are all managed by NEEC on behalf of the IOUs. The requirement for continued education provides the BOC program with an opportunity to direct students to course offerings at the Energy Centers, which count towards continuing education hour requirements.⁴⁴

Reach of the Program

According to IOU program tracking data, between February 2006 and October 2008, 1,147 participants enrolled in the BOC program. As shown in Table 2, the programs vary in size by

⁴⁴ Interviews with BOC program staff. January 2009.

utility and Southern California Edison (SCE) had the largest number of participants with 462. Overall, 95% of attendees graduated from the program and received their BOC certification.

Figure 24: BOC Participants by Utility

Utility Sponsor	Number of Enrollees	Number of Graduates	Completed Interviews
Pacific Gas & Electric (PG&E)	385	359	100
Sothern Cal Edison (SCE)	462	434	64
Southern Cal Gas (SCG)	134	134	25
San Diego Gas & Electric (SDG&E)	166	161	43
Total	1147	1088	232

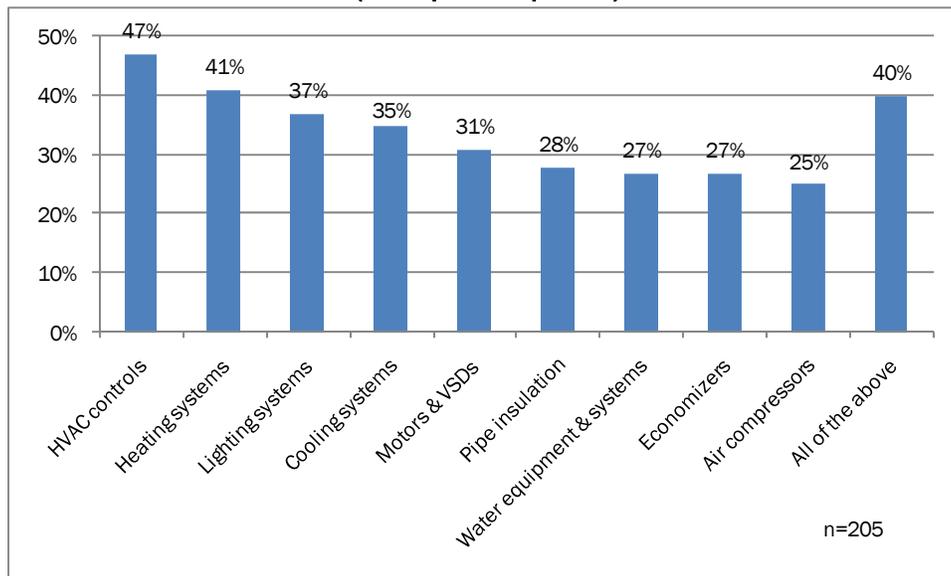
According to a survey of participants, a majority of BOC participants (88%) conduct or manage operations and maintenance (O&M) activities at their facility.⁴⁵ On average, these individuals have just over 4 years of experience in their field and just under half serve as members of O&M teams that are over 20 people in size (47%). Among those who have staff members reporting directly to them, the average number of staff members they oversee is eight.

Responses to the participant survey also indicate that the BOC program reaches O&M professionals working at a variety of facility types. More than three quarters of participants serve in government (31%), commercial (28%) or institutional (28%) buildings while a smaller percentage perform their duties in industrial facilities (10%). On average, a participant facility includes 4 buildings and covers 5,677,405 square feet.

BOC program participants have responsibility for a wide variety of systems and equipment at their facilities. The most common systems are HVAC controls. However, there are slight differences across facility types with participants who manage government (48%), commercial (55%) and institutional (50%) facilities being significantly more likely to deal with HVAC controls in their current position than those at industrial facilities (25%). Those working at commercial facilities (40%) are also significantly more likely to control water systems and equipment than their counterparts at various institutions (19%).

⁴⁵ A small percentage of BOC participants (12%) are not directly involved in O&M and among these individuals, all enrolled in the Level 1 program. The top reasons given for participation were knowledge acquisition (35%), applicability of the training to their current position (23%), and that enrollment was requested or required by their management (15%).

**Figure 25: Equipment and Systems Controlled by BOC Participants
(Multiple Response)**



In addition, the majority of BOC participants surveyed have responsibility for controlling or reducing energy use (81%), maintaining indoor air quality (75%), and monitoring their facility's energy use (64%).

Knowledge and Behavior Change

Knowledge Change

Almost all BOC O&M participants (90%) come to the program with existing knowledge about the material covered in the training program: 45% feel they had “a lot” of prior knowledge while another 45% say they had “some” knowledge. However, when asked the degree to which their knowledge improved across the spectrum of BOC training topics, these individuals still report a moderate increase in knowledge regardless of the course level. For both Level I and II participants, the mean improvement in knowledge was 4.8 based on a 7 point scale where 1 is “not at all” and 7 is “significantly” improved.

The trainings were equally effective in increasing the knowledge of participants who had varying levels of experience with the material at the start of the series. Those with very little (4.9), some (4.9) or a lot (4.7) of knowledge all had similar gains on the 7-point knowledge scale. Level II participants with some prior knowledge of the topics reported a mean improvement in knowledge of 5.0 while those with a lot of prior knowledge had an average of 4.6.

In addition to expanded knowledge, participants report sharing information, increased professional confidence, and engagement on energy efficiency more generally. As illustrated in Figure 26 below, participants provide moderately high ratings in each of these areas.

Figure 26: Knowledge Based Training Outcomes

As a result of the BOC program...	Mean Score* (n=205)
I am more likely to encourage my organization to take steps to improve energy efficiency at my facility	6.1
I better understand how to improve energy efficiency at my facility	5.9
I have more confidence when I take steps to improve energy efficiency at my facility that the expected level of energy savings will actually occur.	5.8
I make greater contributions to O&M discussions about energy efficiency at my facility	5.6
I have increased my knowledge of what to look for when replacing equipment	5.6

* Mean on a 7 point scale where 1=Strongly Disagree and 7=Strongly Agree.

Behavior Change

Information Seeking and Sharing

The information provided through participation in the BOC training course fosters greater information exchange and information seeking behavior. For example, almost all participants (97%) shared the information they learned through the BOC training with colleagues while 61% shared information with people outside their organization. In addition, 70% searched for additional information related to the concepts taught in the course and 86% helped convince others in their organization that energy saving action is needed.

Participants also perform many of these behaviors with greater frequency and confidence after the training. Seventy three percent of participants strongly agree that they recommend energy efficient technologies or practices to their management more often and that they are better prepared to evaluate energy efficient options.⁴⁶ Furthermore, 64% strongly agree that their recommendations regarding energy efficient technologies or practices are viewed by their management as more informed.

Procedural, Maintenance and Equipment Related Practices

Participation in BOC training leads a majority of enrollees to modify the way in which they perform their O&M duties. In fact, 69% of participants made changes to their O&M procedures as a result of participating in BOC training. Those who took the Level II series (79% compared to 66% of Level I) and those who received their certification (72% compared to 59% of un-certified participants) are significantly more likely to have made procedural changes.

Eighty three percent of participants went further and took steps to save energy at their facility. Those that serve industrial (90%), government (88%), and commercial (86%) facilities are significantly more likely to have made efforts to save energy than those employed at institutional facilities (72%). At a minimum, approximately half of participants conducted one of the activities listed in the table below since completing their BOC training.

⁴⁶ This percentage and the that following it represents a score of six or seven on a scale of 1 to 7 where 1 is “strongly disagree” and 7 is “strongly agree”.

In a number of cases (marked with an asterisk), Level II students are significantly more likely to perform the activity than their Level I colleagues.

Figure 27: Activities Conducted Since Completing the BOC Training

Activities Conducted	Percentage of Participants (n=170)
Equipment Installation	
Install energy efficient lighting*	71%
Install new motors*	68%
Install lighting controls*	64%
Install energy management system or thermostat	63%
Install pipe insulation	59%
Install variable frequency drives	58%
Install air handler seals/gaskets*	45%
Maintenance Activities	
Perform motor maintenance*	75%
Conserve water and/or wastewater as a result of actions	71%
Perform maintenance on chillers/cooling towers*	68%
Perform maintenance on unitary equipment*	67%
Perform maintenance on economizers*	67%
Perform maintenance on boilers	67%
Perform maintenance on air compressors*	64%
Perform air compressor leak reduction	46%

Note: The inclusion of an asterisk next to any activity indicates cases where Level II students are significantly more likely to have performed the activity than their Level I colleagues.

On average, participants performed 10 activities after completing the program and 11% performed all of activities listed above. Participants also indicate that the training provided by the BOC program had a moderate impact on their decision to perform these activities. The mean level of program influence was 5.3, although 43% of participants rated the training's affect a 6 or 7 on a seven point scale where 1 is "not at all" and 7 is "very much."

Although a majority of participants (86%) also performed these activities before completing the BOC training program, 95% report performing them more efficiently and 69% report performing the activities more frequently since completing the training program. In terms of future activity, 79% of O&M participants are very likely (a rating of six or seven) to make an effort to save energy at their facility during the next 12 months.

As documented by other evaluations of the BOC program, the actions of O&M professionals also have an impact on facility energy usage. For example, the Northeast Energy Efficiency Partnership (NEEP) developed an estimate of energy savings associated with actions taken as a result of the program that has been used as a reference by the Midwest Energy Efficiency Alliance (MEEA) and those utilities for which MEEA administers the program. NEEP estimates that the program saves 0.35 kWh/square foot per enrollee (including savings from rebated actions) and 0.18 kWh/square foot per enrollee (excluding rebated actions).⁴⁷

Energy savings estimates can differ dramatically across jurisdictions, however, based on differences in average building size, the types of projects implemented, and the degree of influence that the BOC program had on participants' decisions to implement projects. For example, NEEP's estimates are *gross* savings estimates and therefore do not consider that the energy saving actions might only have been partially influenced by the program. In addition, savings estimates developed as part of evaluations from other jurisdictions range from 0.02 kWh/ square foot per graduate to 0.06 kWh/square foot. Despite the variation, these estimates are one indicator of the influence of the program on energy saving actions and their associated energy savings.

Overall Value and Influence of the BOC Program

As demonstrated above, the BOC program provides O&M professionals with enhanced training that enables them to better understand the energy efficiency options available to them, and encourages them to take steps to reduce energy use either for the first time or more frequently. The program also fosters the dissemination of energy efficiency information within the participant's professional networks and organizations.

Participants clearly believe the BOC training is influential in their decision-making regarding energy efficiency actions. Among participants that made efforts to save energy, 44% said the training affected their decision to perform the activities "very much" (a rating of 6 or 7 on the 7 point scale where 1 is "not at all" and 7 is "very much"). The average response was 5.25, which indicates a moderately high influence for the program.

In addition, over half of BOC participants have either participated (38%) or plan to participate (19%) in a utility sponsored energy efficiency program. It is likely that the presence of utility representatives at BOC training sessions and the use of utility program, rate, and other information by instructors help to educate participants about the opportunities available to them through their utilities.⁴⁸ Awareness of these program options is a critical first step in reaching a decision to participate.

⁴⁷ RLW Analytics, "Impact and Process Evaluation – Building Operator Certification (BOC) Program – Final Report", prepared for Northeast Energy Efficiency Partnerships. June 2005.

⁴⁸ Interviews with the BOC program administrator and instructors, as well as course observation.

Overall, all BOC participants generally agree that they have been able to reduce energy usage, enhance comfort and save money at their facility as a result of the BOC training program.

Figure 28: Additional BOC Training Outcomes

I have been able to...	Mean Rating* (n=205)
Enhance the comfort of the facility occupants	6.3
Save money at my facility	5.6
Save energy or reduce energy demand at my facility	5.6

*Note: Mean ratings are based on a seven point scale where 1 is “strongly disagree” and 7 is “strongly agree.”