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Ameren Illinois Company 2020 Building Operator Certification Process Evaluation Report

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Placeholder for executive summary

2. Introduction

This report presents the evaluation team's process findings from the 2020 evaluation of the 2019 Building Operator Certification (BOC) training.[1] These findings are meant to accompany the impact results presented in the 2020 AIC Business Program Annual Impact Evaluation Report.[2] In 2019, AIC and MEEA partnered to offer a Level I BOC training to AIC customers. The training educated building operators on building system maintenance and optimization (see Appendix A for more details). In total, 10 AIC customers attended the trainings (Appendix B). As noted in the impact report, we leveraged an innovative approach to evaluating the BOC training and quantifying the resulting impacts; including capturing baseline O&M practices, facility equipment, and knowledge prior to training interventions; capturing energy-saving actions; and quantifying the resulting savings attributable to BOC training (Appendix D). To do so, we conducted several research activities that allowed us to evaluate the training based on Kirkpatrick's Four-Level Training Model—the gold standard for evaluating adult training interventions. This framework evaluates trainings on four levels: (1) Reaction, (2) Learning, (3) Behavior, and (4) Results. Since the process and impact activities are intertwined in this evaluation approach, we have also included impact results in this report to illustrate the connections between each of Kirkpatrick's four levels and to demonstrate how a positive training experience can ultimately result in energy savings.

[1] Given that most large commercial projects have very long lead times, we designed this process to calculate the 2020 BOC training savings based on the actions of 2019 BOC training participants. Therefore, we refer to the 2019 BOC training throughout this report, though the associated impacts were claimable in the 2020 program year.

[2] This report is saved on the Illinois Energy Stakeholder Advisory Group website: https://ilsag.s3.amazonaws.com/2020-AIC-Business-Program-Annual-Impact-Evaluation-Report-FINAL-2021-04-28.pdf

3. Kirkpatrick's Levels

The following sections provide detailed results for the assessment of each of Kirkpatrick's four levels.

3.1 Reaction and Learning

This section includes the results of the evaluation team's analysis of Kirkpatrick's first two levels as they relate to BOC training: Reaction and Learning. Overall, the BOC participants reported positive reactions to the course. Each participant was asked to complete an "exit survey" after each class to evaluate the instructor, content, and overall usefulness of the class. For each class, the participants reported high ratings for all the components, though participants seemed to be less satisfied with the instructors for classes 1002 and 1005 (Table 1). All respondents reported the course was a valuable use of their time (n=9) and nearly all respondents reported they would recommend each of the classes to others in their network. Notably, six participants reported their company would make equipment purchase decisions within the next two years (n=9), with two reporting that such decisions would take place within the next six months. Five respondents said they planned to start energy efficiency projects at their facility within the next two years, with three of the respondents stating they were likely to initiate projects within the next six months (n=9).

Table 1. BOC Level I Course Exit Survey Results

Question	Average Rating for Each Class							
	1001 n=11	1002 n=10	1003 n=10	1004 n=9	1005 n=10	1006 n=9	1007 n=9	All Classes
How would you rate the instructor's time management?[a]	4.9	4.0	4.0	4.9	4.1	5.0	4.6	4.5
How would you rate the instructor's organization?[a]	4.8	3.9	4.6	5.0	4.2	5.0	4.7	4.6
How would you rate the instructor's clarity?[a]	4.7	3.8	4.4	4.8	4.0	5.0	4.7	4.5
How would you rate the instructor's in-class exercises?[a]	4.2	3.8	4.8	4.9	3.9	4.9	4.7	4.5
How would you rate the opportunity for questions?[a]	4.9	4.1	4.8	4.9	4.4	5.0	4.9	4.7
In general, how useful was today's BOC class?[b]	4.6	4.1	4.2	4.8	4.4	4.7	4.9	4.5
How much of the information presented was new?[c]	3.3	3.8	3.4	4.0	3.6	3.6	3.8	3.6
How would you rate the technical level of the content presented?[d]	3.0	3.1	3.2	3.2	3.2	3.3	3.3	3.2
Do you feel that today's course provided proper instruction and preparation to complete the on-site project (homework)?[e]	4.4	4.3	3.9	4.3	3.9	N/A	N/A	4.2
To what extent do you think this course information will increase the likeliness that you/your company will purchase energy-efficient equipment or energy efficiency practices in the future?[f]	4.0	3.6	4.1	4.0	3.3	4.3	4.6	4.0

[a] Scale of 1 to 5, where 1 = "Needs improvement" and 5 = "Excellent"

[b] Scale of 1 to 5, where 1 = "Not useful," 3 = "Somewhat useful," and 5 = "Useful"

[c] Scale of 1 to 5, where 1 = "None," 3 = "Some," and 5 = "All"

[d] Scale of 1 to 5, where 1 = "Too basic," 3 = "Comprehensive," and 5 = "Too technical"

[e] Scale of 1 to 5, where 1 = "No," 3 = "Maybe," and 5 = "Yes"

[f] Scale of 1 to 5, where 1 = "Very unlikely" and 5 = "Very likely"

The evaluation team also completed interviews with six of the participants following the completion of the course. Table 2 contains the detailed results of these interviews. Overall, participants reported they were impressed by the quality of the instructors and satisfied with the content covered in the course. All the participants felt they left the course with new knowledge and skills they could directly apply in their day-to-day roles. Some participants travelled far distances to attend the course and had challenges balancing the course requirements on top of the responsibilities of their jobs. However, participants noted the homework assignments were a critical component of the learning experience because the students had to think about the material in the context of their own facilities. The "real world" application helped drive home key concepts.

Table 2. BOC Level I Course Interview Results

Component	Participant Experience
Schedule and Pace	▪ Participants felt the course was structured well and the one-class per week pace was effective. ▪ However, some participants traveled far distances and experienced trouble balancing the demands of the course with their full-time jobs. ▪ One participant reported it would have been helpful to receive the textbook for each class a week in advance to allow students the opportunity to read the material ahead of time and better retain the material from the instructor's presentations. The participant also noted this would have been helpful when taking the tests because some material in the book was not covered in-class.
Homework and Tests	▪ Participants found the homework assignments to be useful in emphasizing key concepts by requiring students to think about the coursework in relation to their facilities. Most of the participants mentioned it was difficult to find time in their schedules to complete the assignments and a few experienced issues tracking down the resources (e.g., utility bills) needed to complete the projects. ▪ Generally, participants felt the tests were straightforward, but five respondents mentioned some of the questions seemed intentionally designed as "trick questions."
Content	▪ All the participants felt they left the course with new knowledge and skills they could directly apply in their jobs. They reported picking up new ideas, re-familiarizing themselves with important concepts, and being forced (in a good way) to reconsider their building operations. ▪ Participants reported that most of the content was current. Two students noted that the classes seemed to start with more basic/older material and then worked their way to more advanced/newer material. They felt this was an effective approach. ▪ Many students reported learning new concepts they could immediately implement in their facilities to produce energy savings. Additionally, participants learned how to demonstrate the financial payback/savings of projects to decision-makers by calculating key financial metrics. Finally, participants reported that their new knowledge would allow them to communicate with contractors more effectively. ▪ One participant who held a managerial position noted that some of the content was difficult for them to digest because they were not able to apply the material in a hands-on manner in their day-to-day role. They expressed that they would have liked the training to include a managerial component; however, they did feel the course positioned them to have more informed conversations with the technicians they manage. ▪ Due to the diverse backgrounds of the students, each participant extracted a different level of value from each of the classes. When participants were asked which modules were most useful to them, each module was mentioned by at least one participant.
Instructors	▪ Participants were impressed by the quality of the instructors. They appreciated that the instructors spoke from a position of experience and provided applicable examples to illustrate the material. ▪ Participants reported the instructors made themselves available by email and/or phone for any questions that arose after the class. Two students who contacted the instructors outside of class were impressed by the instructor's quick responses. ▪ Three participants mentioned that some of the instructors spent too much time talking about their own background and experiences. While the participants felt it was important to understand the instructors' background, they felt some instructors provided too much information which limited the

Component	Participant Experience
	amount of time spent on the material. One student noted that some students travel significant distances and are not paid for the time they take off to attend the course; instructors should be courteous to that and focus on the material.
Other Participants	▪ Participants described a collaborative environment where students worked together to complete assignments. ▪ The course included a diverse group of students and the interviewees said they learned from one another. ▪ Many of the students reported the group discussed taking the Level II course together.
Miscellaneous	▪ All six interviewees said they would recommend the course to colleagues in the industry; one participant had already recommended the course to another facility manager in town, and another said they hoped to send a junior staff member to the training. ▪ Two participants mentioned that AIC's timeline for energy efficiency initiatives does not work well for school systems because it does not align with when schools submit their budgets.

This positive learning experience translated to strong performance on the course assignments. Average exam scores for each of the classes were in the mid-to-high eighties while average project grades were in the mid-nineties (Table 3). Notably, the average score on the pre-assessment fielded by MEEA at the beginning of the first class was an 80 (n=9).

Table 3. BOC Level I Course Average Exam and Project Grades

Class	Topic	Average Exam Grade (n=10)	Average Project Grade (n=10)
1001A	Energy-Efficient Operation of Building HVAC Systems	0.86	93.7
1001B		0.85	
1002	Measuring and Benchmarking Energy Performance	0.83	87.7
1003	Efficient Lighting Fundamentals	0.83	95.3
1004	HVAC Control Fundamentals	0.87	96.6
1005	Indoor Environmental Quality	0.94	100.0
1006	Common Opportunities for Low-Cost Operational Improvement	0.89	N/A
1007	Facility Electrical Systems	0.89	N/A

N/A indicates the class did not include a project.

Participants also reported in the interviews that they learned new concepts in the course about how to operate their buildings better. Several participants reported learning new concepts related to optimizing HVAC equipment scheduling and set points, including standards for office space temperatures and their impacts on productivity, reducing system run times by designating unoccupied schedules, improving air quality and reducing HVAC system operations by adjusting the mix of outdoor air entering the facility, and implementing sequencing for heating/cooling systems with multiple units (e.g., multiple chillers, boilers, etc.). Two participants mentioned they learned how to calculate critical financial metrics to demonstrate the viability of capital expenditures (e.g., rate of return, payback period, etc.). Both participants said this information was important in justifying investments to decision-makers. One participant reported they had not been aware of lumen requirements prior to completing the training. Based on learnings from the course, the participant purchased a light meter and learned that the lighting levels throughout their facilities were well above the minimum requirements. The participant identified opportunities to remove excess bulbs while maintaining necessary lumen levels. The same participant was also introduced to the concept of benchmarking for the first time. The participant said they had been interested in trying to measure the results of energy-related projects

to demonstrate the value of their maintenance department. The benchmarking lesson gave them the resources and knowledge to do so. Overall, the feedback provided in the interviews and the performance on the exams and projects indicate the participants experienced positive learning outcomes.

3.2 Behavior and Results

This section includes the results of the evaluation team's analysis of Kirkpatrick's third and fourth levels as they relate to BOC training: Behavior and Results. Five participants (n=6) reported in the reaction interviews that they made changes to their building operations during the training, including lighting retrofits, optimization of HVAC set points, and equipment scheduling. The participants reported that the learnings from the BOC training directly influenced these changes.

These five participants also reported that they planned to make additional energy-saving changes in the future based on what they learned in the training. These changes ranged from minor adjustments like optimizing HVAC set points and updating boiler tune-up schedules, to more intensive efforts like updating an entire preventative maintenance plan, lighting retrofits, and installation of lighting controls. The one participant that did not make any changes during the training and did not have plans for future projects at the time of the reaction interview did report plans to expand their organization's energy monitoring practices. The participant said the BOC training helped them realize the benefit of benchmarking in isolating underperforming facilities and identifying savings opportunities. The participant sought to implement benchmarking practices at all their organization's facilities using the ENERGY STAR® Portfolio Manager.[3] Two other participants also mentioned a desire to benchmark their facilities using Portfolio Manager to demonstrate savings from past and future projects.

Four of the six participants that completed reaction interviews also completed the post-course savings interview. These respondents reported making several changes to their facilities as a result of the BOC training, including delamping of lighting fixtures, lighting retrofits, HVAC system replacements, installation of controls sensors on HVAC units, installation of motion sensitive faucets, and changes to HVAC set points and equipment scheduling.[4] These results indicate participants changed their behavior following BOC training; most of these behavior changes are directly related to the topics covered in the course and the expected outcomes of the training (Appendix C).

"BASICALLY, FOR ME IT WAS A HUGE GAP FILL IN SOME OF MY KNOWLEDGE. THE INSTRUCTORS DID A VERY GOOD JOB OF ANSWERING QUESTIONS AND BASICALLY GROWING MY UNDERSTANDING … . …[IT] JUST KIND OF BROUGHT ME TO THE NEXT LEVEL, SO TO SPEAK." – PARTICIPANT

Importantly, the respondents reported that BOC training was one of several important factors that influenced their decision to take these energy-saving actions. As is typical for large commercial facilities, decision-makers plan for upgrades in advance and weigh a range of factors when considering whether to move forward with operational changes or capital improvements. Notably, the evaluation team only quantified savings for operations changes and capital projects that participants reported they would not have implemented if they had not attended BOC training. We also removed savings associated with projects that participants completed through other AIC initiatives. As a result, we only claimed savings for three participants. For the actions we quantified savings for, on average, respondents rated the likelihood they would have taken the actions in the absence of the training as a 3.8 out of 10, where 0 equaled "definitely would not have taken the action" and 10 equaled "definitely would

[3] ENERGY STAR is a registered trademark owned by the US Environmental Protection Agency.
[4] The evaluation team could not calculate savings for some of these actions because the participants did not respond to subsequent data requests for project specifics and documentation.

have taken the action." Additionally, respondents reported that BOC training was very important when planning these energy-saving changes. On average, respondents rated the importance of BOC training as an 8.4 out of 10, where 0 equated to "very little importance" and 10 equated to "a great deal of importance." Expectedly, the respondents reported that other non-program factors were influential in their decision-making process; respondents most commonly cited financial benefits, increasing occupant comfort, and sustainability initiatives as influential factors (Table 4).

Table 4. Influence of Non-BOC Factors on Decision to Take Energy-Saving Actions

Factor	Post-Course Survey Respondents			
	Total	Influence Score[a]		
		0–3	4–6	7–10
Reducing operating costs	3	0	0	3
Rate of return	3	0	0	3
Increased comfort	3	0	1	2
Commitment to going green	3	1	1	1
Employee, customer, or student complaints	3	1	2	0

[a] Respondents rated the influence of factors other than BOC training on a scale from 0 to 10, where 0 was "very little influence" and 10 was "a great deal of influence."

The energy-saving actions implemented by the participants following BOC training resulted in energy savings (Table 5). In addition to the data presented above related to the role BOC training played in these actions, respondents allocated an average of 64 out of 100 "points of influence" to BOC training when considering all factors that influenced their decision to implement the energy-saving changes. Therefore, the evaluation team attributed savings not claimed by other AIC initiatives to BOC training as level four results under Kirkpatrick's framework.

Table 5. 2019 BOC Level I Course Energy Savings by Enduse

Measure Category	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Return/Exhaust fan scheduling	165.0	0	0
Fluorescent delamping	8.3	0.0008	0
LED T8 replacements	4.2	0.0011	0
LED exit signs	1.2	0.0001	0
Split system CAC replacement	1.0	0.0005	0
Low-Flow faucet replacements	0.3	0	267
Boiler lockout/reset controls	0	0	2,693
Total	**180.0**	**0.0025**	**2,960**

While the evaluation team did not claim any savings for BOC training that were associated with projects incentivized through other AIC initiatives, we did identify the savings for projects BOC participants completed through other AIC initiatives since their completion of the training (Table 6).[5] In addition to the savings included

[5] We included savings from 2019 and 2020 because our evaluation quantifies the energy savings produced in the year following the 2019 BOC training. Therefore, our analysis period spans 2019 and 2020. As such, the evaluation team conducted a cross-participation analysis for the year following the training to (1) ensure that we did not claim savings for the BOC training that were already claimed through other initiatives (in 2019 or 2020), and (2) identify all cases where BOC students participated in other AIC initiatives following the training.

in Table 6, we know BOC training also encourages customers to participate in other AIC offerings, thereby leading indirectly to additional savings.

Table 6. 2019 and 2020 Cross-Program Verified Net Savings

Initiative	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Standard Lighting for Business	82.9	0.0202	0
Instant Incentives	42.4	0.0091	0
Online Store	2.7	0.0015	142
HVAC	35.6	0.0063	5,154
Custom	2,054.6	0.0378	46,419
Steam Trap Repair/Replacement	0	0	996
Total	**2,218.2**	**0.0750**	**52,711**

4. Case Studies

To investigate the connection between Kirkpatrick's four levels on a more granular level, the evaluation team took a deeper look at the data collection results for the four participants who completed all the key evaluation activities. The following sections include the results of this analysis.

4.1 Municipality

4.1.1 Building Description

One of the participants was a Maintenance Supervisor for a municipality. The participant provided information on three of their largest buildings in the baseline O&M survey. The facilities ranged in size from 22,179 to 33,383 square feet and typical occupancy ranged from 30 to 75 people per day. One of the facilities was in operation 24 hours per day, the second was open 8 hours per day, and the third was open 9 hours per day. All three facilities were open seven days a week. All three buildings utilized natural gas boilers for space heating; two used chillers for cooling and the third used a packaged unit for cooling.

4.1.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following completion of BOC training including optimizing HVAC and air distribution set points, replacement of a condenser system, lighting retrofits, and delamping of lighting fixtures. The participant reported that the lighting retrofits and condenser system replacement would have occurred if they had not attended the BOC training, but the learnings from the training helped them justify the project scopes to decision-makers, both in terms of equipment selection and financial returns. Additionally, the participant reported that the changes to HVAC and air distribution scheduling and equipment set points would have occurred in absence of the training because many of the optimization opportunities were identified through an audit a contractor performed on their BMS system. As with the capital projects, however, the participant noted the learnings from BOC training gave them the confidence to implement the findings from the audit and gave them a better understanding of the potential for energy savings. The delamping of lighting fixtures was a direct result of the training. The participant purchased a light meter following a discussion of lumen levels in class 1003. The participant identified opportunities to remove excess bulbs while maintaining required lumen levels. Ultimately, they reduced 48 2-bulb fixtures to 1-bulb each. Notably, as illustrated in Table 7, the energy savings actions the participant completed traverse many of the BOC classes. The participant received an average score of 92 on the course exams and 99 on the projects, indicating they remained engaged throughout the entirety of the course, retained the information, and identified opportunities to implement learnings from the various classes to reduce energy usage at their facilities.

Table 7. Post-Series Energy-Saving Actions Reported by Participant

Enduse Category	Action	Related Course	Claimed Savings
Economizer and ventilation controls	Use natural ventilation instead of cooling	BOC 1006	
	Reduce outside air ventilation	BOC 1006	
	Use economizers and outside air control	BOC 1005	
Fan optimization and air distribution	Scheduled VAVs	BOC 1001	
HVAC equipment scheduling or space temperature	Replaced condenser system	BOC 1001	

Enduse Category	Action	Related Course	Claimed Savings
Lighting	Reduced 2-bulb fixtures to 1-bulb	BOC 1003	✓
	T8 to LED conversions		
	Occupancy sensors on T8s		
	Replaced magnetic and electronic ballasts with direct-wire fixtures		
	CFL to LED conversions		

Note: The participant received AIC incentives for the lighting retrofits.

4.1.3 Program Influence

This participant reported that BOC training was a factor in their decision to take the energy-saving actions included in Table 7, but the participant was already aware of some of the savings opportunities due to a third-party audit of their BMS system. However, the participant acknowledged that their decision to delamp lighting fixtures was entirely driven by BOC training. Overall, the participant rated the importance of BOC training as a 6.3 out of 10, where 0 equated to "very little importance" and 10 equated to "a great deal of importance." Additionally, they rated the likelihood they would have taken the actions in the absence of the training as a 9 out of 10, where 0 equaled "definitely would not have taken the action" and 10 equaled "definitely would have taken the action." Finally, the participant allocated an average of 20 out of 100 "points of influence" to BOC training when considering all influencing factors in their decision to implement the energy-saving changes.

4.1.4 Savings

Table 8 includes a summary of the savings resulting from the post-course changes the participant made.

Table 8. Energy Savings Claimed for Participant

Verified Net Savings		
Energy Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
8.35	0.0008	0

4.2 School District

4.2.1 Building Description

Another participant was a Maintenance Director for a local school district. The participant provided information on three of their largest buildings in the baseline O&M survey. The facilities ranged in size from 25,889 to 48,710 square feet and typical occupancy ranged from 100 to 370 people per day. Two of the facilities used natural gas boilers for space heating and did not have any cooling equipment. The third facility utilized electric baseboard heating for space heating and a packaged unit for cooling. The three facilities were in operation Monday through Friday for 10 hours per day.

4.2.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following the completion of BOC training including lighting retrofits, installation of motion sensitive low-flow faucets, HVAC system replacements, a burner replacement, and installation of boiler controls. The BOC training was integral to all these actions. The participant reported plans for lighting retrofits in the reaction interviews, stating the training gave them the knowledge to confidently work with vendors due to their new knowledge of the different types of LED lighting and what types of projects were best for their facilities, both in terms of equipment and return on investment. The participant also mentioned plans to install boiler controls in the reaction interview, noting the training helped them realize the benefit of these controls and the ability to utilize outside air to decrease boiler run times. The training also impacted the participant's decision to install motion sensitive low-flow faucets. The participant noted that the need to replace the existing faucets was recognized through normal maintenance activities, but the training caused them to install efficient faucets rather than replacing the old faucets with the same type of equipment. Finally, the training played a key role in the participant's decision to install an efficient split-system. The system was installed to cool a specific room in the facility that was previously cooled by moving cool air in from another room. There was an existing split-system that had previously been installed to heat and cool that room in the facility, however, the system was no longer in operation. The learnings from BOC training spurred the participant to install a new, high efficiency split system to provide space cooling only for the room.

As Table 9 shows, the energy savings actions the participant took following the training spanned the 1001, 1002, and 1003 classes. The participant's average score on these exams was an 81 and their average score on the related projects was a 94.5.[6]

Table 9. Post-Series Energy-Saving Actions Reported by Participant

Enduse Category	Action	Related Course	Claimed Savings
Boiler/hot water/steam system changes	Monitor makeup water	BOC 1002	
	Minimized blowdown	BOC 1002	
	Replaced boiler with tankless on demand system	BOC 1001	
	Replaced burner unit with high efficiency burner	BOC 1001	
	Installed sensor on new burner (resets supply water temp, matches operation/capacity to outside temps)	BOC 1001	✓
HVAC systems	Replaced existing split-system with efficient system	BOC 1001	✓
Domestic hot water	Installed low-flow faucets with motion sensors	BOC 1002	✓
Lighting	Replace incandescent/CFL exit signs with LED signs	BOC 1003	✓
	T8 to LED conversions		✓

Note: The evaluation team did not receive the necessary documentation to calculate savings for some actions. Additionally, some actions, such as monitoring makeup water, have maintenance benefits but do not result in quantifiable energy savings.

4.2.3 Program Influence

This participant reported that BOC training was a critical factor in their decision to take the energy-saving actions included in Table 9; rating the importance of BOC training as a 9.5 out of 10, where 0 equated to "very little importance" and 10 equated to "a great deal of importance." Additionally, the participant rated the likelihood they would have taken the actions in the absence of the training as a 1.8 out of 10, where 0 equaled

[6] The participant did not complete project #2.

"definitely would not have taken the action" and 10 equaled "definitely would have taken the action." Lastly, the participant allocated an average of 82.5 out of 100 "points of influence" to BOC training when considering all influencing factors in their decision to implement the energy saving changes.

4.2.4 Savings

Table 10 includes a summary of the savings resulting from all the post-course changes the participant made.

Table 10. Energy Savings Claimed for Participant

Verified Net Savings		
Energy Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
6.64	0.0017	2,960

4.3 University

4.3.1 Building Description

A third participant was a Maintenance Mechanic for a local college. The participant provided information on three of the largest buildings on campus, ranging in size from 25,000 to 113,000 square feet. The participant estimated the typical occupancy range for these buildings was 50 to 250 people per day. All three of the buildings were in operation Monday through Friday for 12 hours per day. One of the buildings used a geothermal heat pump for heating and cooling, another used a natural gas water loop heat pump for heating and a chiller for cooling, and the third used a natural gas furnace for heating and evaporative cooler for cooling.

4.3.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following the completion of BOC training including optimizing chiller sequencing, improving ventilation controls, and refining HVAC scheduling and equipment set points. The participant noted that most of their background was geared toward electrical work, so the training helped them gain a better understanding of their HVAC systems and how to use their BMS system more effectively. In particular, the participant said the training illustrated how small changes to set points or scheduling can increase system efficiency. Notably, the majority of changes the participant made following the training were related to their HVAC systems and the associated controls. For example, the participant said their decision to investigate the sequencing of their geothermal chillers was spurred by a discussion in the training related to the efficiency of geothermal systems. Following the class, the participant checked the operation of their geothermal system and found that there was no sequencing in the chillers; both chillers were always operating. The participant updated the logic in their BMS to operate the chillers more efficiently. Additionally, the participant reported they adjusted the scheduling of their HVAC systems to align with class schedules to ensure they were not overheating or cooling buildings when students and faculty were not present.

The energy-saving actions the participant implemented are most associated with classes 1001 and 1006. The participant performed well on these exams, indicating they effectively retained the material; the average score across the two 1001 exams was an 88 and their score on the 1006 exam was a 90. Additionally, for the 1005 project, students developed an occupancy schedule for their facility. The participant implemented some of these principles in their BMS scheduling.

Table 11. Post-Series Energy-Saving Actions Reported by Participant[a]

Enduse Category	Action	Related Course	Claimed Savings
Chiller/chilled water	Chiller sequencing	1001	
Economizer and ventilation controls	Reset supply air temperature	1006	
	Utilize natural ventilation instead of cooling when possible	1006	
	Reduce outside air ventilation via CO2 sensors	1006	
	Integrated compressors into BMS	1004	
HVAC system equipment scheduling or space temperature changes	Match scheduling to occupancy	1001	
	Schedule optimal start times for AHUs	1001	
	Schedule VAV boxes	1001	
	Schedule return fans	1001	✓
	Schedule exhaust fans	1001	✓
	Schedule pumps	1001	

Note: The evaluation team did not receive the necessary documentation to calculate savings for some actions. Other actions, such as scheduling pumps and utilizing CO2 sensors to reduce outside air ventilation, were associated with a controls project that was incentivized through an AIC program.

4.3.3 Program Influence

This participant reported that BOC training was an important factor in their decision to take the energy-saving actions included in Table 11, rating the importance of BOC training as an 8.7 out of 10, where 0 equated to "very little importance" and 10 equated to "a great deal of importance." Additionally, the participant rated the likelihood they would have taken the actions in the absence of the training as a 5.7 out of 10, where 0 equaled "definitely would not have taken the action" and 10 equaled "definitely would have taken the action." Lastly, the participant allocated an average of 58.3 out of 100 "points of influence" to BOC training when considering all influencing factors in their decision to implement the energy saving changes.

4.3.4 Savings

Table 12 includes a summary of the savings resulting from the post-course changes the participant made.

Table 12. Energy Savings Claimed for Participant

Verified Net Savings		
Energy Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
165	0	0

4.4 Grocery Chain

4.4.1 Building Description

The fourth participant was an HVAC & Energy Engineer for a grocery chain. The participant provided information on three of the largest facilities they managed, with sizes ranging 72,196 to 86,765 square feet. The participant estimated the typical occupancy for these buildings ranged from 500 to 1,000 people per day. One of the facilities was open 24 hours per day, seven days a week, and the other two were open 18 hours per day, seven days a week. Additionally, all three buildings utilized natural gas furnaces for space heating needs and packaged units for cooling.

4.4.2 Energy-Saving Actions

The participant reported taking several energy-saving actions following completion of the course including optimizing HVAC set points, re-activating variable speed drive (VSD) functionality, and lighting retrofits. As Table 13 shows, these concepts are covered in classes 1001, 1002, and 1003, respectively. This participant scored a 95 on both 1001 exams and 100 on both the 1002 and 1003 exams. Additionally, the participant received perfect scores on all their projects. Regarding the HVAC set points, part of the participant's job duties was to respond to BMS alarms and diagnose any issues. The participant reported the training helped them understand how to interpret their BMS system more effectively and what to look for when reviewing equipment schedules and set points. As for the VSD changes, the participant specifically recalled an instructor discussing how VSDs are often switched to "bypass mode" which eliminates the functionality of the equipment. The participant was unaware of this and decided to check on some VSDs they had recently installed on compressors at several of their facilities. The participant found several of the VSDs were in bypass mode and corrected the issue. Finally, the participant noted that prior to BOC training they were not involved in lighting projects. After learning about multiple types of lighting during the training, including wall packs, they decided to investigate opportunities they thought other members of their team who focused more on lighting likely missed. The participant noted that their organization retrofitted the interior lighting of many of their facilities but not the exterior lighting. As such the participant was able to lead projects to retrofit the vestibule lighting and wall packs at several facilities.

In addition to these completed projects, the participant was in the process of initiating a solar generation project. The participant noted the project was inspired by reviewing benchmarking scores at some of their facilities following the benchmarking class. The participant wanted to raise their scores and identified solar as an opportunity to increase the ENERGY STAR rating of the facilities. Unfortunately, the participant was laid off due to the COVID-19 pandemic before they could implement many of the projects. However, the participant noted that one of the greatest benefits of the training was networking. The participant contacted several of the other trainees they had maintained relationships with and was able to secure interviews for new positions through these connections.

Table 13. Post-Series Energy-Saving Actions Reported by Participant

Enduse Category	Action	Related Course	Claimed Savings
HVAC system equipment scheduling or space temperature changes	Set back space temperature	BOC 1001	
	Reactivated VSDs previously installed on condensing fans	BOC 1002	
Lighting	Replaced T12 and T8s with LEDs	BOC 1003	
	Replace incandescent or CFL exit signs with LED exit signs		
	Replaced CFLs with LEDs		

4.4.3 Program Influence

This participant reported that BOC training was an important factor in their decision to take the energy-saving actions included in Table 13; rating the importance of BOC training as a 9.3 out of 10, where 0 equated to "very little importance" and 10 equated to "a great deal of importance." Additionally, the participant rated the likelihood they would have taken the actions in the absence of the training as a 4.7 out of 10, where 0 equaled "definitely would not have taken the action" and 10 equaled "definitely would have taken the action." Lastly, the participant allocated an average of 80 out of 100 "points of influence" to BOC training when considering all influencing factors in their decision to implement the energy saving changes.

4.4.4 Savings

At the time of our interview, this participant no longer worked for the organization through which they completed BOC training and did not have access to the project details needed to support energy savings calculations.

5. Evaluation Findings and Recommendations

This section includes the evaluation team's key findings and recommendations based on the results of the 2020 process evaluation.

5.1 Participant Satisfaction

Overall, participants were very satisfied with the training. All the students reported the instructors communicated the material effectively and spoke from positions of experience. The participants also reported that the content presented in the class was comprehensive, but not too technical. Table 14 includes results from the exit surveys participants completed at the end of each class to evaluate the instructors and content. The results show the participants were satisfied with the instructors and content.

Table 14. BOC Level I Course Exit Survey Results

Question	Average Rating for Each Class							
	1001 n=11	1002 n=10	1003 n=10	1004 n=9	1005 n=10	1006 n=9	1007 n=9	All Classes
How would you rate the instructor's time management?[a]	4.9	4.0	4.0	4.9	4.1	5.0	4.6	4.5
How would you rate the instructor's organization?[a]	4.8	3.9	4.6	5.0	4.2	5.0	4.7	4.6
How would you rate the instructor's clarity?[a]	4.7	3.8	4.4	4.8	4.0	5.0	4.7	4.5
How would you rate the instructor's in-class exercises?[a]	4.2	3.8	4.8	4.9	3.9	4.9	4.7	4.5
How would you rate the opportunity for questions?[a]	4.9	4.1	4.8	4.9	4.4	5.0	4.9	4.7
In general, how useful was today's BOC class?[b]	4.6	4.1	4.2	4.8	4.4	4.7	4.9	4.5
How much of the information presented was new?[c]	3.3	3.8	3.4	4.0	3.6	3.6	3.8	3.6
How would you rate the technical level of the content presented?[d]	3.0	3.1	3.2	3.2	3.2	3.3	3.3	3.2

[a] Scale of 1 to 5, where 1 = "Needs improvement" and 5 = "Excellent"

[b] Scale of 1 to 5, where 1 = "Not useful," 3 = "Somewhat useful," and 5 = "Useful"

[c] Scale of 1 to 5, where 1 = "None," 3 = "Some," and 5 = "All"

[d] Scale of 1 to 5, where 1 = "Too basic," 3 = "Comprehensive," and 5 = "Too technical"

Overall, participants were satisfied with the pace of the course. However, some participants travelled from far distances to attend the course which increased their time commitments. These participants had trouble balancing the workload of the course with their job responsibilities.

5.1.1 Recommendation

Training staff should allow participants to attend the training virtually through forums such as Zoom.[7],[8] This will alleviate the travel burden for potential students who might live far distances from the in-person training center and could increase participation levels. Additionally, the flexibility of a virtual offering could increase

[7] Training staff transitioned BOC to a virtual environment in 2020 due to COVID-19. It is the evaluation team's understanding that training staff plan to continue offering a virtual option for the trainings in 2021.

[8] Zoom and the Zoom logo are trademarks of Zoom Video Communications, Inc.

participation for potential participants that may have other circumstances that make attending in person challenging. With this in mind, there are clear benefits to in-person instruction; training staff should continue to offer an in-person option.

5.2 Participant Learning

This positive learning experience translated to strong performance on the course assignments. On average, the participants scored in the mid-to-high eighties on the exams and mid-nineties on the projects (Table 15). These results indicate that the participants understood the material presented in each class and successfully applied the material in a practical context.

Table 15. BOC Level I Course Average Exam and Project Grades

Class	Topic	Average Exam Grade (n=10)	Average Project Grade (n=10)
1001A	Energy-Efficient Operation of Building HVAC Systems	0.86	93.7
1001B		0.85	
1002	Measuring and Benchmarking Energy Performance	0.83	87.7
1003	Efficient Lighting Fundamentals	0.83	95.3
1004	HVAC Control Fundamentals	0.87	96.6
1005	Indoor Environmental Quality	0.94	100.0
1006	Common Opportunities for Low-Cost Operational Improvement	0.89	N/A
1007	Facility Electrical Systems	0.89	N/A

Note: N/A indicates the class did not include this assignment.

All six participants reported in the reaction interviews that they learned new concepts in the course they could immediately apply in their day-to-day roles. For example, two participants reported learning how to calculate key financial metrics for proposed capital investments, such as payback period and rate of return. Both participants said they would use this new skill to demonstrate the financial viability of proposed projects to decision-makers. Another participant purchased a lighting meter based on the discussions of lighting levels during the training. The participant identified that they were over lighting their facilities considerably and could reduce their energy usage by removing excess bulbs.

5.3 Participant Behavior Change and Energy Savings

It is clear from the feedback that participants learned useful information on how to improve the operation of their facilities during the training. More importantly, the participants applied the new information in their facilities. Five participants reported making energy-saving changes in their facilities during the training and four participants made changes in the year following the training. These energy-saving changes included delamping of lighting fixtures, lighting retrofits, installation of controls on HVAC equipment, installation of motion sensitive faucets, HVAC system replacements, and changes to HVAC set points and equipment scheduling (Table 16).

Participants reported BOC training was an important driver in making these changes. As is typical for large commercial facilities, decision-makers plan building upgrades in advance and weigh a range of factors when considering whether to move forward with operational changes or capital improvements. The evaluation team identified the actions that participants would not have taken if they had not attended the training and only

quantified savings for these actions. For the actions we quantified savings for, on average, respondents rated the importance of BOC training as an 8.4 out of 10, where 0 equated to "very little importance" and 10 equated to "a great deal of importance." Additionally, participants allocated an average of 64 out of 100 "points of influence" to BOC training when considering all the factors that influenced their decision to implement the energy-saving changes. The energy savings resulting from these changes are presented in Table 16 below and represent the results of the training (Level 4 of Kirkpatrick's model).

Table 16. BOC Level I Course Energy Savings by Enduse

Measure Category	Verified Net Savings (MWh)	Verified Net Savings (MW)	Verified Net Savings (Therms)
Return / Exhaust fan scheduling	165.0	0	0
Fluorescent delamping	8.3	0.0008	0
LED T8 replacements	4.2	0.0011	0
LED exit signs	1.2	0.0001	0
Split system CAC replacement	1.0	0.0005	0
Low-Flow faucet replacements	0.3	0	267
Boiler lockout/reset controls	0	0	2,693
Total	**180.0**	**0.0025**	**2,960**

5.3.1 Recommendation

AIC and the evaluation team should continue to consider ways to increase participation in evaluation activities, particularly the post-course savings interviews and savings verification. Without robust participation in these activities, it is difficult to understand the effectiveness of the training and the resulting impacts from participation.

Appendix A. Initiative Description

AIC, in partnership with the Midwest Energy Efficiency Alliance, offers BOC training to building operators in AIC territory. BOC is a nationally recognized training and certification program developed by the Northwest Energy Efficiency Council that focuses on energy-efficient building operations and preventative maintenance procedures. BOC training consists of two levels of training: Level I and Level II. The courses include classroom training, project assignments to be completed at a participant's facility, and in-class tests at the end of each day. Successful graduates of BOC training earn certificates of completion. Graduates who elect to take the certification exam and pass earn the BOC Certification and become a Certified Building Operator. Certified Building Operators retain their certification by maintaining employment, attending approved continuing education webinars, and implementing projects at their facilities. While the training is open to building operators across Illinois, AIC incentivizes participation among its customers by providing a partial tuition reimbursement to building operators in their service territory ($500 to put toward the total cost of $1,400, provided upon completion of the course). In 2019, AIC and the Midwest Energy Efficiency Alliance offered a Level I course in Springfield from early June through the end of July. The Level I course consists of seven classes focused on building systems maintenance (Table 17).

Table 17. List of BOC Level I Training Topics

Topics
1001: Energy-Efficient Operation of Building HVAC Systems
1002: Measuring and Benchmarking Energy Performance
1003: Efficient Lighting Fundamentals
1004: HVAC Controls Fundamentals
1005: Indoor Environmental Quality
1006: Common Opportunities for Operational Improvement
1007: Facility Electrical Systems

Appendix B. Participant Summary

Table 18 summarizes participation in the 2019 Level I BOC training by segment. Overall, 10 AIC customers completed the course, including facilities staff from school districts, local governments, manufacturing facilities, colleges, and grocery chains.

Table 18. 2019 BOC Training Participation Summary

Participant ID	BOC Level	Segment
101	1	Local Government
103	1	Grocery
104	1	Process Industrial
105	1	School/University
106	1	Municipality
107	1	School/University
109	1	School/University
110	1	Local Government
111	1	Local Government
112	1	Local Government

Appendix C. Expected BOC Outcomes

Table 19 includes a list of common outcomes with high energy savings potential. The table also provides information on the BOC classes that are linked to each outcome. The evaluation team prioritized these outcomes in data collection activities.[9]

Table 19. List of Expected Outcomes from BOC Courses

Outcome	1001	1002	1003	1004	1005	1006
Tune-up boiler(s)	✓					
Test and replace faulty steam traps	✓					
Optimize chiller sequencing	✓					
Install thermal storage systems						
Measure and optimize chiller performance	✓					
Schedule optimum starts for AHU system	✓					
Match AHU schedule to space occupancy	✓					
Schedule boilers	✓					
Schedule exhaust fans	✓					
Schedule fan-powered boxes	✓					
Schedule fan-powered/VAV boxes	✓					
Schedule heaters	✓					
Schedule pumps	✓					
Schedule return/exhaust fans	✓					
Set back space temperature	✓					
Install demand control ventilation	✓					
Install hot water pump VSD(s)		✓				
Install combustion fan VSD(s)		✓				
Use variable speed condenser fans for capacity control		✓				
Utilize VSDs for fans		✓				
Install VSD(s) for pumps		✓				
Install ECM(s)		✓				
Install VSD(s)		✓				
Install occupancy sensors			✓			
Install daylighting/photocells on interior fixtures (skylights/window walls)			✓			
Install lighting control panels (sweep/timers)			✓			
Replace incandescent, CFL, HID, or fluorescent fixtures with LED lighting			✓			
Replace incandescent or CFL exit signs with LED exit signs			✓			
Replace stairwell lights with bi-level fixtures with sensors			✓			
Install CO-based ventilation control					✓	
Install CO_2-based demand control ventilation					✓	
Use economizer and outdoor air control					✓	

[9] The evaluation team also asked about outcomes not included in Table 19, including outcomes not directly linked to a specific BOC class such as large capital investments where the BOC Training may have impacted the decision-making process.

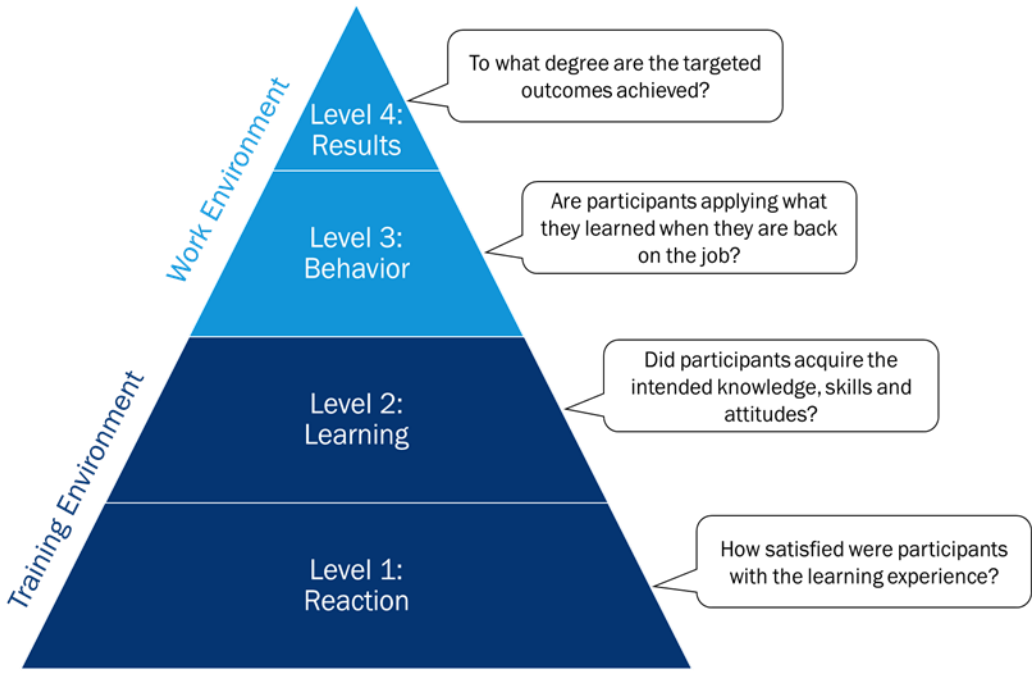
Outcome	1001	1002	1003	1004	1005	1006
Optimize condenser water temperature						✓
Schedule heaters						✓
Use natural ventilation instead of cooling						✓
Install building pressurization control						
Perform night purge cycle for pre-cooling						✓
Perform economizer commissioning						✓
Reset supply air temperature						✓
Balance airside supply						✓
Reduce simultaneous heating and cooling						✓
Reduce outside air ventilation						✓
Commission air systems						✓

Appendix D. Evaluation Methodology

The evaluation team leveraged an innovative evaluation approach to calculate the 2020 gross impacts resulting from BOC training. We aligned the approach with Kirkpatrick's Framework for evaluating adult learning interventions—the gold standard for evaluating adult training interventions in the training industry. As illustrated in Figure 1, Kirkpatrick's Framework consists of four levels:

- **Level 1 – Reaction**: Measures how participants feel about the learning experience. The value of Level 1 is that a good training experience improves knowledge transfer.
- **Level 2 – Learning**: Measures the degree to which participants change attitudes, increase knowledge, or enhance skills as a result of the learning experience. The value of Level 2 is to demonstrate that learning occurs as a result of the training.
- **Level 3 – Behavior**: Measures the degree to which participants apply what they have learned outside of the learning environment. This level seeks to demonstrate whether trainees take the information they learn and apply it.
- **Level 4 – Results**: The degree targeted outcomes are achieved system-wide. In this study, we measured BOC training results in terms of energy savings. The value of measuring Level 4 is to inform the return on training investment realized from the training endeavor.

Figure 1. Kirkpatrick Model



To measure the four levels of learning, we conducted several research activities targeted at specific stages of the training process (see Table 20), including:

- **Baseline operations and maintenance (O&M) and energy efficiency equipment survey**: Participants completed this survey as their first homework assignment. The survey established baseline O&M

conditions and collected information on the energy-related equipment in place prior to the training intervention.

- **Review of course materials**: We reviewed the results of several in-class activities, including a baseline knowledge assessment, exam scores, homework scores, and exit surveys for each class in which participants assessed the effectiveness of the class and instructor.
- **Reaction interviews**: Directly following the course, we interviewed participants to (1) solicit feedback regarding their satisfaction with the course, (2) understand what they learned, (3) document any changes that they made to their facilities during the training, (4) record any future plans for energy efficiency projects, and (5) identify the role BOC training played in these future plans.
- **Post-course savings interview**: We interviewed participants a year after they completed BOC training to understand the actions (if any) that they took as a result of what they learned, including energy efficiency projects and modifications to building or equipment operations.
- **Engineering desk reviews**: Our engineers reviewed the data collected in the post-course savings interviews, set up savings calculations, and identified additional data required to calculate impacts.
- **Savings verification**: Due to COVID-19, we could not conduct on-site audits to verify the details of any energy efficiency projects reported by the participants. In lieu of an on-site audit, we provided participants with an additional incentive to provide documentation of projects, where possible, to support the development of our impact calculations.

Table 20 illustrates how each of the research activities contributed to the assessment of Kirkpatrick's four levels. Through these activities, we gathered information about the energy-saving actions that participants took, and how the BOC training may have motivated participants to take these actions.

Table 20. Summary of Research Activities and the Associated Kirkpatrick Levels

Research Activity	Level 1	Level 2	Level 3	Level 4
Review of course materials	✓	✓		
Reaction interviews	✓	✓	✓	
Baseline O&M and energy efficiency equipment survey			✓	
Post-course savings interviews			✓	✓
Engineering desk reviews				✓
Savings verification				✓

As BOC training indirectly influences participants to implement energy efficiency projects, program administrators do not track detailed information to estimate ex ante energy and demand savings. As such, we were able to estimate savings only for those participants who completed the post-course savings interview. Table 21 presents participation in the evaluation activities by each participant. Notably, four participants completed the post-course savings interview, and three provided sufficient information to support savings verification. The fourth participant no longer worked for the organization through which they completed BOC training and did not have access to the project details needed to support impact evaluation.

Table 21. Summary of Participation in Evaluation Activities

Participant ID	Baseline Survey	Post-course Interview	Post-course Savings Survey	Savings Verification
101	✓			
103	✓	✓	✓	
104	✓			
105	✓	✓	✓	✓
106	✓	✓		
107	✓	✓	✓	✓
109	✓	✓		
110	✓	✓	✓	✓
111	✓			
112	✓			

Note: Participants 111 and 112 screened out of the baseline survey because they indicated they were students and thus not involved in building operations on a permanent basis.

Savings resulting from training programs are akin to spillover in that they are follow-on actions taken by participants as a result of information received from program administrators. Based on guidance provided in the IL-TRM V8.0, the evaluation team treated these savings as participant spillover, which informed our methodology for determining program influence, as well as the timing of this evaluation.[10]

By their nature, follow-on actions from training interventions require time to be completed, particularly those aimed at encouraging upgrades in large commercial facilities. Because the 2019 BOC training occurred in Q2 and Q3 of 2019, the evaluation team felt strongly that the 2019 evaluation would not capture all of the follow-on work, given that most large commercial projects have long lead times. We, therefore, chose to evaluate follow-on savings resulting from the 2019 training as part of the 2020 evaluation. Similarly, because these savings were evaluated in the manner of spillover, we did not apply a NTGR to evaluated savings.

The evaluation team calculated verified savings only for projects we deemed attributable to BOC training based on participant responses to attribution questions in the post-course interviews. We estimated savings using a combination of data collected through the post-course interviews, a review of EMS data and other documentation participants provided, and assumptions from the IL-TRM V8.0. Finally, we filled in gaps with IL-TRM baseline assumptions where possible.

[10] *IL-TRM V8.0 Attachment A: Illinois Statewide Net-to-Gross Methodologies*. Page 26.

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