Perspectives from the Trenches: Insights from Evaluation Field Engineers on Best Approaches for Working with Customers

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This paper provides a set of unique perspectives from the engineering, field work side of the impact and process evaluation discipline. Most typically, evaluation managers have a non-technical, non-field work perspective, and maintain a much higher sensitivity to developing an approach that ensures statistical confidence and precision or idealized framing of key survey and data collection questions. In contrast, those engineering managers who lead the highly trained engineering field staffs, may establish a slightly different set of priorities.

This paper provides a number of key observations, where engineering experts, based on their in-facility experiences, may have developed a somewhat different set of priorities for conducting some important aspects of evaluation field work. These perspectives may address how to best conduct field monitoring, how to best use and interpret tracking system information, customer receptiveness to certain types of inquiries, how well commissioning and equipment set-up work is done, and the effectiveness of using on-site sampling strategies for observing and measuring certain performance factors.

In many cases, as an example, engineering field staff is asked to use a so-called in-field random sample approach for selecting specific areas for gathering installed lighting quantity data or for deploying lighting loggers. Such approaches may be used when there are very large projects and when there are many different space types and locations for logger deployment that must be judiciously selected. While it may be theoretically sound to believe that such a sampling approach is best for the evaluation, such an effort can be technically inappropriate. In large projects, spaces may be inaccessible, facility managers may not be amenable to such a random selection, and the actual process may be excessively inconvenient and costly. In such a case, the desire to use the on-site statistical sampling, may actually result in making unfortunate trade-offs that compromise the actual quality of the gathered data and logger information.

There are many examples, where it is believed that the results of an evaluation can be improved through a better understanding of the trials and tribulations of field based engineering data collection. This paper will discuss some common challenges or issues. Recommendations will be made that describe enhanced approaches and how they can be incorporated in cost effective evaluation projects that produce excellent results.

Introduction

There are many different types of energy professionals involved who handle the various tasks that are components of planning and evaluation projects. These include statisticians, economists, program managers, policy specialists, engineers, and auditors. The backgrounds of these individuals can be highly varied, and it has been observed that there is frequently a fundamental disconnect in understanding between the non-technical and engineering professionals involved in the projects.

This paper focuses on key observations from the engineers who do evaluation field work, collecting primary research data, and performing the analyses upon which fundamental project results depend. The

objective of our communication of these "perspectives from the trenches" is to inform all of the professionals involved in planning and evaluation projects of key field engineering or technical issues that can affect results. It is the authors' hope that this will serve as an important step towards improving overall project approaches, establishing a more realistic expectation of engineering field data collection, and improving overall results.

We do note that some of the offered perspectives have certainly been articulated previously. However, it is the field data collection engineers who have the first opportunity and the explicit view of certain challenges that affect the results.

In the following sections we have organized a variety of perspectives into cohesive categories. The observations and perspectives offered are generally common from facility-to-facility, developed through the efforts of field engineering and data collection professionals who have conducted hundreds of site visits and field surveys.

General Field Data Collection Concerns

This section addresses our most general observations in conducting facility site assessments and data collection. Some of these observations are interrelated. Note that much of the language below reflects specific experiences from recent field surveys that have been conducted as part of evaluation projects.

Customer Needs to Know They Are Not Being Evaluated

Many program participants, whether high-level corporate decision-makers or facility management, have the perspective that their general practices and performance are being evaluated, not the operation of technologies or measures that have been installed through the program. Questions regularly arise that indicate a concern that if observations are not consistent with some unknown standard, incentives may have to be returned or measures that have already been completed may no longer qualify. Thus, the field engineer, in many or most cases, has to spend considerable time assuring the participant that the program and the measures installed through the program are being evaluated and not the individual or firm being interviewed. Openly conveying the real objectives of an evaluation site visit to the participant, both prior to and during the M&V site visit, can be highly effective in eliminating such mistaken perspectives. Alternatively, when the facility management or staff carry the notion that he/she is being evaluated, the field engineer may not receive accurate information since the facility staff may either try to withhold information, or present information they believe the field engineer (and the program managers) ought to hear.

This is one of the most critical insights we will offer in this paper since any perception of the participant that leads to manipulated responses contributes to error in the final results. Thus, it is absolutely necessary that real objectives of the evaluation be communicated to the customer prior to the site visit, and the field engineer reestablishes the objectives and priorities during the site visit, continually reassuring the customer so that receptiveness for accurate answers is maintained.

It is noted that such dialog during the site visit may add considerable time to the effort. This is particularly true since the same discussion may have to be had with multiple facility staff at different times during the engineering site visit.

Gathering Data for Specific Measure vs. Facility Overview

In order to effectively gather the data and subsequently perform analyses for even a single measure at a site, it is generally advisable to develop a solid foundation understanding of the facility and its operating characteristics. This includes operational data on facility systems that may seem irrelevant to non-technical evaluation management. This provides the engineering team with insights into the general operation of the facility and into other systems that may impact the use of the measure that is actually being evaluated. Thus, it is vital that the field engineer take the extra time to get a comprehensive overview of the facility, its equipment, and develop an understanding of all measures the participant installed through the program.

This data is not only useful in determining actual measure savings, but also in assessing free-ridership and spillover. Even if those net effects parameters are not part of the goal of a site visit, it is still valuable for the field engineer to obtain the site contact's view on what he or she would have installed in the absence of the incentive program.

Impacts of Multiple Years of Project Participation

The energy efficiency program facilitates the installation of energy efficient equipment by providing financial incentives to the participants thereby reducing the net project cost. The participants often take advantage of the energy efficiency programs repeatedly and in such cases, different installations may be observed at the sites that were done at different times. The field engineer should interview the site contact and obtain as much information as possible to identify the actual measure implemented in the program year being evaluated.

If the project file fails to provide adequate information about the details of all measures installed (during multiple years) for such sites, it can be very difficult to locate the actual measure and collect the appropriate data for the program year in question. This tends to be most complicated for lighting measures, where similar technologies may be installed in the same or adjacent spaces over a multiple year period. In order to address such a challenge, the field engineer must be persistent and insist on clarity from their contacts at the facility.

But the field engineer must be very cautious about several issues. As the engineer is persistent, they must be concerned about their tone with the customer, understanding that their attempt to differentiate between multiple measures is not a real concern of the customer. The effort must be an informed investigation, where the engineer presents the need to clearly identify the technologies associated with the measure in question as a challenge, being continuously careful to avoid criticizing the customer for a lack of memory on when certain efficient systems were actually installed. Finally, while well-designed data collection forms may be helpful, the data collection effort must be customer-centric, using judgment to guide their investigative work in the measure details.

Safety

Safety issues and concerns can be a significant concern in many facilities being investigated during M&V site visits. While simple lighting systems validation efforts in commercial sites present limited challenges, any work in mechanical rooms requires considerable caution. Tight spaces with numerous obstructions are common, and most end use systems involve rotating machinery and other moving equipment. Investigation of electrical efficiency systems often requires access to equipment electrical

panels or power components. Care should be taken so that only appropriately trained and qualified staff are working with such systems, particularly when installed power monitoring systems.

Industrial facilities can present even greater challenges. Busy passageways and corridors with lifts, cranes, moving vehicles, and industrial process equipment requires continuous diligence in order to ensure safety. Access to certain spaces requires climbing precarious ladders and moving through spaces can be dangerous. Some facilities, in their effort to safeguard their staff and visitors, require viewing of safety videos and signing of liability waivers.

All efforts to ensure safety are of paramount importance in conducting site visits. It must be understood that any site visit, whether in a commercial or industrial facility, requires a safety-focused approach. These will add time to site visit efforts. Anticipating such requirements leads to higher estimates of labor time for site work.

Field Monitoring and Validation Challenges

Customer Interpretation of Field Engineer Inquiries

In many situations, the customer may try to interpret the motivation behind field engineer inquiries, and may give responses that are not fully accurate. This is particularly true when addressing issues such as free ridership and spillover, when the respondent may view an ulterior motivation behind survey questions such as "…would you have installed this measure without an incentive?"

When queried whether or not a particular efficiency measure would have been implemented without program assistance, customers, not wanting to seem ignorant or negligent in the eyes of the engineer, often misrepresent their situation to portray themselves as responsible and progressive facility managers. Customers frequently suggest that they are constantly mindful of energy savings opportunities and consistently invest in the overall energy efficiency of their facility. Further investigation, however, often reveals that a facility has been less diligent in identifying potential efficiency improvements and less effective in the operation of standard or efficient systems.

Thus, it is critical to politely, yet effectively, scrutinize all verbal survey responses. Typical survey instruments do not generally allow for detailed probing, but accurate responses and correct data is the result of approaches that go beyond the scope of the survey tool. In order to ensure that quality data is developed, the field engineer must ask for explicit evidence of past efficiency projects, operational practices, and other efficiency endeavors. Visual confirmation can be critical in understanding customer practices and behaviors. In the absence of such probing and physical exploration, inaccurate estimates of gross and net realization rates are probable. Survey instruments should increasingly encompass and facilitate these approaches, but the field engineer must use the proper approach to develop the best data even if the instrument is lacking these features.

Handling Seasonal Operation

Occasionally the field engineer is called upon to evaluate weather-dependent or seasonally-dependent equipment operation, typically HVAC equipment, but also addressing systems that change usage patterns at different times of the year. Even during periods of so called "typical" seasonal operation, evaluating weather-based equipment presents challenges. For instance, evaluation-level monitoring generally lasts no longer than a month or two while seasonal variability can last up to six months. Because the field engineer may only capture a relatively small sample of the actual equipment operation, he or she must use appropriate weather data to extrapolate seasonal energy savings over the

entire year. Weather data brings with it some level of uncertainty because it is merely a prediction of future temperature conditions based on historical trends. While this difference may be significant, it can be controlled through extended monitoring that better captures the range of operating conditions.

A more difficult challenge in evaluating weather- or seasonally-based equipment operation is determining energy savings for non-operational equipment (at the time of the survey). This challenge arises when evaluations of equipment are scheduled for evaluation during off-seasonal operation. In this situation the field engineer may have little to no actual installed performance information on which to base his or her estimate. Equipment performance data can shed some light on these matters but may not approach an acceptable level of information required for accurate energy savings estimates. Attempts should be made for the data collection tasks to occur during a long enough window that weather-dependence and seasonal variability can be effectively captured.

Addressing Inaccessible Equipment

Inaccessible equipment represents obstacles to the field engineer's ability to visually verify installation and operation, and potentially conducting monitoring of system performance. While most equipment is not totally inaccessible, some components such as AHU fans or high-bay lighting may be out of the safe reach of the field engineer. In these situations, the field engineer must request that facility personnel assume this responsibility. Facility personnel are often either unwilling or unable to undertake these tasks, which then forces the engineer to reference as-built drawings or contract documents or even accept verbal verification of proper installation and operation from facility personnel or contractors.

Issues When Measure Systems Are Not Yet Operational

It seems increasingly common to have to conduct evaluation site visits for projects and measures that are either not operating yet or are not fully-operational. There are numerous examples where incentives have been paid and one or two years have passed and the measure is still not fully functional. It may be erroneous to claim that there will be reduced lifetime savings for the project, since many or most of the systems will become operational and may save in accordance with pre-installation estimates. Approaches must be defined to adequately address such eventualities, either through selection of alternative sites, an analytical approach that assesses the likelihood of effective installation, or an approach for developing a discounted savings.

Interpretation of Tracking System Information

Effective use of tracking data frequently presents a challenge for an evaluation engineer. It is very common that tracking system information is not consistent with site data collection information. The most common discrepancy between tracking data and inspection data is in quantity, particularly true with larger lighting projects. Evaluating a quantity discrepancy is generally a simple task occasionally complicated by other documentation inconsistencies such as the specific locations for installed equipment.

Data inconsistencies can also be associated with the explicit features and capabilities of the tracking system. Evaluation inspection data is often developed as a very explicit listing of specific technologies, auxiliaries, manufacturers, and performance specifications. For lighting, a line item would also include specific fixture location and quantity, and there could be hundreds of these technology line items. Tracking data, in contrast, may have considerably less detail, often aggregating line items in numerous

locations by technology types, and then further aggregating specific technologies into broader categories. The verification task can become very cumbersome, particularly when there are similar systems that the customer has installed without the program, or as previously mentioned, if the customer has installed similar systems over the course of multiple years of program participation. Clearly, tracking system data structures that facilitate consistency with evaluation data development requirements will help minimize the challenges.

Commissioning and Equipment Set-Up

Commissioning is or should be a key component in the installation of any equipment. If equipment is not installed properly the system may not operate as desired and the desired energy savings may not be realized. This is an important issue for the customer who is installing measures in order to reduce their energy operating costs, and the efficiency program that is seeking to incentivize projects that have will have high realization rates.

Unfortunately, it is uncommon for equipment installation to be effectively commissioned, even for large, complex, engineered systems. As a consequence, it is typical to observe equipment that is not operating as specified, with parts missing or not installed at all. In some cases the equipment is installed properly, but it is not effectively controlled. For example, for a recent evaluation at a large hospital, twenty-four (24) variable speed drives (VSDs) were installed on air handling unit (AHU) supply and return fans. On investigation it was found that a large percentage of the VSDs on several of the AHUs were not commissioned, and these devices were ineffective at adjusting fan speed.

The lack of commissioning can become an even more significant issue for prescriptive measures, which frequently have no efficiency program post-installation inspection. In the absence of proper commissioning and post-installation inspection, problems may not be diagnosed and energy savings may not be fully realized.

Based on several site visits where we observed that measures were not operating properly, or had not been operating at all, we recommend increased commissioning requirements. This was particularly true for measures involving VSDs and EMS to ensure proper system operation and to achieve the projected electric savings.

On-Site Sampling Considerations

Requests to conduct on-site statistical sampling and randomization approaches, while they may seem simple and basic to the statistical analyst, present considerable challenges to the practical field engineer. This type of approach is frequently used when there are many units installed through the measures, as with lighting, and only a randomized sample of units are required for a monitoring sample. Quite often, the selection of a fixture or space on a randomized basis is severely constrained by the accessibility or practicality of the selected fixture.

As an example, in a recent project old lighting technologies in a large multi-story parking garage were replaced with new energy efficient systems. Ten fixtures were randomly selected for monitoring. However, at two of the selected locations, cars were parked directly underneath the targeted lighting fixtures. This made it impossible for the field engineer to reach the lighting fixtures and install lighting loggers on them. In such cases it is advisable to have a backup lighting fixture in the same area near the targeted fixture. Selection of an alternate fixture must be considered acceptable, particularly when the alternative lighting fixtures has like operating characteristics as the originally selected unit.

It is also common to encounter situations, especially for large lighting retrofit projects, where the quantity of fixtures installed is significant and the fixtures may be located in large spaces. In such cases there is a good chance that a large number of lighting fixtures are on the same circuit. The field engineer should attempt to identify the different circuits through discussions with the site contact and install lighting loggers on lighting fixtures for each of the circuits. The field engineer should also install additional lighting loggers in lighting fixtures for the same circuit as a precautionary measure so that even if the lamps in the logged fixture burns out the data from the second logger could be used in the savings analysis.

Although the common practice has been to visit a site with a pre-determined site plan, spontaneous decisions have to be made by the field engineer at the site due to the existing conditions at the site. Based on the observed space types the field engineer may need the autonomy to change the spaces to be logged for lighting usage. This may due to unconventional occupancy pattern in the targeted space type or lack of cooperation from the individuals working the targeted space type. The field engineer's efforts to understand the facility operation as a whole and then decide the space types that he/she may think reflect the facility operation. Thus, the randomized approach must be effectively integrated with practical considerations and limitations reflective of the site.

A different approach may be needed for HVAC systems. It is noted that in large facilities with many packaged air conditioning units, as an example, each unit may have dramatically different operating profiles. Thus, clear dependence on the randomized selection may be critical for ensuring the analytical integrity of results.

Observations and Conclusions

The preceding pages have laid out a number of interrelated observations and perspectives that are common amongst field engineers as they endeavor to perform quality evaluation field work and to collect data under tight time constraints and in challenging environments. Some key summary observations and associated recommendations include:

- **Respect Customer Perspectives and Understand Their Frame of Reference** – Customer facility management view energy efficiency and the administration of programs very differently than those operating the programs. It is important to be sensitive to their unique view on the programs and evaluation requirements.
- **Understand Factors That Effect Time Requirements for Site Work** – Many factors that may not be anticipated can result in a significant increase in time requirements for site work. Factors such as need to collect comprehensive general operational information, equipment installed through multiple program years, and safety concerns can and will regularly add complexity and scope to site visits.
- **Be Cognizant of Safety Challenges** – Site efforts often present significant safety challenges. Data collection approaches that require visits to mechanical rooms, work with industrial process equipment, or monitoring of electrical systems must be addressed with the utmost emphasis on safety and respect for the operational integrity of the customer's systems. This can require significant time beyond a normal anticipated level of effort.
- **Be Cognizant of Interpretation of Survey Questions by Facility Staff** – Facility management personnel may interpret interview questions very differently than the framers of the questioned intended, and the responses may be developed to offer information that they believe the program management wants to hear. Care should be taken to carefully explain the specific purpose of each question, without directing towards a particular response.

- **Tracking Systems or Project Files Should Capture Necessary Detail** – As explained, it is often a significant challenge to establish whether there is true consistency between tracking system data, project file data, and evaluation-developed data. Tracking systems and project files should be developed to more effectively capture project details, thereby established a sound frame of reference for comparison with detailed evaluation findings and results.
- **Tracking Systems Should Provide Data (with details) of Multiple Year Projects** – We have discussed the challenges associated with handling sites with multiple similar projects over several years. Tracking systems should have readily available data reports that capture historical project trends for customers, thereby minimizing inappropriate complexity during site assessments.
- **Cut Sheet That Describes Evaluation Process and Objectives** – Facility management at customer sites often do not understand the real requirements or objectives of evaluations. We recommend developing a summary sheet describing evaluation intent, which can be distributed to customers selected for evaluations. This may aid in an enhanced understanding and improved participation.
- **Education of Evaluation Staff on Engineering Approaches** – Non-technical evaluation project management and staff should take the opportunity to attend some of the evaluation site work. This will enable development of important insights that can improve the overall evaluation process.
- **Education on Safety Requirements** – Proper consideration of on-site dangers and effective safety procedures are of critical importance. Evaluation consultants, engineers, and management should all have the opportunity to become better informed of risks and protocols for avoiding problems.
- **Be Realistic Regarding Practical Challenges When On-Site** – As the discussions in this paper have demonstrated, there can be numerous unanticipated challenges associated with conducting engineering site work for evaluations. All parties involved in evaluations should be aware of these and be prepared for modest delays that may be unavoidable in the conduct of this work.