

Quantitative On-Site Evaluation of Energy Efficiency Program Service Delivery (322)

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ABSTRACT

Residential retrofit programs achieve their greatest impact when auditors select appropriate measures, crews install these measures in accordance with technical protocols, and clients are effectively educated. Concurrent process evaluations are an important tool for ensuring that programs meet these objectives.

The concurrent process evaluations that we have designed include onsite observation and post job inspections to determine how program impacts may be improved. The observations and inspections are done on a systematic sample of providers, crews, and jobs to ensure that the full range of program experiences is assessed. Onsite observations as part of comprehensive program evaluations should focus on how well providers identify savings opportunities, whether the correct measures are selected, and the extent and quality of energy education that is provided to occupants. Inspections should focus on accuracy of data collection, appropriateness of measure selection, and quality of installation work.

Our work is unique because we follow systematic procedures for observing treatments and recording information, rather than relying on descriptive case studies. Consistent application of such procedures has led to important findings and recommendations for program design and delivery. In this paper, we present information on the design and implementation of a model for the systematic measurement of implementation quality. We demonstrate how we used quantitative data collection methods to provide rigorous assessments of service delivery, present results we have obtained from using these procedures, and illustrate how the model will be used for a national low-income retrofit program.

Introduction

Concurrent process evaluations go beyond billing analyses to understand why programs succeed or fall short of goals and to recommend improvements. One of the most challenging evaluation tasks needed to understand program implementation is accurate documentation of program delivery. This aspect of the evaluation poses challenges because each agency, auditor, installer, home, and client is unique, no one visit can be representative of how services are delivered, and it is difficult to accurately record quantitative information about service delivery. Many evaluations collect qualitative, anecdotal information that cannot be generalized. However, we have found, that by conducting the evaluation in a systematic and quantitative manner, we can collect information that provides concrete information on implementation challenges and solutions. This requires appropriate sample selection, detailed data collection instruments, and informed analysis of resulting data.

Process Evaluation Research

Process evaluations of energy efficiency programs usually consist of several research tasks. Some of the typical tasks included are:

- **Background research** – We review all program documentation, conduct in-depth interviews with program designers and managers, and review program performance statistics. The purpose is to develop a complete understanding of program policies and procedures, and to identify potential improvements.
- **Contractor surveys** – We survey program providers to assess understanding, implementation, and challenges and barriers associated with program procedures.
- **Client surveys** – We conduct telephone surveys with program participants to understand program experiences, energy education, how education impacted energy usage behavior, other impacts on safety and comfort, and program satisfaction.

Importance of On-Site Work

While the research tasks above provide important information, there are several important evaluation questions that cannot be answered without on-site research. Without direct observations, the evaluation cannot determine whether program protocols were followed in the field, how protocols worked, and whether other important savings opportunities were missed. The important questions that the on-site work can answer include the following.

- **Protocols – Provider Compliance:** Were the program protocols followed in the field? These include the program explanation, diagnostic tests conducted, measures installed, and client education.
- **Protocols – Applicability:** How well do the protocols work in the field? What types of barriers are there to consistent application of the protocols?
- **Use of Equipment:** Do the crews appropriately employ available field tools including blower doors, duct leakage tools, monometers, and health and safety testing equipment? Are instruments properly maintained and applied to provide accurate readings?
- **Provider Adaptability:** Are the providers able to adapt program protocols in the field? How well do providers address complicated issues?
- **Comprehensiveness:** Were all cost-effective procedures specified by the program addressed? Could procedures be modified to more effectively address what is seen?
- **Quality of Work:** Do providers meet the program standard for their work? Do they show respect for the home when applying measures? Did they apply all measures safely, neatly, and in a manner that will result in maximum impact and persistence?
- **Client Education:** Do the providers focus on areas with the greatest potential? Do they motivate the clients to take appropriate actions to reduce energy usage?
- **Client Interaction:** How well do the providers interact with clients? Do they explain the program and the work in a manner that will result in maximum impact and persistence? Do they use feedback from the client as part of their audit for potential measures?

Consistent metrics obtained from observations and inspections will allow for informed recommendations on program procedures and contractor training.

Sample Selection

One challenge of on-site data collection is that the cost per observation or inspection may limit the sample size. Depending on the number of homes that can be included and the various characteristics that merit attention, small sample sizes can pose challenges for drawing

inferences about the quality of program implementation. Such challenges make the sample design extremely important.

Because on-site studies are small in scale, purposive sampling is often the most appropriate method. Under a purposive method, the sample is selected in steps and additional cases are selected to round out the sample. Purposive sampling differs from probability sampling in that random selection techniques are not used. While confidence intervals cannot be developed for statistical analysis, the sample design can allow for an assessment of overall program performance with greater applicability than anecdotal results allow.

When selecting a sample, evaluators should consider provider characteristics, service delivery characteristics, and home characteristics – these factors are likely to be related to program performance. The more diverse the program is, the more challenging it will be to represent the full range of what is seen in the field. The sample is unlikely to be large enough to compare findings across the various provider, delivery, and home characteristics.

Data Collection Instruments

Data collection instruments need to be tailored to individual studies to relate to the program's and the evaluation's goals and objectives. It is extremely important to have a detailed understanding of the program goals and design prior to developing the instruments.

The procedures should be designed to quantitatively assess the work in a systematic manner. Scales that rate the providers on their implementation of procedures can enhance data quality, but directions and training should be provided to evaluation staff to ensure that the scales are consistently applied. While the quantitative data are important, observers and inspectors should also provide insight through a descriptive narrative of the visit, particular challenges or problems that were encountered, and the client's engagement in the process.

Example 1 – Electric Utility Low-Income Program

The program studied is a utility low-income program that addresses the electric usage of customers with installed electric heat or annual electric usage of 6,000 kWh or more. Customers can be referred for one of three types of services:

1. **Baseload:** Customers with no electric heat will receive this type of service. Measures include CFLs, refrigerator replacement, air conditioner replacement, dryer venting, waterbed replacement, heating filter changing or cleaning, water heater set-back, and other measures that meet the program's payback criteria.
2. **Low Cost:** In addition to the baseload measures, customers with electric hot water are eligible for water heater replacement, gravity film exchange¹, repairs of plumbing leaks, water pipe insulation, showerheads/aerators, horizontal washing machine pilot, and solar water heating.
3. **Full Cost:** Customers with installed electric heat or 3,600 kWh seasonal heating and/or cooling usage are eligible for this type of service. In addition to the baseload and water heating measures, they may receive heating and/or cooling measures, as well as additional follow-up energy education (site or phone). The additional measures for full cost customers include blower-door guided air sealing, insulation, heating

¹ Gravity film exchange is a drain water heat recovery system designed to reduce hot water usage.

repair/retrofit/replacement, cooling system repair and replacement, duct insulation and repair, caulking and weather stripping, and thermostat replacement.

Sample Selection

The utility had specified that the evaluation should include observations and inspections in each of their five service areas. We requested that the utility provide a summary of the number of completed jobs by service area, job type, and contractor for the previous program year to facilitate the selection of providers. Table 1 displays the number of jobs completed. Examination of these data showed that, for the most part, there was one dominant contractor in each service area for each job type. Because the budget only allowed for observation/inspection of one contractor in each service area for each job type, the dominant contractor was chosen as most representative of the work done in that area. The shaded cells show each contractor that was selected for the baseload and full cost jobs. Because there were so few baseload jobs in region 1, we selected both the smallest and largest baseload contractor from region 2, the region with the greatest number of contractors. We selected to observe/inspect contractor F for full cost jobs, as contractor D was being observed for baseload jobs.

The selected contractors represent 60 percent of Baseload jobs and 68 percent of Full Cost jobs. Because these contractors use only one to three auditors, we were able to observe auditors who do 30 to 40 percent of the audit work. Therefore, the findings from our work represent a significant percentage of the job experiences.

Table 1. Previous Year Job Delivery – By Service Area, Contractor, and Job Type

Region(s)	Contractor	# Baseload	# Full Cost
1	A	6	272
1	B	0	23
1	C	1	107
2	D	81	115
2	E	36	58
2	F	44	102
2	G	53	0
2	H	28	46

Region(s)	Contractor	# Baseload	# Full Cost
3	I	135	102
3/4	J	46	128
3/4	K	153	1
4	L	38	27
4	M	2	106
4	N	63	0
5	O	4	412
5	P	57	0

Baseload Observations – Procedures and Forms

We conducted observations of baseload service delivery provided in two customer homes by each of the selected contractors. The following forms and procedures were developed to facilitate data collection for baseload jobs.

1. Baseload Observation Procedures – specified how the observers were to conduct the visit, forms to be completed, visit write-up, and forms to collect from the contractor.

Baseload Observation Procedures

I. During the Visit

- Record auditor work and customer interactions
- Every 10 minutes record time and auditor actions
- Record if auditor addresses the Potential Big Users

II. During/After the Visit

- Complete Baseload Observation Form
- Complete Potential Big Users Form

III. Immediately Following Completion of the Audit

- Debrief the customer and the auditor

IV. That Evening or the Next Day

- Complete the customer debriefing

2. Baseload Observation Data Collection Form – requested specific information to be filled in about the home, electric usage, and services provided.
3. Baseload Observation Potential Big Users Form – requested specific information to be filled in about lights and appliances that could lead to high baseload usage.

Parts of the baseload data collection form are shown below. In addition, the baseload data collection form included questions on data the auditor had prior to the visit, types of major electric appliances, refrigerator testing, waterbeds, other baseload measures, water heater measures, energy education forms used and provided to the client, education about specific actions and appliances, and an overview for qualitative observations.

Baseload Observation Procedures

V. Write-Up

- Write a narrative of the audit
 - Chronologically document the audit
 - Estimate length of key audit aspects
 - Assess interaction between the auditor and client
- Include the following documentation
 - Baseload Observation Form
 - Potential Big Users Form

VI. Forms – Obtain copies of all forms used during the visit

- Customer’s Usage History
- Program Application
- Core Assessment Form
- Refrigerator Data Form if the refrigerator is tested
- Water Heater checklist, if electric water heater
- Customer Profile Form
- Your Electric Bill Form
- Money Saving Tips Form
- Actions to Save Form

Baseload Observation Form (Selected Parts)

I. Introduction

- | | | |
|---|----------|---------|
| 1. Did the customer expect the visit? | Yes_____ | No_____ |
| 2. Did the auditor describe the program to the customer? | Yes_____ | No_____ |
| 3. Did the auditor review and explain the electric bill? | Yes_____ | No_____ |
| 4. Did the auditor discuss whether there were any health and safety issues? | Yes_____ | No_____ |
| 5. Did the auditor discuss whether there were any comfort issues? | Yes_____ | No_____ |
| 6. Did the auditor discuss whether there were any problems with energy usage? | Yes_____ | No_____ |

II. Priority List

- | | | |
|---|----------|---------|
| 1. Visual walkthrough of home and customer interview | | |
| • Did the auditor inspect every room in the home? | Yes_____ | No_____ |
| • Did the auditor have a systematic method for inspecting the home? | Yes_____ | No_____ |
| • Did the auditor discuss electric uses with the customer during the walkthrough? | Yes_____ | No_____ |
| • Did the auditor estimate costs of those uses? | Yes_____ | No_____ |
| Costs noted during walkthrough? | Yes_____ | No_____ |
| Costs reinforced later in the visit? | Yes_____ | No_____ |
| • Did the auditor discuss actions to reduce the uses? | Yes_____ | No_____ |
| • Did the auditor estimate how much the customer could save by taking those actions? | Yes_____ | No_____ |
| • Did the auditor ask the customer if he/she was willing to take actions? | Yes_____ | No_____ |
| • Did the auditor obtain commitment from the customer to take actions to reduce electric use? | Yes_____ | No_____ |
| • How long did the walkthrough take? _____ | | |
| • How much of this time was spent educating the customer? _____ | | |
| 2. Replace incandescent lights with CFLs if used 3+ hours per day | | |
| • Did auditor discuss all lights in the home? | Yes_____ | No_____ |
| • Did the auditor discuss all outside lights? | Yes_____ | No_____ |
| • Did the auditor discuss the installation of CFLs in all lights used 3+ hours per day? | Yes_____ | No_____ |
| • Did the auditor install all CFLs and ask customer if he satisfied with the lighting? | Yes_____ | No_____ |
| • Did the auditor leave any extra bulbs for the customer? | Yes_____ | No_____ |

Baseload Observation Form (Selected Parts)

- | | | |
|---|----------|---------|
| 3. Does the customer have window air conditioners? | Yes_____ | No_____ |
| • If yes, did the auditor inspect all window air conditioners? | Yes_____ | No_____ |
| • Did the auditor do sealing around the air conditioner? | Yes_____ | No_____ |
| • Did the auditor talk about seasonal storage? | Yes_____ | No_____ |
| • Did the auditor determine that an air conditioners had EER of < 6 or in poor condition? | Yes_____ | No_____ |
| • If yes, did the auditor offer to replace the air conditioner? | Yes_____ | No_____ |
| • Did the customer accept the replacement? | Yes_____ | No_____ |
| • If no, why did the customer refuse? | | |

III. Energy Education

- | | | |
|---|----------|---------|
| 1. Did the auditor review the measures that were installed? | Yes_____ | No_____ |
| 2. Did the auditor analyze the customer's electric bill? | Yes_____ | No_____ |
| 3. Did the auditor review the customer's heating and cooling systems? | Yes_____ | No_____ |
| 4. Did the auditor review the customer's appliances? | Yes_____ | No_____ |
| 5. Did the auditor encourage the customer to ask questions? | Yes_____ | No_____ |
| 6. Did the auditor discuss other programs with the customer? | | |
| • Utility Bill Assistance | Yes_____ | No_____ |
| • LIHEAP | Yes_____ | No_____ |
| • State Weatherization | Yes_____ | No_____ |
| 7. Did the customer cooperate with the education process? | Yes_____ | No_____ |

Full Cost Observation Procedures and Forms

The following forms and procedures were developed to facilitate data collection for full cost jobs.

1. Full Cost Observation Procedures – provided instructions for the visit and write-up.
2. Full Cost Observation Data Collection Form – requested specific information to be filled in about the customer's home, electric usage, and services provided. In addition to the information collected on the Baseload Observation Data Collection Form, this form collected information on combustion appliance testing, potential safety problems, electric heating system, thermostats, blower door testing, pressure diagnostics, recommended shell measures, education about electric heating usage, and education about cooling usage.
3. Full Cost Inspection Procedures – provided instructions for the visit and write-up.
4. Full Cost Inspection Form – requested specific information to be filled in about the inspection, with areas similar to the Full Cost Observation Data Collection Form.

Parts of the Full Cost Inspection Data Collection Form are shown below.

Full Cost Inspection Form (Selected Parts)

Lighting:

Location	Replaced Quantity	Non-Replaced Quantity	Type: CFL INC	Watts Pre	Watts Post	Usage = Avg. hours per day	Over or Under Illuminating	Protocol Y/N/O/C*

* Protocol: Y = Replacement met protocol, N = Replacement did not meet protocol, O = Missed Opportunity for replacement that would meet protocol, C = Condition exists to prevent replacement

Customer acceptance: _____
 Removals? _____
 Lighting comments: _____

Thermostat(s):

Location						
System controlled						
Programmable? Y/N						
Replaced? Y/N						
Condition						
Accuracy						
Program	Heat	Cool	Heat	Cool	Heat	Cool
Temp Day						
Temp Night						

Is current program same as recorded by program? Yes No/Why _____
 Customer's acceptance/ usage of replacement: _____

Effort: Ex Gd Sat Fr Pr Quality: Ex Gd Sat Fr Pr Appropriateness: Ex Gd Sat Fr Pr

Attic Air Sealing & Insulation Visual Inspection

Attic Location/ type			
Accessibility (good/ poor/ none)	good poor none	good poor none	good poor none
Air Sealing: performed?	Yes No	Yes No	Yes NO
Access w/strip/ insulated	Yes No / Yes No	Yes No / Yes No	Yes No / Yes No
Soffits, dropped ceilings, stairwells (bypasses)	Yes No	Yes No	Yes No
Top plates, penetrations, etc	Yes No	Yes No	Yes No
Effort of work performed	Ex Gd Sat Fr Pr	Ex Gd Sat Fr Pr	Ex Gd Sat Fr Pr
Quality of work performed	Ex Gd Sat Fr Pr	Ex Gd Sat Fr Pr	Ex Gd Sat Fr Pr

Technical Evaluation Rating Scores

Exceptional (Ex): No possible improvements identified, Good (Gd): Minor improvements possible, Satisfactory (Sat): Some improvements recommended, Fair (Fr): Extensive improvements necessary, Poor (Pr): Substandard in all respects

Findings and Recommendations – Baseload

Below we provide a sample of the baseload observations data that were displayed in the report and some the key findings from these observations.

- *Visit Introduction:* The observations showed that some of the auditors did a very thorough job of explaining the program and assessing the customers' needs, but some auditors need to improve the content of the information provided to the customer at the introduction of the audit.

Table II. Visit Introduction

	Number of Observations		Comments
	Yes	No	
Customer expected visit	10	0	
Explained Program	6	4	
Reviewed electric usage	4	6	Two of the auditors who did not do this in the introduction covered it later in the visit.
Discussed health and safety issues	4	6	Two of the auditors who did not do this in the introduction covered it later in the visit.
Discussed comfort issues	3	7	Two of the auditors who did not do this in the introduction covered it later in the visit.
Discussed whether there were any problems with energy usage	3	7	One of the auditors who did not do this in the introduction covered it later in the visit.

- *Home Walkthrough:* One of the contractors did not conduct a walkthrough. He remained in the kitchen except to install CFLs. One other contractor did not do a complete walkthrough. The other contractors did a thorough walkthrough and addressed all issues in the home.
- *Measures:* Contractors monitored refrigerators in six of the ten homes observed. In two of the cases the refrigerator was new, and in two other cases there were justifiable reasons not to monitor. There was one instance in which a contractor explored the opportunity for a two-for-one swap, but the customer refused. In two other cases, there was an opportunity that the contractor did not explore.

To determine which lights to replace, two of the contractors went through the home, room by room, and asked how long the lights in each room were used each day. Two contractors only asked which bulbs were used three or more hours per day. The other contractor asked the customer whether any bulbs were used four or more hours per day.

Table III. CFLs

	# of Observations			Comments
	Yes	No	NA	
Discussed all lights in the home	4	6		Two auditors just asked if there were any lights used 3 or more hours per day. One discussed replacing lights that were used more than 4 hours per day.
Discussed all outside lights	7	3		Auditor did not have needed replacement
Discussed installation of CFLs in all lights used 3+ hours/day	7	2	1	One customer said none used more than 3 hours/day.
Installed CFLs	8		2	
Asked customer if satisfied with lighting	8		2	
Left extra bulbs for customer		10		

- *Education:* In most of the cases the contractor engaged the customer as an active participant in the process and found the customer's self-interest in program participation. The contractor also usually reviewed the measures that were installed or ordered, analyzed the customer's electric bill, reviewed the customer's heating and cooling systems and appliances, and encouraged the customer to ask questions. Most of the contractors did a good job of finding those customer actions that could have the biggest

impact on the electric use. The one contractor who did not do the walkthrough also did not analyze the customers' electric uses.

- *Summary:* All of the auditors performed consistently in both of their observed jobs. Two of the auditors did an excellent job on their four observed jobs. They thoroughly explained WRAP, explained the customer's electric uses and the costs of those uses, worked with the customer to develop actions to reduce electric use, and estimated how much the customer could save through those actions. Two other auditors did a good job.

One of the auditors did not do the job as specified by the utility. He did not walk through the home with the customer to determine the customer's electric uses. He did not provide information to the customer about his/her home, but provided the same actions and cost estimates to both customers from a pre-written sheet.

Table IV. Visit Summary

	Length of Visit			
	Min	Max	Average	
Length of visit (minutes)	70	180	119	
	Rating			
	Excellent	Good	Fair	Not Acceptable
Overall rating (number of jobs)	4	2	2	2

- *Recommendations from the Baseload Observations:* Program managers should do the following:
 - Review requirements and expectations with contractors.
 - Reinforce importance of the walkthrough for baseload jobs with all contractors.
 - Provide additional training to contractors on the importance of 2-for-1 swaps in refrigerator replacement, and train contractors to work with customers to obtain their acceptance of this measure.
 - Review CFL replacement procedures with contractors.
 - Review customer education requirements with contractors.
 - Observe baseload service delivery to ensure that contractors meet program standards for service delivery.

Findings and Recommendations – Full Cost

Below we provide a sample of the full cost observation and inspection data that were displayed in the report and some the key findings from these observations and inspections.

- *Observation Findings:* While none of the Full Cost observations included what was considered the education visit, the contractors did a good job of communicating with the customers. While two of the visits were installation visits (and the other four were audits), all of the contractors inspected the home and most discussed actions to reduce electric usage. The contractors did not discuss the costs of the usage and generally did not estimate how much could be saved by taking certain actions, but presumably these efforts would be undertaken during the education visit.

Table V. Observations Overview

	Number of Observations	
	Very Good	Good
Technical Skills	4	2
Communication Skills	4	2

- *Inspection Findings:* There were missed opportunities found in three of the four homes. The missed opportunities included solar water heating, connections that remained between the house and the garage, and the attic, and incomplete air sealing and insulation work. Some of the data collection ratings were lowered because the evaluator was not able to duplicate the tests or not all of the forms were used. The measure selection and the appropriateness of installed measures were rated good or very good. Most contractors received the top rating with respect to effort and appropriateness of selected measures.

Table VI. Inspections Overview

	Number of Observations			Comments
	Very Good	Good	Fair	
Accuracy of data collection	1	1	2	Evaluator was unable to duplicate some of the test results in one home. Not all of the forms were used in another.
Measure selection	1	3		The attic was sealed shut in one home, so the work done there could not be inspected.
Appropriateness of installed measures	2	2		One of the inspections was a hardship case and the contractor was told to do anything they could to reduce energy use.
	Number of Observations			Comments
	Exceptional	Good	Satisfactory	
Effort	3	1		Hard to assess in one home because the customer had moved and the home was not occupied. In another home the evaluator's tests did not match the contractor's results.
Quality	1	2	1	
Appropriateness	3	1		
Overall Rating	1	3		

- *Recommendations from the Full Cost Observations:* The evaluator was generally impressed with the quality and comprehensiveness of work conducted by the contractors.
 - *One Set of Required Forms:* Many of the contractors used different types of paperwork. This made it difficult to determine whether all of the required paperwork had been completed and it made it difficult to assess and compare jobs.
 - *Instructions for Forms:* Some of the contractors were not sure what was required for some of the forms. The utility should provide instructions for each form on the back of the form, so that the contractor can easily flip the form over and read the instructions if necessary. Such instructions would improve the probability that all forms were filled out correctly.
 - *Diagnostic Tests:* All applicable diagnostic tests should be required at the audit visit. In some cases blower door and pressure differentials were not conducted during the audit. They should be required so that the auditor can accurately predict what work is needed during the measure installation visit.

Example 2 – National Low-Income Weatherization Program

We are currently embarking on a national study of state-run low-income weatherization programs that will include on-site observations of the full range of program services in 200 homes from 25 providers in 25 different states. This work poses some critical challenges but provides an opportunity for a large-scale on-site assessment project. One of the key challenges is the fact that while the national program has a set of general guidelines, the program is implemented differently in every state, and there are important differences including how the audit is performed, what measures are eligible for selection, and the type of education that is provided. This makes it difficult to develop general forms and procedures that still collect the detailed quantitative data that are needed to assess the program.

Observation Forms

With 200 homes in this study, we will be able to provide a more detailed analysis of program implementation and how that implementation relates to procedures, methods, and training. Therefore, forms currently under design for this evaluation will be even more quantitative in nature and will collect data in Excel spreadsheets to be imported into statistical analysis software. The following forms and procedures will be developed for each of the following components this study.

1. Audit observation data collection
2. Audit write-up assessment
3. Measure installation observation data collection
4. Agency Final Inspection observation
5. Evaluation Post Job Inspection
6. Post Job Client Interview
7. Survey instruments – auditors, crews, inspectors, and agency managers
8. Template for Observation and Inspection Write-ups

Below we provide a few excerpts from the in-progress observation data collection forms to illustrate how this evaluation will be implemented. The form below displays the Combustion Safety Testing Section of the Audit Observation Data Collection Form.

Audit Observation Data Collection Form
Combustion Safety Testing Section

Combustion Safety Testing			Rate Test Quality (1-5)
	Was test Performed?	Should test have been Performed?	
Ambient CO level in CAZ			
Ambient CO level outside of CAZ			
Heating system CO level			
Water heating system CO level			
Gas/propane burners CO level			
Gas/propane stove CO level			
Gas/propane/fuel oil leaks			
Worst case draft test on heating system			
Worst case draft test on water heater			
Natural conditions draft test on heating system			
Natural conditions draft test on water heater			
Vented combustion appliance steady state efficiency			
Measure CAZ for sufficient volume for combustion air			
Pressure rise and temperature drop tests on forced air furnace			
Assess duct sizes for forced air systems			
Auditor addressed any immediate safety issues (y/n/NA)			

The form below displays the Air Sealing section of the Measure Installation Observation Data Collection Form.

Measure Installation Data Collection Form
Air Sealing Section

Air Sealing			
All ratings on scale of 1 (lowest) to 5 (highest)			
Mark NA if not part of work scope and skip section			
Mark NA if not addressed in this visit and skip section			
Blower door used to guide air sealing (y/n/NA)			
Sealing at top and bottom of envelope prioritized (y/n/NA)			
In Work Scope? (y/n)	Done This Visit? (y/n)	Rate Quality (1-5)	
Attic leaks sealed			
Plumbing vent stacks sealed			
Electrical penetrations sealed			
Chases around chimneys sealed			
Mechanical penetrations sealed			
Attic access hatch sealed			
Gap between sill plate and foundation sealed			
Rim joists sealed			
Kneewalls sealed			
All major opportunities were sealed (y/n)			
Overall quality of air sealing work (Rate 1-5)			
Overall cleanliness of air sealing work (Rate 1-5)			

Training sessions will be held with all on-site evaluators to develop an understanding of how the procedures are to be followed, how the forms are to be used, and how the rating scales are to be employed. Where needed, specific instructions will be provided as to how ratings relate to individual items. In general, the rating scale will be employed as follows, but additional detail will be provided for specific assessment areas.

- 5 – Exceptional: No possible improvements identified
- 4 – Good: Minor improvements possible
- 3 – Satisfactory: Some improvements recommended
- 2 – Fair: Extensive improvements necessary
- 1 – Poor: Substandard in all respects

Summary and Conclusions

On-site observation and post job inspections of energy efficiency program service delivery are important components of technical process evaluations that can provide key insights into how programs can be modified to improve impacts on energy usage, as well as home comfort, health and safety. It is critical that the research be conducted systematically and rigorously to provide accurate information on program challenges and opportunities. The evaluators should select a sample that most accurately represents the program, design tools to comprehensively capture what is observed in the field, train staff to systematically record data and information, and analyze and assess the quantitative and qualitative findings in conjunction with other research findings.

This paper presented observation and inspection tools and results from a utility-specific weatherization program. We found that requiring that specific data is recorded from important components of the visit led to more quantitative data and an increased ability to provide recommendations for program improvement. We also presented research tools currently under development for a national evaluation that will include observations on all aspects of service delivery in 200 homes across the country. We believe that these evaluation instruments will allow for quantification of findings and allow us to relate findings about service delivery quality to program characteristics, agency procedures, and staff training.

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