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National Weatherization Assistance Program Process Field Study: Findings from Observations and Interviews at 19 Local Agencies Across the Country

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ACRONYMS

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning
DOE	Department of Energy
EPA	Environmental Protection Agency
HVAC	Heating, ventilation and air conditioning
IR	Infrared
LIHEAP	Low Income Home Energy Assistance Program
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PY	Program Year
WAP	Weatherization Assistance Program

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EXECUTIVE SUMMARY

The Process Field Study documented how the U.S. Department of Energy's (DOE) Weatherization Assistance Program (WAP) services were delivered to clients and the quality with which those services were delivered. These assessments were conducted by visiting 19 agencies in 19 different states around the country between March and September 2011; interviewing agency managers, staff, and contractors; observing program intake, audits, measure installation and final inspections; and conducting debriefing interviews with clients and weatherization staff following observation of service delivery. The assessments were conducted in both quantitative and qualitative manners, so that both program strengths and opportunities for improvement could be both quantified and described.

Study Design

The overall goal of the study was to accurately document how program services are delivered. We aimed to collect information in a systematic and quantitative manner to obtain data that provides a rigorous assessment of service delivery and concrete information on implementation challenges and solutions. This approach required purposive selection of agencies across the country, development and extensive testing of detailed data collection instruments and quality rating scales, and informed analysis of the resulting data.

Weatherization Experts were recruited from the evaluation team's professional contacts across the country. All of the Weatherization Experts had extensive experience managing, implementing, and/or training on weatherization procedures, service delivery, and quality assurance. The Weatherization Experts were responsible for documenting the characteristics and quality of service delivery using a detailed set of data collection forms.

Social Scientists from various disciplines (urban planning, social anthropology, psychology, sociology, etc.) were also engaged for this study, to obtain a variety of perspectives on the interactions between clients and providers, and among providers. Social Scientists were responsible for documenting and assessing the interactions between weatherization staff and clients, the interactions among weatherization staff, and the characteristics of agencies, staff, training, and clients that influence service delivery.

Sample Selection

Because of the small scale of the study relative to the wide variety of characteristics that describe the agencies and how they deliver program services, purposive sampling was the most appropriate method. Under the purposive method, the sample was selected in steps, to round out the sample and represent the important characteristics of the delivery agencies and programs. The purposive sampling differed from probability sampling in that random selection techniques were not used. As a result, confidence intervals cannot be developed for statistical analysis. However, the sample design allows for an assessment of overall program performance, with greater applicability than anecdotal results would allow.

When selecting the sample, we aimed to take the factors into account that were likely to be related to program performance – provider characteristics, service delivery characteristics, and county characteristics. Twenty local service delivery agencies were sampled from the 400 agencies that comprised the agency billing data sample[1] (out of the nearly 1,000 agencies that deliver services across the country.) The sample was selected in the following manner.

[1]The agency billing data sample was a subset of agencies that were selected to provide detailed program data, including data on the characteristics and services delivered to program participants. Utility data were then requested for these program participants to estimate the impacts of the program on electricity and natural gas usage.

1. The number of states per region was determined based on program funding.
2. States were selected within region based on the part of the region and the program size.
3. Agencies were selected within selected states to represent urban/rural, measure selection technique, and self-reported levels of client education, staff training, and quality control.
4. One agency was selected in each of the 20 selected states.

Data Collection Instruments

Design of the data collection instruments was a critical part of the research. These forms were planned to ensure that systematic data were collected about the work that was done and that the quality of the work was rated equivalently by the ten Weatherization Experts.

One of the key challenges in the form development was the fact that while the program has a set of general guidelines, it is implemented differently in every state, and differently by agencies within each state. Important variations include how the audit is performed, the diagnostic testing procedures that are required, what measures are eligible for selection, and the type of education that is provided. This variation made it challenging to develop general forms and procedures that still collected the detailed quantitative data that were needed to assess the program.

The evaluation team decided that all agencies would be evaluated on the same scale, using the same forms, according to a set of best practices agreed to by the weatherization professionals who consulted on the form development. For example, even if an agency did not include a particular diagnostic test in their audit procedures, their work would be assessed as being less than complete. Additionally, if the agency did not have a tool needed to conduct a particular test that was determined to be needed, the work would be assessed as less than complete. However, the Weatherization Experts would debrief the weatherization staff following the audit and record whether or not that test was part of the agency standards. This would allow an understanding of whether the standards needed to be addressed, or whether staff needed to be better trained to follow agency procedures.

A rating scale was developed for each aspect of the weatherization work that was rated for quality. The rating scale asked the observer to record whether or not each of several tasks were performed correctly, and the score was based on the percentage of required tasks that were completed. Additionally, several of the items rated required the staff to have a "yes" for some specific tasks to receive one of the top two ratings (4/5 or 5/5 on the scale.)

The Table ES 1.0 displays a sample rating scale for attic insulation quality. The Weatherization Experts noted whether each of the actions listed in the table were completed during the work. If an item was not applicable, the installer would be given the points for that item, and not be downgraded for omitting it. The first six items in the table are bold, as it was determined that all of these items would need to be completed for the installer to receive a rating of "4" or "5" on the 5-point scale. This was due to the importance of these actions to a good-quality job.

Table ES 1.0 Quality of attic insulation rating design

Action	Quality of Attic Insulation Work
1	All air sealing work completed first
2	Exhaust fans vented to exterior as needed
3	Heat producing devices or systems protected from insulation contact
4	Attic checked for knob and tube wiring
5	Workers wore respirators, safety glasses, gloves, and hard hats while insulating attic
6	Insulation installed in sufficient quantity (bags per ft^2) to meet R-value requirement
7	Proper insulation material chosen for attic conditions
8	Open blow insulation is level and of consistent depth
9	Attic ventilation maintained
10	Confined areas blown to dense pack
11	Proper containment used to protect client and belongings

Table ES 2.0 describes how the ratings were assigned, based on the number of items on each scale. As shown in the table below, staff would need to complete all actions noted in the table to receive a "5" on the 5-point scale, and would need to complete 90 to 99 percent of the actions and all bold actions to receive a "4" on the scale. For example, if there were ten points on the scale, the staff would need to obtain at least five points to obtain a score of "2", at least eight points to receive a score of "3", at least nine points to receive a score of "4", and all ten points to receive a score of "5". As a result, it was difficult for the work to receive the top rating.

Table ES 2.0 Rating design

Rating	**1**	**2**	**3**	**4***	**5***
% of Points Needed	**0%-49%**	**50%-74%**	**75%-89%**	**90%-99%**	**100%**
Total points	**Number of Points needed for each rating**				
4	0-1	2	3	--	4
5	0-2	3	4	--	5
6	0-2	3-4	--	5	6
7	0-3	4	5	6	7
8	0-3	4-5	6	7	8
9	0-4	5-6	7	8	9
10	0-4	5-7	8	9	10
11	0-5	6-7	8-9	10	11
12	0-5	6-8	9-10	11	12
13	0-6	7-9	10-11	12	13
14	0-6	7-9	10-12	13	14
15	0-7	8-10	11-13	14	15

*In several cases, bolded items must be checked to receive a rating of 4 or 5. The bold items are displayed in specific rating tables included later in this report.

The data collection forms included several notes fields to allow the observers to record additional information that affected the quality of the work or specific challenges faced on site. For example, in

some cases, the quality of work was rated low primarily because important safety precautions were not followed. In these cases, observers would document this information in the notes field.

Data collection forms were created for the three types of visits observed by the Weatherization Experts and for an evaluation of the audit write-up. The following forms were used.

1. Audit observation data collection
2. Audit write-up assessment
3. Measure installation observation data collection
4. Agency final inspection data collection

Observations Conducted

Weatherization Experts and Social Scientists visited 19 agencies in total because one of the 20 selected agencies was not performing weatherization work, due to exhaustion of weatherization funding, at the time that the visit was planned. In total, 155 audits, 159 installations, and 128 final inspections were observed between January 2011 and September 2011. This includes the pilot visit that was conducted by the study manager prior to Weatherization Expert and Social Scientist training in February 2011.

Staff

Agency staff and contractors played an important role in this research by cooperating with evaluators and providing access to their work. The staff members at the agencies were ready for the Social Scientists and the Weatherization Experts and helped ensure that they were able to conduct interviews and observe work in progress.

Both the Social Scientists and the Weatherization Experts reported that the staff members were uniformly dedicated to their work, showed tremendous concern for the clients they served, and often went beyond their defined jobs to assist clients in additional realms. The weatherization staff showed great pride in their work and took care to leave the homes safer for the occupant.

The observers reported that the installers on the jobs worked well as a team. They worked together to call on past experiences and collectively solve the problems that they encountered. There was an understanding among the members of the team, where each member knows his or her role, and took that responsibility seriously. The crew leaders had pride and ownership in their trucks, and were careful with how they were set up. Many long-time contractors were seen, and appeared to provide great benefit to the program.

There were many challenging conditions that were faced by the weatherization staff and contractors. These included difficult conditions in the home, dogs, dirty and hot working environments, rough neighborhoods, clients who were not trusting, clients that did not follow instructions for preparing the home, language barriers, and long travel times in large service territories. Despite these challenges, these staff and contractors were dedicated to assist clients and help improve their lives.

Client Intake

Client intake was a focus of the Social Scientists' observations, but not the Weatherization Experts' observations. Social Scientists tried to observe in-person or telephone intake during their agency visits, and they conducted interviews with intake workers.

The most common route into WAP is through the Low-Income Home Energy Assistance Program (LIHEAP). The next most common source of clients for WAP was referrals from other programs at that agency or other agencies, or from utility companies. The most common primary method of intake was the phone, followed by the mail. Many agencies used more than one intake method.

In addition to eligibility verification, another goal for intake is to form a partnership with the client and to provide education. The partnership approach aims to establish that both the agency and the client have responsibilities. While the agency's responsibility is to weatherize the home, the client's responsibility is to make sure that the home is ready for weatherization, to take an active role in the process, and to make commitments toward behavior changes that could reduce energy usage. The Social Scientists did not hear or observe much in the way of these partnerships. While three agencies reported or demonstrated some type of partnership activity, 16 did not.

When asked what information was provided to clients at the time of intake, most of the agency managers reported that clients receive a basic description of WAP and what the client could expect from the program.

Audit

Weatherization Experts observed 112 audits and Social Scientists observed 43 audits during the agency visits. The study covers findings in the following areas.

- Audit Introduction and Home Walkthrough
- Heating, Ventilation, and Air Conditioning
- Water Heating
- Diagnostic Testing
- Refrigerators and Lighting
- Client Interaction and Education
- Exit Interview
- Audit Summary Ratings
- Auditor Professionalism
- Audit Write-up

Analysis of all audit observation ratings across educational categories, technical categories, and professional categories showed that auditors scored highest in terms of their professionalism. The mean ratings on the five-point scale were as follows.

- Audit education – the mean rating was 2.0, a low rating indicating significant room for improvement.
- Audit technical – the mean rating was 2.5, between low and mid-level, also indicating significant room for improvement.
- Audit professional – the mean rating was 3.8, fairly high, indicating the high level of concern and respect for clients.

The strengths of the audit education process are summarized below.

- The audit introduction included an explanation of WAP in 77 percent of the observed cases.

- The audit exit interview included a summary of findings in 81 percent of the observations, a discussion of measure options in 80 percent of the observations, and information on next steps in 95 percent of the cases.

We found that auditors could improve the audit education process by discussing the following issues with clients during the audit. Weatherization Experts observed that these issues were discussed in fewer than 40 percent of the observed audits, and often much less frequently.

- Energy bills – 12 percent reviewed bills at the introduction and seven percent at the exit.
- Client problems with energy usage – 34 percent asked about problems with energy usage.
- Potential actions to reduce usage – 21 percent discussed actions to reduce usage.
- Home comfort issues – 38 percent discussed whether part of the home is too cold.
- Thermostat settings – 29 percent discussed heat and 39 percent discussed air conditioner settings.
- Heat setback – 10 percent discussed heat setback when not at home.
- Hot water usage – 8 percent discussed efficient hot water usage.
- Lighting – 29 percent discussed how clients use lighting.
- Behavior change opportunities – 10 percent summarized behavior change opportunities.

As a result of these needed improvements, audit-related education ratings were low.

- Audit intro rating – the mean rating was 2.2, low on the rating scale.
- Exit interview – the mean rating was 1.6, very low on the rating scale.
- Client engagement – the mean rating was 2.0.
- Education quality – the mean rating was 1.7.

There were a greater number of strengths noted with respect to the technical aspects of the audit. The following aspects were included in 70 percent or more of the observed audits.

- Inspection – 99 percent inspected every accessible room.
- Heating system – 94 percent inspected the heating system.
- Filters – 72 percent inspected filters.
- Ventilation – 72 percent inspected the kitchen and 78 percent the bathroom ventilation.
- Water heater – 93 percent inspected the water heater.
- Air conditioning – 82 percent inspected the outside air conditioning unit.
- Insulation – 89 percent measured insulation in all accessible attics.
- Testing – 97 percent conducted a blower door test and 84 percent were done correctly.

As a result, the audits were rated by the Weatherization Experts to be comprehensive.

- Comprehensiveness – 48 percent were rated as excellent and 47 percent as good.
- Planned work comprehensiveness – 49 percent were rated as excellent and 48 percent as good.

Major opportunities with respect to the technical aspects of the audit were as follows. In most cases, these assessments were done in fewer than half of the observed audits.

- Bathroom ventilation flow – 24 percent assessed this aspect of ventilation.
- Hot water – 39 percent checked the hot water temperature at the faucet.

- Shower flow – none of the auditors measured the water flow.
- Insulation – 49 percent measured insulation in exterior walls.
- Blower door – 67 percent used the blower door while inspecting for leaks.
- Zonal pressure diagnostics – 42 percent conducted (87 percent done correctly.)
- Infrared (IR) camera – 49 percent used the camera (70 percent correctly.)

As a result of these missed opportunities, the audit testing ratings were rated in the low to mid-range.

- Testing completeness – the mean rating was 1.9, low on the rating scale.
- Testing quality – the mean rating of 2.4, low to mid-level on the rating scale.

The audit write-ups also were incomplete.

- Audit write-up quality – the mean rating of 2.6, low to mid-level on rating scale.

Measure Installation

Weatherization Experts observed 114 installations and Social Scientists observed 45 installations during the agency visits. The report provides a detailed review of findings in the following areas.

- Introduction
- Window and Door Work
- Air Sealing
- Attic Insulation
- Wall Insulation
- Basement and Crawl Space Insulation
- Ventilation
- Heating and Cooling
- Hot Water System
- Other Measures – Refrigerator, Dryer, Lighting, Low-Cost Measures
- Professionalism
- Communication and Education

Analysis of all measure installation observation ratings across educational categories, technical categories, and professional categories showed that auditors scored highest in terms of their professionalism. The mean ratings on the five-point scale were as follows.

- Measure installation education – the mean rating was 2.2, a low rating indicating significant room for improvement.
- Measure installation technical – the mean rating was 3.0, a mid-level rating, indicating that some measures were done well and some showed opportunities for improvement.
- Measure installation professional – the mean rating was 3.8, fairly high, indicating the high level of concern and respect for clients.

The strengths of the measure installation education process are summarized below.

- The installers provided good introductions – 77 percent explained the purpose of the visit and 79 percent explained the planned measures.
- The installers communicated well – the mean rating was 3.2 for installer communication.

The opportunities for improvement found in the measure installation education process were as follows.

- The installers did not explain the program during the introduction – 29 percent of the installers explained WAP.
- The installers received low ratings on client engagement – the mean rating was 2.1.
- The installers received low ratings on education quality – the mean rating was 1.9.

There were a greater number of strengths noted with respect to the technical aspects of the measure installation. As a result, the following ratings were in the mid to high range.

- Window work ratings – the majority of window measure ratings averaged between 3.5 and 4.0.
- Door work ratings – the ratings averaged between 2.8 to 3.5, mostly in the mid-level.
- Air sealing cleanliness rating – the rating averaged 3.9, high on the ratings scale.
- Attic insulation ratings – quality averaged 3.3 and cleanliness averaged 4.0, mid and high on the rating scale.
- Wall insulation ratings – quality averaged 2.9 and cleanliness averaged 4.3.
- Basement insulation ratings – quality averaged 3.6 and cleanliness averaged 4.5.
- Crawl space ratings – measures averaged 3.1 to 4.0.
- Ventilation ratings – measures averaged 4.1 to 4.8.
- Thermostat installation rating – quality averaged 4.1.
- Air conditioning rating – most measures averaged 3.0 to 4.0.
- Water heater – measures averaged 3.1 to 4.0.

Additionally, the following aspects of air sealing and insulation were done well.

- Correct prioritization of air sealing – 77 percent prioritized sealing at the top and bottom of the envelope.
- Proper attic insulation process – 77 percent completed attic floor sealing prior to insulation, 88 percent had no gaps or voids, and 95 percent used appropriate materials.

Major opportunities for improvement with respect to the technical aspects of the measure installation were as follows.

- Air sealing diagnostics were incomplete – 22 percent used the blower door to guide air sealing and 11 percent used the zonal pressure test to affirm appropriate pressure boundaries.
- Air sealing did not address all opportunities in many cases – 57 percent sealed all major opportunities.

As a result, the following ratings were low.

- Air sealing ratings – overall quality averaged 2.4, fairly low on the rating scale.
- Heating system ratings – they averaged 2.0 to 2.5 in most cases.
- Smoke and CO detector ratings – these ratings averaged 2.6 and 2.0.

Final Inspection

There were 91 final inspections observed by the Weatherization Experts and 37 observed by the Social Scientists. The following aspects of the final inspections are discussed in the report.

- Home Walkthrough
- Testing
- Occupant Interaction
- Professionalism

Analysis of all final inspection observation ratings across educational categories, technical categories, and professional categories showed that auditors scored highest in terms of their professionalism. The mean ratings on the five-point scale were as follows.

- Final inspection education – the mean rating was 1.9, a low rating indicating significant room for improvement.
- Final inspection technical – the mean rating was 2.5, a low rating, indicating some opportunities for improvement.
- Final inspection professional – the mean rating was 4.1, fairly high, indicating the high level of concern and respect for clients.
- The strengths of the final inspection education process are summarized below.
- Clients expected the inspectors – 97 percent expected the visit.
- Inspectors communicated with the clients – 75 percent discussed the work that was performed.

There were opportunities for improved client education seen in the final inspection education process, including additional discussion with the client.

- Discussion of energy and cost savings that could result from the services – 28 percent discussed this with the client.
- Discussion of health and safety issues found in the home – 29 percent discussed this with the client.

As a result, the ratings relating to education conducted at the final inspection were low.

- Client engagement rating – the mean rating was 1.8.
- Education quality – the mean rating was 1.7.

The strengths noted with respect to the technical aspects of the final inspection are summarized below.

- Inspections were comprehensive – 90 percent examined all accessible rooms.
- Blower door tests were usually conducted – 85 percent conducted this test (85 percent of those performed correctly.)
- The testing quality ratings were in the mid-range – the mean rating was 3.3.

Major opportunities with respect to the technical aspects of the final inspections were as follows.

- Zonal pressure test was not usually conducted – 33 percent performed the test (87 percent done correctly.)

- IR camera was used in less than half of the observations – 44 percent used the camera (95 percent done correctly.)
- Combustion safety tests were not complete – 31 percent performed this test on the gas stove (100 percent done correctly.)
- Worst case draft tests were not routinely conducted – 60 percent performed this test on the heating system (92 percent correctly.)
- Completeness ratings were low – the mean inspection rating was 2.3 and the mean testing rating was 1.9.

Ratings Summary

Figure ES 1.0 provides a summary of the ratings across all visits and by agency. The charts clearly show that ratings were lowest for educational aspects of the visits. The average audit rating for all education-related aspects was 2.0. However, there was an agency with an average rating of 2.8 on the educational aspects of the visits. By contrast, the professional aspects of the audit averaged 3.8 across all visits, and the agency-level averages ranged from 2.3 to 4.6.

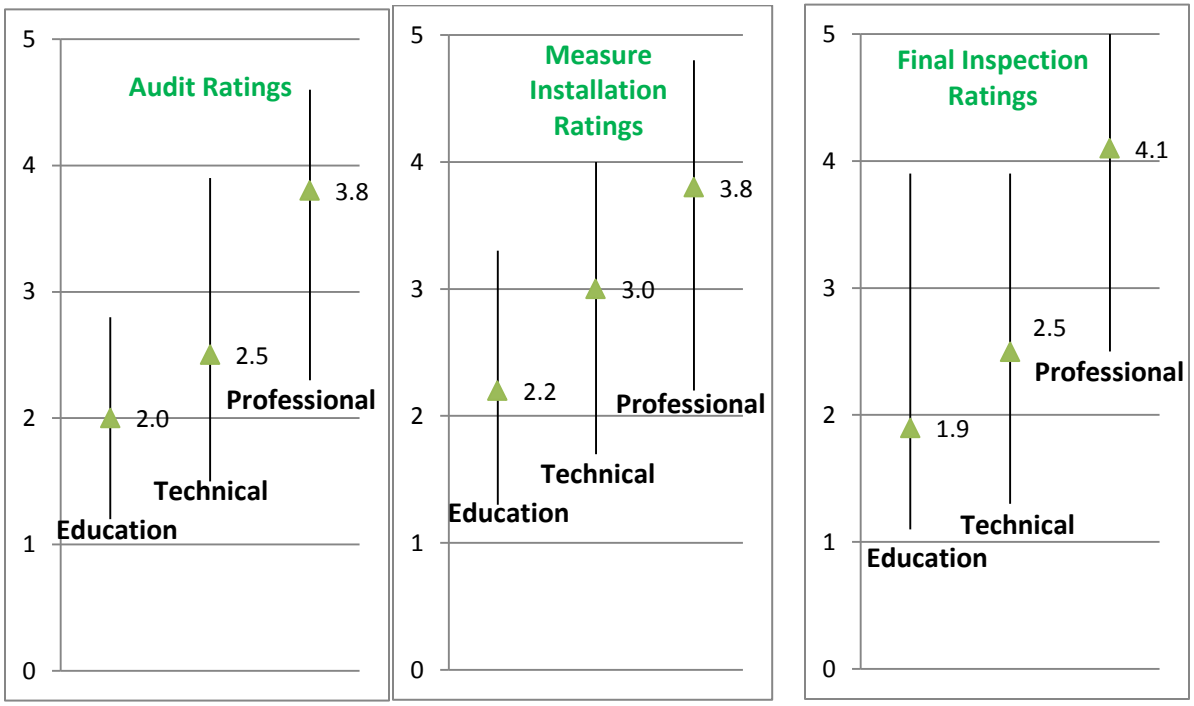

Figure ES 1.0 Average ratings by agency and overall

Education

Observers noted that the provision of information that auditors and other weatherization staff referred to as client education was often dissemination of information about the weatherization process, rather than information that would enable the clients to take an active role in the process and in reducing their energy usage. Clients were told about the weatherization process and what was going to be done to their home, they received required notifications about potential hazards, and they sometimes received printed materials about energy savings and structured client action plans. We did not observe a process where education began at intake and was communicated through the paperwork, so that a client action plan could be discussed at each stage of the weatherization process.

Safety

Installers generally did not follow practices to protect themselves while performing the installations. The level of lead safe work observed varied from being in compliance with regulations to completely ignoring the hazard and exposing both workers and clients to the potential hazard of lead paint dust. Observers found that installers often did not wear personal protective equipment, including not wearing respiratory protection while in confined areas or while blowing insulation and not using protective equipment while cutting and sawing, including no safety glasses, ear plugs, or gloves. There were several observed cases where workers put themselves or their clients at risk.

Factors

State programs, local agencies, weatherization staff, and contractors differ on numerous dimensions that may impact the quality and effectiveness of services delivered. One of the goals of this study was to determine whether there were characteristics of agency management, staff qualifications, or training that are related to service delivery quality, as assessed in this study. Definitive conclusions cannot be drawn due to the small number of agencies and jobs observed compared to the large number of factors that can influence success, but the study did investigate whether there were any meaningful relationships between potentially determining factors and agency performance.

Audit Factors

The factors studied were based upon agency responses to surveys included as part of the program evaluation. The following factors related to audits were reviewed.

- Use of in-person instruction at the time of the audit.
- Requirements for staff engaged in measure selection.
    - Technical certification
    - Extensive weatherization work experience
    - Extensive weatherization supervision experience
    - Construction experience
- Requirements for staff engaged in diagnostic procedures.
    - Technical certification
    - Extensive weatherization work experience
    - Extensive weatherization supervision experience
    - Construction experience

For the most part, there were no relationships seen between these factors and ratings made by the Weatherization Experts. However, there were some quality factors that were related to higher ratings.

- The audit technical ratings averaged 2.5 for observations at agencies that did require the certification, compared to 2.1 for those that did not.
- The audit technical ratings averaged 2.6 for observations at agencies that did require the certification, compared to 2.2 for those that did not.
- Agencies that required extensive weatherization work experience had an average audit education rating of 2.1 compared to 1.6 for those who did not.
- Agencies that required extensive weatherization supervision experience had an average audit education rating of 2.3 compared to 1.9 for those who did not.

Measure Installation Factors

With respect to measure installation, we assessed whether there was a relationship between whether crews or contractors were used and the Weatherization Experts' assessments. There were some differences.

- Crews were more likely to have important information at the time of the installation.
  - 91 percent of crews had household demographic data, compared to 22 percent of contractors.
  - 77 percent of crews had the audit report, compared to 34 percent of contractors.
  - 91 percent of crews had a materials list, compared to 49 percent of contractors.

- Crews had higher mean ratings than contractors for efficiency, professionalism and safety practices.
  - Crews had an average mean rating of 4.4 for efficiency, compared to 3.9 for contractors.
  - Crews had an average mean rating of 4.2 for professionalism, compared to 3.7 for contractors.
  - Crews had an average mean rating of 2.9 for safety, compared to 2.3 for contractors.

Final Inspection Factors

The following factors related to final inspections were reviewed.

- Use of innovative program for inspection of weatherized units
- Whether in-person instruction is required at the time of the final inspection.

There were some relationships between these factors and agency final inspection rating scores.

- Agencies that reported they had an innovative program had a mean technical inspection rating of 3.3, compared to a mean rating of 2.3 for those who did not.
- Agencies that reported in-person instruction had higher technical and professional ratings than those who did not.
  - Agencies with in-person instruction had a mean technical inspection rating of 2.6, compared to 1.7 for those who did not.
  - Agencies with in-person instruction had a mean professional rating of 4.2, compared to 3.5 for those who did not.

However, contrary to what would be expected, they did not have higher education ratings.

All Program Area Factors

The following factors related to all aspects of weatherization services were reviewed.

- Use of an innovative education approach.
- Use of an innovative weatherization staff training approach.
- Number of different types of training activities provided by the agencies.
- Level of education provided by the agency, determined by the mix of education methods reported by the agencies.

- Level of training provided by the agency, determined by the mix of training activities reported by the agencies.
- Agency quality rating.

The only one of these factors that was related to observation ratings was that agencies that reported they had an innovative training program had higher ratings in all parts of the process than those who did not. Agencies that reported the training program had the following higher scores.

- All audit technical ratings averaged 3.4 compared to 2.3 for those without.
- All installation technical ratings averaged 3.3 compared to 3.0 for those without.
- All inspection technical ratings averaged 3.2 compared to 2.4 for those without.

Impacts

The rationale behind this study's design is that if weatherization providers accurately determine which measures have the greatest potential impact; effectively install selected measures according to best weatherization practices; and carefully inspect the completed job for safety, completeness, and quality, the program will produce high quality work that significantly reduces energy usage.

This study focused on the implementation of the program, rather than the savings that were achieved. However, the program's impact analysis assessed agency-specific results for agencies that had at least eight single family homes with sufficient usage data to assess energy savings. There were 120 agencies that had sufficient data to assess the agency-specific gas savings and eight of the 19 observed agencies were included in this group. There were 103 agencies that had sufficient data to assess the agency-specific electric savings and eight of the studied agencies were included in this group.

Due to the small numbers of observations per agency, and the fact that only eight of the agencies had enough data to compute agency-specific savings results, it is difficult to draw conclusions regarding the relationship between observed performance quality and energy savings impacts. While there is not enough data to draw conclusions, it is noteworthy that three of the top four ranked agencies, over all observation quality ratings, had either gas or electric savings that were in the top five percent of the agencies that could be ranked by savings values.

Training and Equipment

There were several specific training needs that were identified as a result of the observation findings.

- Energy bill utilization – how to use bills to assess services needed and to educate clients
- Building science fundamentals
- Critical thinking – assessing unique situations
- Combustion safety testing
- Zonal pressure testing
- IR camera use – they were not used consistently
- Ventilation assessment
- Safe work practices – worker safety and lead safe work
- Interviewing skills – how to understand the client's needs
- Client education

The key equipment needs that were noted were as follows.

- GPS

- IR camera
- Boroscope and fiber optic scope and video
- Personal safety equipment

Challenges identified with providing adequate training were as follows.

- More clarity is needed on program specifications and procedures.
- Sufficient time must be allocated for training.
- Pressure for job production often overwhelms the need for training.
- Agency management does not always prioritize training.

Some strategies for national, state, and local management to improve the availability and quality of training are as follows.

- Increased resources for staff training can lead to improved client outcomes and workforce development.

- A combination of classroom and field training can provide all types of learners with the types of experiences needed.

- Greater attendance at national conferences can provide information on best practices and increase motivation for improved performance.

- A focus on why tests are conducted can improve understanding of how to properly conduct the tests.

- An emphasis on client education as an important "measure" is needed to improve this aspect of service delivery.

- Reinforcement of training topics with monitoring, assessment, and feedback can lead to improved implementation and service delivery quality.

Management

The general opportunities identified for program management were as follows.

- Standards and procedures
- Policy manuals
- Forms and checklists

Specific recommendations with respect to standards and procedures were identified.

- Basic training – guidelines for what basic training and certification is needed should be developed. (DOE is in the process of developing certifications for auditor, crew chief, installer, and quality assurance staff.)

- Health and safety policies – these policies need to be defined. Health and safety issues were ignored by some agencies and taken very seriously by others. The state needs to define how staff members are to deal with pets, parking, bathroom use, and overall job cleanliness.

- Personal protective equipment – use of this equipment was often lacking. Agencies should be required to provide equipment and enforce that it is used.

- Blower doors – staff should be required to use this equipment. Some staff did not have them and some just did not use them. In one state, the contractors did not have them.

- Diagnostic and safety testing – the state should specify what tests need to be conducted and when. Testing varied tremendously from one agency to another.

- Heating, ventilation and air conditioning (HVAC) contractors testing – the state should require HVAC contractors to test on the way out. Weatherization Experts observed cases where this was not required.

- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 62.2 – the state should define when this policy needs to be implemented.

- Deferral policies – the reasons for deferring a job need to be clearly defined.

Specific recommendations with respect to policy manuals were identified.

- States should be required to create and periodically update procedures manuals.
- DOE should provide a model guide and allow states to adopt the model as is, revise, or create their own.
- States should be required to have a process and timetable for revising and updating the manual, and should have a stakeholder input process.

Recommendations with respect to standards and procedures were identified.

- Agencies need to have a formal audit checklist and process. When auditors did not have good forms to utilize, they left out important aspects of the audit. When there was a formal process, the staff followed it step-by-step, and every auditor did the same work.

- Agencies should require detailed audit write-ups and work orders. Many of the write-ups and work orders that Weatherization Experts reviewed were not thorough or sufficient.

Agencies should have a checklist for the test out, as well as for the audit and work scope.

I. INTRODUCTION

The Process Field Study documented how Weatherization Assistance Program (WAP) services were delivered to clients and the quality with which those services were delivered. These assessments were conducted by visiting 19 agencies in 19 different states around the country; interviewing agency managers, staff, and contractors; observing program intake, audits, measure installation and final inspections; and conducting debriefing interviews with clients and weatherization staff following observation of service delivery.

A. OBJECTIVES

The objectives of the Process Field Study were to document the following.

- How services are delivered to clients.
- The consistency of implementation procedures with best practices.
- The effectiveness of agency staff and contractors in adapting to various housing conditions.
- The training needs of auditors, crews, and contractors.
- How program procedures could be modified to improve service delivery.

B. DESIGN

The overall goal of the Field Process Study was to accurately document how WAP is delivered. We aimed to collect information in a systematic and quantitative manner to allow for collection of data that provides a rigorous assessment of service delivery and concrete information on implementation challenges and solutions. This approach required purposive selection of agencies across the country, development and extensive testing of detailed data collection instruments and quality rating scales, and informed analysis of the resulting data.

Weatherization Experts were recruited from the evaluation team's professional contacts across the country. All of the Weatherization Experts had extensive experience managing, implementing, and/or training on weatherization procedures, service delivery, and quality assurance. The Weatherization Experts were responsible for documenting the characteristics and quality of service delivery using a detailed set of data collection forms.

Social Scientists from various disciplines (urban planning, social anthropology, psychology, and sociology) were engaged for this study, to obtain a variety of perspectives on the interactions between providers and clients, and among providers. Social Scientists were responsible for documenting and assessing the interactions between weatherization staff and clients, the interactions among weatherization staff, and the characteristics of agencies, staff, training, and clients that influence service delivery.

Agency staff and contractors played an important role in this research by cooperating with evaluators and providing access to their work. The staff members at the agencies were ready for the Social Scientists and the Weatherization Experts and helped ensure that they were able to conduct interviews and observe work in progress.

C. REPORT

This report describes how the study was designed and implemented; findings from interviews with staff and clients and observations of client intake, audits, measure installations, and final inspections; factors related to higher program performance; and the relationship between assessed performance and program impacts. Seven sections follow this introduction.

- Section II – Study Design and Implementation
- Section III – Client Intake
- Section IV – Audit
- Section V – Measure Installation
- Section VI – Final Inspection
- Section VII – Factors and Impacts
- Section VIII – Findings and Recommendations

II. STUDY DESIGN AND IMPLEMENTATION

This section provides a detailed discussion of the Process Field Study design. We provide an overview of how the study was approached, discuss how the sample of 19 agencies was selected, the role of social scientists and weatherization experts in the study, how the data collection procedures were designed, how the observers were trained, and the observations and interviews that were conducted.

A. OVERVIEW

The overall goal of the Field Process Study was to accurately document how WAP is delivered. 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 observations aimed to answer included 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 form effective partnerships with the clients? Do the providers focus on energy saving behaviors with the greatest savings 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?

On-site observation of weatherization service delivery always 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. The evaluation of the National WAP is even more challenging because of the diversity of program implementation across the country.

Many on-site evaluations collect qualitative, anecdotal information that cannot be analyzed or generalized. By conducting the evaluation in a systematic and quantitative manner, we collected information that provides a rigorous assessment of service delivery and concrete information on implementation challenges and solutions. This required appropriate sample selection, detailed data collection instruments, and informed analysis of the resulting data.

Figure II-1 displays the procedures employed to implement the Field Process Study. One of the key challenges entailed designing data collection forms that would capture the information needed in a systematic manner. To accomplish this task, APPRISE implemented several iterations of the design, review, and pre-testing of the data collection forms. Many weatherization experts from different types of organizations, and who play myriad roles in the weatherization process, were brought in to consult on the form development. The process also included an expert panel comprised of individuals who assisted with the original evaluation design.

Figure II-1. Field process study flow chart

B. AGENCY SAMPLE

The on-site study was relatively small in scale, allowing for visits to only 19 of the 50 states and to 19 of the over 900 local agencies. While statistical theory dictates that the size of the sample determines the statistical precision of the resulting data, rather than the percent of the universe sampled, the underlying variation in the universe would have required a much larger sample size to accurately characterize the population.

Because of the small scale of the study and the wide variety of characteristics that describe the agencies and how they deliver WAP, purposive sampling was the most appropriate method. Under the purposive method, the sample was selected in steps, to round out the sample and represent the important characteristics of the delivery agencies and programs. The purposive sampling differed from probability sampling in that random selection techniques were not used. As a result, confidence intervals cannot be developed for statistical analysis. However, the sample design allows for an assessment of overall program performance, with greater applicability than anecdotal results would allow.

When selecting the sample, we aimed to take the factors into account that were likely to be related to program performance - provider characteristics, service delivery characteristics, and county characteristics. Because the program is so diverse, we could only make the best effort to represent the full range of what is seen in the field. The sample was not large enough to compare findings across the various providers, but we do aim to determine whether certain agency characteristics are related to better performance and whether higher ratings in field performance are related to greater savings.

Twenty agencies were sampled from the 400 agencies that comprised the agency billing data sample. The sample was selected in the following manner.

1. The number of states per region was determined based on WAP funding.

Table II-1 displays the Program Year 2008 funding by region, the percent of funding allocated to each region, and the proportional selection of states according to the funding. Slight adjustments were made to the proportional selection.

Table II-1. Number of states selected per region

Region	PY* 2008 WAP Funding ($ Millions)	% of Funding	Number of States Per Region	
			Proportional Selection	Adjusted Number
Midwest	$86.12	31%	6.18	6
Northeast	$92.39	33%	6.63	5
South	$54.33	20%	3.90	5
West	$45.72	16%	3.28	4
TOTAL	$278.56	100%	20	20

***** Program Year

2. States were selected within region based on the part of the region and the WAP program size.

Table II-2 displays the states selected (highlighted) by part of the region and the program size. The table shows that large, medium, and lower production states were selected across the sub-divisions of the regions.

3. Agencies were selected within selected states to represent urban/rural, measure selection technique, and self-reported levels of client education, staff training, and quality control.[2]

Table II-3 displays the characteristics of the 20 selected agencies.

The method that was used for the classification is described below.

- The agency's county was marked as urban if it included a central city, as defined by the census. A rural county was defined according to the Office of Rural Health Policy.[3] Some agencies served both urban and rural areas.

[2]The self-reports were responses to surveys of state and local WAP offices conducted as part of the evaluation. The surveys were designed by Oak Ridge National Laboratory.

[3]ftp://ftp.hrsa.gov/ruralhealth/eligibility2005.pdf

Table II-2. State selection

Midwest (6)					
West North Central (3)			East North Central (3)		
State	$ (Millions)	Units	State	$ (Millions)	Units
SD	$1.89	547	IN	$6.36	1,776
KS	$2.22	571	WI	$7.04	2,341
NE	$2.37	601	IL	$10.91	3,876
ND	$4.17	980	OH	$14.55	6,694
IA	$4.35	1,074	MI	$16.06	5,000
MO	$6.48	1,954			
MN	$9.72	2,916			
Northeast (5)					
New England (3)			Middle Atlantic (2)		
State	$ (Millions)	Units	State	$ (Millions)	Units
RI	$0.95	243	NJ	$4.71	1,261
VT	$1.13	797	PA	$13.66	3,798
NH	$1.38	396	NY	$58.72	12,800
ME	$2.86	824			
CT	$2.93	830			
MA	$6.05	2,623			
South (5)					
West South Central (1)			South Atlantic (3)		
State	$ (Millions)	Units	State	$ (Millions)	Units
AR	$1.76	533	DC	$0.57	175
OK	$2.96	820	DE	$1.49	431
TX	$5.26	1,417	SC	$1.60	443
LA	$7.15	1,953	FL	$1.82	602
East South Central (1)			GA	$2.49	662
MS	$1.40	414	MD	$2.90	980
AL	$2.72	753	WV	$3.18	1,291
KY	$3.33	924	VA	$3.62	901
TN	$8.29	2,984	NC	$3.79	994
West (4)					
Pacific (2)			Mountain (2)		
State	$ (Millions)	Units	State	$ (Millions)	Units
OR	$3.24	891	NV	$0.76	189
WA	$3.91	1,092	AZ	$1.38	770
CA	$5.64	3,252	WY	$1.53	380
Alaska and Hawaii (0)			ID	$1.85	432
HI	$0.19	115	UT	$2.09	554
AK	$1.54	456	NM	$2.26	777
			MT	$9.54	2,262
			CO	$11.79	3,275

Table II-3. Characteristics of the 20 selected agencies

	Urban/Rural	PY 2008 Jobs	Measure Selection	Education	Training	Quality Control
1	Urban, Rural	Medium	Calc. Procedure	High	Medium	Medium
2	Rural	Low	Priority List	Medium	Low	Medium
3	--	Medium	Calc. Procedure	Medium	Medium	Very High
4	Urban, Rural	Medium	Priority List	Low	Medium	Medium
5	Urban	Medium	Calc. Procedure	Low	Low	Low
6	Urban	Very high	Priority List	High	High	Medium
7	Rural	Medium	Calc. Procedure	High	High	Very High
8	Rural	Low	Priority List	Medium	High	Medium
9	Urban	High	Priority List	Low	High	Very High
10	--	Low	Priority List	Medium	Medium	Medium
11	Urban	High	Priority List	Medium	Medium	Very High
12	Urban, Rural	Low	Calc. Procedure	Low	Medium	Medium
13	Rural	Medium	Priority List	High	Medium	Medium
14	Rural, Urban	Low	Priority List	Low	Very Low	Medium
15	Urban	Medium	Priority List	High	Medium	Medium
16	Urban, Rural	Medium	Priority List	High	Medium	Low
17	Urban	Medium	Other	Very Low	High	Low
18	Urban	Medium	Priority List	Low	Medium	Medium
19	Rural, Urban	Medium	Priority List	High	Medium	Medium
20	Rural, Urban	High	Calc. Procedure	Medium	Low	Very High

Of the 20 selected agencies, seven were in urban counties, four were in rural counties, and seven were in urban and rural counties. Two were not defined.

- The measure selection technique was defined based on agency responses to surveys conducted as part of this National WAP Retrospective Evaluation. The agency responses to the following questions were utilized.

  What is the primary method that your agency used in Program Year 2008 to select weatherization measures for clients' dwelling units (excluding health, safety, and repair measures and general heat waste measures)? Please select one response.

  - *Priority list used for all dwelling units*
  - *Calculation procedure (e.g., spreadsheet, computerized audit) used for all dwelling units*
  - *Priority list applied to dwelling units meeting specified guidelines and calculation procedure used for remaining units*

Of the 20 selected agencies, six reported that their primary method was a calculation procedure, 13 reported that their primary method was a priority list, and one reported that it was another method.

- The level of client education was based on agency responses to questions about the various types of education provided to clients. Agencies were defined as providing high, medium, low, very low, or no education based on their responses to several questions.

Agencies were rated as providing a high level of education if they reported the following.

  - In person education is provided at separate education visit

Or if they reported that

  - In person education is provided at intake, **and**
  - In person education is provided at audit, **and**
  - In person education is provide at weatherization visit, **and**
  - In person education is provided at final inspection

Agencies were rated as providing a medium level of education if they reported the following.

  - In person education is provided at audit, **and**
  - In person education is provided at final inspection

Agencies were rated as providing a low level of education if they reported the following.

  - In person education is only provided in one or more of the four – intake, audit, wx visit, or final inspection

Agencies were rated as providing a very low level of education if they reported the following.

  - In person education is not provided at any of the four – intake, audit, wx visit, or final inspection, **but**
  - They did have at least one of the education methods checked

Agencies were rated as providing no education if they reported that they did not do any of the client education activities.

Of the 20 agencies selected, seven had a high level of education, six had a medium level of education, six had a low level of education, and one had a very low level of education.

- The level of staff training was based on agency responses to questions about the various types of training provided to staff. Agencies were defined as providing high, medium, low, very low, or no training based on their responses to several questions.

Agencies were rated as providing a high level of training if they reported that staff attend the following.

  - Attend National wx conference, **OR** regional wx conference, **OR** state wx conference, **and**
  - Attend Affordable Comfort Conference, **and**
  - Attend State/regional training center class **OR** Manufacturer's training school class **OR** Utility training class, **OR** State sponsored class taught at central location **OR** Class not sponsored by state

Agencies were rated as providing a medium level of training if they reported that staff attend the following.

- Attend National wx conference, **OR** regional wx conference, **OR** state wx conference, **OR** Attend Affordable Comfort Conference

Agencies were rated as providing a low level of training if they reported that staff attend the following.

- Attend State/regional training center class **OR** Manufacturer's training school class **OR** Utility training class, **OR** State sponsored class taught at central location **OR** Class not sponsored by state.

Agencies were rated as providing a very low level of training if they reported that they have at least one training activity, but did not fall into the other categories.

Agencies were rated as providing no training if they reported that they did not do any of the staff training activities.

Of the 20 agencies selected, five had a high level of training, 11 had a medium level of training, three had a low level of training, and one had a very low level of training.

- The level of quality control was based on agency responses to questions about the various types of quality control provided by the agency. Agencies were defined as providing very high, high, medium, low, very low, or no quality control based on their responses to several questions.

Agencies were rated as providing a very high level of quality control if they have more than 11 quality control methods and they do all of the following.

- Verification of insulation depths/quantities
- Verification of operation of measures installed
- Assessment of quality of measures installed
- Identification of needed measures that were not installed
- Blower door test
- Heating system efficiency test (flue gas analysis)
- Draft/spillage tests of heating systems
- Carbon monoxide (CO) monitoring
- Infrared scanning
- Identification of unresolved health and safety issues
- Discussion with occupants

Agencies were rated as providing a high level of quality control if they use the 11 quality control methods listed above, but do not use any other methods.

Agencies were rated as providing a medium level of quality control if they have five to ten of the quality control methods listed above, including a discussion with occupants.

Agencies were rated as providing a low level of quality control if they have five to ten of the quality control methods listed above but do not have a discussion with the occupants.

Agencies were rated as providing a very low level of quality control if they reported that they did at least one quality control method, but did not fall into the other categories.

Agencies were rated as providing no quality control if they did not report any quality control method.

Of the 20 agencies selected, five had a very high level of quality control, 12 had a medium level of quality control, and three had a low level of quality control.

4. Only one agency was selected in each of the 20 selected states.

C. AGENCY SCHEDULING

One APPRISE staff member was responsible for making the initial agency contact, scheduling the Social Scientist and Weatherization Expert visits, and collecting basic information about the agency. The initial information gathering included the following data.

Basic Agency and Staff Data

- Office locations
- Weatherization managers
- Intake staff
- Other in-house staff
- Trainers
- Auditors
- Installers
- Final inspectors
- Educators

Agency Schedule Data

- Other staff
- Size (in driving time) of agency service territory
- Number of weatherization staff members
- Work day start and end times for in-house and field staff
- Staff time at the agency prior to going to clients' homes
- Whether staff return to agency at end of the day
- Lag time between each stage in the weatherization process
- How often no shows occur
- What is done in the case of a no show

Agency Intake

- Number of agency locations where in-person client intake is done
- Whether client intake is done by telephone
- Hours for client intake

Audits

- How far in advance audits are scheduled
- Agency staff member who schedules audits

- Length of typical audit
- Number done in typical day
- When audit write-up is completed

Installation

- How far in advance installations are scheduled
- Use of crews and contractors
- Number of crews
- Number of contractors
- Crew roles
- Contractor roles
- Number of workers on installation crews
- How crews/contractors are scheduled
- How much in advance crew/contractor schedules are set

Final Inspections

- How far in advance final inspections are scheduled
- Agency staff member who schedules final inspections
- Length of typical final inspection

Collection of these data allowed Social Scientists to obtain an understanding of the agency structure and processes, and to have information needed to plan the visit.

D. SOCIAL SCIENTISTS

Consultants titled "Social Scientists" were responsible for documenting and assessing the interactions between weatherization staff and clients; the interactions among weatherization staff; and the characteristics of agencies, staff, training, and clients that influence service delivery.

APPRISE worked with Social Scientists from various disciplines (energy education, social anthropology, organizational psychology, and urban planning) to obtain a variety of perspectives on the interactions between clients and providers, and among providers.

There were five requirements for Social Scientist participation in the study.

- Pre-field training
- Agency visits
- Post observation write-ups
- Monthly call updates
- Final debriefing

1. Training

The pre-field training in February 2011 consisted of 1.5 days in a classroom setting. The training covered the following topics.

- Low-Income Usage Reduction Programs – background and various approaches to providing services.

- Weatherization Assistance Program – program parameters and focus.
- Energy Education Delivery and Research – how energy education is delivered as part of low-income energy efficiency programs and research on its effectiveness.
- National WAP Evaluation – outline and scope of the overall evaluation.
- Process Field Study – goals and how it fits into the overall evaluation.
- Evaluation procedures and expectations – procedures for the study.
- Write-up – outline and instructions for writing up findings from observations and interviews.

2. Agency Visits

Five Social Scientists participated in the study, with each Social Scientist responsible for three to five agencies. Visits to the different agencies allowed the Social Scientists to compare and contrast different approaches to the program and service delivery. Agency visits involved the following tasks.

- Interviews with weatherization managers and staff at the agency. These interviews focused on the agency's approach to weatherization, staff qualifications, staff training, client recruitment, service delivery, and quality control.

- Observation of client intake at the agency. The goal of the observations was to document the relationship that is established with the client and the initial information provided to the client about the program.

- Observation of the audit/inspection process at the client home. The Social Scientist observed the audit process and the interaction between the auditor and client, with a particular focus on education. Following completion of the audit, the Social Scientist interviewed the client to develop an understanding of how well the auditor communicated to the client and the client's perceptions of the program, as well as potential changes in client behavior as a result of education.

- Observation of the measure installation. The Social Scientist observed parts of measure installation to determine if and how the client is involved in the process, the communication between weatherization crews or contractors and the client, and interaction among the weatherization staff. Following the observation, the Social Scientist interviewed the client to determine the client's assessment of the services delivered.

- Observation of the final inspection. The Social Scientist observed the final inspection to determine how education delivery is assessed, how the client is involved in the inspection process, and the additional education that occurs during the final inspection. Following the observation, the Social Scientist interviewed the client to determine how well the inspector communicated, the client's perceptions of the program, and potential changes in client energy usage behavior.

The Social Scientist agency visits were conducted between March and September 2011. There was an effort to coordinate the Social Scientist observation week with one of the three weeks that the Weatherization Expert visited the agency.

3. Post Observation Write-Ups

Following each visit, the Social Scientist completed any remaining weatherization staff or client interviews and wrote up the findings from the visit. The write-up followed a structured outline to ensure

that key issues were addressed and that information on different issues was easily accessible in the document.

4. Monthly Call Updates

Social Scientists participated in monthly update conference calls during the field period to discuss preliminary findings and any barriers to conducting the research as designed.

5. Final Debriefing

The Social Scientists participated in a 1.5 day debriefing where key findings and recommendations were discussed. One half day overlapped with the Weatherization Expert debriefing to allow for interaction and discussion between the two types of observers.

E. WEATHERIZATION EXPERTS

Consultants titled "Weatherization Experts" were responsible for documenting the work that was performed and the quality of service delivery using a detailed set of data collection forms. All of the Weatherization Experts had extensive experience delivering, assessing, and/or training staff to perform weatherization services.

There were five requirements for Weatherization Expert participation in the study.

- Pre-field training
- Agency visits
- Post observation data entry
- Monthly call updates
- Final debriefing

1. Training

The pre-field training in February 2011 consisted of 1.5 days in a classroom setting. The training covered the following topics.

- National WAP Evaluation – outline and scope of the overall evaluation.
- Process Field Study – goals and how it fits into the overall evaluation.
- Procedures and expectations – procedures, including use of data collection forms.
- Forms – weatherization job forms to collect.
- Write-up – outline and instructions for data entry and reporting.

2. Agency Visits

Ten Weatherization Experts participated in the study, with each Weatherization Expert responsible for one to three agencies. Weatherization Experts were originally scheduled to spend four weeks at each of their assigned agencies, but the plan was reduced to three weeks at each agency, due to budget constraints. Agency visits included the following tasks.

- Brief interview with the weatherization manager at the agency. This interview focused on the agency's approach to weatherization and any special procedures that they employed.

- Observation of audits. The Weatherization Expert observed the full audit process to allow assessment of how the auditor introduced himself/herself to the client, conducted the exit interview, and everything in between. Following the audit, the Weatherization Expert debriefed the auditor to understand why things were done in the way that they were, focusing on the areas where the Weatherization Expert disagreed with the auditor's work. The Weatherization Expert filled out a detailed form to document everything that was done during the visit, anything that was missed, and whether the diagnostic tests were performed correctly. The work included documentation of the energy education delivered to the client.

- Observation of measure installation visits. The Weatherization Expert observed the complete measure installation process. Following the measure installation visits, the weatherization expert debriefed the installers to understand why things were done in the way that they were, focusing on the areas where the Weatherization Expert disagreed with the installers' work. The Weatherization Expert filled out a detailed form that documented what was done and the quality of the work. This included documentation of education provided to the client. Detailed instructions were provided to allow for systematic scoring of work across the ten Weatherization Experts.

- Observation of final inspections. The Weatherization Expert observed the final inspection. Following the final inspection, the Weatherization Expert debriefed the inspector to understand why things were done in the way that they were, focusing on the areas where the Weatherization Expert disagreed with the inspector's work. The Weatherization Expert filled out a detailed form that documented what was done and the types of education provided to the client.

The agency visits were conducted between March and September 2011.

3. Post Observation Data Entry

Following each visit, the Weatherization Expert entered the data from the forms into the Access database. In addition to the reporting on the observation of the audits, measure installation, and final inspections, the Weatherization Expert reviewed and assessed the paperwork completed by the auditor during and following the audit. There was a detailed data entry form that the Weatherization Experts used to document and assess the audit write-up.

4. Monthly Call Updates

Weatherization Experts participated in monthly update conference calls during the field period to discuss preliminary findings and any barriers to conducting the research as designed.

5. Final Debriefing

The Weatherization Experts participated in a 1.5 day debriefing where key findings and recommendations were discussed. One half day overlapped with the Social Scientist debriefing to allow for interaction and discussion between the two types of observers.

F. DATA COLLECTION INSTRUMENTS

Design of the data collection instruments was a critical part of the research. These forms were designed to ensure that systematic data were collected about the work that was done and that the quality of the work was rated equivalently by the Weatherization Experts.

One of the key challenges in the form development was the fact that while the National WAP has a set of general guidelines, the program is implemented differently in every state, and by agencies within a state. Important variations include how the audit is performed, the diagnostic testing procedures that are required, what measures are eligible for selection, and the type of education provided. This made it challenging to develop general forms and procedures that still collect the detailed quantitative data that were needed to assess the program.

The evaluation team decided that all agencies would be evaluated on the same scale, using the same form, according to a set of best practices agreed to by the weatherization professionals who consulted on the form development. For example, even if an agency did not include a particular diagnostic test in their audit procedures, their work would be assessed as being less than complete. However, the Weatherization Experts would debrief the weatherization staff following the audit and record whether or not that test was part of the agency standards. This would allow an understanding of whether the standards needed to be addressed, or whether staff needed to be better trained to follow agency procedures.

A rating scale was developed for each aspect of the weatherization work that was rated for quality. The rating scale asked the observer to record whether or not each of several tasks were performed correctly, and then the score was based on the percentage of required tasks that were completed. Additionally, several of the items rated required the staff to have a "yes" for some specific tasks in order to receive one of the top two ratings (4/5 or 5/5 on the scale.) If an item was not applicable in the particular case, it was counted as a "yes" so that the exclusion of that activity would not count against the item being scored. The detailed rating scores that were used are displayed in this report to allow the reader to understand how each item was assessed. Table II-4 displays an example of the rating scales, shown here for attic insulation quality.

Table II-5 provides the general guidelines for how the rating scales were designed. The table shows the number of points needed based on the total number of items being rated to score each rating.

- All of the items must have been done for the rating to be a 5.
- Between 90 and 99 percent of the items must have been done for the rating to be a 4.
- Between 75 and 89 percent of the items must have been done for the rating to be a 3.
- Between 50 and 74 percent of the items needed to be done for the rating to be a 2.
- The rating was 1 if less than half of the required items were done.

Table II-4. Quality of attic insulation rating design

Action	Quality of Attic Insulation Work
1	**All air sealing work completed first**
2	**Exhaust fans vented to exterior as needed**
3	**Heat producing devices or systems protected from insulation contact**
4	**Attic checked for knob and tube wiring**
5	**Workers wore respirators, safety glasses, gloves, and hard hats while insulating attic**
6	**Insulation installed in sufficient quantity (bags per ft^2) to meet R-value requirement**
7	Proper insulation material chosen for attic conditions
8	Open blow insulation is level and of consistent depth
9	Attic ventilation maintained
10	Confined areas blown to dense pack
11	Proper containment used to protect client and belongings

Table II-5. Rating design

Rating	1	2	3	4*	5*
% of Points Needed	**0%-49%**	**50%-74%**	**75%-89%**	**90%-99%**	**100%**
Total points	**Number of Points needed for each rating**				
4	0-1	2	3	--	4
5	0-2	3	4	--	5
6	0-2	3-4	--	5	6
7	0-3	4	5	6	7
8	0-3	4-5	6	7	8
9	0-4	5-6	7	8	9
10	0-4	5-7	8	9	10
11	0-5	6-7	8-9	10	11
12	0-5	6-8	9-10	11	12
13	0-6	7-9	10-11	12	13
14	0-6	7-9	10-12	13	14
15	0-7	8-10	11-13	14	15

*In several cases, bolded items must be checked to receive a rating of 4 or 5. The bold items are displayed in specific rating tables included later in this report.

The data collection forms included several notes fields to allow the observers to record additional information that affected the quality of the work or specific challenges faced on site. For example, in some cases, the quality of work was rated low primarily because important safety precautions were not followed. In these cases, observers would document this information in the notes field.

Data collection forms were created for the three types of visits observed by the Weatherization Expert and to evaluate the audit write-up. The following forms were used.

1. Audit observation data collection
2. Audit write-up assessment
3. Measure installation observation data collection
4. Agency final inspection observation

The measure installation form contained many rating scales to assess the quality of the work that was done. The rating scales included applicable safety steps. For example, on the quality of dryer venting rating, Weatherization Experts were instructed to assess whether the worker wore safety glasses when cutting vent material and whether the worker wore gloves for moving the dryer and working with venting materials. Installers who did not follow these practices lost points on the rating scale.

Weatherization Experts found during the observation process that many of the installers were lacking in these types of safety procedures. Therefore, many of the installers received lower level quality ratings due to lack of safety procedures. Several of the Weatherization Experts commented that the safety items should be assessed separately from the quality of work, so that work quality could still be rated high, in the absence of safe work practices. This suggestion will be considered if additional research is conducted using these types of rating scales.

G. EXPERT PANEL

The National WAP evaluation plan written by ORNL included the meeting of an expert panel of state and agency weatherization leaders and other experts to discuss the field visits and to identify different approaches that should be included.[4]

The expert panel meeting was held in May 2010. In addition to the APPRISE and ORNL staff members, there were representatives from two state WAP offices, four local weatherization agencies, and four other weatherization professionals from organizations that provide research and support to the weatherization program.

The expert panel meeting covered all areas of the Field Process Study, as listed below.

- Field Process Study Overview
- Audit Observation Form
- Audit Write-up Form
- Measure Installation Observation Form
- Final Inspection Observation Form
- Social Scientist Role
- Staff and Client Interviews
- Agency Sample Selection

Expert panel members provided important information and feedback that was incorporated into the study process and data collection forms.

H. OBSERVATIONS CONDUCTED

The study was reduced in scope from the original plans due to the high cost of conducting the observations. The original plan was to visit 25 agencies and observe 200 instances of each type of visit. APPRISE originally planned to have Weatherization Experts spend four weeks at each agency. The number of agencies was reduced from 25 to 20 and the number of weeks spent at the agency by Weatherization Experts was reduced from four weeks to three weeks. A total of 19 agencies was visited because one of the agencies was not performing weatherization work, due to exhaustion of weatherization funding, at the time that the visit was planned.

Table II-6 details the number of observations conducted of each type of visit by the Social Scientists and Weatherization Experts. In total, 155 audits, 159 installations, and 128 final inspections were observed between January 2011 and September 2011. This includes the pilot visit that was conducted by the study manager prior to Weatherization Expert and Social Scientist training in February 2011.

Table II-6. Process field study observations

	Number of Observations		
	Social Scientist	**Weatherization Expert**	**Total**
Audit	43	112	155
Measure Installation	45	114	159

[4] Ternes, M., Schweitzer, M., Tonn, B., Schmoyer, R., and Eisenberg, J. 2007. National Evaluation of the Department of Energy's Weatherization Assistance Program (WAP): Program Year 2006 Experimental Plan. ORNL/CON-498, Oak Ridge National Laboratory, Oak Ridge, TN, February.

Final Inspection	37	91	128
TOTAL	125	317	442

I. DEBRIEFING

APPRISE held a two and a half day debriefing meeting in October 2011. The Social Scientists and the Weatherization Experts each met for 1.5 days and met together for half of a day. The debriefing provided an opportunity to discuss both anecdotal information and overall findings from the agency visits. For each aspect of the visit, the observers discussed key findings and recommendations.

The following key information was covered during these meetings.

- WAP Evaluation Overview
- Field Study Process and Recommendations
- Agency, Staff, and Contractors - Areas for Improvement
- Agency, Staff, and Contractors – What they Did Well
- Challenges Faced by the Weatherization Staff
- Staff Equipment and Training Needs
- Program Guideline and Management Changes Recommended
    - U.S. Department of Energy (DOE) Guideline Changes
    - State Guideline and Management Changes
    - Agency Guideline and Management Changes

The debriefing was an important opportunity to bring together the observers and discuss key findings and recommendations from the visits.

III. CLIENT INTAKE

Client intake was a focus of the Social Scientist observations, but not the Weatherization Expert observations. This section provides a summary of the findings from observations and interviews about the weatherization intake process.

A. RECRUITMENT

There was a wide variety of circumstances addressed in agency recruitment. While some agencies struggled to find enough clients to serve, others had long waiting lists that they could not address in one or more years of service delivery. The waiting list remained for some of the agencies visited, even with the large amount of available ARRA funding.

The most common route into WAP is through the Low-Income Home Energy Assistance Program (LIHEAP). While seven agencies reported that they had a joint application with LIHEAP or created a waiting list from the LIHEAP applications, five agencies reported that they received referrals from LIHEAP. The next most common source of clients for WAP was referrals from other programs at that agency or other agencies, or from utility companies. Word of mouth through friends and relatives who had participated was another common source of information. Some agencies provided advertising on their trucks, and in newspapers and other media. Other approaches were outreach presentations at agencies, clients obtaining information from the agency website, and the agency's waiting list.

Table III-1. Client recruitment methods

Method	Number of Agencies
LIHEAP Application/Referral	12
Program or Utility Referrals	11
Word of Mouth	9
Advertisements	4

B. INTAKE

Agencies conduct intake on the phone, through mailed applications, and with office visits. Table III-2 shows that the most common primary method of intake was the phone, followed by the mail. Two agencies did not specify a primary intake method. Ten agencies stated that they used the phone for intake and ten stated that they conducted intake in the office, while only seven stated that they conduct intake through the mail.

Table III-2. Client intake methods

Method	Number of Agencies	
	Primary	Used at the Agency
Phone	7	10
Mail	6	7
Office Visit	4	10

One of the primary purposes of intake is to verify the client's eligibility for services. While all of the agencies conduct the client verification at the time of intake, one agency noted that the auditor re-verifies eligibility at the time of the audit.

C. PARTNERSHIPS AND EDUCATION

In addition to eligibility verification, another goal for intake is to form a partnership with the client and to provide education. The partnership approach aims to establish that both the agency and the client have responsibilities. While the agency's responsibility is to weatherize the home, the client's responsibility is to make sure that the home is ready for weatherization, to take an active role in the process, and to make commitments toward behavior changes that could reduce energy usage.

The Social Scientists did not hear or observe much in the way of these partnerships. While three agencies reported or demonstrated some type of partnership activity, 16 did not. Of the three that did, the Social Scientists were told and/or observed the following.

- The manager and staff at one agency asserted that they partner with the client during the intake process and discuss the client's role in reducing energy usage. The Social Scientist was unable to observe a client intake session at this agency.

- The manager at another agency stated that one of the agency's goals is to include energy education during intake, that intake includes discussion about family issues, household budgeting, employment options, healthcare, and nutrition, and that the intake worker is expected to fit the interview to the needs of the client.

- A manager at the third agency stated that at intake, they ask the client to make a list of questions and concerns for the auditor. While this does not have the client begin to think about energy behavior, it does involve the client in the process and let the client know that he/she is expected to play a role in the audit.

When asked what information was provided to clients at the time of intake, most of the agency managers reported that clients receive a basic description of WAP and what the client could expect from the program. Table III-3 shows that 15 agencies reported that staff provide a program description, two agencies reported that the description is provided only in cases where they speak with the client on the telephone (in other cases the entire application is done by mail), and two agencies did not report that any program information was provided at the time of intake.

Table III-3. Information provided to client at intake

Information Provided	Number of Agencies
Program Description	15
Program Description if Phone Call	2
No Information	2

The Social Scientists also observed instances with positive interactions and education during the intakes. Some examples of these positive interactions were described as follows.

- Weatherization staff used the intake time to provide referrals with clients and connect them with additional needed services.

- An intake worker conducted a comprehensive interview with the client, and discussed how the client should prepare for the auditor.

- One intake worker described how he engages clients during phone intake by asking them to draw a box with a triangle on top to visualize the home, and then discussing how the program will address various parts of the home.

D. SUMMARY

Some of the intake workers provided an excellent description of the program during the intake process. However, several opportunities for improvement were noted.

- Some of the agencies had no personal interaction. The intake was done by internet or phone call.

- Intake focused on eligibility and documentation, and often overlooked education about the program, beginning the partnership, and explaining next steps.

- In some cases, the Social Scientists noted that the level of documentation required was onerous.

- The intake process was complicated, and most applicants did not submit all required materials on first try.

- Some of the intake workers focused on windows and doors when they discussed potential energy measures, misleading the clients as to what to expect from the program.

- There were cases where deferrals could have been avoided if the intake worker collected more information from the client about the condition of the home.

IV. AUDIT

Social Scientists observed 43 audits and Weatherization Experts observed 112 audits during the agency visits. This section of the report provides a detailed review of their findings from these observations. Findings in the following areas are discussed.

- Audit Introduction and Home Walkthrough
- Heating, Ventilation, and Air Conditioning
- Water Heating
- Diagnostic Testing
- Refrigerators and Lighting
- Client Interaction and Education
- Exit Interview
- Audit Summary Ratings
- Auditor Professionalism
- Audit Write-up

Each section provides data from the Weatherization Experts, as well as more qualitative findings from both the Weatherization Experts and the Social Scientists.

A. AUDIT INTRODUCTION AND HOME WALKTHROUGH

Weatherization Experts were asked to document the types of information that auditors had available at the time of the audit. Table IV-1 displays the findings from their data collection. The table shows that while most of the auditors had client demographic information, less than half had energy usage data and only six percent had an end use breakout for usage.

Table IV-1. Audit preparation

	Applicable Observations	Information Was Available	
		Number	Percent
Demographics	110	94	85%
Natural Gas Usage	79	35	44%
Bulk Fuel Usage	31	7	23%
Electric Usage	110	49	45%
End Use Breakout	110	7	6%

Weatherization Experts observed whether expected aspects of the audit introduction were included at the time that the auditor introduced the program or at a later point in the visit. Table IV-2 shows that more than 70 percent of the auditors explained WAP and the auditor's role in the WAP program. However, many observers noted that auditors did not explain that WAP is a Federal program, and the role of the local agency in the program. Many auditors did a good job explaining the overall job scope and tasks to be performed, which helped the clients to feel more comfortable with the many visitors they would have in their homes. A much lower percentage covered other important aspects of the program.

- Health and Safety – only 64 percent discussed health and safety issues at some point during the visit.

- Comfort – only 59 percent discussed comfort issues at some point during the audit.
- Energy Usage Problems – only 34 percent asked the client about problems with energy usage at some point during the audit.
- Energy Bills – only 12 percent reviewed energy bills with the client at some point during the audit. Both Weatherization Experts and Social Scientists noted that the energy bills would often be placed in the client's file, but the auditor rarely made use of them.

Table IV-2. Audit introduction

	Intro		Later		Intro or Later	
	#	%	#	%	#	%
Explained WAP	74	71%	6	6%	80	77%
Explained auditor's role in WAP	76	73%	4	4%	80	77%
Explained client's role in WAP	39	38%	9	9%	48	46%
Asked what client hoped to get from WAP	27	26%	4	4%	31	30%
Reviewed energy bill(s)	12	12%	0	0%	12	12%
Discussed health and safety	63	61%	4	4%	67	64%
Discussed comfort	59	57%	2	2%	61	59%
Asked about problems with energy usage	34	33%	1	1%	35	34%

Table IV-3A displays the rating tool used to assess the audit introduction. The Audit Introduction Rating was based upon the eight elements displayed in this table.

Table IV-3A. Audit introduction rating design

Action	Quality of Introduction
1	**Auditor introduced self**
2	**Auditor explained purpose of visit**
3	**Auditor explained WAP process**
4	Auditor reviewed energy bills with client
5	Auditor asked about comfort issues
6	Auditor asked about energy issues
7	Auditor asked about H&S issues
8	Auditor assessed client's desired outcomes

Table IV-3B displays the number of points needed to attain each rating out of the total of eight points. The three bold items needed to be covered for the auditor to receive a rating of 4 or a rating of 5 on the 5-point rating scale.

The previous results showed that many of the audits did not cover several of the items listed in the Audit Introduction Rating Scale. Table IV-3C shows that the mean rating across all of the audits was a 2.2, meaning that on average, auditors covered about five of the eight elements listed in the table above. Only two percent covered all eight points and only 11 percent scored a rating of 4 out of 5.

Table IV-3B. Audit introduction rating

	Needs Improvement	Percent With Each Rating →			Excellent
Rating	**1**	**2**	**3**	**4***	**5***
% of Points Needed	**0%-49%**	**50%-74%**	**75%-89%**	**90%-99%**	**100%**
Rating	**1**	**2**	**3**	**4**	**5**
Total Points needed (out of 8 points)	0-3	4-5	6	7	8
Bold Points needed (out of 3 bold points)	0	0	0	3	3

Table IV-3C. Audit introduction ratings

	Number Assessed	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	**2**	**3**	**4***	**5***	
		0%-49%	**50%-74%**	**75%-89%**	**90%-99%**	**100%**	
Audit Introduction	103	31%	32%	24%	11%	2%	2.2

The next aspect of the audit that was assessed was the home walk through. Table IV-4 displays information on the expected elements of the home walk through that were covered during the walk through or at some later point in the visit. The table shows that almost all of the auditors inspected covered three critical elements.

- Inspection – 98 percent inspected every accessible room.
- Outside walk around – 93 percent conducted an outside home walk around.
- Systematic inspection – 99 percent followed a systematic inspection process.

However, the auditors were much less likely to include the expected client interaction aspects of the home walk through.

- Energy usage – only 30 percent discussed energy usage with the client during the home walk through and 36 percent discussed energy usage during the walk through or later in the audit.

- Actions to reduce energy usage – only 15 percent discussed potential actions to reduce energy usage during the walk through and 21 percent discussed it during the walk through or at some later point in the audit.

- Potential monetary savings from behavior changes – only four percent discussed these potential savings during the walk through and only six percent discussed them at some point during the visit.

Several of the Social Scientists noted that the auditors made it an option for the client to accompany them on the walk through, but did not make it a priority. The tone was closer to "come along if you want" than "you would be a valuable resource on the home walk through."

Table IV-4. Audit home walk through

	Applicable Number	Walk Through		Later		Walk Through or Later	
		#	%	#	%	#	%
Inspected every accessible room	109	107	98%	0	0%	107	98%
Inspected all accessible attics	108	71	66%	26	24%	97	90%
Inspected the basement	108	54	50%	53	49%	107	99%
Inspected all accessible crawl spaces	108	49	45%	52	48%	101	93%
Inspected the garage	108	19	18%	85	79%	104	97%
Did outside home walk around	107	97	91%	3	3%	100	93%
Had systematic inspection method	108	107	99%	-	-	107	99%
Discussed energy usage with client	108	32	30%	7	6%	39	36%
Discussed actions to reduce usage	108	16	15%	7	6%	23	21%
Discussed $ savings from behavior changes	108	4	4%	2	2%	6	6%
Discussed use/safety of electric space heaters	45	16	36%	1	2%	17	38%
Discussed use/safety of combustion space heaters	29	10	34%	1	3%	11	37%
Verbally remarked to client about:							
Presence or absence of CO detector	106	52	49%	8	8%	60	57%
Presence or absence of smoke detector	106	52	49%	7	7%	59	56%
Presence of moisture	65	45	69%	1	2%	46	71%
Presence of mold	42	24	57%	1	2%	25	59%
Potential for lead paint	83	58	70%	2	2%	60	72%
Presence of asbestos/vermiculite insulation	14	6	43%	0	-	6	43%
Presence of structural issue	31	18	58%	0	-	18	58%
Presence of electrical issue	33	16	48%	1	3%	17	51%
Presence of clutter issue	30	6	20%	1	3%	7	23%
Ended at this point due to deferral issue	106	10	9%	-	-	10	9%

B. HEATING, VENTILATION, AND AIR CONDITIONING ASSESSMENT

This section addresses assessments of the heating, ventilation, and cooling systems in clients' homes.

Table IV-5 displays information on the heating assessments that were observed. There were 105 Weatherization Expert observations where there was a heating system that should have been inspected. While 94 percent of the auditors conducted this inspection, several of the expected educational aspects of a heating assessment were not conducted.

- Home comfort – only 38 percent discussed whether part of the home was too cold.
- Health and safety – only 37 percent discussed heating system health and safety.
- Temperature settings – only 29 percent discussed thermostat settings.
- Night setbacks – only 14 percent discussed night setback.
- Not at home setback – only ten percent discussed setback when no one is at home.

- Supplemental heating usage – only 30 percent asked the client about supplemental heating usage.

Table IV-5. Heating assessment

	Applicable Observations	Work Completed	
		#	%
Inspected heating system	105	99	94%
Inspected ducted or hydronic distribution system	82	65	79%
Assessed heating system combustion venting	103	70	68%
Discussed whether part of home is cold	103	39	38%
Discussed thermostat settings	104	30	29%
Discussed programmable installation	74	18	24%
Discussed night time heat setback	103	14	14%
Discussed heat setback when not home	102	10	10%
Asked client about supplemental heating use	105	31	30%
Discussed efficient use of supplemental heat	50	11	22%
Inspected filters	79	57	72%
Cleaned/replaced filters	70	10	14%
Discussed regular filter cleaning/replacement	77	30	39%
Discussed heating system health & safety	91	34	37%

Table IV-6 displays information on the air conditioner assessments that were observed. There were 34 Weatherization Expert observations where there was a central air conditioning system, 18 with a room air conditioner, and 4 with a swamp cooler. Observations in the table only include those where the weatherization program addressed air conditioners. The table shows that some of the auditors did not complete the expected inspections of room air conditioners, outside units, or distribution systems. Additionally, client education about cooling usage often missed areas such as discussing air conditioning usage and discussing energy saving cooling practices.

Table IV-7 displays findings from observations of ventilation assessments. While more than 75 percent of the auditors inspected the kitchen and bathroom ventilation, only 24 percent assessed the bathroom ventilation flow and only 59 percent assessed ducting for mechanical ventilation.

C. WATER HEATING

Table IV-8 displays information on the water heating assessments that were observed. Auditors inspected the hot water heater in 93 percent of applicable cases, but only 39 percent checked the hot water temperature, only eight percent discussed efficient hot water usage, and none of the auditors measured the shower flow.

Table IV-6. Air conditioning assessment

	Applicable Observations	Action Taken	
		#	%
Asked client about air conditioner usage	47	18	38%
Discussed cooling usage from electric bill analysis	47	3	6%
Inspected all room air conditioners	18	12	67%
Sealed around air conditioners	17	0	0%
Asked about seasonal storage	16	2	13%
Discussed air conditioner replacement	18	8	44%
Client accepted air conditioner replacement	8	5	63%
Client has central air conditioning	50	34	68%
Discussed thermostat settings with client	33	13	39%
Discussed programmable thermostat install	28	5	18%
Inspected outside unit	34	28	82%
Inspected distribution system	33	21	64%
Inspected cooling coils	32	10	31%
Cleaned cooling coils	27	2	7%
Verbally remarked to client about condensate problem	16	2	13%
Discussed energy saving cooling practices	42	6	14%
Client have a swamp cooler/evaporate cooler?	49	4	8%
Inspected swamp cooler/evaporate cooler	4	3	75%

Table IV-7. Ventilation assessment

	Applicable Observations	Work Completed	
		#	%
Inspected kitchen ventilation	58	44	76%
Inspected bathroom ventilation	58	45	78%
Assessed bathroom ventilation flow	58	14	24%
Assessed ducting for mechanical ventilation	54	32	59%

Table IV-8. Water heater assessment

	Applicable Observations	Work Completed	
		#	%
Inspected water heater	101	94	93%
Water heater replacement offered to client	99	7	7%
Water heater replacement accepted by client	6	6	100%
Checked hot water temperature at faucet	99	39	39%
Hot water temp needs adjustment	78	17	22%
Adjusted hot water temp	97	6	6%
Wrapped hot water heater	99	0	0%
Insulated hot water heater pipes	99	0	0%
Measured shower water flow	99	0	0%
Showerhead installed	92	1	1%
Faucet aerators installed	91	2	2%
Discussed efficient hot water usage	99	8	8%
Discussed hot water system health and safety problems	63	23	37%

D. DIAGNOSTIC TESTING

Table IV-9 displays information from observations of air leakage and insulation diagnostics conducted during the audits. There were 100 applicable audits. While the basic analyses, including measurements, inspections of windows and attics, and visual inspections were conducted in the majority of applicable homes observed, the more in-depth analyses were less commonly performed. For example, auditors only created access to inaccessible attics in ten percent of applicable cases, they measured insulation in exterior walls in 49 percent of applicable cases, and they inspected for all typical bypasses in 62 percent of the homes.

Table IV-9. Air leakage and insulation diagnostics

	Applicable Observations	Action Taken	
		#	%
Measured surfaces	100	94	94%
Inspected windows	100	96	96%
Inspected all accessible attics	78	69	88%
Measured insulation in all accessible attics	79	70	89%
Created access to inaccessible attics	33	3	10%
Measured insulation in exterior walls	95	47	49%
Measured insulation in basement/crawlspace	74	55	74%
Inspected for all typical bypasses	100	62	62%
Visual inspection for air sealing opportunities	100	83	83%
Used blower door while inspecting for leaks	96	64	67%

The level of diagnostic testing varied between the visited agencies. Testing is sometimes limited by state regulations that restrict the work that can be done on heating systems without a license. Often the state WAP policies guide what occurs at the local level, and it appeared that states have different requirements. It was noted in one visit that the state staff couldn't agree on what testing was required. A Weatherization Expert noted that some auditors skipped testing when they did not know how to perform it, and skipped the parts of the audit form where the test results were supposed to be reported. Improperly conducted testing was also observed, indicating a need for additional training.

Observations also showed that testing was often not complete or used to provide all potential information. The blower door was not used to its full potential in many places. More frequent testing during air sealing work along with simple zonal pressure diagnostics would improve the quality of air sealing work. In many cases, the blower door was used to record a number and not to diagnose the house.

Table IV-10 provides a quantitative analysis of the diagnostic testing that was conducted. For each test, the Weatherization Expert noted whether the test should have been done, whether it was done, and whether it was performed correctly. The table shows the following key results.

- Blower door testing – the test was performed in 97 percent of the cases where it should have been performed, and was done correctly in 84 percent of these cases.

- Zonal pressure diagnostics – the tests were performed in 42 percent of the cases where it should have been performed, and was done correctly in 87 percent of these cases.

- Steady state efficiency – these tests were conducted in 79 percent of the cases where it should have been performed, and was done correctly in 98 percent of these cases.

Table IV-10. Diagnostic tests

	Tests Performed			
	Should Have Been	**Should Have Been & Was**	**% Performed**	**% Performed Correctly**
Blower door testing	94	91	97%	84%
Zonal pressure diagnostics	57	24	42%	87%
Infrared camera	41	20	49%	70%
Steady state efficiency	56	44	79%	98%
Air flow test on forced air furnace	35	14	40%	93%
Proper coolant charge	5	0	0%	N/A

One of the agency surveys conducted as part of the evaluation asked agencies to report whether they conducted some of these diagnostic tests. As noted below, the reports were consistent with what was observed in the field, providing evidence that these results are applicable to agencies in general.

- While 99 percent of agencies reported that they conducted the blower door test, Weatherization Experts observed that it was conducted in 97 percent of the cases where it should have been done.

- While 51 percent of agencies reported that they used the infrared camera, Weatherization Experts observed that it was used in 49 percent of the cases where it should have been used.

- While 58 percent of agencies reported that they used zonal pressure measurements, Weatherization Experts observed that they were used in 42 percent of cases where it should have been used.

Table IV-11 displays findings for combustion safety tests. The Weatherization Experts found that there were many times these tests should have been performed, but were not. However, in most cases, these tests were performed correctly when they were implemented. Some examples of the findings are as follows.

- Ambient CO – the level in the CAZ was checked in 61 percent and the level outside the CAZ was checked in 48 percent of the cases where it should have been checked. These tests were performed correctly in almost all cases.

- Water Heater CO – the level was checked in 87 percent of the cases it should have been checked and was done correctly in 93 percent of these cases.

- Heating System Draft – the test was conducted in 78 percent of cases where it should have been done, and it was done correctly in 95 percent of these cases.

- Ranges and Stove CO – these levels were checked in 43 and 59 percent of the cases where they should have been checked, and the work was done correctly in 75 and 77 percent of the cases.

Table IV-11. Combustion safety tests

	Tests Performed			
	Should Have Been	**Should Have Been & Was**	**% Performed**	**% Performed Correctly**
Ambient CO level in CAZ	66	40	61%	98%
Ambient CO level outside CAZ	50	24	48%	100%
Gas/propane/fuel oil leaks	74	46	62%	83%
Spillage testing on all atmospheric furnaces, boilers, water heaters	57	40	70%	95%
Heating system CO level	63	50	79%	94%
Water heating system CO level	53	46	87%	93%
Draft test on heating system (worst case, natural conditions)	51	40	78%	95%
Draft test on water heater (worst case, natural conditions)	45	33	73%	88%
Measure CAZ for sufficient volume for combustion air	39	21	54%	85%
Gas/propane ranges CO level	37	16	43%	75%
Gas/propane stove CO level	37	22	59%	77%

The agency survey conducted as part of the evaluation also asked agencies to report on whether they conducted some of these combustion safety tests. As noted below, in most cases these reports were also consistent with what was observed in the field, providing evidence that these results are broadly applicable to agencies in general.

- While 78 percent of agencies reported that they conducted draft/spillage testing in normal operation and 63 percent in worst case conditions, Weatherization Experts observed that it was conducted in 78 percent of the cases where it should have been done.

- While 91 percent of agencies reported that they take CO measures in heating system flues, Weatherization Experts observed that the measurement was taken in 79 percent of the cases where it should have been done.

- While 88 percent of agencies reported that they take CO measures in water heating system flues, Weatherization Experts observed that the measurement was taken in 87 percent of the cases where it should have been done.

- While 82 percent of agencies reported that they take CO measures from the cooking stove, Weatherization Experts observed that the measurement was taken in 59 percent of the cases where it should have been done.

E. REFRIGERATORS AND LIGHTING

This section furnishes information on the refrigerator and lighting assessments that were observed. Table IV-12 displays findings from the refrigerator assessments. There were 81 assessments observed. Refrigerators were assessed in the following ways.

- 33 percent of clients had one or more refrigerators metered.
- 52 percent of clients had one or more refrigerators assessed in another way.
- 85 percent of clients had one or more refrigerators metered or assessed in another way.

Separate freezers were assessed in the follow ways.

- Auditors did not meter separate freezers in the 26 applicable cases.
- 27 percent of the separate freezers were assessed in another way.

Other opportunities taken advantages of were as follows.

- 35 percent of clients were offered a replacement refrigerator or freezer.
- 61 percent of those who were offered the appliance accepted it.
- Auditors explored the opportunity for a 2 for 1 swap in four percent of applicable cases (one observed case).

Table IV-13 displays findings from the lighting assessments. There were 87 cases where lighting was part of the WAP program. In many of these cases, lighting is done at the measure installation visit, rather than during the audit. However, many of the auditors did not discuss lighting or CFLs with clients.

- 29 percent discussed how clients use lights
- 49 percent discussed installation of CFLs

Table IV-12. Refrigerator assessment

	Applicable Observations	Number	Percent
One or more refrigerators metered	81	27	33%
All refrigerators metered	81	26	32%
Refrigerator(s) assessed another way	81	42	52%
At least one refrigerator metered or assessed in another way	81	69	85%
One or more separate freezers metered	26	0	0%
All separate freezers metered	26	0	0%
If not metered, freezer(s) assessed another way	26	7	27%
Client offered a replacement refrigerator or freezer	81	28	35%
Client accepted replacement refrigerator or freezer	28	17	61%
Opportunity for 2 for 1 swap explored	24	1	4%

Table IV-13. Lighting assessment

	Applicable Observations	Number	Percent
Discussed how the client uses lights	87	25	29%
Discussed installation of CFLs	87	43	49%
Auditor installed CFLs	85	4	5%
Gave CFLs to client	85	4	5%
Removed incandescent	6	3	50%
Asked client if satisfied with CFLs installed	4	2	50%

F. CLIENT INTERACTION AND EDUCATION

This section addresses various aspects of client interaction and education that were observed during the audits. The following ratings were developed.

- Auditor Attempt to Engage Client in Audit Process
- Client Engagement in Audit Process
- Auditor Communication Skills
- Quantity of Education
- Quality of Education

Tables IV-14A through IV-14E display the factors that were assessed to develop these ratings. Table IV-14A relates to the auditors' actions. The scale assesses the extent to which the auditor explained the process, requested client participation, and asked questions to elicit client participation in the process.

Table IV-14A. Auditor attempt to engage client in audit process rating design

Action	Auditor Attempt to Engage Client in Audit Process
1	**Auditor explained audit process**
2	Auditor asked client to participate in audit
3	Auditor asked client to accompany him on walkthrough
4	Auditor explained why each test was done
5	Auditor asked client about home equipment management
6	Auditor asked client about comfort issues

Table IV-14B relates to the client's responses to the auditor's efforts. While the auditor has great potential to impact the level of client engagement, some clients will not engage due to a language barrier or lack of interest no matter how engaging the auditor is, and some clients will engage despite a lack of effort on the part of the auditor.

Table IV-14B. Client engagement in audit process rating design

Action	Client Engagement in Audit Process
1	**Responsible adult home for entire visit**
2	**No language barrier to client communication**
3	**Client accompanied auditor on home walkthrough**
4	**Client asked at least one question**
5	Client explained how they operate the home
6	Client asked why certain tests were being done
7	Client asked what the test results meant about their home
8	Client asked what they can do to save energy
9	Client asked question about energy bill

Table IV-14C describes the rating on the auditor's communication skills. The scale assesses whether the auditor communicated in a way that would relate to the client and responded to concerns raised by the client.

Table IV-14C. Auditor communication skills rating design

Action	Auditor Communication Skills
1	Auditor used appropriate language/not technical or jargon
2	Auditor spoke clearly
3	Auditor asked questions to check for client understanding
4	Auditor used examples to show benefits of client actions
5	Auditor was responsive to client concerns

Table IV-14D displays the rating scale for the quantity of education provided. This scale only assesses the extent to which the auditor covered energy topics that should be discussed during the audit. It does not address how well the topics were explained.

Table IV-14D. Quantity of education rating design

Action	Quantity of Education
1	Explained WAP
2	Explained audit process
3	Explained client's role in the process
4	Reviewed energy bills
5	Discussed health and safety issues
6	Discussed comfort issues
7	Asked about problems with energy usage
8	Explained testing procedures
9	Explained how the mechanical equipment works
10	Discussed opportunities for energy savings
11	Discussed $ savings from behavioral changes
12	Reviewed savings opportunities at end of visit
13	Provided information on next steps

Table IV-14E displays the rating scale for the quality of education provided. This scale assesses the extent to which the education was tailored and whether the auditor engaged the client to increase the potential energy efficiency impacts.

Table IV-14E. Quality of education rating design

Action	Quality of Education
1	**Auditor provided clear and concise explanations**
2	Auditor asked client if he/she had questions about the program or what was being done
3	Auditor discussed client interest in program services
4	Auditor asked the client questions to assess need
5	Auditor assessed client understanding of what was done
6	Auditor tailored education to client and home
7	Auditor discussed client ability to undertake energy saving actions
8	Auditor discussed monetary benefit of client actions
9	Auditor obtained client commitment to undertake energy saving actions
10	Auditor provided contact info in case of problems

Table IV-14F displays the ratings for the 100 audits where these issues could be assessed. The table shows low overall scores for the education and communication ratings, with averages ranging from 1.6 for the quantity of education to 2.5 for the auditor communication skills.

Observers noted that the provision of information that auditors and other weatherization staff referred to as client education was often dissemination of information about the weatherization process, rather than information that would enable the clients to take an active role in the process and in reducing their energy usage. Clients were told about the weatherization process and what was going to be done to their home, they received required notifications about potential hazards, and they sometimes received printed

materials about energy savings and structured client action plans. In one case, the Social Scientist observed the auditor say "here is something to help you get to sleep" when providing the educational pamphlets.

Table IV-14F. Communication ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Auditor attempt to engage client	100	45%	30%	6%	14%	5%	2.0
Client engagement	100	40%	22%	29%	6%	3%	2.1
Auditor commun-cation skills	100	15%	43%	32%	2%	8%	2.5
Quantity of education	100	61%	26%	8%	5%	0%	1.6
Quality of education	100	48%	40%	6%	5%	1%	1.7

The observers saw significant variation in the level and types of education provided, even within an agency. One agency provided a list of potential actions for auditors to discuss with the clients. The idea was that the auditor and client would together select three actions that would work for the client in his/her home. Social Scientists observed this method being implemented effectively, but they also observed cases where the auditors picked out the actions without consulting the client or even selected the actions prior to arriving at the home.

In most cases, education around health and safety issues focused on providing pamphlets and obtaining client sign offs that they received the information. However, there were examples of effective education in this area. One auditor who discovered asbestos in the home sat down with the client, explained what he had found, explained the state policy about asbestos, discussed that he was taking a sample and sending it for testing. The auditor told the client that if the material was not asbestos, they would return to the home and complete the work, and if it did test positive for asbestos, the client would need to deal with the issue.

The observers found that auditors always developed good relationships with the clients and were always respectful to the clients. There were cases where auditors worked hard to engage the client. In one case the client slept through parts of the audit, but the auditor tried to engage her at the times she was awake. The auditor was patient and continued to make an effort even though the client was disinterested.

In general, the Social Scientists and Weatherization Experts noted that the observed client communication was conducted to inform the client about the work and the hazards and limitations. Much less frequently, the communication covered actions that the client could take to save energy. It was very rare that they observed the development of a partnership between the client and the program.

G. EXIT INTERVIEW

This section addresses the auditor's exit interview. Table IV-15 assesses whether expected actions were taken during the exit interview. The auditors were likely to provide a summary of the audit process and findings.

- Audit findings – 81 percent summarized findings for the client.
- Measure options – 80 percent discussed measure options with the clients
- Next steps – 95 percent provided information on the next steps.

Auditors were much less likely to discuss other issues in the home and the role that the client could take to reduce energy usage.

- Energy bills – Seven percent reviewed energy bills with the client.
- Comfort issues – 38 percent discussed comfort issues.
- Behavior change opportunities – ten percent summarized behavior change opportunities.

Table IV-15. Exit interview

	Applicable Observations	Action Taken	
		#	%
Reviewed bills with client	101	7	7%
Provided context (high/low/average) for usage	99	13	13%
Summarized findings for client	102	83	81%
Discussed health and safety issues	100	55	55%
Discussed comfort issues	100	38	38%
Discussed measure options	99	79	80%
Summarized behavior change opportunities	100	10	10%
Discussed potential $ savings from behavior change	100	7	7%
Obtained client commitment for behavior change	100	7	7%
Recommended behavior changes w/ potential for saving	93	10	11%
Provided information on next steps	101	96	95%

Table IV-16A displays the scale used to rate the audit exit interview. The rating assesses the extent to which the auditor explained the WAP process and discussed potential client energy saving actions.

Table IV-16A. Exit interview rating design

Action	Quality of Exit Interview
1	**Auditor explained next steps**
2	Auditor reviewed discussed behavior changes
3	Auditor discussed potential $ saved from behavior change
4	Auditor explained client actions with the greatest impact
5	Auditor assessed client's desired outcomes
6	Auditor obtained client commitments for energy saving actions
7	Client was asked if they have any concerns
8	Auditor explained the work proposed

Table IV-16B displays the ratings from the 101 rated audits. The table shows that the mean rating was only 1.6, as most of the auditors did not address several of the items listed in the table above. Only one of the auditors scored a five on the scale and only ten percent were rated as three or higher.

Table IV-16B. Overall quality of audit exit interview

	Number Assessed	Percent With Each Rating					Mean Rating
		Needs Improvement →				Excellent	
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Quality of Exit Interview	101	55%	35%	7%	2%	1%	1.6

H. AUDIT SUMMARY RATINGS

Weatherization experts were asked to rate the completeness of the observed inspections, the completeness of testing performed, and the quality of testing performed. Tables IV-17A, IV-17B, and IV-17C display the factors that were used to rate this performance.

Table IV-17A displays the completeness of inspection rating scale. There were nine elements included in the inspection completeness rating. This focused on whether all areas of the home were checked, whether the auditor discussed issues with the client, and whether the blower door test was conducted.

Table IV-17A. Completeness of inspection rating design

Action	Completeness of Inspection
1	**Auditor walked through all rooms in the house**
2	Auditor measured and recorded dimensions of building
3	Auditor physically checked existing insulation levels in the attic(s), walls, and basement/crawlspace
4	Auditor talked with client about comfort issues
5	Auditor talked with client about energy issues
6	Auditor talked with client about health and safety issues
7	Auditor assessed all accessible attics
8	Auditor assessed all accessible basement/crawlspace areas
9	Auditor conducted a blower door test

Table IV-17B displays the completeness of testing rating scale. There were twelve elements included in the testing completeness rating. This focused on whether all applicable tests were conducted in the home.

Table IV-17C displays the quality of testing rating scale. There were five elements included in the testing quality rating. This focused on whether equipment was properly calibrated, whether tests were completed correctly, and whether health issues were considered when implementing the tests.

Table IV-17D displays the results from these three ratings. The table shows that just over 100 audits were rated. The inspections received a mid-level rating of 3.0, but the completeness and quality of testing were only rated 1.9 and 2.4. Over one third of the cases received a rating of only one out of five for completeness and quality of testing.

Table IV-17B. Completeness of testing rating design

Action	Completeness of Testing
1	**Conducted blower door test**
2	**Conducted a worst case draft test**
3	**Conducted combustion appliance safety testing**
4	**Checked for combustible gas leaks**
5	Conducted zonal pressure diagnostics
6	Conducted combustion appliance efficiency testing
7	Conducted duct testing
8	Checked air flow in duct system
9	Performed an Infrared scan
10	Checked air conditioner charge level
11	Checked ventilation fan air flow
12	Metered refrigerator or freezer

Table IV-17C. Quality of testing rating design

Action	Quality of Testing
1	**Equipment within calibration date**
2	**Combustion appliances disabled during blower door and duct testing**
3	**All tests done correctly to obtain needed information**
4	Tests repeated to improve accuracy
5	Client health conditions directed appropriate tests

Table IV-17D. Audit ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Completeness of inspection	103	8%	32%	28%	17%	15%	3.0
Completeness of testing	104	39%	37%	20%	4%	0%	1.9
Quality of testing	104	35%	25%	10%	25%	6%	2.4

I. AUDITOR PROFESSIONALISM

This section assesses the auditor's professionalism. The following items are rated in this section.

- Audit Efficiency
- Auditor Professionalism
- Auditor Respect of Client's Home
- Auditor Safety Practices

Table IV-18A displays the scale used to rate the audit efficiency. The scale addresses punctuality, organization, and time management.

Table IV-18A. Audit efficiency rating design

Action	Audit Efficiency
1	Auditor arrived on time
2	Auditor's tools organized by task
3	Auditor did not make frequent trips to the vehicle
4	Auditor worked systematically through the house collecting data and performing tests
5	Auditor able to control interactions with client
6	Auditor used information obtained from the client to help improve the audit
7	Auditor only conducted tests necessary for safety or to determine what was needed
8	Auditor took photos of important areas of the home
9	Auditor recorded all data while on site
10	Auditor discussed work scope with client at exit interview

Table IV-18B displays the scale used to rate the auditor's professionalism. The scale covers dress, use of WAP name, explanation of WAP, and client contact.

Table IV-18B. Auditor professionalism rating design

Action	Auditor Professionalism
1	Auditor dressed neatly
2	Auditor arrived on time or called to let client know that he/she would be late
3	Auditor had visible identification
4	Auditor introduced self to client
5	Auditor mentioned WAP by name
6	Auditor explained the purpose of the visit
7	Auditor spoke clearly and directly to the client
8	Auditor was tactful in dealing with client issues

Table IV-18C displays the scale used to rate the auditor's respect for the client's home. The scale assesses clean-up, containment, and request for permission to enter all areas of the home.

Table IV-18C. Auditor respect of client's home rating design

Action	Auditor Respect of Client's Home
1	Auditor cleaned up when done with the audit
2	Auditor returned everything to the as-found condition
3	The auditor used containment to protect client's belongings
4	The auditor used containment to reduce exposure to client from dust, etc.
5	Access holes made out-of-sight or sealed when done
6	Auditor asked if the client had any restricted areas before conducting a walk through

Table IV-18D displays the scale used to assess the auditor's safety practices. These factors affect both the safety of the client and the auditor's personal safety.

Table IV-18D. Auditor safety practices rating design

Action	Auditor Safety Practices
1	**Auditor recognized house pre-1978 requiring Lead Safe Weatherization**
2	**Auditor wore respirator when in attics and crawlspace**
3	**Auditor wore hard hat when in confined spaces**
4	**Auditor disabled all combustion appliances before conducting a blower door or duct testing**
5	Auditor was careful with the use of smoke when looking for air leaks
6	Auditor took appropriate steps to keep the house warm/cool during testing procedures
7	Auditor did not miss appropriate precautions with tools and equipment if young children around
8	Auditor only entered house if adult present

Table IV-18E displays the ratings for the audit. The table shows that auditors were rated much higher on professionalism than on many of the other items rated.

- Respect of client's home – the auditors averaged a 4.1 on this rating. Observers specifically noted that the auditors consistently showed respect for clients by asking permission before they entered a room.
- Professionalism – the auditors averaged a 3.9 on this rating.
- Efficiency – the auditors averaged a 3.9 on this rating.
- Safety practices – the auditors averaged a 3.2 on this rating.

Table IV-18E. Audit ratings

	Number Rated	Percent With Each Rating: Needs Improvement → Excellent					Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Audit efficiency	104	0%	10%	26%	34%	31%	3.9
Auditor professionalism	103	1%	10%	19%	41%	29%	3.9
Auditor respect of home	104	4%	11%	2%	38%	46%	4.1
Auditor safety practices	103	15%	21%	24%	14%	26%	3.2

J. AUDIT WRITE-UP

Weatherization Experts were asked to review audit forms and information and to assess the accuracy and thoroughness with which the information observed during the audit was recorded. This is an important step in the weatherization process, to ensure that the installers have access to the information obtained by the auditor, can plan for materials needed, and understand the work that needs to be done.

Weatherization Experts noted that they saw extreme variations in the quantity and quality of information included in the audit write-ups. In some cases there was only a narrative, and installers worked from a priority list. In other cases, the auditors specified exactly how many bags of insulation and other materials would be needed. The detailed specifications were sometimes missing in cases where contractors were used, and these are the cases where they are most important.

Table IV-19 assesses the extent to which information from the audit introduction was recorded by the auditor. The table shows that while 80 percent of the auditors recorded health and safety issues that were observed or discussed, only 30 percent recorded comfort issues and only 37 percent recorded issues related to problems with energy usage. Health and safety issues were recorded thoroughly and accurately, as assessed by the Weatherization Experts, in 62 percent of the cases where an issue existed.

Table IV-19. Audit introduction write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Health and Safety Issues	93	46	80%	62%
Comfort Issues	93	47	30%	30%
Problems with Energy Usage	93	41	37%	34%

Table IV-20 displays the Weatherization Experts' assessments of the quality of audit write-ups relating to information from the home walk through. The table shows that the majority recorded whether CO and smoke detectors were absent. Fewer than 80 percent recorded information when there was an issue relating to lead paint, structural or other hazards, or a deferral issue. These situations were even less commonly recorded thoroughly and accurately. Auditors were least likely to thoroughly record information on inaccessible spaces, mold and moisture, and asbestos and vermiculite.

Table IV-20. Home walkthrough write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Spaces not Accessible	91	28	54%	43%
Mold/Moisture	89	24	63%	54%
Asbestos/Vermiculite	89	5	60%	20%
Lead Paint	89	43	79%	67%
Structural/Electrical/Other Hazard	89	27	74%	63%
Deferral Issue	89	4	75%	50%
CO Detectors Absent	91	60	88%	86%
Smoke Detectors Absent	91	53	85%	83%

Table IV-21 displays whether the auditor recorded information on what the client agreed to do to prepare for the installers and what actions the client agreed to take to reduce energy usage. The table shows that 43 percent thoroughly and accurately recorded what the client agreed to do to prepare for the installers and 67 percent recorded what actions the client agreed to take to reduce energy usage. In the other cases, the installers would not have as much of an opportunity to reinforce energy actions that the client had agreed to take.

Table IV-21. Home walkthrough write-up

	Number Assessed	Number Where Client Agreed to Actions	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Prepare for Crew/Contractor	90	37	49%	43%
Reduce Energy Usage	89	13	67%	67%

Table IV-22 displays the assessments of the information recorded about refrigerator and freezer monitoring. The table shows that this information was recorded in 77 to 90 percent of the applicable cases, but the information was recorded thoroughly and accurately in 52 to 67 percent of applicable cases.

Table IV-22. Refrigerator write-up

	Number Assessed	Number Where Work Was Done	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Refrigerators/Freezers Metered	88	31	77%	52%
Refrigerators/Freezers Assessed Another Way	88	37	78%	64%
Replacement Ordered	87	30	90%	67%
Instructions Needed	86	7	86%	57%

Table IV-23 displays information on lighting data recorded by the auditor. The table shows that 94 percent described CFLs that were discussed during the audit and 75 percent recorded the information thoroughly and accurately.

Table IV-23. Lighting write-up

	Number Assessed	Discussed During Audit	% Described on Write-Up	% Recorded Thoroughly and Accurately
CFLs	88	72	94%	75%
Lighting Behavior Changes	88	1	0%	0%

Table IV-24 displays how the auditor recorded information about air conditioning issues. The table shows that while 95 percent recorded if there was a central air conditioning issue and 74 percent recoded this information thoroughly and accurately, auditors were less likely to record information about AC distribution issues, room air conditioner issues, and other AC issues.

Table IV-24. Air conditioning write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Room Air Conditioner Issue	89	13	69%	62%
Sealing around Air Conditioner Needed	89	15	67%	53%
Seasonal Storage Potential	89	11	0%	0%
Central Air Conditioning Issue	89	21	95%	74%
AC Distribution Issue	88	16	73%	67%
Cooling Coils Cleaning Needed	86	13	50%	33%

Table IV-25 displays whether the auditor recorded information about discussions with the client about air conditioning usage and behaviors. The table shows that when these issues were discussed with clients, they were not likely to be recorded thoroughly and accurately by the auditors. Recording this information on the audit form could assist later staff to follow up with clients about actions that they had taken to reduce their cooling usage.

Table IV-25. Air conditioning – client communication write-up

	Number Assessed	Number Discussed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Client Agreed to Air Conditioner Replacement	89	11	82%	73%
Thermostat Settings Discussed with Client	89	4	50%	25%
AC Settings Discussed With Client	89	5	40%	0%
Cooling Strategies Discussed with Client	89	4	100%	50%

Table IV-26 displays information on heating system information that was recorded by the auditor. Auditors recorded information on these issues between 59 and 100 percent of the time that there was an issue, and they recorded the information thoroughly and accurately between 58 and 100 percent of the time that there was an issue. Recording information on the audit form about heating system problems could assist later staff to follow up with clients about whether these issues had been resolved.

Table IV-26. Heating system write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Heating System Issue	93	61	90%	68%
Hydronic Or Forced Air Distribution System Issue	93	28	82%	68%
Heating System Venting Issue	93	16	67%	60%
Distribution System Insulation Issue	93	24	88%	58%
Radiator Issue	93	2	100%	100%
HVAC* Filter Cleaning Needed	88	17	59%	59%
HVAC Filters Replacement Needed	88	26	73%	69%
Heating System Health And Safety Issues	93	23	78%	70%

***** Heating, ventilation and air conditioning

Table IV-27 displays information that the auditor recorded about client communication on heating system issues. The table shows that auditors were most likely to record information about heat setbacks and thermostat settings, but only did this in 50 to 60 percent of applicable cases. They were less likely to record information about heating comfort, supplemental heating usage, and heating strategies that were discussed with the clients.

Table IV-27. Heating system – client communication write-up

	Number Assessed	Number Discussed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Heating Comfort Issue Discussed With Client	92	28	37%	30%
Thermostat Settings Discussed With Client	92	22	50%	41%
Heat Setbacks Discussed With Client	92	10	60%	60%
Supplemental Heating Use Discussed With Client	92	15	27%	13%
Heating Strategies Discussed With Client	92	14	21%	14%

Table IV-28 displays information about whether auditors recorded issues related to ventilation on their audit write-ups. The table shows that auditors recorded this information in most cases, but they needed to improve the thoroughness and accuracy of recording information on additional ventilation needed, ventilation flow issues, and ventilation control issues.

Table IV-28. Ventilation write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Additional Mechanical Ventilation Needed	88	31	71%	65%
Existing Mechanical Ventilation Flow Issue	88	17	82%	65%
Existing Mechanical Ventilation Ducting Issue	88	25	100%	96%
Ventilation Controls Issue	88	9	89%	67%

Table IV-29 displays information about how water heater issues were written up by the auditors. The table shows that auditors did a good job of recording information about water heater replacements needed, faucet aerators and showerheads needed, and leaks. However, they did not often record information about hot water temperature adjustments, and needed to improve information recorded about hot water heater wraps needed, hot water health and safety issues, and hot water behavior changes that were discussed.

Table IV-30 shows that there was room for improved recording of information on air leakage and insulation diagnostics. Areas where the greatest improvement was needed are additional wall insulation specifications, additional basement or crawl space insulation specified, other insulation specified, and crawl space air sealing opportunities.

Table IV-29. Water heater write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Leak Or Corrosion Issue	90	11	91%	82%
Water Heater Replacement Needed	90	17	94%	88%
Hot Water Temperature Adjustment Needed	84	11	36%	36%
Hot Water Heater Wrap Needed	86	42	67%	64%
Hot Water Pipe Insulation Needed	87	58	81%	74%
Faucet Aerators Needed	85	31	94%	94%
Showerhead Needed	86	41	85%	76%
Hot Water Health And Safety Issues	90	22	82%	64%
Hot Water Behavior Changes Discussed	89	5	20%	20%

Table IV-30. Air leakage and insulation diagnostics write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Building Measurements Recorded	91	91	89%	76%
Window Problems	91	50	94%	86%
Attic Insulation Type/Level Recorded	87	87	77%	69%
Additional Attic Insulation Quantity Specified	88	84	71%	65%
Wall Insulation Type/Level Recorded	90	89	67%	60%
Additional Wall Insulation Specified	91	85	29%	28%
Basement Or Crawlspace Insulation Type/Level Recorded	86	80	58%	54%
Additional Basement Or Crawlspace Insulation Specified	86	79	41%	37%
Crawl Venting Decision Consistent With Insulation Location	87	15	53%	53%
Other Insulation Type/Level Recorded	84	55	7%	7%
Other Additional Insulation Specified	84	57	11%	9%
Existing Insulation Problems	87	37	76%	68%
Attic Air Sealing Opportunities	88	62	73%	52%
Basement Air Sealing Opportunities	90	33	88%	79%
Crawl Space Air Sealing Opportunities	88	31	48%	35%
Other Air Sealing Opportunities	86	32	81%	69%

Table IV-31 shows that in most cases the auditors recorded needed information about diagnostic tests results. However, the Weatherization Experts noted that the zonal pressure diagnostic test results and the infrared camera data were often not recorded thoroughly and accurately.

Table IV-31. Diagnostic tests write-up

	Number Assessed	Number Where Tests were Conducted	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Blower Door Testing	93	78	97%	90%
Zonal Pressure Diagnostics	93	18	94%	56%
Infrared Camera	93	12	50%	42%
Steady State Efficiency Testing On Furnaces, Boilers, Water Heaters	93	39	82%	82%
Air Flow Test On Forced Air Furnace	90	10	90%	90%
Proper Coolant Charge	90	0	NA	NA
Furnace Distribution Tests				
Pressure Pan	88	22	100%	95%
Duct Blaster	88	1	100%	100%
Delta Q	88	0	NA	NA

Table IV-32 displays assessments of combustion safety test results included in the audit write-ups. The table shows that the information was recorded in 78 to 94 percent of the cases and was recorded thoroughly and accurately in 50 to 92 percent of the cases. Information on CO levels was least likely to be recorded thoroughly and accurately. A particular area of concern was that information on immediate safety issues was only recorded thoroughly and accurately in 61 percent of applicable cases.

Table IV-32. Combustion safety tests write-up

	Number Assessed	Number Where Tests were Conducted	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Ambient CO Level In CAZ	92	37	86%	57%
Ambient CO Level Outside Of CAZ	92	29	86%	50%
Gas/Propane/Fuel Oil Leaks	92	39	89%	76%
Spillage Testing On All Atmospheric Furnaces, Boilers, Water Heaters	92	40	85%	70%
Heating System CO Level	92	46	93%	87%
Water Heating System CO Level	92	38	92%	92%
Draft Test On Heating System	92	33	91%	82%
Draft Test On Water Heater	92	29	90%	79%
Pressure Drop And Heat Rise Tests On Forced Air Furnace	88	16	94%	88%
Measure CAZ For Sufficient Volume For Combustion Air	92	18	78%	78%
Gas/Propane Ranges (Burners) CO Level	92	16	88%	63%
Gas/Propane Stove (Oven) CO Level	92	21	81%	62%
Any Immediate Safety Issues	91	18	83%	61%

Table IV-33 displays information recorded by the auditor about safety issues in the home. The table shows that most of the auditors did a good job recording this information. There were some cases where some detectors and minor repairs were needed but were not recorded thoroughly and accurately.

Table IV-33. Safety issues write-up

	Number Assessed	Number Where Issue Existed	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Dryer Venting Needed	91	39	97%	97%
CO Detector Needed	91	55	93%	87%
Smoke Detector Needed	91	57	86%	79%
Minor Repairs Needed	91	44	86%	80%

Table IV-34 displays information recorded about the audit exit interview. The table shows that the auditors need to do a better job recording information about these issues, especially comfort issues.

Table IV-34. Exit interview write-up

	Number Assessed	Number Discussed with Client	% Noted on Write-Up	% Recorded Thoroughly and Accurately
Health And Safety Issues	75	39	79%	55%
Comfort Issues	75	30	21%	21%
Measure Options	75	60	86%	69%
Client Commitment For Behavior Changes	75	10	56%	56%

Table IV-35 displays the rating for the overall comprehensiveness of the audit and the planned work scope. The Weatherization Experts provided these ratings based on the observation of the audit and the review of the audit write-up and work order. The following scale was used.

- Excellent – Major issues were explored and there was only the potential for minor missed opportunities.
- Good – There was the potential for some important issues to be missed based upon incomplete or inaccurate diagnostic work or incomplete home examination.
- Poor – The major opportunities in the home were missed.

Weatherization Experts provided the assessment that about half of the jobs were excellent and about half were good in terms of comprehensiveness of the audit and planned work. Only six percent were rated as poor in terms of audit comprehensiveness and only three percent were rated poor in terms of planned work comprehensiveness.

Table IV-36A displays the rating design for the quality of the audit write-up. The scale assesses whether the auditor documented materials and quantities, documented health and safety issues, gave clear directions, and documented client information.

Table IV-35. Audit and work order summary assessment

	Number Assessed	Percent		
		Poor	Good	Excellent
Audit Comprehensiveness	88	6%	47%	48%
Planned Work Comprehensiveness	88	3%	48%	49%

Table IV-36A. Quality of audit write-up rating design

Action	Quality of Audit Write-Up
1	**Did not fail to clearly document need for lead safe weatherization if needed**
2	**Included estimated material quantities**
3	**Specified any needed special materials**
4	**Clearly documented client health and safety issues**
5	Recommended measures prioritized by savings to investment ratio
6	Set air leakage reduction targets for crews
7	Directed crews to access areas inaccessible during the audit
8	Contained clear directions for crews
9	Documented client concerns/needs
10	Documented client commitments if made
11	Included special instructions if needed
12	Clear and easy to understand

Table IV-36B displays the ratings for the quality of the audit write-up. The table shows that the mean rating is 2.6. Only 21 percent of the auditors scored a four or five on this scale.

Table IV-36B. Quality of audit write-up ratings

	Number Assessed	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Quality of Audit Write-Up	91	25%	23%	31%	12%	9%	2.6

K. SUMMARY

This section provides a summary of the findings from the audit observations. Table IV-37 provides means of all audit observation ratings across educational categories, technical categories, professional categories, and all ratings. The table shows that auditors scored highest in terms of their professionalism – efficiency, dress, use of WAP name, explanation of WAP, client contact, respect of client's home, and safety practices. The technical rating was between the middle and low level, and the overall education rating was low, at only 2.0 on the five point scale.

Table IV-37. Audit summary ratings

	Number Assessed	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Audit Education	704	42%	33%	16%	6%	3%	2.0
Audit Technical	401	27%	29%	22%	15%	7%	2.5
Audit Professional	414	5%	13%	18%	31%	33%	3.8
Audit Overall	1,519	28%	26%	18%	15%	12%	2.6

There were several strengths that were noted by the Social Scientists and Weatherization Experts who observed the audits.

- Weatherization staff showed exceptional respect and concern for the clients that they served. This was a universal sentiment expressed by all Social Scientists and Weatherization Experts.

- Auditors provided a comprehensive explanation of the WAP program and process. The auditors did a good job explaining what the services would entail, what the client could expect, and making the client feel at ease. This was important given the number of potential appointments the client would have to keep and the number of visitors that the clients would interact with and have in the home.

- Auditors who had data collection forms, usually made good use of these forms. This ensured that the visits were systematic and comprehensive.

- Several of the observers noted that the auditors visited the work site and met with the installers to explain the audit findings and work scope. They also observed that auditors provided pictures with the work order to help explain what was needed. In some cases, the auditor takes pre-work photos and the crew/contractor provides the post treatment photos to show the work was done. Both of these practices helped to ensure that the work was completed in accordance with the audit findings.

Both the Social Scientists and the Weatherization Experts reported that the staff members were uniformly dedicated to their work, showed tremendous concern for the clients they served, and often went beyond their defined jobs to assist clients in additional realms. Auditors faced many challenging conditions while assessing their clients' homes.

- They encountered difficult conditions in the home, such as hoarding, which added hours to the time needed to complete their work.

- They fended off dogs; worked in dirty, dusty, and hot attics; and saw many rough neighborhoods.

- They faced clients that were not always trusting. In one case, the client would not open the door until the husband came home, and the staff stayed and waited.

- There were language barriers. Some of the auditors and staff communicated with clients in the foreign language, or they had neighbors or relatives provide translation.

- Some of the providers had very large service territories, meaning that they had to spend their work week travelling and staying in hotels, because it was too far to return home to their families.

Despite these challenges, auditors were dedicated to assist clients and help improve their lives.

There were several opportunities to improve the services delivered through revised approaches to the audit.

- Auditors often did not introduce the visit by stating the name of the program, the name of the agency, and explaining that the funding for the program is provided through tax dollars. Such explanations could increase program buy-in.

- Utility bills were rarely used to assist in the home assessment, even when they were readily available. Auditors should make use of these bills that provide important information about potential opportunities in the home.

- The client engagement in the audit was often low. The auditor did not partner with the client and make use of the client as an important information source. Client input could greatly improve the home assessment and client interaction could improve the impact and persistence of measures installed.

- The auditors showed need for additional training and experience in certain areas. The key areas were as follows.

    - Understanding of pressure boundaries
    - Understanding of diagnostic testing purposes and procedures
    - Use of worst case draft testing in all appropriate cases

- The work scope that the auditors created for the installers often lacked needed detail. These work orders are the plans to weatherize a home and the crew or contractor must use this information to determine how to improve the efficiency of the building. The actual work plan may be very complex because of the existing structure, and it is often difficult to communicate the action plan on paper. Observers commonly reviewed work orders that simply stated "two hours of air sealing", with no additional guidance. Most work orders did not help the crew or contractor estimate their material needs. This resulted in many trips to the lumber yard for materials.

- Auditors also must be available by phone during the installation process to answer questions that arise. While the work order is an estimate of the work to be done, it is very common for the crews or contractors to discover additional problems or energy saving opportunities as they work on the house. There must be an easy way to accommodate these change orders.

Additional recommendations relating to training needs and management priorities are provided in the concluding section of the report.

V. MEASURE INSTALLATION

Social Scientists observed 45 installations and Weatherization Experts observed 114 installations during the agency visits. This section of the report provides a detailed review of their findings from these observations. Findings in the following areas are discussed.

- Introduction
- Window and Door Work
- Air Sealing
- Attic Insulation
- Wall Insulation
- Basement and Crawl Space Insulation
- Ventilation
- Heating and Cooling
- Hot Water System
- Other Measures – Refrigerator, Dryer, Lighting, Low-Cost Measures
- Professionalism
- Communication and Education

Each section provides data from the Weatherization Experts, as well as more qualitative findings from both the Weatherization Experts and the Social Scientists.

A. INTRODUCTION

This section assesses the information that the installers had when they arrived at the home and the work introduction provided to the client. Table V-1 shows that while almost all of the installers had a work order, they were less likely to have the other preparatory information.

- Work order – 97 percent had a work order.
- Materials list – 64 percent had a materials list.
- Audit report – 49 percent had a report of the audit findings.
- Household demographics – 46 percent had information on the household composition.

Table V-1. Measure installation preparation

	Information Available	
	#	%
Household demographics	52	46%
Audit report	56	49%
Work order	111	97%
Materials list	73	64%

Table V-2 displays information on the client interaction. The table shows that 97 percent of the clients expected the visit and there was an adult occupant present in 93 percent of the visits.

Table V-2. Measure installation client interaction

	Applicable Number	Number	Percent
Visit expected	112	109	97%
Adult occupant present	113	105	93%

Table V-3 displays information about the introduction provided to the visit. The table shows that the installers were likely to explain the purpose of the visit and the planned measures, but were less likely to ask the client if he/she had questions and to explain WAP.

- WAP explanation – 29 percent explained the program.
- Visit purpose – 77 percent explained why they were there to install measures.
- Planned measures – 79 percent explained what they would be installing.
- Client questions – 56 percent asked if the client had questions about the planned work.

Table V-3. Measure installation introduction

	Applicable Number	Intro		Later		Intro or Later	
		#	%	#	%	#	%
Explained WAP	101	26	26%	3	3%	29	29%
Explained purpose of visit	101	77	76%	1	1%	78	77%
Explained planned measures	101	77	76%	3	3%	80	79%
Asked if client had questions	101	52	51%	5	5%	57	56%

B. WINDOW AND DOOR WORK

This section provides findings with respect to observation of the window and door measures. The following topics are covered in this section.

- Window Sealing
- Interior Storm Windows
- Exterior Storm Windows
- Sash Kit Work
- Window Repair
- Window Replacement
- Door Weather Stripping
- Door Replacement

Tables V-4A through V-4F display the rating scales for the window measures. Table V-4A displays the factors taken into account when rating the quality of window sealing work. The factors include the technical procedures, the neatness of the work, and the safety practices of the workers.

Table V-4A. Quality of windows sealed rating design

Action	Quality of Windows Sealed
1	**Weather stripping mechanically fastened**
2	**Weather stripping backed with caulk**
3	**Work area cleaned up**
4	**Gloves and safety glasses worn for window work**
5	Old caulking removed and surfaces prepared for new caulk
6	Caulking is installed neatly
7	Old weather stripping removed including old fasteners
8	Materials integrated with existing finishes
9	All material scraps and packaging removed from home

V-4B displays the factors taken into account when rating the quality of interior storm window work.

Table V-4B. Quality of interior storm window work rating design

Action	Quality of Interior Storm Window Work
1	**Storm window mechanically secured in place**
2	**Clear view remains with storm in place**
3	**Work area cleaned up**
4	**Materials integrated with existing finishes, tapes won't ruin finish**
5	Framing cleaned before storm installed
6	All material scraps and packaging removed from home

V-4C displays the factors taken into account when rating the quality of exterior storm window work.

Table V-4C. Quality of exterior storm window work rating design

Action	Quality of Exterior Storm Window Work
1	**Storm window fits opening**
2	**Storm window mechanically secured in place**
3	**Unit backed with caulking**
4	**Weep holes left open at bottom**
5	**Work area cleaned up**
6	**Gloves and safety glasses worn for window work**
7	Window framing surfaces cleaned and prepared
8	Materials integrated with existing finishes
9	Client can open storm window
10	All material scraps and packaging removed from home

V-4D displays the factors taken into account when rating the quality of the sash kit work. Installers were required to use lead safe practices in pre-1978 homes to receive a 4 or a 5 on this rating. If the home was not built prior to 1978, all installers would receive this point.

Table V-4D. Quality of sash kit work rating design

Action	Quality of Sash Kit Work
1	**Lead safe practices used in pre-1978 homes**
2	**Client can operate windows**
3	**Work area cleaned up**
4	**Gloves and safety glasses worn for window work**
5	Minimal damage caused when old sash removed
6	Meeting rails pulled tightly together
7	Materials integrated with existing finishes
8	All material scraps and packaging removed from home

V-4E displays the factors taken into account when rating the quality of the window repair work.

Table V-4E. Quality of windows repair rating design

Action	Quality of Window Repair Work
1	**Lead safe practices used in pre-1978 homes**
2	**Client can operate window**
3	**Work area cleaned up**
4	**Gloves and safety glasses worn for window work**
5	Minimal damage caused when old windows removed
6	Materials integrated with existing finishes
7	All material scraps and packaging removed from home

V-4F displays the factors taken into account when rating the quality of the window replacement work.

Table V-4F. Quality of windows replacement rating design

Action	Quality of Window Replacement Work
1	**Lead safe practices used in pre-1978 homes**
2	**Client can operate window**
3	**Work area cleaned up**
4	**Gloves and safety glasses worn for window work**
5	**Flashing integrated with weather resistant barrier**
6	Minimal damage caused when old windows removed
7	Materials integrated with existing finishes
8	All material scraps and packaging removed from home

V-4G displays the ratings for the window measures. The table shows that installers received fairly high mean ratings for the window work, ranging from 3.0 to 4.0. All four of the interior storm window work ratings were a 4.0.

Table V-4G. Window work ratings

	Number Rated	Percent With Each Rating: Needs Improvement → Excellent					Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Windows sealed	12	8%	0%	33%	50%	8%	3.5
Interior storm work	4	0%	0%	0%	100%	0%	4.0
Sash kit work	1	0%	0%	100%	0%	0%	3.0
Window repair	12	0%	8%	42%	42%	8%	3.5
Window replacement	9	0%	0%	44%	56%	0%	3.6

Tables V-5A, V-5B, and V-5C display the rating scales for the door measures. Table V-5A displays the factors taken into account when rating the quality of the door weather stripping.

Table V-5A. Quality of door weather stripping rating design

Action	Quality of Door Weather Stripping Work
1	**Weather stripping mechanically fastened**
2	**Weather stripping backed with caulk**
3	**Work area cleaned up**
4	**Wore safety glasses and respirators while machining**
5	Old weather stripping removed including old fasteners
6	Surfaces cleaned before new weather stripping installed
7	Materials integrated with existing finishes
8	All material scraps and packaging removed from home
9	Workers wore gloves while working on doors

Table V-5B displays the factors taken into account when rating the quality of the doors treated.

Table V-5B. Quality of doors treated rating design

Action	Quality of Door Weather Stripping Work
1	**Lead safe practices used when in pre-1978 homes**
2	**Client can operate door**
3	**Work area cleaned up**
4	**Wore safety glasses and respirators while machining**
5	Materials integrated with existing finishes
6	All material scraps and packaging removed from home
7	Workers wore gloves while working on doors

Table V-5C displays the factors taken into account when rating the quality of the door replacement.

Table V-5C. Quality of door replacement rating design

Action	Quality of Door Replacement
1	**Lead safe practices used in pre-1978 homes**
2	**Door is straight, equal gap on sides and top**
3	**Client can operate door**
4	**Work area cleaned up**
5	**Wore safety glasses and respirators while machining**
6	**Flashing integrated with weather resistant barrier**
7	Minimal damage caused to existing surfaces
8	Materials integrated with existing finishes
9	All material scraps and packaging removed from home
10	Gloves and steel-toed boots worn while working on doors

Table V-5D displays the rating scales for the door work. The table shows that the mean ratings were 2.8 for weather stripping, 3.5 for doors treated, and 2.9 for door replacement.

Table V-5D. Door installation ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Door weather stripping	38	11%	34%	32%	21%	5%	2.8
Doors treated	13	8%	15%	15%	46%	15%	3.5
Door replacement	16	0%	38%	38%	25%	0%	2.9

C. AIR SEALING

This section provides findings with respect to observation of the air sealing work. Weatherization Experts assessed how the work was done and rated air sealing work done in attics, basements, crawl spaces, and other areas of the home. They assessed work in individual areas, overall air sealing quality, and overall cleanliness of the air sealing work.

Table V-6 displays procedures used in the air sealing that was observed. The table shows that there was room for improvement in several areas.

- The blower door was used to guide the air sealing in only 22 percent of the cases.
- Zonal pressure was conducted in only 11 percent of the cases.
- Sealing at the top and bottom of the envelope was done in 77 percent of the cases.
- All major opportunities were sealed in 57 percent of the cases.

Table V-6. Air sealing procedures

	# Applicable	Action Taken	
		#	%
Blower door used to guide air sealing	83	18	22%
Zone pressure testing done to affirm appropriate pressure boundary	80	9	11%
Sealing at top and bottom of envelope prioritized	82	63	77%
All major opportunities sealed	83	47	57%

Table V-7A displays the rating scale that was used to assess the air sealing work that was done in various parts of the home. This one scale was used to determine all of the ratings shown in Table V-7B. The scale includes aspects of effectiveness, cleanliness, client safety, and worker safety.

Table V-7A. Air sealing rating design

Action	Quality of Air Sealing in Specific Places
1	**Fire rated materials used around chimneys, flue pipes, recessed lighting, etc.**
2	**Materials integrated with existing finishes**
3	**Used supply-air respirators when using two-part foams**
4	**Blower door used to target air sealing**
5	**Blower door and smoke used to verify air sealing effectiveness**
6	Caulk not used to seal gaps larger than 1/8”
7	Large holes and gaps covered with rigid materials
8	Area cleaned before caulk or foam applied
9	All material scraps and packaging removed from home
10	Materials installed consistently and are uniform in appearance
11	Gloves and eye protection used when cutting, or using caulk or foam
12	Used hard hats when working in confined spaces

Table V-7B displays the ratings for the air sealing work that was done in various parts of the home. The table shows that mean ratings range from 2.2 for the air sealing in the area of the basement to the conditioned space to 2.7 for the air sealing of the second floor rim joist. However, most of the ratings were relatively low. The only area where any installers scored a four or five on the rating scale was sealing of the attic floor penetrations and the crawl space to the conditioned space.

Table V-8A displays the rating scale that was used to assess the overall quality of the air sealing work. The scale was based upon the safety, neatness, and potential effectiveness of the work.

Table V-8B displays the rating scale that was used to assess the cleanliness of the air sealing work. This scale is based upon the neatness of the work, the appearance of the materials used, and the protection of the client’s home and property.

Table V-7B. Air sealing ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Attic floor penetrations	58	10%	41%	34%	9%	5%	2.6
Knee walls	19	5%	58%	37%	0%	0%	2.3
Second floor rim joist	3	0%	33%	67%	0%	0%	2.7
Basement penetrations to outside	24	8%	46%	46%	0%	0%	2.4
Basement to conditioned space	12	17%	50%	33%	0%	0%	2.2
Crawl space to conditioned space	14	0%	64%	29%	7%	0%	2.4
Crawl space to outside	9	0%	56%	44%	0%	0%	2.4
Garage to conditioned space	8	0%	63%	38%	0%	0%	2.4

Table V-8A. Overall air sealing rating design

Action	Quality of Overall Air Sealing Work
1	**Fire rated materials used around chimneys, flue pipes, recessed lighting, etc.**
2	**Materials integrated with existing finishes**
3	**Blower door used to target air leakage sites**
4	**Blower door and smoke used to verify air sealing effectiveness**
5	Caulk not used to seal gaps larger than 1/8”
6	Large holes and gaps covered with rigid materials
7	Area cleaned before caulk or foam applied
8	All material scraps and packaging removed from home
9	Materials installed consistently and are uniform in appearance
10	Gloves and eye protection used when cutting or using caulk or foam
11	Workers used supply-air respirators when using two-part foams
12	Workers used hard hats when working in confined spaces

Table V-8B. Cleanliness of air sealing work rating design

Action	Cleanliness of Overall Air Sealing Work
1	**All work done is neat in appearance**
2	**Work area cleaned up**
3	**Materials used are compatible with finishes**
4	**Air sealing materials used are durable and appropriate for location and exposure**
5	All packaging and excess materials removed from work site
6	Proper containment used to protect client and belongings

Table V-8C displays the overall air sealing rating and the rating for the cleanliness of the work. While the mean cleanliness rating was high, the average quality rating was relatively low. Only eight percent of the observed work was rated as a four or five on the five-point scale.

Table V-8C. Overall air sealing quality and cleanliness ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Overall Quality	83	13%	48%	31%	4%	4%	2.4
Overall Cleanliness	83	5%	16%	12%	24%	43%	3.9

D. ATTIC INSULATION

This section provides assessments of the attic insulation work and attic access insulation work that was observed. The Weatherization Experts noted that the program has matured in the installation of insulation in attics (and also in walls and basement/crawlspaces.) Attic work is usually level and of sufficient depth and good coverage. There are issues with controlling the dust from the insulation during installation, but it is expected that the measures will have high performance.

Table V-9 displays aspects of the work that were assessed. The table shows that while most used appropriate materials, did not have insulation gaps or voids, and achieved a constant insulation depth, only 77 sealed the attic floor prior to the air sealing and only 56 percent used baffles where appropriate.

Table V-9. Attic insulation

	Applicable Number	Action Taken	
		#	%
Attic floor sealing complete before	52	40	77%
Baffles used	32	18	56%
Constant insulation depth achieved	58	49	85%
No insulation gaps or voids	58	51	88%
Appropriate material used	58	55	95%

Table V-10A displays the rating scale used to assess the quality of the attic insulation work. The scale is based upon use of appropriate procedures, safe installation, use of proper materials, and protection of the client's home and possessions.

Table V-10B displays the rating scale used to assess the cleanliness of the attic insulation work. This assessment is based upon work clean up, protection of client's home, and work appearance.

Table V-10C displays the ratings for the attic insulation quality and cleanliness. The table shows that the mean rating for quality was 3.3 and the mean rating for cleanliness was 4.0.

Table V-10A. Quality of attic insulation rating design

Action	Quality of Attic Insulation Work
1	**All air sealing work completed first**
2	**Exhaust fans vented to exterior as needed**
3	**Heat producing devices or systems protected from insulation contact**
4	**Attic checked for knob and tube wiring**
5	**Workers wore respirators, safety glasses, gloves, and hard hats while insulating attic**
6	**Insulation installed in sufficient quantity (bags per ft^2) to meet R-value requirement**
7	Proper insulation material chosen for attic conditions
8	Open blow insulation is level and of consistent depth
9	Attic ventilation maintained
10	Confined areas blown to dense pack
11	Proper containment used to protect client and belongings

Table V-10B. Cleanliness of attic insulation rating design

Action	Cleanliness of Attic Insulation Work
1	**Work area cleaned up**
2	**Proper containment used to protect client and belongings**
3	**Dams built at access points to prevent insulation from entering the home**
4	**Holes patched to prevent installed insulation from entering the home**
5	**All packaging and excess materials removed from site**
6	All work done is neat in appearance
7	Materials used are compatible with finishes

Table V-10C. Attic insulation ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Attic insulation quality	57	4%	18%	42%	19%	18%	3.3
Attic insulation cleanliness	58	2%	3%	31%	17%	47%	4.0

Tables V-11A through V-11C display the scales used to assess the quality of the attic access work. Table V-11A displays the rating scale used to assess the quality of the attic hatch work.

Table V-11A. Quality of attic hatch work rating design

Action	Quality of Attic Hatch Work
1	**Work area cleaned up**
2	**Installed weather stripping mechanically fastened**
3	**Installed weather stripping bedded in caulk**
4	**Insulation fastened to hatch/door**
5	**Insulation R-value meets requirement**
6	Materials integrated with existing finishes
7	Workers wore safety glasses when cutting
8	Air tight seal created
9	Blower door used to test effectiveness of sealing
10	Thermal boundary maintained around the access
11	Access has been maintained to attic

Table V-11B displays the rating scale used to assess the quality of the walk up attic work.

Table V-11B. Quality of walk up attic work rating design

Action	Quality of Walk Up Attic Work
1	**Work area cleaned up**
2	**Installed weather stripping mechanically fastened**
3	**Installed weather stripping bedded in caulk**
4	**Insulation fastened to hatch/door**
5	**Insulation R-value meets requirement**
6	Materials integrated with existing finishes
7	Workers wore safety glasses when cutting
8	Air tight seal created
9	Blower door used to test effectiveness of sealing
10	Thermal boundary maintained around the access
11	Access has been maintained to attic

Table V-11C displays the rating scale used to assess the cleanliness of the attic access work.

Table V-11C. Cleanliness of attic access work rating design

Action	Cleanliness of Attic Access Work
1	**Work area cleaned up**
2	All work done is neat in appearance
3	All packaging and excess materials removed from site
4	Materials used are compatible with finishes
5	Proper containment used to protect client and belongings

Table V-11D displays the ratings for the attic access work quality and cleanliness. The table shows that while the cleanliness of the work was very good, the quality of the work was rated as low to mid-level quality.

Table V-11D. Attic access work ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Attic hatch work quality	48	6%	23%	56%	13%	2%	2.8
Walk-up attic work quality	3	67%	0%	33%	0%	0%	1.7
Attic access work cleanliness	47	2%	2%	9%	40%	47%	4.3

E. WALL INSULATION

This section displays findings from the assessments of the wall insulation work that was observed. Table V-12A displays the rating scale for the quality of the wall insulation work.

Table V-12A. Quality of wall insulation work rating design

Action	Quality of Wall Insulation Work
1	**Crew used lead safe practices in pre-1978 homes**
2	**Walls checked for knob and tube wiring**
3	**Walls checked prior to blowing to assure adequate structure**
4	**Insulation installed to required density to meet R-value requirements**
5	**Workers wore respirators, gloves, safety glasses and protective overalls when insulating walls**
6	**Wall cavities probed side-to-side, up and down during installation process**
7	**Complete coverage achieved**
8	**Work area cleaned up**
9	**Infrared scan used to confirm coverage achieved**
10	Materials integrated with existing finishes
11	Proper material chosen for existing conditions
12	Siding reinstallation of interior patching results in as-found conditions
13	Insulation installed to dense pack
14	Tubing method used

Table V-12B displays the rating scale used to assess the cleanliness of the wall insulation work.

Table V-12B. Cleanliness of wall insulation work rating design

Action	Cleanliness of Wall Insulation Work
1	**Work area cleaned up**
2	All work done is neat in appearance
3	All packaging and excess materials removed from site
4	Materials used are compatible with finishes
5	Proper containment used to protect client and belongings
6	Siding or interior finish returned to as-found condition

Table V-12C displays the rating scale used to assess the quality of siding preservation or interior wall finish for the wall insulation work.

Table V-12C. Quality of siding preservation/interior wall finish rating design

Action	Quality of Siding Preservation/Interior Wall Finish
1	**Crew used lead safe practices in pre-1978 homes**
2	Materials integrated with existing finishes
3	Wore gloves and safety glasses when removing siding
4	No visible signs of access

Table V-12D displays the ratings for the wall insulation work. The table shows that installers received a high average rating for cleanliness of the work, and mid-level ratings for the wall insulation quality and the siding or interior wall preservation or finish. Weatherization Experts observed that walls were dense packed at most locations and the tubing method was used in most places.

Table V-12D. Wall insulation ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Wall insulation quality	32	3%	13%	75%	6%	3%	2.9
Wall insulation cleanliness	32	0%	16%	3%	19%	63%	4.3
Siding preservation/ interior wall	31	10%	19%	26%	29%	16%	3.2

F. BASEMENT AND CRAWL SPACE INSULATION

This section assesses the quality of the basement insulation and crawl space work that was observed. Table V-13A displays the rating design for the quality of basement insulation.

Table V-13A. Quality of basement insulation rating design

Action	Quality of Basement Insulation
1	**All air sealing work completed before insulation installed**
2	**Work area cleaned up**
3	**Workers wore respirators, gloves and safety glasses**
4	**Installed insulation quantity sufficient to meet R-value requirement**
5	Materials integrated with existing finishes
6	Insulation type appropriate for basement moisture levels
7	Vapor barrier installed on correct side

Table V-13B displays the rating scales used to assess the cleanliness of the basement insulation work.

Table V-13B. Cleanliness of basement insulation rating design

Action	Cleanliness of Basement Insulation Work
1	**Work area cleaned up**
2	All work done is neat in appearance
3	All packaging and excess materials removed from site
4	Materials used are compatible with finishes
5	Proper containment used to protect client and belongings

Table V-13C displays the ratings for the basement insulation work. The table shows that the installers received very high ratings for the cleanliness of the work and mid to high ratings for the quality of the work.

Table V-13C. Basement insulation ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Basement insulation quality	22	0%	0%	50%	36%	14%	3.6
Basement insulation cleanliness	22	0%	0%	14%	18%	68%	4.5

Table V-13D displays the rating scales used to assess the crawl space treatments. This rating scale was used to assess the quality of the vapor barrier installation, the perimeter wall insulation, the vents sealing, and the crawl space ceiling insulation and air barrier installation, as shown in table V-13E.

Table V-13E displays the ratings for the observed crawl space work. The table shows that the installers did a relatively good job with these measures. Average ratings ranged from 3.1 for the crawl space ceiling insulation and air barrier installation to 4.0 for the perimeter wall insulation. Installers used more

two-part foam when working in crawlspaces. Along with vapor retarders on the floor and vinyl faced fiberglass, crawlspaces were effectively air sealed.

Table V-13D. Quality of crawl space treatments rating design

Action	Quality of Crawl Space Treatments
1	**All air sealing work completed first**
2	**Air barrier established consistent with insulation treatments**
3	**Work area cleaned up**
4	Workers wore hard hats when working in confined spaces
5	Ground barrier sealed to walls
6	Appropriate insulation chosen for damp conditions

Table V-13E. Crawl space ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Vapor barrier installation	21	0%	29%	14%	48%	10%	3.4
Perimeter wall insulation	5	0%	0%	20%	60%	20%	4.0
Vents sealing	2	0%	0%	50%	50%	0%	3.5
Crawl space ceiling insulation and air barrier installation	16	6%	31%	13%	44%	6%	3.1

G. VENTILATION

This section assesses the ventilation work that was observed. Table V-14A displays the rating scale used to assess all of the ventilation rating shown in table V-14B.

Table V-14A. Quality of Ventilation Work Rating Design

Action	Quality of Ventilation Work
1	**Ventilation installed before insulation measures**
2	Materials integrated with existing finishes
3	Work area cleaned up
4	Fan ductwork sealed, insulated, low-restriction, terminated
5	Added venting sized to applicable codes and standards

Table V-14B displays the ratings for the ventilation work. The table shows that the ventilation work was rated highly. All of the mean ventilation ratings ranged from 4.1 to 4.8, and the majority of the installers received the top score for all types of ventilation work.

Table V-14B. Ventilation ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Existing fans ducted to outside	15	0%	0%	7%	27%	67%	4.6
Whole house ventilation	3	0%	0%	33%	0%	67%	4.3
Attic ventilation	12	0%	0%	0%	25%	75%	4.8
Kitchen ventilation	8	0%	0%	13%	0%	88%	4.8
Bathroom ventilation	15	7%	20%	0%	0%	73%	4.1

H. HEATING AND COOLING

This section assesses the heating and cooling work observed by the Weatherization Experts. The Weatherization Experts assessed the following.

- Heating System Work
- Heating System Replacement
- Thermostat Installation
- Air Conditioning Work
- Air Conditioning Replacement
- Evaporative Cooler Repair
- Evaporative Cooler Replacement

Tables V-15A displays the rating scale used to assess the heating system work. The rating is based upon safe and clean work practices, consistency of work with the audit specifications, and appropriate work procedures. The scale was used to rate the heating system tune-up and heating system repair scales shown in table V-15C.

Table V-15A. Quality of heating system work rating design

Action	Quality of Heating System Work
1	**Hazardous materials contained or removed**
2	**Work area cleaned up**
3	**Equipment tested for worst case draft**
4	Work based on audit write-up
5	Materials integrated with existing finishes
6	Workers wore a respirator when cleaning heating equipment
7	Workers wore gloves when working on ductwork
8	Equipment tested for efficiency
9	Equipment tested for CO production
10	Ducts tested for leakage

Tables V-15B displays the rating scale used to assess the heating system replacements. This scale was used to rate the heating system replacement and installation scales shown in table V-15C.

Table V-15B. Quality of heating system replacement rating design

Action	Quality of Heating System Replacement
1	Unit sized with Manual J or equivalent
2	Hazardous materials contained or removed
3	Work area cleaned up
4	Equipment tested for worst case draft
5	Common vented water heater venting addressed
6	Venting installed per manufacturers instruction
7	Furnace system air-flow tested
8	Work based on audit write-up
9	Workers wore a respirator when cleaning or removing heating equipment
10	Equipment tested for efficiency
11	Equipment tested for CO production
12	Ducts tested for leakage

Table V-15C displays the heating system ratings. The heating system repair was rated well, but the other heating system ratings were low.

Table V-15C. Heating system ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Heating system tune-up	6	17%	50%	0%	33%	0%	2.5
Heating system repair	4	0%	25%	25%	25%	25%	3.5
Heating system replacement	7	14%	57%	14%	14%	0%	2.3
80% efficient system installation	1	0%	100%	0%	0%	0%	2.0
90%+ efficient system installation	5	20%	60%	0%	20%	0%	2.2
Heating system vent correction	5	60%	0%	20%	20%	0%	2.0

Table V-16 displays information on the thermostat installation. The table shows that 85 percent of the installers who replaced thermostats provided a manual and discussed the operation with the client.

Table V-16. Thermostat installation

	Applicable Number	Action Taken	
		#	%
Instruction manual provided	13	11	85%
Operation discussed with client	13	11	85%

Table V-17A displays the scale used to rate the thermostat installation. The rating relates to compatibility of the thermostat with systems, communication to the client, testing the system, and work cleanliness.

Table V-17A. Quality of thermostat installation rating design

Action	Quality of Thermostat Installation
1	Work area cleaned up
2	Thermostat compatible with existing heat and AC system
3	Client was given instruction manual
4	Client was instructed on the use of the new thermostat
5	Confirmed that client can program / operate thermostat
6	HVAC system was tested after the installation
7	Materials integrated with existing interior finishes

Table V-17B displays the thermostat installation rating. The installers had a high mean rating of 4.1. All of the installers received a rating of 5 or of 3.

Table V-17B. Thermostat installation rating

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4	5	
Thermostat installation quality	13	0%	0%	46%	0%	54%	4.1

Tables V-18A through V-18D display the scales used to assess the cooling system work. Table V-18A displays the scale used to assess air conditioning tune-ups.

Table V-18A. Quality of air conditioning tune-up rating design

Action	Quality of Air Conditioning Tune-Up
1	Refrigerant recovered per EPA* requirement
2	Work area cleaned up
3	Work based on audit write-up
4	Materials integrated with existing interior finishes
5	Workers wore safety glasses
6	Refrigerant charge checked
7	Ducts tested

*U.S. Environmental Protection Agency

Table V-18B displays the scale used to assess air conditioning replacement work.

Table V-18B. Quality of air conditioning replacement rating design

Action	Quality of Air Conditioner Replacement
1	New unit sized with Manual J or equivalent
2	Old unit removed compliant with EPA rules, refrigerant recovery
3	Work area cleaned up
4	New unit commissioned
5	Work based on audit write-up
6	Workers wore safety glasses
7	Ducts tested

Table V-18C displays the scale used to assess evaporative cooler repair work.

Table V-18C. Quality of evaporative cooler repair rating design

Action	Quality of Evaporative Cooler Repair
1	Water leaks were repaired
2	Fill float valve was adjusted to correct overflow
3	Work was based on audit write up
4	The system was tested for proper operation and air flow after repairs were completed
5	Workers used proper tools, equipment and safety procedures
6	The work area was cleaned up

Table V-18D displays the scale used to assess evaporative cooler replacement work.

Table V-18D. Quality of evaporative cooler replacement rating design

Action	Quality of Evaporative Cooler Replacement
1	Unit is properly sized
2	Unit has a dedicated water supply with accessible shut off
3	Water filtration, bleed off or sump dump system installed & discharge water is run to garden or other appropriate location
4	Unit is sealed and insulated
5	Unit is controlled with a low-voltage thermostat, interlocked with A/C to prevent simultaneous operation
6	The cooler inlet is 10 ft away from, or 3 ft below, plumbing vents, gas flues, clothes dryer vents, or bathroom, kitchen, or laundry exhaust fan vents
7	Unit was checked for proper operation, air flow and float adjustment
8	Workers used proper tools, equipment and safety procedures
9	The work area was cleaned up

Table V-18E displays the ratings for the air conditioner work. The table shows that while there were few jobs observed, the ratings were good for the most part. Only the evaporative cooler replacement ratings averaged below a three. The other cooling ratings averaged between 3.0 and 4.0.

Table V-18E. Air conditioning ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Sealing around air conditioners	2	0%	0%	50%	50%	0%	3.5
Air conditioner tune-up	1	0%	0%	100%	0%	0%	3.0
Air conditioner replacement	2	0%	0%	0%	100%	0%	4.0
Evaporative cooler repair	4	0%	25%	0%	50%	25%	3.8
Evaporative cooler replacement	2	0%	50%	50%	0%	0%	2.5

I. DUCT SEALING

This section furnishes findings from observations of duct sealing and insulation. The following assessments were made.

- Quality of Duct Sealing Work
- Quality of Duct Insulation Work
- Cleanliness of Duct Improvement Work

Table V-19A displays the rating scale used to assess the quality of the duct sealing work. The scale assesses the health and safety aspects of the work, the materials applied, the effectiveness of the work, and the cleanliness of the approach.

Table V-19A. Quality of duct sealing work rating design

Action	Quality of Duct Sealing Work
1	Appropriate precautions taken in the presence of suspected asbestos
2	Sealing materials are durable and appropriate for location
3	No duct tape used
4	Duct testing done to target leaks
5	Duct testing done to measure effectiveness
6	Duct surfaces cleaned before sealing
7	Materials integrated with existing finishes
8	Workers wore gloves and safety glasses

Table V-19B displays the rating scale used to assess the quality of the duct insulation work.

Table V-19B. Quality of duct insulation work rating design

Action	Quality of Duct Insulation Work
1	Appropriate precautions taken in the presence of suspected asbestos
2	Ducts tested for leakage before insulation installed
3	Correct R-value of insulation installed
4	Seams sealed with tape or mechanical fasteners (no duct tape)
5	Workers wore gloves, safety glasses and respirators while insulating ducts
6	Insulation securely fastened to ducts
7	Vapor retarder in correct location

Table V-19C displays the rating scale used to assess the cleanliness of the duct improvement work.

Table V-19C. Cleanliness of duct improvement work rating design

Action	Cleanliness of Duct Improvement Work
1	Appropriate precautions taken in the presence of suspected asbestos
2	All work done is neat in appearance
3	Work area cleaned up
4	Materials used are compatible with finishes
5	Proper containment used to protect client and belongings
6	Insulation secured to contain friable insulation
7	Mastic or tape applied neatly
8	All packaging and excess materials removed from site

Table V-19D displays the ratings for the observed duct work. The cleanliness of the duct improvement work was rated highly, and the insulation and sealing quality work had mid-level ratings.

Table V-19D. Duct work ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Duct sealing quality	27	7%	48%	15%	22%	7%	2.7
Duct insulation quality	9	22%	0%	33%	33%	11%	3.1
Duct improvement cleanliness	26	0%	8%	8%	15%	69%	4.5

J. HOT WATER SYSTEM

This section assesses the hot water system work. The following aspects of the work were assessed.

- Hot Water Temperature Adjustment

- Hot Water Heater Wrap
- Hot Water Pipe Insulation
- Hot Water Heater Repair
- Hot Water Heater Replaced
- Hot Water Heater Venting Repaired or Replaced

Tables V-20A through V-20F display the rating scales used to assess the hot water heater work. Table V-20A displays the table used to assess the hot water heater temperature adjustment. Installers must check the water before and after adjustment, show the client how it was adjusted, and mark the original temperature to receive the highest rating.

Table V-20A. Quality of hot water temperature adjusted rating design

Action	Quality of Hot Water Temp Adjusted
1	Hot water temp checked prior to adjustment
2	Client showed how to adjust water heater temperature
3	Original temperature setting marked before adjustment made
4	Water temperature checked at closest fixture after adjustment

Table V-20B displays the rating scale used to assess the quality of the hot water heater wrap.

Table V-20B. Quality of hot water heater wrapped rating design

Action	Quality of Hot Water Heater Wrapped
1	Tank wrap kept away from flue pipe, gas valve, combustion air intake
2	Tank wrap secured with at least 3 mechanical straps of double wraps of approved tape
3	Tank wrap edges taped to reduce exposure to glass fibers
4	Tank wrap marked at location of access panels
5	T&P valve not covered by wrap
6	Work based on audit write-up
7	Workers wore a respirator, gloves and safety glasses when insulating water tank
8	Work area cleaned up

Table V-20C displays the rating scale used to assess the quality of the hot water pipe insulation.

Table V-20C. Quality of hot water pipes insulated rating design

Action	Quality of Hot Water Pipes Insulated
1	Pipe insulation mitered at elbows
2	Minimum six feet of hot water line insulated
3	Seams and junctions sealed with tape or mechanical fasteners
4	Work based on audit write-up
5	Minimum three feet of cold water inlet insulated
6	Pipe insulation kept away from flue pipe
7	Work area cleaned up

Table V-20D displays the rating scale used to assess the quality of the hot water heater repair work.

Table V-20D. Quality of hot water heater repaired rating design

Action	Quality of Hot Water Heater Repaired
1	Work based on audit write-up
2	Water heater confirmed working when repair completed
3	Water temperature checked at the closest fixture and adjusted as needed
4	Work area cleaned up

Table V-20E displays the rating scale used to assess the quality of the hot water heater replacement work.

Table V-20E. Quality of hot water heater replacement rating design

Action	Quality of Hot Water Heater Replacement
1	Water heater installed on solid footing
2	New water heater appropriate for location
3	Di-electric unions installed on hot and cold lines
4	T&P valve discharge tube approx 6 inches from floor
5	T&P valve discharge tube proper material
6	Water heater confirmed working
7	Water temperature checked at the closest fixture and adjusted as needed
8	Vent pipe secured with three screws at each junction
9	Vent has positive pitch up toward chimney w/min elbows
10	Work based on audit write-up
11	Work area cleaned up

Table V-20F displays the rating scale used to assess the quality of the hot water heater ventilation repair or replacement work.

Table V-20F. Quality of Hot Water Venting Repair or Replacement Rating Design

Action	Quality of Hot Water Heater Venting Repaire/Replacement
1	Vent pipe secured with three screws at each junction
2	Vent has positive pitch up toward chimney w/min elbows
3	Work based on audit write-up
4	Vent material correct for type of equipment and chimney configuration
5	Common vent installed above furnace vent
6	Workers wore gloves while cutting and installing vent pipe

Table V-20G displays the ratings for the hot water heater work. The table shows that the installers scored high on the hot water adjustments, pipe insulation, and hot water heater venting work. They scored in the mid-range on the hot water heater wraps and repairs.

Table V-20G. Water heater ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Hot water temperature adjustment	2	0%	0%	50%	0%	50%	4.0
Hot water heater wrapped	14	0%	29%	36%	36%	0%	3.1
Hot water heater pipes insulated	36	8%	3%	25%	19%	44%	3.9
Hot water heater repaired	7	0%	0%	71%	14%	14%	3.4
Hot water heater replaced	8	0%	0%	50%	38%	13%	3.6
Hot water heater venting work	7	0%	14%	0%	71%	14%	3.9

K. OTHER MEASURES – REFRIGERATOR, DRYER, LIGHTING, LOW-COST MEASURES

This section provides findings with respect to observation of additional measures. The following measures were assessed.

- Refrigerators
- Dryer Venting
- Air Conditioning Coils Cleaned
- Heating, ventilation and air conditioning (HVAC) Filters Cleaned or Replaced
- Aerators and Showerheads
- Carbon Monoxide Detectors, Smoke Detectors, and Fire Extinguishers
- Lighting

Table 21A displays the rating scale used to assess the refrigerator subcontractor's treatment of the refrigerator and the home. The rating is based on removal of old appliances, client communication, new appliance condition, and clean and safe work.

Table V-21A. Subcontract treatment of refrigerator and home rating design

Action	Subcontract treatment of refrigeration and home
1	Old appliance removed from site
2	Appliance operation confirmed
3	Client confirmed satisfaction with new appliance
4	Client confirmed satisfaction with installation
5	Appliance installed level
6	Doors close by themselves
7	Appliance not dented
8	All packaging material removed from site
9	Complied with Occupational Safety and Health Administration (OSHA) by safely lifting/moving appliance
10	Installers wore steel-toed boots, gloves

Action	Subcontract treatment of refrigeration and home
11	No damage done to the floors or surrounding woodwork

Table 21B displays the ratings for the subcontractor treatment of the refrigerator and the home when doing refrigerator replacements. Only seven replacements were observed. The table shows that they had a mid-level rating of 3.1.

Table V-21B. Subcontract treatment of refrigeration and home ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Subcontractor Treatment of Refrigeration and Home	7	0%	14%	71%	0%	14%	3.1

Table 22A displays the scale used to assess the quality of the dryer venting work. This rating was based upon use of appropriate materials, quality of work completed, and cleanliness and safety of the work.

Table V-22A. Quality of dryer venting rating design

Action	Quality of Dryer Venting
1	Dryer vented with metal ducting
2	Sections secured with appropriate tape (no duct tape)
3	No screws used to secure vent sections
4	Minimum number of elbows installed in vent
5	Damper with flapper securely installed on exterior
6	Damper penetration air sealed
7	All material scraps and packaging removed from home
8	Wore safety glasses when cutting vent material
9	Lint cleaned from rear of dryer
10	Gloves worn for moving dryer, work with venting materials

Table 22B displays the ratings for the dryer venting work. The table shows that the installers had a mean rating of 3.1 and that the ratings ranged from 2 to 5.

Table V-22B. Quality of dryer venting ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Quality of Dryer Venting	31	0%	23%	52%	16%	10%	3.1

Tables 23A through 23G display the rating scales used to assess the low-cost measure installation work. Table 23A displays the scale used to assess the quality of the air conditioning coils cleaning.

Table V-23A. Air conditioning cooling coils cleaning rating design

Action	Quality of AC Cooling Coils Cleaning
1	Cooling fins not bent or damaged by cleaning process
2	Cleaning fluid and rinse water drained away from unit
3	Access to cooling coil sealed when cleaning completed
4	Work area cleaned up

Table 23B displays the scale used to assess the quality of the HVAC filters cleaning or replacement.

Table V-23B. HVAC filters cleaning or replacement rating design

Action	Quality of HVAC Filters Cleaning or Replacement
1	Work area cleaned up
2	Old filter bagged and removed from house or filter not cleaned in sink used for washing dishes
3	Filter slot covered and temporarily sealed after filter installed
4	Client showed how to access and change filter

Table 23C displays the scale used to assess the quality of the faucet aerators installation. This scale is based upon the use of proper materials, the condition of the spout after installation, and the client communication.

Table V-23C. Faucet aerators installation rating design

Action	Quality of Faucet Aerators Installation
1	Teflon tape installed on aerator before installation
2	No Teflon tape visible after installation
3	Client confirmed satisfaction with new aerator
4	No damage caused to spout

Table 23D displays the scale used to assess the quality of the showerhead installation. The rating is based upon the use of proper materials, the condition of the showerhead after installation, and client communication.

Table V-23D. Showerhead installation rating design

Action	Quality of Showerhead Installation
1	Teflon tape installed on pipe before installation
2	No Teflon tape visible after installation
3	Client confirmed satisfaction with new showerhead
4	No damage caused to existing gooseneck
5	No water leaks caused by the installation

Table 23E displays the scale used to assess the quality of the carbon monoxide detector installation. The rating is based upon client education and detector placement away from the kitchen and close to the bedroom.

Table V-23E. Carbon monoxide detector installation rating design

Action	Quality of Carbon Monoxide Detector Installation
1	Client showed how the CO detector works and how to test it
2	Client instructed maintenance/battery replacement
3	Client instructed on what to do if detector alarms
4	CO detector installed close to bedrooms in the home
5	CO detector not installed in kitchen

Table 23F displays the scale used to assess the quality of the smoke detector installation. The rating is based upon client education and detector placement away from the kitchen and close to the bedrooms.

Table V-23F. Smoke detector installation rating design

Action	Quality of Smoke Detector Installation
1	Client showed how smoke detector works and how to test it
2	Client instructed maintenance/battery replacement
3	Client instructed on what to do if detector alarms
4	Installed close to bedrooms in the home
5	Not installed in kitchen
6	Installed at least 6” from intersection of the wall and ceiling

Table 23G displays the scale used to assess the quality of the fire extinguisher installation. The rating is based upon client education and placement in convenient location.

Table V-23G. Fire extinguisher installation rating design

Action	Quality of Fire Extinguisher Installation
1	Client showed how to operate the fire extinguisher
2	Client showed how to check for proper charge
3	Installed in convenient location allowing easy access
4	Fire extinguisher installed on bracket at least 4’ above floor

Table V-23H displays the ratings for the installation of the low-cost measures. The table shows that the installers received high ratings for cleaning of AC cooling coils and cleaning and replacement of HVAC filters. They received mid-level ratings for installation of faucet aerators and showerheads. They received low ratings for CO detectors and smoke detectors. No fire extinguisher installations were observed.

Installations of CO detectors and smoke detectors often did not include the educational information that should be provided. Social Scientists noted that the installers usually did not provide instructions on how

to use, on replacing batteries at regular intervals, and on what to do if the alarm went off. In one case the installer placed the monitor in an ineffective location to prevent the client from tampering with it.

Table V-23H. Quality of additional low-cost measures installed ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
AC cooling coils cleaned	3	0%	0%	0%	33%	67%	4.7
HVAC filters cleaned or replaced	11	0%	9%	55%	0%	36%	3.6
Faucet aerators installed	11	9%	36%	27%	0%	27%	3.0
Showerhead installed	7	0%	29%	43%	14%	14%	3.1
CO Detector installed	36	53%	22%	6%	8%	11%	2.0
Smoke Detector installed	38	11%	58%	5%	11%	16%	2.6
Fire extinguisher installed	0	-	-	-	-	-	-

Table V-24A displays information on the CFLs that were provided and installed during the observed measure installation visits. The table shows the mean number, and the 25th, 50th, and 75th percentiles for each statistic. There were 45 cases where lighting was part of the work scope and clients were provided with CFLs in all but one of these cases.

- CFLs were handed to the client in 60 percent of the observations.
- The mean number of bulbs handed to the client was four CFLs.
- CFLs were installed by the crew in 47 percent of the observations.
- The mean number of bulbs installed by the crew was eight CFLs.
- CFLs were both handed to client and installed in nine percent of the observations.

Table V-24A. CFLs provided and installed

	Applicable Observations	One or more bulbs	Number of Bulbs			
			Mean	p25	p50	p75
CFLs handed to client	45	60%	4	0	3	8
CFLs installed by crew	45	47%	8	0	0	8
Incandescent bulbs removed from home	45	20%	2	0	0	0

Table V-24B displays information on the communication about CFLs. The table shows that installers were not likely to discuss the CFLs. While 24 percent asked if the client was satisfied, only five percent explained benefits and proper disposal of CFLs.

Table V-24B. CFL communication

	Applicable Observations	Action Taken	
		#	%
Crew asked client if satisfied with CFLs installed	34	8	24%
Crew explained benefits and proper disposal of CFLs	43	2	5%

In general, there was minimal communication between the client and the program about the CFLs. Little guidance was given to the installers about where to install the bulbs, so it was common for them to be installed in fixtures that were not often used or in locations that require more light output than the CFLs could provide. The result is this measure does not achieve its potential energy savings, because the lights are not placed in the most appropriate and high-use fixtures.

L. PROFESSIONALISM

This section assesses the professionalism of the installers. The following factors were assessed.

- Crew Efficiency
- Crew Professionalism
- Crew Cleanliness
- Crew Safety Practices

Tables V-25A through V-25D display the rating scales that were used to assess these aspects of the work. Table V-25A displays the rating scale used to assess crew efficiency. This rating relates to the crew having information, their timeliness, availability of needed equipment and materials, and their organization.

Table V-25A. Crew efficiency rating design

Action	Crew Efficiency
1	Crew had clear instructions on work needed to be completed
2	Crew arrived on time
3	Crew had work plan prior to arrival
4	Crew arrived with needed tools and equipment
5	Crew preps tools and materials prior to each installation
6	No trips to the warehouse or store needed
7	Tools organized by task
8	Truck organized allowing easy access to tools and equipment

Table V-25B displays the rating scale used to assess the crew's professionalism. The table shows that the issues included are timeliness, appearance, respect of the client's home, and informing the client about the work progress.

Table V-25C displays the scale used to assess the crew's cleanliness while working in the client's home. The scale addresses lead-safe practices if applicable, neatness of work, removal of packaging, and daily clean-up.

Table V-25D displays the rating scale used to assess the crew's safety practices. This scale also includes use of lead-safe practices with many other actions that enable the crews to protect themselves while doing the work.

Table V-25E displays the professionalism ratings. The table showed that except for the safety practices, the installers were very professional. The majority of the crews scored a four or a five for efficiency, professionalism, and cleanliness, and the mean ratings were 3.9 and 4.1.

Table V-25B. Crew professionalism rating design

Action	Crew Professionalism
1	Crew arrived on time
2	Vehicle clean
3	Crew members neat in appearance upon arrival
4	Crew identified themselves to client
5	Crew respected client and belongings
6	Crew kept work area clean
7	Crew cleaned-up daily
8	Crew kept client informed of work progress
9	Crew did not fail to take precautions if young children

Table V-25C. Crew cleanliness rating design

Action	Crew Cleanliness
1	Crew used lead safe practices in pre-1978 homes
2	All work done is neat in appearance
3	All packaging and excess materials removed from site
4	Materials used are compatible with finishes
5	Crew kept work area clean
6	Crew cleaned-up daily
7	Proper containment used to protect client and belongings

Table V-25D. Crew safety practices rating design

Action	Crew Safety Practices
1	Crew used lead safe practices in pre-1978 homes
2	Crew practice ladder safety
3	Crew used containment to protect client and belongings
4	Wore respirators when performing tasks that disturb dust
5	Crew used supply air respirators when using two-part foam
6	Crew wore safety glasses when cutting, insulating, foaming
7	Crew wore gloves when working with metal, moving equipment, appliances, water heaters, heating and AC units
8	Crew had access to MSDS for products being used
9	Crew maintained vehicle safety log
10	Crew had access to First Aid
11	Crew had access to fresh water

12	Crew equipment had safety guards in place
13	Used ground fault protection if working with elec. equip.

Table V-25E. Crew professionalism ratings

	Number Rated	Needs Improvement		Percent With Each Rating →		Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Efficiency	113	0%	11%	14%	31%	44%	4.1
Professionalism	113	2%	13%	21%	24%	40%	3.9
Cleanliness	113	7%	5%	19%	28%	40%	3.9
Safety practices	111	14%	41%	33%	5%	6%	2.5

The WAP regulations require crews and contractors to follow the Occupational Safety and Health Administration (OSHA) safety requirements when working. In some cases, crews and contractors tried to meet the intent of these requirements in protecting themselves and the clients. More often, it was observed that workers took unnecessary personal risk. Especially in recent years, there has been tremendous emphasis on working lead safe. The level of lead safe work observed varied from being in compliance with regulations to completely ignoring the hazard and exposing both workers and clients to the potential hazard of lead paint dust. Observers found that installers often did not wear personal protective equipment, including not wearing respiratory protection while in confined areas or while blowing insulation and not using protective equipment while cutting and sawing, including no safety glasses, ear plugs, or gloves.

Social Scientists and Weatherization Experts noted that in almost all cases, the members of the installation team worked very well together. The installers were organized in different ways, but both ways appeared to work well.

- Team leader model – under this approach there was a clear leader who directed and supervised the work. The leader also was responsible for communication with the auditor and the inspector, and for quality control on the team's work.

- No leader model – under this approach, all of the installers were at equal levels. There was no leader to provide quality control, but the team members worked well together and supported one another.

M. COMMUNICATION AND EDUCATION

This section assesses the client communication and the education that the installers provided to the clients. The following aspects of the work were assessed.

- Quality of Crew Communication
- Attempt to Engage Client
- Client Engagement
- Quantity of Education Provided
- Quality of Education Provided

Table V-26A displays the rating scale used to assess the quality of the crew communication. The scale assesses whether the crew communicated information about the work plan, job progress, and issues encountered.

Table V-26A. Quality of crew communication rating design

Action	Quality of Crew Communication
1	Crew informed client when work began
2	Crew kept client informed of progress
3	Crew asked client about any concerns with work scope
4	Crew discussed work plan and individual roles
5	Crew called auditor when unusual conditions encountered
6	Crew discussed work around when problems encountered

Table V-26B displays the rating scale used to assess the crew's attempt to engage the client.

Table V-26B. Attempt to engage client rating design

Action	Attempt to Engage Client
1	**Crew discussed work scope with client**
2	**Explained necessary maintenance of installed equipment**
3	Crew asked client if he/she had any questions about work
4	Crew discussed ways for client to save energy

Table V-26C displays the rating scale used to assess the client's engagement in the work process.

Table V-26C. Client engagement rating design

Action	Client Engagement
1	**Responsible adult home for entire visit**
2	**No language barrier to client communication**
3	**Client asked at least one question**
4	Client asked about the work scope
5	Client asked about the materials being installed
6	Client asked about how installed measures save energy
7	Client helped with installation of low-cost measures
8	Client cleaned up clutter that would have hindered wx

Table V-26D displays the rating scale used to assess the quantity of education provided by the installers.

Table V-26D. Quantity of education provided rating design

Action	Quantity of Education Provided
1	**Crew discussed work scope with client**
2	**Explained necessary maintenance of installed equipment**
3	Asked client if he/she had any questions about work
4	Used all opportunities to discuss the project with the client
5	Explained the purpose for the installation of each measure
6	Gave manuals for new equipment to the client
7	Highlighted problems discovered during the work project

Table V-26E displays the rating scale used to assess the quality of education provided by the installers.

Table V-26E. Quality of education provided rating design

Action	Quality of Education Provided
1	**Crew provided clear and concise explanations**
2	Asked client if he/she had questions about the program or what was being done
3	Asked client questions to assess problems/needs
4	Assessed client understanding of what was being done
5	Discussed client ability to undertake energy saving actions
6	Discussed monetary benefit of client energy actions
7	Obtained client commitment to take energy saving actions
8	Provided contact information in case client had problems

Table V-26F displays the communication and education ratings for the installation observations. The table shows a mid-level rating for communication, but low ratings for client engagement and education.

Table V-26F. Communication and education ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Communication	105	8%	38%	7%	22%	26%	3.2
Attempt to engage client	104	36%	37%	9%	17%	2%	2.1
Client engagement	103	28%	37%	24%	7%	4%	2.2
Education quantity	99	55%	22%	10%	7%	6%	1.9
Education quality	98	70%	25%	2%	2%	1%	1.4

The installers were very focused on their mission of installing measures in the home. One Social Scientist noted that an installer said the best client is "…one that goes upstairs and lies down for a nap."

However, there were installers who did a better job at education. One Social Scientist described a useful interaction about the insulation that was installed. The installer provided a certificate of insulation to the client, explained why the client should not disturb the insulation, and discussed what the expected benefits of the insulation. Another installer provided a good explanation of why they would be repairing the kitchen exhaust.

N. SUMMARY

This section provides a summary of the findings from the observation of measure installations. Table V-27 provides a ratings summary with mean ratings across the three rating categories and across all ratings.

- Installers received a low average rating of 2.2 on education.
- Installers received a mid-average rating of 3.0 on technical aspects of the work. Some of the work was rated very highly, but some was not rated as high.
- Installers received a high average rating of 3.8 on professional aspects of the work.

Table V-27. Measure installation summary ratings

	Number Assessed	Needs Improvement → Excellent					Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Education	509	39%	32%	10%	11%	8%	2.2
Technical	940	9%	28%	32%	18%	14%	3.0
Professional	727	4%	14%	20%	23%	39%	3.8
Overall	2176	14%	24%	23%	18%	21%	3.1

There were several strengths that were noted by the Social Scientists and Weatherization Experts who observed the installations.

- Observers noted many instances of installer flexibility and dedication that went above and beyond the work scope. The desire to maximize the benefit of the visit for the client was repeatedly observed. The crews and contractors spend the most amount of time in the home and have the opportunity to get to know the client better than anyone at the agency. The example of the contractor running the client over to the nursing home so she could visit her husband is one of many. In rural areas, the contractors and crews may even know the client or know someone in common. In those cases, there is an instant level of trust, and it sometimes seemed like the workers felt they were working on a relative's house. The crews and contractors were always looking for feedback on their work quality and what they could do to be better. Most viewed training and feedback as a way of providing an even better service.
- Problem solving skills of the installers were often remarkable. They were often able to find creative solutions to unique problems and used different types of skills they had acquired in construction or carpentry to assist the clients.

- One particular area in which high quality work was observed was in insulation. The Weatherization Experts noted that the program has matured in the installation of insulation in attics and in walls, basements, and crawlspaces. Attic work was usually level and of sufficient depth and good coverage. Walls were dense packed at most locations and the tubing method was used in most instances. Installers used more two-part foam when working in crawlspaces. Along with vapor retarders on the floor and vinyl faced fiberglass, crawlspaces were effectively air sealed. There were still issues with controlling the dust from the insulation during installation, but it is expected that the performance of the measures will be high.

- Experienced HVAC contractors were brought on to do heating system work.

The weatherization staff showed great pride in their work. They took care to leave the homes safer for the occupant. When there were issues with the hand railings, steps, or other structural issues that could contribute to falls, they were usually addressed right away, even on a crew member's own time.

The observers reported that the installers on the jobs worked well together as a team. They worked together to call on past experiences and collectively solve the problems that they encountered. There was an understanding among the members of the team, where each member knows his or her role, and took that responsibility seriously. The crew leaders had pride and ownership in their trucks, and were careful with how they were set up. Some of the very hands on crew leaders assisted their staff with the work and reassigned those who finished their tasks. Many long-time contractors were seen, and appeared to provide great benefit to the program. Several observers commented specifically on highly skilled HVAC contractors who were part of the program.

There were several opportunities to improve the services delivered through revised approaches to the installations.

- Installers can improve the quality of their air sealing work by using the blower door as a tool to guide the work. Weatherization Experts observed that blower door guided air sealing was done in a minority of the cases observed.

- While the installers usually showed great respect for the clients' and their homes, there were times when they did not make use of booties and did not cover the clients' furniture. In these cases, there appeared to be an attitude of "we'll clean it up later."

- Installers did not follow practices to protect themselves while performing the installations. The level of lead safe work observed varied from being in compliance with regulations to completely ignoring the hazard and exposing both workers and clients to the potential hazard of lead paint dust. Observers found that installers often did not wear personal protective equipment, including not wearing respiratory protection while in confined areas or while blowing insulation and not using protective equipment while cutting and sawing, including no safety glasses, ear plugs, or gloves.

- Weatherization Experts noted that the weatherization staff accepted the HVAC contractors' assessments without question. While many of the HVAC contractors were highly experienced and performed high quality work, there were times that the weatherization staff did not provide the required oversight and scrutiny of this work.

- Installers usually did not provide an explanation to clients about the CFLs when they installed the bulbs. They did not assess client satisfaction or discuss proper bulb disposal.

- Client education was rarely observed during the installation visits. Installers generally did not attempt to engage the client and did not provide education around the installed measures. This was especially a problem around measures such as smoke alarms and carbon monoxide detectors.

Additional recommendations relating to training needs and management priorities are provided in the concluding section of the report.

VI. FINAL INSPECTION

This section provides an analysis of the observations of final inspections. There were 37 final inspections observed by the Social Scientists and 91 observed by the Weatherization Experts. The following aspects of the final inspections were assessed.

- Home Walkthrough
- Testing
- Occupant Interaction
- Professionalism

A. HOME WALKTHROUGH

Table VI-1 displays results from observations of the home walkthroughs. The table shows the percent of each visit where inspectors examined the home and noted the presence or absence of CO and smoke detectors during the walk through or later in the visit. While almost all of the inspectors examined the basement and all accessible rooms, the inspectors were less likely to examine crawl spaces, garages, conduct an outside home walk-around, and note the presence or absence of CO and/or smoke detectors.

Table VI-1. Home walkthrough

	Applicable Number	Walkthrough		Later		Walkthrough or Later	
		#	%	#	%	#	%
Examined all accessible rooms	91	80	88%	2	2%	82	90%
Noted CO detector presence/absence	91	59	65%	0	0%	59	65%
Noted smoke detector presence/absence	91	58	64%	0	0%	58	64%
Examined all accessible attic(s)	67	47	70%	2	3%	49	73%
Examined basement	47	45	96%	0	0%	45	96%
Examined all accessible crawl spaces	47	30	64%	3	6%	33	70%
Examined garage	20	15	75%	0	0%	15	75%
Conducted outside home walk-around	91	65	71%	2	2%	67	74%

B. TESTING

This section summarizes the assessments of diagnostic testing, combustion safety testing, and draft testing. The table shows that blower door tests, duct leakage tests, and combustion efficiency tests were done in the majority of cases where they should have been done. However, the air handler flow test, the infrared scan, and the zonal pressure tests were less commonly conducted.

Table VI-3 displays findings with respect to the combustion safety tests. This table shows that tests on the heating system and water heater were only done about 75 percent of the time, and tests on the gas stove, space heater, and the ambient test were even less frequently done.

Table VI-2. Diagnostic tests

	Tests Performed			
	Should Have Been	**Should Have Been & Was**	**% Performed**	**% Performed Correctly**
Blower door	86	73	85%	85%
Zonal pressure	45	15	33%	87%
Duct leakage test	45	28	62%	79%
Infrared Scan	43	19	44%	95%
Combustion efficiency test	47	28	60%	89%
Air handler air flow test	32	17	53%	94%
Proper coolant charge	3	0	0%	N/A

Table VI-3. Combustion safety tests

	Tests Performed			
	Should Have Been	**Should Have Been & Was**	**% Performed**	**% Performed Correctly**
Heating system	54	39	72%	97%
Water heater	50	38	76%	95%
Gas stove	26	8	31%	100%
Space Heater	7	0	0%	N/A
Ambient	45	18	40%	100%

Table VI-4 displays information on the observed draft tests. The table shows that these tests were only performed in about two thirds of the cases where they should have been done. However, they were performed correctly in most cases where they were done.

Table VI-4. Draft tests

	Tests Performed			
	Should Have Been	**Should Have Been & Was**	**% Performed**	**% Performed Correctly**
WCD heating system	40	24	60%	92%
WCD water heater	45	30	67%	83%
WCD Other	7	0	0%	N/A
Spillage Testing	41	27	66%	96%

Table VI-5A displays the rating scale used to assess the completeness of the inspection. The rating is based upon review of work done, completion of testing, and communication with the client.

Table VI-5A. Completeness of inspection rating design

Action	Completeness of Inspection
1	Inspector made sure there was nothing done to compromise the safety of the client
2	Inspector compared audit recommendation to installations
3	Inspector compared installed measure list to installations
4	Inspector conducted a blower door test
5	Inspector conducted zonal pressure diagnostics
6	Inspector conducted a worst case draft test
7	Inspector used infrared camera to check insulation
8	Inspector completed duct testing
9	Inspector compared initial and final test results for changes
10	Inspector asked client about any problems or concerns
11	Inspector confirmed client can operate new equipment
12	Inspector confirmed client had manuals for new equipment
13	Inspector checked to confirm crew/contractor cleaned up
14	Inspector assured old appliances removed
15	Inspector verified depth or amount of insulation installed

Table VI-5B displays the rating scale used to assess the quality of testing. The rating is based upon testing equipment, correctness of test procedures, and safety.

Table VI-5B. Quality of testing rating design

Action	Quality of Testing
1	Inspector test equipment calibration current
2	Tests done correctly
3	Test results used to grade work quality
4	Inspectors proficient in operating test equipment
5	Combustion appliances disabled during blower door and duct testing

Table VI-5C displays the rating scale used to assess the completeness of testing. The rating is based upon whether all applicable tests were conducted.

Table VI-5D displays the inspection completeness, testing completeness, and inspection quality. The table shows that inspectors received low ratings for inspection and testing completeness and mid-level ratings for testing quality.

Weatherization Experts and Social Scientists both noted that inspections often did not include client discussion, determination if work was completed properly, or important safety tests. However, there were observations of inspections where the inspector did an excellent job. In one case where the inspector

Table VI-5C. Testing completeness rating design

Action	Quality of Education Provided
1	Conducted blower door test
2	Conducted zonal pressure diagnostics
3	Conducted a worst case draft test
4	Conducted combustion appliance safety testing
5	Conducted combustion appliance efficiency testing
6	Conducted duct testing
7	Checked air flow in duct system
8	Performed an infrared scan
9	Checked air conditioner charge level
10	Checked ventilation fan air flow
11	Checked for combustible gas leaks
12	Metered refrigerator or freezer

arrived prior to the contractor's departure, the inspector used the blower door to inspect for air leakage, had the homeowner walk around the home to assist in looking for air leakage, found additional air sealing opportunities, and had the contractor perform additional air sealing right at that point in time.

Table VI-5D. Final inspection summary ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Inspection completeness	88	23%	39%	24%	11%	3%	2.3
Testing completeness	89	38%	37%	21%	0%	3%	1.9
Testing quality	88	16%	17%	19%	13%	35%	3.3

C. OCCUPANT INTERACTION

Table VI-6 assesses the level of occupant interaction during the final inspection. The table shows that while almost all of the clients expected the visit and had an adult occupant at home, the inspector only discussed the work performed in 75 percent of the cases and only discussed job satisfaction in 70 percent of the cases. Additionally the inspector only discussed energy savings and health and safety issues in fewer than 30 percent of the observations.

Table VI-7A displays the rating scale used to assess the inspector attempt to engage the client in the inspection. The scale is based upon the inspector explaining the visit purpose and scope, explaining the tests conducted, and asking the client to participate and about experiences and satisfaction with the process.

Table VI-6. Occupant interaction

	Applicable Number	Work Completed	
		#	%
Visit expected	91	88	97%
Adult occupant present	91	87	96%
Discussed work performed	89	67	75%
Discussed energy/cost savings	89	25	28%
Discussed health & safety issues	89	26	29%
Discussed job satisfaction	90	63	70%

Table VI-7A. Inspector attempt to engage client in inspection rating design

Action	Inspector Attempt to Engage Client in Inspection
1	Inspector explained purpose and scope of inspection
2	Inspector explicitly asked client to participate
3	Inspector asked client to accompany him on walkthrough
4	Inspector asked client about satisfaction with providers
5	Inspector asked client about satisfaction with work done
6	Inspector explained why each test is done
7	Inspector asked client about satisfaction with work cleanup
8	Inspector asked client about satisfaction with new equipment
9	Inspector asked client about change in energy usage
10	Inspector asked client if noticed changes in energy bills
11	Inspector asked client about changes in comfort of home

Table VI-7B displays the rating scale used to assess the client engagement in the inspection. The rating is based upon the client being home and communicating with the inspector, the client asking questions, and the client providing feedback on the work completed.

Table VI-7C displays the rating scale used to assess the inspector's communication skills. The rating is based upon use of understandable language, asking questions, using examples, and being responsive to the client.

Table VI-7D displays the rating scale used to assess the quantity of education provided by the inspector. The assessment is based upon whether the inspector explained the process, the work done, equipment use and maintenance procedures, and whether the inspector discussed client comfort and actions to reduce energy usage.

Table VI-7B. Client engagement in the inspection rating design

Action	Client Engagement in the Inspection
1	Responsible adult home for entire visit
2	No language barrier to client communication
3	Client accompanied inspector on home walkthrough
4	Client asked at least one question
5	Client told inspector about satisfaction with work done
6	Client explained how they operate home
7	Client asked what test results meant about the home
8	Client asked what they can do to save energy
9	Client asked questions about energy bill
10	Client explained differences in home and /or energy bills that they have noticed since work was completed

Table VI-7C. Inspector communication skills rating design

Action	Inspector Communication Skills
1	Inspector used appropriate language/not technical or jargon
2	Inspector spoke clearly
3	Inspector asked questions to check for client understanding
4	Inspector used examples to show benefits of client actions
5	Inspector was responsive to client concerns

Table VI-7D. Quantity of education provided rating design

Action	Quantity of Education Provided
1	Inspector explained purpose and scope of inspection
2	Inspector explained what he was looking at
3	Inspector explained why each test is done
4	Inspector explained client maintain for measures installed
5	Inspector showed client how to maintain HVAC equipment
6	Inspector let customer demo use of new equipment and provided feedback
7	Inspector discussed client comfort
8	Inspector discussed client actions to reduce energy usage
9	Inspector left client with additional educational materials
10	Inspector provided contact information in case of problems

Table VI-7E displays the rating scale used to assess the quality of education provided by the inspector. The assessment is based upon the provision of clear explanations, assessment of client understanding, and discussion with the client about energy-saving behaviors.

Table VI-7E. Quality of education provided rating design

Action	Quality of Education Provided
1	Inspector provided clear and concise explanations
2	Inspector asked client if he/she had questions about the program or what was being done
3	Inspector asked the client questions to assess problems
4	Inspector assessed client understanding of work completed
5	Inspector tailored education to client and home
6	Inspector discussed client ability to take energy saving actions
7	Inspector discussed monetary benefit of client energy actions
8	Inspector obtained client commitment for energy saving actions
9	Inspector provided contact information in case of problems

Table VI-7F displays the inspectors' communication and education ratings. The table shows that the inspectors received low ratings on all of the topics. The one rating that was between low and mid-level was the inspectors' communication skills.

Table VI-7F. Communication and education ratings

	Number Rated	Needs Improvement	Percent With Each Rating →			Excellent	Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Inspector attempt to engage client	89	65%	11%	11%	4%	8%	1.8
Client engagement	88	44%	39%	10%	6%	1%	1.8
Inspector communication skills	89	22%	40%	20%	0%	17%	2.5
Education quantity	86	65%	22%	7%	5%	1%	1.5
Education quality	86	63%	20%	8%	6%	3%	1.7

D. PROFESSIONALISM

This section assesses the inspectors' professionalism. Tables VI-8A through VI-8D display the rating scales used to assess various aspects of professionalism. Table VI-8A displays the rating scale used to assess the efficiency of the inspection. The rating is based upon on-time arrival and organization.

Table VI-8A. Inspection efficiency rating design

Action	Inspection Efficiency
1	Inspector arrived on time
2	Inspector introduced themselves to the client
3	Inspector's tools organized by task
4	Inspector used audit to guide inspection work
5	Inspector assured program standards had been met
6	Inspector moved through house in a logical order

Table VI-8B displays the rating scale use to assess the professionalism of the inspectors. The scale is based upon client communication, neatness, respect, and cleanliness.

Table VI-8B. Inspection professionalism rating design

Action	Inspector Professionalism
1	Inspector introduced themselves to the client
2	Inspector had proper identification
3	Inspector's appearance was neat and clean
4	Inspector treated client with respect
5	Inspector treated client's belongings with respect
6	Inspector cleaned up any mess created during the inspection
7	Inspector tried to engage client in the inspection
8	Inspector listened to client concerns

Table VI-8C DISPLAYS the rating scale used to assess the cleanliness of the inspectors' work. The rating is based upon cleaning up after the work is done, returning everything to its original condition, and using containment.

Table VI-8C. Inspector cleanliness rating design

Action	Inspector Cleanliness
1	Inspector cleaned up when done with the inspection
2	Inspector returned everything to the as-found condition
3	Inspector used containment to protect client's belongings
4	Inspector used containment to reduce dust exposure
5	Access holes made out-of-sight or were sealed when done

Table VI-8D displays the rating scale used to assess the inspector's safety practices. The rating is based upon practices that affect the safety of the inspector and the client.

Table VI-8D. Inspector safety practices rating design

Action	Inspector Safety Practices
1	Inspector used appropriate PPE (respirator in attics/crawls, hard hat in confined areas)
2	Inspector disabled combustion appliances during blower door test
3	Inspector practiced ladder safety as needed
4	Inspector was careful with smoke when looking for air leaks
5	Inspector took appropriate steps to keep the house warm during testing procedures
6	Inspector did not fail to take appropriate precautions with tools and equipment when young children around
7	Inspector only entered house if adult present

Table VI-8E displays the professionalism ratings for the observed inspections. The table shows that the inspectors received high ratings for cleanliness, efficiency, and safety, and mid-level ratings for professionalism.

Table VI-8E. Inspector professionalism ratings

	Number Rated	Needs Improvement → Excellent					Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Inspector efficiency	89	0%	16%	0%	27%	57%	4.3
Inspector professionalism	90	0%	16%	30%	29%	26%	3.6
Inspector cleanliness	90	7%	2%	7%	0%	84%	4.5
Inspector safety practices	89	2%	3%	25%	22%	47%	4.1

E. SUMMARY

This section provides a summary of the findings from the observations of the final inspections. Table VI-9 displays the final inspection summary ratings. The table shows the mean ratings for education, technical, and professional aspects of the inspections.

- Inspectors received a low mean education rating of 1.9.
- Inspectors received a low mean technical rating of 2.5.
- Inspectors received a high mean professional rating of 4.1.

Table VI-9. Final inspection summary ratings

	Number Assessed	Needs Improvement → Excellent					Mean Rating
		1	2	3	4*	5*	
		0%-49%	50%-74%	75%-89%	90%-99%	100%	
Education	438	52%	26%	11%	4%	6%	1.9
Technical	265	26%	31%	22%	8%	14%	2.5
Professional	358	2%	9%	15%	20%	54%	4.1
Overall	1061	29%	22%	15%	10%	24%	2.8

There were several strengths that were noted by the Social Scientists and Weatherization Experts who observed the final inspections.

- Inspectors did a good job when they closely followed the work orders.

- Inspectors were able to save time when the installers attended the final inspection. Installers could repair problems while the inspector was on site and the inspector could confirm that the measure was properly installed following the repair. Additionally, the diagnostic testing is done while both the installer and inspector are on site, eliminating the need for one set of tests. One drawback to this approach is that the client is not a focus of the final inspection and little education occurs. The client also has not had time to experience the changed house,

and cannot know if the work was done well and the impact that it has had. Having the inspector present at the conclusion of the installation appears to increase efficiency, but limits the closing opportunity to impact the client's behavior.

- Inspectors usually provided clients with information on who to call if they encountered any problems with the work.

- Inspectors provided referrals to additional assistance programs.

There were also several opportunities to improve the services delivered through revised approaches to the final inspections.

- The inspectors did not provide sufficient client education. Increased client education through explanation of installed measures and reinforcement of the client action plan cold improve program outcomes.

- Inspectors did not conduct comprehensive testing and needed to improve the quality of the tests that they did conduct.

- Inspectors often only checked to see if a measure was installed, but did not conduct additional assessment to confirm that the installation was done properly.

- Auditors were used at times to inspect the work at homes they had audited. Reduced use of auditors to conduct the final inspection would provide additional perspective on the work required in the home.

VII. FACTORS AND IMPACTS

This section assesses the relationships between the program assessment ratings made by the Weatherization Experts and (1) the agency and staff characteristics, and (2) the mean agency's energy usage impacts.

A. FACTORS

State programs, local agencies, weatherization staff, and contractors differ on numerous dimensions that may impact the quality and effectiveness of services delivered. One of the goals of this study was to determine whether there were characteristics of agency management, staff qualifications, or training that are related to service delivery quality, as assessed in this study. Definitive conclusions cannot be drawn due to the small number of agencies and jobs observed compared to the large number of factors that can influence success, but the study did investigate whether there were any meaningful relationships between potentially determining factors and agency performance.

The factors studied in this analysis are based upon agency responses to surveys included as part of the National WAP Evaluation. The following factors related to audits were reviewed.

- Use of in-person instruction at the time of the audit.
- Requirements for staff engaged in measure selection.
    - Technical certification
    - Extensive weatherization work experience
    - Extensive weatherization supervision experience
    - Construction experience
- Requirements for staff engaged in diagnostic procedures.
    - Technical certification
    - Extensive weatherization work experience
    - Extensive weatherization supervision experience
    - Construction experience

For the most part, there were no relationships seen between factors that are expected to influence work quality and ratings made by the Weatherization Experts. However, there were some quality factors that were related to observation ratings.

Table VII-1 displays ratings by whether the agency reported that they require staff engaged in measure selection to have technical certification. The table shows that 16 of the 19 observed agencies did require certification. The audit technical ratings averaged 2.5 for observations at agencies that did require the certification, compared to 2.1 for those that did not. However, the other types of ratings did not vary by whether the agency required technical certification.

Table VII-2 displays ratings by whether the agency reported that they require staff engaged in diagnostic procedures to have technical certification. The table shows that 14 of the 19 observed agencies did require certification. The audit technical ratings averaged 2.6 for observations at agencies that did require the certification, compared to 2.2 for those that did not. Again, the other types of ratings did not vary by this requirement.

Table VII-1. Audit ratings summaries by technical certification required for staff engaged in measure selection

# of Agencies	Required Technical Certification		Did not Require Technical Certification	
	16		3	
	Number of Ratings	Mean Rating	Number of Ratings	Mean Rating
Audit Technical	335	2.5	66	2.1
Audit Education	596	2.0	108	1.9
Audit Professional	350	3.7	64	3.9
All Audit Ratings	1281	2.6	238	2.5

Table VII-2. Audit ratings summaries by technical certification required for staff engaged in diagnostic procedures

# of Agencies	Required Technical Certification		Did not Require Technical Certification	
	14		5	
	Number of Ratings	Mean Rating	Number of Ratings	Mean Rating
Audit Technical	286	2.6	115	2.2
Audit Education	502	2.0	202	1.9
Audit Professional	298	3.8	116	3.6
All Audit Ratings	1086	2.6	433	2.4

Table VII-3 displays ratings by whether the agency reported that they require staff engaged in diagnostic procedures to have work experience. The table shows that 14 of the 19 observed agencies required extensive weatherization work experience. Those that required the work experience had an average audit education rating of 2.1 compared to 1.6 for those who did not. The average audit education ratings were 2.3 for the agencies that required extensive weatherization supervision experience, compared to 1.9 for those who did not. One of the relationships that was found to be in the opposite direction of expectations was that weatherization agencies that did not require extensive weatherization supervision experience had a mean professional audit rating of 4.0 compared to a mean rating of 2.9 for those who did require this type of experience. The professional rating for those who did not require construction experience was also higher than for those agencies that did.

With respect to measure installation, we assessed whether there was a relationship between whether crews or contractors were used and the Weatherization Experts' assessments. Most of the ratings did not differ with respect to the type of installers used. The quality ratings for the different types of installation work were very similar across crews and contractors. However, there were a few differences in other aspects of the work that are summarized below.

Table VII-3. Audit ratings summaries by work experience required for staff engaged in diagnostic procedures

	Work Experience Required											
	Extensive Wx Work				Extensive Wx Supervision				Construction			
	Required		Not Required		Required		Not Required		Required		Not Required	
#of Agencies	14		5		3		16		6		13	
	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean
Technical	308	2.5	93	2.2	74	2.3	327	2.5	140	2.4	261	2.5
Education	545	2.1	159	1.6	131	2.3	573	1.9	244	2.0	460	1.9
Professional	322	3.8	92	3.7	79	2.9	335	4.0	140	3.5	274	3.9
All Audit Ratings	1175	2.6	344	2.3	284	2.5	1235	2.6	524	2.5	995	2.6

Table VII-4A shows that the Weatherization Experts' reported that contractors performed the installations for 65 percent of the observed visits and crews performed the installations for 31 percent of the observed visits.

Table VII-4A. Crews and contractors observed

	Number	Percent
Crews	35	31%
Contractors	74	65%
Both	5	4%
TOTAL	114	100%

Table VII-4B shows that crews were more likely to have important information at the time of the installation.

- 91 percent of crews had household demographic data, compared to 22 percent of contractors.
- 77 percent of crews had the audit report, compared to 34 percent of contractors.
- 91 percent of crews had a materials list, compared to 49 percent of contractors.

Table VII-4B. Crews and contractors observed

Installer Information	Contractor		Crew	
	#	%	#	%
Household Demographics	16	22%	32	91%
Audit Report	25	34%	27	77%
Work Order	71	96%	35	100%
Materials List	36	49%	32	91%

Table VII-4C shows that crews had higher mean ratings for efficiency, professionalism and safety practices.

- Crews had a mean rating of 4.4 for measure installation efficiency, compared to 3.9 for contractors.

- Crews had a mean rating of 4.2 for measure installation professionalism, compared to 3.7 for contractors.

- Crews had a mean rating of 2.9 for measure installation safety practices, compared to 2.3 for contractors.

Table VII-4C. Measure installation professionalism ratings by type of measure installation staff

	Contractor		Crew	
	Number Rated	**Mean Rating**	**Number Rated**	**Mean Rating**
Efficiency	73	3.9	35	4.4
Professionalism	73	3.7	35	4.2
Cleanliness	73	3.8	35	4.0
Safety Practices	71	2.3	35	2.9

Table VII-4D displays mean ratings across all rated installation performance measures that were categorized as technical, education, or professional. The table shows that crews had higher mean ratings for professionalism than contractors. The other ratings were very similar for crews and contractors.

Table VII-4D. Measure installation ratings summaries by type of measure installation staff

	Contractor		Crew	
	Number Rated	**Mean Rating**	**Number Rated**	**Mean Rating**
Technical	554	3.0	386	3.1
Education	343	2.1	166	2.2
Professional	463	3.6	264	4.0
All Installation Ratings	1360	3.0	816	3.2

Note: Three agencies had different staff work on individual installations. One agency classified as contractor-based had 7 installations performed by contractors and 2 performed by crews. One agency classified as crew-based had 3 installations performed by crews, 1 performed by contractors, and 1 performed by both. One agency classified as crew-based had 4 installations performed by crews and 3 installations performed by both.

The following factors related to final inspections were reviewed.

- Use of an innovative program for inspection of weatherized units.
- Whether in-person instruction is required at the time of the final inspection.
- Agency quality control rating, based on the types of assessments conducted at the final inspection.

Table VII-5 shows that five agencies reported they had an innovative program for inspection of weatherized units and 13 reported that they did not. Agencies that reported they had an innovative program had a mean technical inspection rating of 3.3, compared to a mean rating of 2.3 for those who did not.

Table VII-5. Final inspection ratings summaries by agency report on inspection of weatherized units

	Agency Reported Innovative Program for Inspection of Weatherized Units			
	Yes		No	
# of Agencies[1]	5		13	
	Number of Ratings	Mean Rating	Number of Ratings	Mean Rating
Technical	63	3.3	202	2.3
Education	105	1.6	333	1.9
Professional	84	4.3	274	4.1
All Inspection Ratings	252	2.9	809	2.8

[1]One agency did not complete any final inspections and is not included in this table.

Table VII-6 displays final inspection summary ratings by whether or not the agency reported that the client education approach included in-person instruction at the time of the final inspection. The table shows that agencies that reported in-person instruction had higher technical and professional ratings than those who did not. However, they did not have higher education ratings.

Table VII-6. Final inspection ratings summaries by provision of in-person instruction at time of inspection

	Agency Provided In-Person Instruction at Time of Inspection			
	Yes		No	
# of Agencies[1]	14		4	
	Number of Ratings	Mean Rating	Number of Ratings	Mean Rating
Technical	234	2.6	31	1.7
Education	382	1.9	56	1.8
Professional	312	4.2	46	3.5
All Inspection Ratings	928	2.9	133	2.4

[1]One agency did not complete any final inspections and is not included in this table.

The following factors related to all aspects of weatherization services were reviewed.

- Use of an innovative education approach.
- Use of an innovative weatherization staff training approach.
- Number of different types of training activities provided by the agencies.
- Level of education provided by the agency, determined by the mix of education methods reported by the agencies.
- Level of training provided by the agency, determined by the mix of training activities reported by the agencies.

The only one of these factors that was related to agency ratings was the reports of having an innovative program for training weatherization staff. Table VII-7 displays averages across all technical ratings by whether the agency reported that they have an innovative program for training their weatherization staff. The table shows that agencies that reported they had an innovative training program had higher mean technical audit and inspection ratings than those who did not. Three of the 19 agencies reported that they had this type of program.

- Agencies that reported an innovative training program had a mean across all technical audit ratings of 3.4 compared to 2.3 for those who did not.

- Agencies that reported an innovative training program had a mean across all technical inspection ratings of 3.2 compared to 2.4 for those who did not.

Table VII-7. Technical ratings summaries by agency report on weatherization training program

	Agency Reported Innovative Program for Training Weatherization Staff			
	Yes		**No**	
# of Agencies[1]	3		16	
	Number of Ratings	**Mean Rating**	**Number of Ratings**	**Mean Rating**
Audit	58	3.4	343	2.3
Installation	125	3.3	815	3.0
Inspection	39	3.2	226	2.4
All Technical Ratings	222	3.3	1384	2.7

[1]One agency did not complete any final inspections and is not included in the Final Inspection Technical figures.

B. IMPACTS

The rationale behind the study design was that if weatherization providers accurately determine which measures have the greatest potential impact; effectively install selected measures according to best weatherization practices; and carefully inspect the completed job for safety, completeness, and quality, the program will produce high quality work that significantly reduces energy usage.

This study focused on the implementation of the program, rather than the savings that were achieved. However, the WAP impact analysis assessed agency-specific results for agencies that had at least eight single family homes with sufficient usage data to assess energy savings. There were 120 agencies that had sufficient data to assess the agency-specific gas savings and eight of the 19 observed agencies were included. There were 103 agencies that had sufficient data to assess the agency-specific electric savings and eight of the studied agencies were included.

Due to the small numbers of observations per agency and the fact that only eight of the agencies had enough data to compute agency-specific savings results, it is difficult to draw conclusions regarding the relationship between observed performance quality and energy savings impacts.

Table VII-8 displays agency-specific summary ratings and savings for agencies that had sufficient usage data. There is not enough data to draw any conclusions, but it is noteworthy that three of the top four ranked agencies had either gas or electric savings that were in the top five percent of the agencies that could be ranked by savings values.

Table VII-8. Agency-specific summary ratings and savings

Education		Technical		Professionalism		Overall		Electric Savings	Gas Savings
Number of Ratings	Mean Rating	Number of Ratings	Mean Rating	Number of Ratings	Mean Rating	Number of Ratings	Mean Rating	Top 5%	Top 5%
83	3.2	106	3.0	104	4.7	293	3.7	NO	YES
77	2.9	67	3.7	74	4.2	218	3.6	NO	NO
107	2.1	97	3.7	94	4.6	298	3.4	YES	NO
90	2.5	58	3.2	82	4.1	230	3.3		YES
65	2.8	67	3.1	60	4.3	192	3.3		
71	2.5	67	2.8	66	4.2	204	3.1		
76	2.1	91	3.2	74	4.2	241	3.1	NO	NO
104	2.4	97	2.8	87	4.3	288	3.1	NO	NO
63	1.7	58	2.9	53	3.9	174	2.8	NO	NO
80	1.7	78	3.1	72	3.8	230	2.8		
141	1.9	143	2.6	123	3.7	407	2.7	NO	
90	2.4	84	3	73	2.9	247	2.7		
77	1.4	81	2.7	84	3.7	242	2.6		
71	1.4	60	2.5	60	4.1	191	2.6		
89	1.5	103	2.6	73	3.7	265	2.5		
107	1.2	116	2.5	98	3.6	321	2.4	NO	NO
103	1.4	113	2.2	92	3.4	308	2.3		
85	1.6	58	1.9	65	3	208	2.2		
72	1.7	62	1.6	65	2.3	199	1.9		

VIII. FINDINGS AND RECOMMENDATIONS

This research study demonstrated that there are many strong areas in the service delivery process, but also significant opportunities for improvement. This section of the report summarizes the strengths and opportunities and provides recommendations for staff training and program management.

Weatherization Experts and Social Scientists concluded that the Weatherization Assistance Program works very well in most cases. Services are delivered relatively efficiently. Most of the work observed was of good or fairly good quality. Staff members and contractors were reported to have a true commitment to do their best to assist clients, but often need more training and experience.

Detailed results show the specific areas for focus, but the general findings were that client education, communication through written audit findings, and parts of the technical implementation could be improved. To significantly impact these areas, agency management needs to set the tone for what is expected. The key issues are as follows.

- Ensure that program requirements and specifications are clearly defined by agency management and are systematically documented in procedures manuals.
- Prioritize classroom and in-field training for all auditors and installers.
- Conduct assessments to determine where additional training is needed.
- Tailor additional training to quality control findings.
- Emphasize client communication and education as an integral aspect of all stages of service delivery.

Table VIII-1 displays means and the number of each level rating across all education ratings, all technical ratings, all professional ratings, and all ratings.

- Education: The mean rating was 2.0. This is a low rating and indicates the need for significant improvement in staff and contractor communication and education.

- Technical: The mean rating was 2.8. This is a mid-level rating and indicates that there is some opportunity for improving technical skills of the staff and contractors who implement the program.

- Professional: The mean rating was 3.9. This is a high rating that reflects the commitment and dedication that was seen in the field. The one aspect of professionalism that needs improvement is the safety practices, particularly for the installation workers.

Table VIII-1. Summary ratings

	Number Assessed	Needs Improvement → Percent With Each Rating → Excellent					Mean Rating
		1	2	3	4	5	
All Education	1,651	44%	31%	13%	7%	5%	2.0
All Technical	1,606	16%	29%	27%	16%	12%	2.8
All Professional	1,499	4%	13%	18%	24%	41%	3.9
All Ratings	4756	22%	24%	20%	15%	19%	2.9

A. STAFF

Agency staff and contractors played an important role in this research by cooperating with evaluators and providing access to their work. The staff members at the agencies were ready for the Social Scientists and the Weatherization Experts and helped ensure that they were able to conduct interviews and observe work in progress.

Both the Social Scientists and the Weatherization Experts reported that the staff members were uniformly dedicated to their work, showed tremendous concern for the clients they served, and often went beyond their defined jobs to assist clients in additional realms. On one job, the installer drove the client to the nursing home to visit her husband on the installer's lunch hour.

The weatherization staff showed great pride in their work. They took care to leave the homes safer for the occupant. When there were issues with the hand railings, steps, or other structural issues that could contribute to falls, they were usually addressed right away, even on a crew member's own time.

The observers reported that the installers on the jobs worked well together as a team. They worked together to call on past experiences and collectively solve the problems that they encountered. There was an understanding among the members of the team, where each member knows his or her role, and took that responsibility seriously. The crew leaders had pride and ownership in their trucks, and were careful with how they were set up. Some of the very hands on crew leaders assisted their staff with the work and reassigned those who finished their tasks. Many long-time contractors were seen, and appeared to provide great benefit to the program. Several observers commented specifically on highly skilled HVAC contractors who were part of the program.

There were many additional challenging conditions that were faced by the weatherization staff and contractors.

- They encountered difficult conditions in the home, such as hoarding, which added hours to the time needed to complete their work.
- They fended off dogs; worked in dirty, dusty, and hot attics; and saw many rough neighborhoods.
- They faced clients that were not always trusting. In one case, the client would not open the door until the husband came home, and the staff stayed and waited.
- The clients did not always follow the auditor's instructions. Clients had not cleaned attics when the installers arrived to do their jobs, leading to the need to reschedule.
- There were language barriers. Some of the auditors and staff communicated with clients in the foreign language, or they had neighbors or relatives provide translation.
- Some of the providers had very large service territories, meaning that they had to spend their work week travelling and staying in hotels, because it was too far to return home to their families.

Despite these challenges, these staff and contractors were dedicated to assist clients and help improve their lives.

B. AUDIT

Analysis of all audit observation ratings across educational categories, technical categories, and professional categories showed that auditors scored highest in terms of their professionalism. The mean ratings on the five-point scale were as follows.

- Audit education – the mean rating was 2.0, a low rating indicating significant room for improvement.

- Audit technical – the mean rating was 2.5, between low and mid-level, also indicating significant room for improvement.

- Audit professional – the mean rating was 3.8, fairly high, indicating the high level of concern and respect for clients.

The strengths of the audit education process are summarized below.

- The audit introduction included an explanation of WAP in 77 percent of the observed cases.

- The audit exit interview included a summary of findings in 81 percent of the observations, a discussion of measure options in 80 percent of the observations, and information on next steps in 95 percent of the cases.

There were many opportunities for improvement found in the audit education process. The following areas could be improved by providing additional discussion with clients.

- Energy bills – 12 percent reviewed bills at the introduction and seven percent at the exit.
- Problems with energy usage – 34 percent asked about problems with energy usage.
- Usage reduction – 21 percent discussed actions to reduce usage.
- Home comfort – 38 percent discussed whether part of the home is too cold.
- Thermostat settings – 29 percent discussed heat and 39 percent discussed air conditioner settings.
- Heat setback – 10 percent discussed heat setback when not at home.
- Hot water usage – 8 percent discussed efficient hot water usage.
- Lighting – 29 percent discussed how clients use lighting.
- Behavior change opportunities – 10 percent summarized behavior change opportunities.

Because these discussions were frequently not part of the audit, the audit education ratings were low.

- Audit intro rating – the mean rating was 2.2, low on the rating scale.
- Exit interview – the mean rating was 1.6, very low on the rating scale.
- Client engagement – the mean rating was 2.0.
- Education quality – the mean rating was 1.7.

There were a greater number of strengths noted with respect to the technical aspects of the audit. The following areas of the home were inspected or the items were measured in more than 70 percent of the observations.

- Inspection – 99 percent inspected every accessible room.
- Heating system – 94 percent inspected the heating system.

- Filters – 72 percent inspected filters.
- Ventilation – 72 percent inspected the kitchen and 78 percent the bathroom ventilation.
- Water heater – 93 percent inspected the water heater.
- Air conditioning – 82 percent inspected the outside air conditioning unit.
- Insulation – 89 percent measured insulation in all accessible attics.
- Testing – 97 percent conducted a blower door test and 84 percent were done correctly.

As a result, the audits were rated to be comprehensive, as was the work that was planned at the conclusion of the audit.

- Audit comprehensiveness was rated highly – 48 percent were rated as excellent and 47 percent as good.
- Planned work comprehensiveness was rated highly – 49 percent were rated as excellent and 48 percent as good.

There were major opportunities for improvement with respect to the technical aspects of the audit. The following items were not regularly inspected or tested.

- Bathroom ventilation flow – 24 percent assessed this aspect of ventilation.
- Hot water – 39 percent checked the hot water temperature at the faucet.
- Shower flow – none of the auditors measured the water flow.
- Insulation – 49 percent measured insulation in exterior walls.
- Blower door – 67 percent used the blower door while inspecting for leaks.
- Zonal pressure diagnostics – 42 percent conducted (87 percent done correctly.)
- Infrared (IR) camera – 49 percent used the camera (70 percent correctly.)

As a result, the audit testing ratings were low.

- Testing completeness – the mean rating was 1.9, low on the rating scale.
- Testing quality – the mean rating of 2.4, low to mid-level on the rating scale.

The Weatherization Experts also found that the audit forms did not often contain all of the necessary information or the information was not recorded accurately. Therefore, the audit write-up quality was rated 2.6, low to mid-level on the rating scale.

C. MEASURE INSTALLATION

Analysis of all measure installation observation ratings across educational categories, technical categories, and professional categories showed that installers scored highest in terms of their professionalism. The mean ratings on the five-point scale were as follows.

- Measure installation education – the mean rating was 2.2, a low rating indicating significant room for improvement.

- Measure installation technical – the mean rating was 3.0, a mid-level rating, indicating that some measures were done well and some showed opportunities for improvement.

- Measure installation professional – the mean rating was 3.8, fairly high, indicating the high level of concern and respect for clients.

The strengths of the measure installation education process are summarized below.

- The introduction included important explanations – 77 percent explained the purpose of the visit and 79 percent explained the planned measures.
- The auditors received good communication ratings – the mean rating was 3.2 for installer communication.

The opportunities found in the measure installation education process were as follows.

- The introduction often did not include an explanation of WAP – 29 percent of the installers explained WAP.
- The auditors received low ratings for client engagement – the mean rating was 2.1.
- The auditors received low ratings for education quality – the mean rating was 1.9.

There were a greater number of strengths noted with respect to the technical aspects of the measure installation. The air sealing and insulation were usually implemented according to best practices.

- Air sealing prioritized the right arrears – 77 percent prioritized sealing at the top and bottom of the envelope.
- Attic insulation followed best practices – 77 percent completed attic floor sealing prior to insulation, 88 percent had no gaps or voids, and 95 percent used appropriate materials.

As a result, installation ratings were mid-level to high on average.

- Window work ratings – the majority of window measure ratings averaged between 3.5 and 4.0.
- Door work ratings – the ratings averaged between 2.8 to 3.5, mostly in the mid-level.
- Air sealing cleanliness rating – the rating averaged 3.9, high on the ratings scale.
- Attic insulation ratings – quality averaged 3.3 and cleanliness averaged 4.0, mid and high on the rating scale.
- Wall insulation ratings – quality averaged 2.9 and cleanliness averaged 4.3.
- Basement insulation ratings – quality averaged 3.6 and cleanliness averaged 4.5.
- Crawl space ratings – measures averaged 3.1 to 4.0.
- Ventilation ratings – measures averaged 4.1 to 4.8.
- Thermostat installation rating – quality averaged 4.1.
- Air conditioning rating – most measures averaged 3.0 to 4.0.
- Water heater – measures averaged 3.1 to 4.0.

There were major opportunities for improvement with respect to the technical aspects of the measure installation.

- Air sealing diagnostics often did not the appropriate tests – 22 percent used the blower door to guide air sealing and 11 percent used the zonal pressure test to affirm appropriate pressure boundaries.
- Air sealing often missed major opportunities – 57 percent sealed all major opportunities.

Ratings were on the lower side for air sealing, heating system work, and smoke and CO detectors.

- Air sealing ratings – overall quality averaged 2.4, fairly low on the rating scale.
- Heating system ratings – most measures averaged 2.0 to 2.5.
- Smoke and CO detector ratings – these ratings averaged 2.6 and 2.0.

D. FINAL INSPECTIONS

Analysis of all final inspection observation ratings across educational categories, technical categories, and professional categories showed that inspectors scored highest in terms of their professionalism. The mean ratings on the five-point scale were as follows.

- Final inspection education – the mean rating was 1.9, a low rating indicating significant room for improvement.

- Final inspection technical – the mean rating was 2.5, a low rating, indicating some opportunities for improvement.

- Final inspection professional – the mean rating was 4.1, fairly high, indicating the high level of concern and respect for clients.

The strengths of the final inspection education process are summarized below.

- The final inspection visit was expected – 97 percent expected the visit.
- The inspectors discussed the work that was performed – 75 percent discussed the work that was performed with the client.

The opportunities found in the final inspection education process were as follows.

- Energy and cost savings were usually not discussed with clients – 28 percent discussed this with the client.
- Health and safety issues were usually not discussed with clients – 29 percent discussed this with the client.

As a result, the final inspection education ratings were low.

- Client engagement rating – mean rating was 1.8.
- Education quality – mean rating was 1.7.

The strengths noted with respect to the technical aspects of the final inspection are summarized below.

- Inspections were complete – 90 percent examined all accessible rooms.
- Blower door testing was usually conducted – 85 percent conducted this test (85 percent of those performed correctly.)

The final inspection testing was found to be of fairly good quality. The final inspection testing quality rating was 3.3 on average.

Major opportunities with respect to the technical aspects of the final inspections were to conduct additional testing.

- Zonal pressure test – 33 percent performed the test (87 percent done correctly.)
- IR camera – 44 percent used the camera (95 percent done correctly.)
- Combustion safety – 31 percent performed this test on the gas stove (100 percent done correctly.)

- Worst case draft test – 60 percent performed this test on the heating system (92 percent correctly.)

Therefore, the completeness rating for the final inspection testing was low, averaging 1.9.

Some of the specific findings that were noted with respect to opportunities for improved final inspections are summarized below.

- Huge variability was observed in terms of the breadth and depth of the final inspections. Some were done within 20 minutes, and did not go beyond a check that the work was done. Other inspections covered all aspects of the home and included complete health and safety testing. Program standards should define what the inspections include, to ensure that adequate quality control is provided.

- Some agencies had the staff member who conducted the audit on the home return to conduct the final inspection. This process does not provide a second opinion on the comprehensiveness of the work scope.

- Weatherization Experts found that homes were sometimes left in unsafe conditions following the final inspection. The inspectors did not always conduct combustion safety and worst case draft tests.

- Most inspectors had little interaction with the clients. They had the client sign their form, and this would have been a great opportunity to review the work that was done and explain each point of the process. This was a missed opportunity to communicate with the client.

However, some of the final inspections were more complete and some of the inspectors did take this opportunity to interact with the clients. Some inspectors made sure the client was satisfied with all of the work before they left the home.

E. EDUCATION

Observers noted that the provision of information that auditors and other weatherization staff referred to as client education was often dissemination of information about the weatherization process, rather than information that would enable the clients to take an active role in the process and in reducing their energy usage. Clients were told about the weatherization process and what was going to be done to their home, they received required notifications about potential hazards, and they sometimes received printed materials about energy savings and structured client action plans.

The client communication was conducted to inform the client about the work, the hazards and limitations, and, less frequently, actions that the client could take to save energy. It was very rare to observe a partnership developed between the client and the program. There was no continuity from intake to the final inspection concerning any individualized client action plan. We did not observe a process where education began at intake and was communicated through the paperwork, so that a client action plan could be discussed at each stage of the weatherization process.

Auditors have the opportunity to inform clients that they are a valuable resource in the audit. Some examples of how to positively engage the client were observed.

- The auditor asked the client to show him where the furnace was located. This achieved the intended effect of having the client accompany the auditor through the home.

- The auditor asked the client to demonstrate how she uses the clothes dryer. This engaged the client in the audit and provided an opportunity for education about efficient dryer usage.

- The auditor handed the client a tape measure and had the client assist with measuring the room. This established the client as a partner in the process, and treated the client as a part of the team, as opposed to someone that the auditor is doing something for.

- The auditor used the diagnostic testing as an opportunity to educate the client. This engaged the client in the audit and provided the client with information about how energy is used in the home.

- The auditor acknowledged positive actions the client had taken, such as installing smoke detectors and installing CFLs. This positive reinforcement can lead to additional client actions.

Many of these actions were observed by the Social Scientists and Weatherization Experts. However, the typical workers did not take these actions or only did so at infrequent intervals during the process.

F. SAFETY

Installers generally did not follow practices to protect themselves while performing the installations. The level of lead safe work observed varied from being in compliance with regulations to completely ignoring the hazard and exposing both workers and clients to the potential hazard of lead paint dust. Observers found that installers often did not wear personal protective equipment, including not wearing respiratory protection while in confined areas or while blowing insulation and not using protective equipment while cutting and sawing, including no safety glasses, ear plugs, or gloves. There were several observed cases where workers put themselves or their clients at risk.

- One Weatherization Expert observed a home where the installer was creating vermiculate dust and did not have the client leave the home.

- There were cases where the auditors and installers did not check for knob and tube wiring.

- Installers often did not use gloves or eye protection, and were not safe on their ladders. Most did not wear respirators.

- One of the workers installed spray foam against the chimney. This is a rare example of where the Weatherization Expert intervened, to prevent an unsafe condition for the client. In this case, the worker did not understand that this was an unsafe procedure.

- There were observations where booties and drop clothes were not used. The workers sometimes have the mindset that they should work quickly and can clean later.

- In another case the installers placed a sheet to walk on to enter the home, but then walked back and forth, creating a mess on sheet that was tracked into the home. The contaminants were not contained.

- A Weatherization Expert saw a large amount of plaster disturbed in a baby's room without any of the furniture or toys covered.

It is important to note that these instances were specific to certain crews and contractors. There were other staff and contractors who did very good jobs, such as calling for the auditor to come to the job when knob and tube wiring was discovered during insulation installation, and using plastic and other safe practices when working with lead.

G. TRAINING AND EQUIPMENT

There were several specific training needs that were identified as a result of the observation findings.

- Energy bill utilization – how to use bills to assess services needed and to educate clients
- Building science fundamentals
- Critical thinking – assessing unique situations
- Combustion safety testing
- Zonal pressure testing
- IR camera use – they were not used consistently
- Ventilation assessment
- Safe work practices – worker safety and lead safe work
- Interviewing skills – how to understand the client's needs
- Client education

The key equipment needs that were noted were as follows.

- GPS
- IR camera
- Boroscope and fiber optic scope and video
- Personal safety equipment

Challenges identified with providing adequate training were as follows.

- More clarity is needed on program specifications and procedures.
- Sufficient time must be allocated for training.
- Pressure for job production often overwhelms the need for training.
- Agency management does not always prioritize training.

Some strategies for national, state, and local management to improve the availability and quality of training are as follows.

- Increased resources for staff training can lead to improved client outcomes and workforce development.
- A combination of classroom and field training can provide all types of learners with the types of experiences needed.
- Greater attendance at national conferences can provide information on best practices and increase motivation for improved performance.
- A focus on why tests are conducted can improve understanding of how to properly conduct the tests.
- An emphasis on client education as an important "measure" is needed to improve this aspect of service delivery.
- Reinforcement of training topics with monitoring, assessment, and feedback can lead to improved implementation and service delivery quality.

H. MANAGEMENT

The general opportunities identified for program management were as follows.

- Standards and procedures
- Policy manuals
- Forms and checklists

Specific recommendations with respect to standards and procedures were identified.

- Basic training – guidelines for what basic training and certification is needed should be developed. (DOE is in the process of developing certifications for auditor, crew chief, installer, and quality assurance staff.)

- Health and safety policies – these policies need to be defined. Health and safety issues were ignored by some agencies and taken very seriously by others. The state needs to define how staff members are to deal with pets, parking, bathroom use, and overall job cleanliness.

- Personal protective equipment – use of this equipment was often lacking. Agencies should be required to provide equipment and enforce that it is used.

- Blower doors – staff should be required to use this equipment. Some staff did not have them and some just did not use them. In one state, the contractors did not have them.

- Diagnostic and safety testing – the state should specify what tests need to be conducted and when. Testing varied tremendously from one agency to another.

- HVAC contractors testing – the state should require HVAC contractors to test on the way out. Weatherization Experts observed cases where this was not required.

- ASHRAE 62.2 – the state should define when this policy needs to be implemented.

- Deferral policies – the reasons for deferring a job need to be clearly defined.

Specific recommendations with respect to policy manuals were identified from the perspective of the local agency.

- States should be required to create and periodically update procedures manuals. These manuals were not always available at the local agency.

- DOE could provide a model guide and allow states to adopt the model as is, revise, or create their own. This could help the states to ensure that their manuals were well-designed, comprehensive, and useful to local agency staff.

- States should be required to have a process and timetable for revising and updating the manual, and should have a stakeholder input process.

Recommendations with respect to forms and checklists were identified.

- Agencies need to have a formal audit checklist and process. When auditors did not have good forms to utilize, they left out important aspects of the audit. When there was a formal process, the staff followed it step-by-step, and every auditor did the same work.

- Agencies should require detailed audit write-ups and work orders. Many of the write-ups and work orders that Weatherization Experts reviewed were not thorough or sufficient.

- Agencies should have a checklist for the test out, as well as for the audit and work scope.