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ORNL/CON-498

National Evaluation of the Weatherization Assistance Program: Preliminary Evaluation Plan for Program Year 2006

February 2007

Prepared by

Mark P. Ternes
Martin Schweitzer
Bruce Tonn
Richard Schmoyer
Joel F. Eisenberg

UT-BATTELLE

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Engineering Science and Technology Division

NATIONAL EVALUATION OF THE WEATHERIZATION ASSISTANCE PROGRAM: PRELIMINARY EVALUATION PLAN FOR PROGRAM YEAR 2006

Mark P. Ternes
Martin Schweitzer
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Prepared by
OAK RIDGE NATIONAL LABORATORY
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LIST OF ACRONYMS

AFUE	Annual Fuel Utilization Efficiency
AHS	American Housing Survey
ANOVA	Analysis of variance
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
Btu	British thermal unit
CATI	Computer assisted telephone interviewing
CDA	Conditional demand analysis
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
CH4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CPS	Current Population Survey
CV	Coefficient of variance
DOE	Department of Energy
EERE	Energy Efficiency and Renewable Energy
GPRA	Government Performance and Results Act
IMT	Inverse Modeling Toolkit
kWh	Kilowatt hours
LIHEAP	Low-Income Home Energy Assistance Program
NAC	Normalized annual consumption
NASCSP	National Association For State Community Services Programs
NCAF	National Community Action Foundation
NEI	Non-energy impact
NOx	Nitrogen oxides
O_2	Oxygen
OMB	Office of Management and Budget
ORNL	Oak Ridge National Laboratory
PBA	Planning, Budget, and Analysis
PM	Particulate matter
PRA	Paperwork Reduction Act
PRISM	Princeton Scorekeeping Method
PVE	Petroleum Violation Escrow
PY	Program year
R^2	Coefficient of determination
RECS	Residential Energy Consumption Survey
SAE	Statistically Adjusted Engineering
SIR	Savings-to-investment ratio
SOx	Sulfur oxides
SSI	Supplemental Security Income
TANF	Temporary Assistance for Needy Families

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1. INTRODUCTION AND OVERVIEW

The U.S. Department of Energy's (DOE's) Weatherization Assistance Program was created by Congress in 1976 under Title IV of the Energy Conservation and Production Act. The purpose and scope of the Program as currently stated in the Code of Federal Regulations (CFR) 10CFR 440.1 is "to increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential expenditures, and improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden" (Code of Federal Regulations, 2005).

DOE sponsored a comprehensive evaluation of the Program in the early 1990's to provide policy makers and program implementers with up-to-date and reliable information they needed for effective decision making and cost-effective operations. Oak Ridge National Laboratory (ORNL) managed the five part study which was based primarily on data from Program Year (PY) 1989 and supplemented by data from 1991–92 (Brown, Berry, and Kinney, 1994). In more recent years, ORNL has conducted four metaevaluations[1] of the Program's energy savings using studies conducted by individual states between the years 1990–1996 (Berry, 1997), 1996–1998 (Schweitzer and Berry, 1999), 1993–2002 (Berry and Schweitzer, 2003), and 1993-2005 (Schweitzer, 2005).

DOE announced through its Weatherization Program Notice 05-1 (DOE, 2004) that it would undertake a new national evaluation of the Program because the Program that was evaluated comprehensively in the early 1990's is vastly different from the Program of today. The Program has incorporated new funding sources, management principles, audit procedures, and energy-efficiency measures in response to findings and recommendations resulting from the 1989 National Evaluation, the Weatherization *Plus* strategic planning process, and other federal, state, and local initiatives. For example, the use of computerized audits has increased, cooling and baseload measures have been added, weatherization approaches tailored to the unique construction characteristics of mobile homes have been developed, the weatherization of large multifamily buildings has expanded and become more sophisticated, the flexibility to improve "energy-related" health and safety has been provided, and leveraging with utilities, other state programs, and owners of large multifamily buildings has increased considerably.

The Department of Energy tasked ORNL with planning the new evaluation in light of its experience in conducting the previous national evaluation and the metaevaluations. This preliminary evaluation plan, developed by ORNL, documents how the new national evaluation will be performed. In the remaining portion of this section, the purpose and fundamental questions the evaluation will address are identified and how these questions were derived is discussed.

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[1]Metaevaluations refer to the analysis of analyses, and are a more rigorous alternative to the narrative discussion of research studies. Metaevaluations involve the statistical analysis of a collection of analysis results from individual studies for the purpose of integrating the findings.

1.1 PURPOSES AND RESEARCH QUESTIONS

DOE stated in Program Notice 05-1 that the purposes of the new evaluation are to (1) provide a comprehensive review of Program performance, and (2) enable DOE to make any necessary improvements and guide the direction of the Program into the next decade. In addition, a third purpose identified during the planning process is for the evaluation to provide information of interest to potential funders in order to support leveraging activities. To expand upon these directives and develop a consensus on the general questions to be addressed by the evaluation, input was solicited from a Network Planning Committee and a formalized planning process based on the concept of a program logic model and evaluation design matrix as developed by the W. K. Kellogg Foundation (2001) was undertaken.

1.1.1 Network Planning Committee

The evaluation must meet the needs of the weatherization community since they will be a primary beneficiary and user of the evaluation's findings to improve the Program. In addition, the network of state offices and 900 local agencies will be relied upon to collect and provide significant amounts of the data needed for the evaluation. Therefore, ORNL felt that it was important to engage the weatherization network early in the planning process in order to establish open communications with them, get them actively engaged in the evaluation, strengthen the network's voice in the planning process, clearly identify their expectations of the evaluation, and increase the network's participation in the evaluation's implementation.

ORNL selected 41 people to serve on the committee after receiving recommendations from DOE headquarters and regional program staff, the National Association For State Community Services Programs (NASCSP), and the National Community Action Foundation (NCAF). The committee members are identified in Appendix A. Seventeen committee members represented their state's weatherization program, 12 committee members were from local agencies from 10 states, 3 staff from DOE headquarters and 2 staff from DOE regional offices were on the committee, 2 people were from advocacy organizations, 2 people were from state training centers, 2 people were contractors to either DOE headquarters or the Central region office, and 1 person was a citizen's advocate.

The Network Planning Committee met on March 23-24, 2005. The committee was chartered by ORNL to provide input on the information that could be provided by the national evaluation that they would find useful; identify data pertinent to the evaluation that are available at national, regional, state, and local levels; and provide insights into how implementation of the evaluation and specifically data collection could be optimized. This information was solicited to assist ORNL in developing the research questions to be addressed by the evaluation, identifying the various studies that would need to be performed under the evaluation, and formulating implementation details.

A moderator led the group through various discussions of how results from the 1989 National Evaluation were used, how the Program and its operating environment have changed since 1989, and how these changes might impact the national evaluation. After brainstorming on possible goals and priorities for the national evaluation, details were developed on nine high priority and consensus goals:

1. **Energy Savings Analysis**—In measuring the energy savings achieved by the Program, the evaluation should quantify the savings by climate region[2], house type, and type of household; measure savings in houses heated by oil and propane; isolate the direct effect of specific measures when possible; and supplement analysis using monthly client bills with submetered data if possible to improve accuracy and add context to the bill analysis results.

2. **Baseload Measures**—Baseload electricity savings (for end uses other than space heating or air conditioning) should be measured so that reasonable expectations for this "new" category of measures allowed under the Program are established and validated, electricity savings are calculated on all houses, and the evaluation provides information pertinent to electric utilities and ratepayers.

3. **Non-Energy Impacts**—Non-energy impacts should be quantified so that areas where the Program should be credited (e.g., health and safety, comfort, sustainability, emission reductions, market transformation) are systematically laid out; the benefits from weatherization efforts such as client education, incidental repairs, and health and safety are quantified; total Program costs can be compared against total benefits; and the synergy for multiple funding sources and the groundwork for partnerships between the Program and other organizations can be established.

4. **Cost Effectiveness**—In examining the Program's cost effectiveness, the evaluation should address a policy issue concerning the impact that alternative per household investment levels can have on key Program metrics such as number of units weatherized, average savings per house, and Program-wide cost effectiveness.

5. **Computerized Audits**—The use of computerized audits and computer-based priority lists should be evaluated to determine the personnel, their skill levels, and costs required to implement each approach; the weatherization measures installed, their costs, and the energy savings achieved under each approach; the incremental benefits and cost effectiveness of moving from a priority list to a computerized audit approach; and ultimately which approach is better and/or more effective.

6. **Client Education**—Client education should be evaluated to determine its impacts and effects on energy savings, cost effectiveness, health and safety, longevity of measures, and other Program and client variables; what methods (approaches and materials) are most effective to different demographic groups; who is most effective in delivering client education; and the incremental benefits and cost effectiveness of moving from minimum approaches (e.g., dropping off a pamphlet) to more in-depth education.

7. **Training**—Training and certification provided primarily at the state level but also by the Program nationally and by agencies to their staff should be evaluated to determine its impact

[2] Four climate regions consistent with those used in the 1989 National Evaluation will be used: cold climate, moderate climate, hot-humid climate, and hot-dry climate.

on energy savings, cost effectiveness, staff retention, quality of work, and measure effectiveness; what methods (e.g., classroom versus field, use of training centers) and frequency are most effective, result in greater knowledge retention by the attendees, and are best suited for training subcontractors; the qualifications of trainers; the training requirements for weatherization and management staff; and if training funds are being spent expeditiously.

8. **Monitoring**—Technical monitoring performed by states of agencies and the internal quality assurance performed by agencies of their own work should be evaluated. State-level monitoring should be assessed to determine the consistency of monitoring among states and among monitors within a state; the impact of monitoring on energy savings, cost effectiveness, quality of work, and measure effectiveness; what sampling rates (e.g., monitoring of every unit versus a sample) are most effective; who is most effective at performing monitoring (e.g., state staff, subcontractors, monitors assigned to agencies versus random assignment, peers); the qualifications of monitors; and the role technical assistance has in the state's monitoring efforts. Agency-level quality assurance should be assessed to determine if post-weatherization inspections are being done properly; the impact of quality assurance on energy savings, cost effectiveness, quality of work, and measure effectiveness; what methods (e.g., post-inspections versus inspecting work in progress) are most effective; who is most effective at performing monitoring (e.g., agency staff, subcontractors, a dedicated agency inspector versus using crew foreman to inspect each other); and the qualifications of inspectors.

9. **Hot Climate/Cooling Measures**—Emphasis should be placed on the hot climate region and cooling measures so that cooling savings along with heating and baseload savings are accounted for; issues related to the condition of the housing stock, health and safety (e.g., unvented space heaters), and weatherization measures (e.g., window air conditioners, shading devices) that are specific to the hot climate region are addressed; the weatherization services provided and savings achieved in the hot climate states are substantiated; and ultimately the level of investment and weatherization approaches needed to achieve cost-effective energy savings are determined.

The Network Committee was apprized of the status of the evaluation during the development of the preliminary evaluation plan and given an opportunity to review and comment on draft versions of the preliminary evaluation plan.

1.1.2 Program Logic Model

In following the W. K. Kellogg Foundation's formalized evaluation planning process, development of a program logic model is an integral first step before formulating a set of program evaluation questions within the framework of a design matrix. The logic model shown in Table 1.1 presents a picture of how the Program is intended to work by systematically identifying the resources available to operate the Program, the activities the Program is intended to perform, and the changes or results the Program hopes to accomplish. The logic model for the Program shown in Table 1.1 is comprised of five sections:

Table 1.1. Logic model for the Weatherization Assistance Program

Resources/ Inputs	Roles/Activities	Outputs	Outcomes		
			Short-Term	Medium-Term	Long-Term
Federal authorizing legislation Direct funding from DOE, LIHEAP, PVE, and leveraged sources DOE Program staff State grant administration agencies and related national organizations Local service network of 900 agencies and related national organizations Support network in national laboratories, training centers, and support contractors with special technical skills Utilities and national and state energy organizations	**DOE** - Establish and explain national policy direction - Formulate annual budgets and grant guidance, and make grants - Formulate Program rules and regulations - Initiate and coordinate strategic planning with network - Approve and monitor state plans and their implementation - Create, coordinate, and conduct technical training and assistance to state and local agencies - Develop and maintain core capabilities of the Program including audit tools and standards, evaluations, and assessments - Coordinate Program relations with other Federal agencies, programs, and institutions **States** - Set eligibility requirements and priorities for participants - Contract with local agencies and allocate funding - Establish production goals (number of units weatherized) and schedule - Specify diagnostic, audit, and inspection procedures and allowable measures for local agencies - Determine extent of allowable repair, health, and safety work - Provide training and assistance to local agencies - Establish leveraging programs and expand resources and partnerships - Monitor local agency work **Local Agencies** - Solicit and process applications and select low-income residents to receive weatherization services - Train crew members - Perform home energy diagnostics, audits, and inspections - Determine most cost-effective weatherization measures and other work needed for each home - Purchase, store, and maintain equipment, materials, and supplies - Install measures and perform other specified work - Perform quality assurance work - Meet with clients to review improvements and provide educational materials - Support advocacy and leveraging - Link clients to other programs and services - Track and report client status, expenditures, and funding	Number of low-income homes weatherized Number of priority households weatherized Cost-effective measures installed in weatherized homes Health and safety deficiencies mitigated in weatherized houses Clients receive education on energy savings Number of weatherization staff trained Number of clients referred to social programs Guidance and regulations published Audits developed, improved, and approved Partnerships established	Weatherized homes, particularly those of priority populations, have increased energy efficiency Health and safety of those living in weatherized homes improved Indoor comfort of those living in weatherized homes improved Clients have increased knowledge of energy savings strategies	Reduced energy consumption in weatherized houses Reduced energy bills and burdens for clients Reduced emissions of pollutants and greenhouse gases involved in energy production and consumption Other non-energy benefits for clients, utility rate payers, and society Robust weatherization network Increased Program leveraging	Reduced gap between low-income energy needs and actual consumption of energy services Reduced impact of energy price inflation and market disruptions on low-income communities Improved health and safety for communities Improved local housing stock Workforce enhancement in local communities Creation of sustainable weatherization services market Increased non-energy purchases in low-income communities Transform market for weatherization products

1. **Resources/Inputs** — The human, financial, organizational, and community resources available to operate the Program are identified in this column. The federal legislation authorizing the Program was identified as an input because it stipulates the mission and overall objectives of the Program. Financial resources include direct DOE funding of the Program, funding from other federal sources such as the Low-Income Home Energy Assistance Program (LIHEAP), Petroleum Violation Escrow (PVE) funds, and leveraged sources such as state public benefits funds or utility programs. The organizations involved with the Program include the DOE Program staff; the state grantees and local agency subgrantees that directly implement the program along with their related national organizations; a network of support groups such as the DOE national laboratories, state and regional training centers, and various support contractors; and other organizations such as utilities and national and state energy organizations.

2. **Activities**—The processes, techniques, tools, events, technologies, and actions that the Program conducts with the resources are considered its activities. The primary activities within the Program are performed by three groups: DOE, the state grantees, and the local agency subgrantees. DOE's activities focus on administrating and running the Program and involve developing policy, guidance, and regulations, making and monitoring grants, providing training, maintaining technical capabilities and tools, performing periodic evaluations, and coordinating with other organizations. The activities of the state are also administrative in nature as they involve making and monitoring contracts with the local agencies, establishing goals and implementation procedures for the agencies, providing training, and establishing partnerships to leverage resources. The activities of the local agencies implement the program at its basic level because they identify clients and perform all the tasks needed to select and install weatherization measures. The local agencies also perform some administrative functions such as providing client education, referring clients to other programs and services, and teaching crews correct procedures to perform these tasks.

3. **Outputs**—The Program's outputs are the direct products and services delivered as a result of the Program's activities. DOE's activities result in guidance and regulations being published and audits being developed, improved, and approved. Quantitatively, through the activities of DOE, the states, and local agencies, a known number of homes are weatherized, priority households weatherized, weatherization staff trained, and clients referred to other programs or services. Other important services resulting from the Program include the installation of cost-effective measures in the weatherized homes, the mitigation of health and safety deficiencies in these homes, and the education of clients on energy. Through the combined efforts of all organizations, partnerships with the Program are established.

4. **Short-Term and Medium-Term Outcomes**—Program outcomes are those short-term (1–3 months) and medium-term (1 year) changes that occur in the Program participants, participating households, and the Program itself as a result of the Program's activities. Immediate results of the Program are that the energy efficiency of the weatherized homes is increased; the health, safety, and comfort of those living in the weatherized houses are improved; and clients have an increased knowledge of energy saving strategies. In the medium term, energy consumption in the weatherized houses is reduced which leads to reduced energy bills and energy burdens for the clients, and non-energy benefits are realized

by the clients, utility ratepayers, and society as a whole, especially those related to a reduction in pollution and greenhouse gases from reduced energy use. In addition, a more robust weatherization network should result and Program leveraging should increase.

5. **Long-Term Outcomes**—The fundamental, long-term (3–7 years) changes in organizations, communities, or systems that result from the Program's activities should be thought of as its long-term outcomes. Over time, by reducing energy use and energy burdens on low-income clients, the gap between the energy needs of the low-income community and the available resources to meet this need should be reduced, the low-income community should be less susceptible to rising energy prices and market fluctuations, and clients should have more funds available to make non-energy purchases within the low-income community. Non-energy benefits realized by the community as a result of the Program include improved health and safety, better housing stock, job creation, and a more skilled work force. Finally, the Program should assist in the market transformation of weatherization products.

1.1.3 Program Evaluation Design Matrix

The evaluation design matrix shown in Table 1.2 identifies the general questions the Program evaluation will address. These questions were developed by examining the Program's logic model (see Table 1.1 and Section 1.1.2) and incorporating the input received from the Network Planning Committee (see Section 1.1.1). The evaluation questions are organized into three categories in the design matrix:

1. **Context: Relationships and Capacity**—The context questions explore how the Program functioned within the economic, social, and political environment of the weatherization community and address issues regarding the Program's relationships and capacity. Referring to the Program's logic model, these questions focus on how the Program's resources and inputs led to its activities. The evaluation questions dealing with the Program's context focus primarily on characterizing the low-income weatherization market, the weatherization network and how it operates, and the partnership and leveraging opportunities available to the Program and how well the Program is taking advantage of these opportunities. Context questions also deal with whether the Program has the capacity and structure to fulfill the mission and objectives established by law for the Program, and putting into context the role the Program plays in the larger low-income energy assistance effort.

2. **Implementation: Quality and Quantity**—Implementation questions assess the extent to which activities as listed in the Program's logic model were executed as planned, such that the outputs listed in the Program's logic model were achieved. Implementation questions deal with the characterization of the clients and households served by the Program, the services the Program delivered to these clients and households and how well these services were provided, and the costs associated with delivering the Program. An important implementation question based on the input received from the Network Planning Committee is to fully determine the best approaches to implementing audits, client education, training, and technical monitoring (see Items 5–8 in Section 1.1.1). A final implementation question deals with whether the states and local agencies are fulfilling their obligations under federal regulations and the state plans they have submitted.

Table 1.2. Evaluation design matrix for the Weatherization Assistance Program

Evaluation focus area	Question	Audience	Information use	Study
Context — Relationships and Capacity	1. What are the mission and associated objectives of the Program as established by law?	DOE – WAP Weatherization network	Establish mission context	Process Assessment
	2. Does the Program have the capacity and structure (e.g., funding, staffing) to meet its objectives?	DOE – EERE DOE – WAP Weatherization network	Program administration	Synthesis
	3. What are the characteristics of the national low-income weatherization market?	DOE – WAP Weatherization network	Strategic planning; Program design and marketing	Impact Assessment
	4. Which segments of this market are being served by the Program and other parties?	DOE – WAP Weatherization network	Strategic planning; Program design and marketing	Impact Assessment
	5. What organizations are involved in national low-income weatherization (e.g., agencies, states, utilities, private sector firms)?	White House Congress DOE – Secretarial DOE – EERE DOE – WAP Weatherization network	Establish Program context; Program support and marketing	Process Assessment
	6. What are the characteristics of the weatherization network?	DOE – WAP Weatherization network	Strategic planning; Program design and marketing	Impact Assessment
	7. How does the weatherization network work?	DOE – WAP Weatherization network	Organization and participation decisions	Process Assessment
	8. What are the core leveraging and partnership opportunities for the Program?	DOE – WAP Weatherization network	Program design and marketing	Process Assessment
	9. Is the Program exploiting its leveraging and partnership opportunities?	DOE – WAP Weatherization network	Program design and marketing	Process Assessment
	10. Are the Program's regulations enhancing and/or inhibiting leveraging and partnership opportunities?	Congress DOE – Secretarial DOE – EERE DOE – WAP Weatherization network	Program design	Process Assessment
	11. What role does the Program play in the larger low-income energy assistance effort?	DOE – WAP Weatherization network	Program design and marketing	Process Assessment

Table 1.2. Evaluation design matrix for the Weatherization Assistance Program

Evaluation focus area	Question	Audience	Information use	Study
Implementation — Quality and Quantity	1. What are the characteristics of those receiving Program services?	DOE – WAP Weatherization network	Program design, planning, and implementation	Impact Assessment
	2. What Program services are being delivered to low-income households?	DOE – WAP Weatherization network	Program design, planning, and implementation	Impact Assessment
	3. How well is the Program delivering its services, including from the client perspective?	DOE – WAP Weatherization network	Program design, planning, and implementation	Process Assessment
	4. What are the costs associated with the Program services?	DOE – WAP Weatherization network	Program design, planning, and implementation	Impact Assessment
	5. What are the best approaches to implementing audits and measure selection tools, client education, training, and monitoring?	Weatherization network	State- and agency-level Program design, planning, and implementation	Process Assessment
	6. Are the Program characterization and process results valid and reliable?	Evaluation community	Generalize results to other contexts	Peer Review
	7. Are the states and local agencies fulfilling their obligations under federal regulations and state plans?	DOE – WAP Weatherization network	Program design, planning, and implementation	Synthesis
Outcomes — Effectiveness, Magnitude, and Satisfaction	1. What are the Programs average energy benefits (heating, cooling, and baseload) nationally and by climate region, housing type, and fuel type?	OMB DOE – Secretarial DOE – EERE DOE – WAP Weatherization network Utilities Commissioners	Budget justification; Program marketing; utility business planning; rule making	Impact Assessment
	2. How much energy is saved in aggregate by the Program?	DOE – EERE (PBA) DOE – EERE	Energy savings and GPRA metrics	Impact Assessment
	3. What are the Program’s non-energy impacts?	DOE – WAP Weatherization network Utilities Commissioners	Program marketing; utility business planning; rule making	Impact Assessment

Table 1.2. Evaluation design matrix for the Weatherization Assistance Program

Evaluation focus area	Question	Audience	Information use	Study
	4. What are the client perceptions of the Program impact on their comfort, health and safety, and energy costs?	DOE – WAP Weatherization network	Program design, planning, and implementation	Impact Assessment
	5. Is the Program cost effective?	White House Congress OMB DOE – Secretarial DOE – EERE DOE – WAP Weatherization network	Cost-benefit analysis; future funding decisions; Program design, planning, and implementation	Impact Assessment
	6. What impact do alternative per household investment levels have on key Program metrics (e.g., units weatherized, average savings per house, house and Program SIRs)?		State and agency-level Program design, planning, and implementation	Impact Assessment
	7. How well do selected measures work?	DOE – WAP Weatherization network	Program design, planning, and implementation	Special Technical Studies
	8. What factors and measures explain variation in energy savings and cost-effective results?	DOE – WAP Weatherization network	Program design, planning, and implementation	Impact Assessment
	9. What makes the hot climate region market and performance unique?	DOE – WAP Weatherization network	Program design, planning, and implementation	Impact Assessment and Special Technical Studies
	10. Are the outcome estimates valid and reliable?	Evaluation community	Generalize results to other contexts	Peer Review
	11. Is the Program meeting its legislative missions and objectives?	DOE – WAP Weatherization network	Budget justification; Program marketing	Synthesis

Table 1.2. Evaluation design matrix for the Weatherization Assistance Program

Evaluation focus area	Question	Audience	Information use	Study
	12. To what extent is the Program meeting the needs of the national low-income weatherization market?	DOE – WAP Weatherization network	Budget justification; strategic planning	Synthesis
	13. In what ways can the weatherization network's performance be improved?	DOE – WAP Weatherization network	Program planning	Synthesis

3. **Outcomes: Effectiveness, Magnitude, and Satisfaction**—Outcome questions focus on the extent to which progress was made toward the desired changes in the Program participants, participating households, and the low-income community and systems. Referring to the Program's logic model, these questions examine how well the Program's outputs led to its desired outcomes. Outcomes questions focus on the energy savings achieved under the Program, the non-energy impacts that are being realized, the Program's cost effectiveness, how well individual measures work, and process variables that effect these outcomes. These outcome questions include Items 1–4 raised by the Network Planning Committee (see Section 1.1.1). An important outcomes question based on the input received from the Network Planning Committee is to understand what makes the market and performance of the hot climate region unique so that performance can be improved (see Item 9 in Section 1.1.1). Several final outcomes questions bring all the results of the evaluation together, asking if the Program is meeting the legislative missions and objectives identified previously in the context questions, the extent the Program is meeting the needs of the low-income weatherization community, and how the Program and the weatherization network can be improved.

Table 1.3 cross-walks the Program outcomes identified in the logic model (Table 1.1) to the Program evaluation questions listed in the design matrix (Table 1.2) to make sure that the evaluation is addressing and measuring all the outcomes associated with the Program. As shown by Table 1.3, all the Program outcomes are being addressed by the questions posed in the design matrix with the exception of the market transformation activity associated with the Program which is beyond the scope of this evaluation.

The evaluation as planned is basically evaluating a snap-shot of the Program's performance as it was implemented in Program Year 2006 (PY 2006). Consequently, the evaluation most directly focuses on the short-term and medium-term outcomes listed in the logic model (Table 1.1). Long-term outcomes are also being addressed, in some cases by inferring that short- and medium-term results will have larger community impacts as they are sustained over time. The snap-shot type evaluation being planned does not allow long-term market transformation activity to be evaluated. Although this outcome could be addressed by looking back in time at how the Program helped transform the weatherization market (e.g., use of blower doors), such an effort is not being planned at this time.

As part of the evaluation's final synthesis (see Section 5), the evaluation should recommend how a longer-term, more continuous evaluation of the Program could be implemented by DOE so that the longer-term outcomes of the Program could be more fully addressed. One process that should be explored is to identify other government programs that are evaluating community and public welfare issues (e.g., the Health Department, the Census Bureau) and determine how the Program's long-term outcomes might be evaluated from these existing sources.

Table 1.3. Design matrix questions addressing each logic model outcome

Outcomes listed in the logic model (Table 1.1)	Questions listed in the evaluation design matrix (Table 1.2)		
	Context	Implementation	Outcomes
Short -Term Outcomes			
1. Increased energy efficiency in homes	4		1, 2
2. Improved health and safety in homes			3, 4
3. Improved indoor comfort			3, 4
4. Increased client knowledge of energy		5	
Medium -Term Outcomes			
1. Reduced energy use in homes		7	1, 2, 8
2. Reduced bills and burden for clients		7	1, 2, 4, 8
3. Reduced emissions			3
4. Other non-energy benefits			3, 4
5. Robust weatherization network	2, 5, 6, 7		13
6. Increased Program leveraging	8, 9, 10		
Long-Term Outcomes			
1. Reduced gap between energy need and use			1, 2, 4, 11, 12
2. Reduced impact of inflation/market fluctuations			1, 2, 4, 12
3. Improved health and safety in community			3, 4
4. Improved local housing stock			3, 4
5. Workforce enhancements			3
6. Create sustainable weatherization service market	2, 4-11		12
7. Increased non-energy purchases			3
8. Transformed market for weatherization products	Will not be addressed in this evaluation		

1.2 EVALUATION ORGANIZATION

Based on a review of the evaluation design matrix (see Section 1.1.3), the Program evaluation will be comprised of four studies. The study that will address each of the questions listed in the evaluation design matrix are identified in Table 1.2. These studies and the remaining report organization are outlined below:

- **Impact Assessment**—Section 2 describes how the Program's impact in PY 2006 will be assessed. The weatherization network will be characterized along with the nature and scope of the Program's implementation and weatherization processes. Energy and its subsequent costs savings will be quantified along with non-energy impacts so that Program cost effectiveness can be determined. Explanatory factors pertinent to energy savings, energy costs savings, and cost effectiveness will be identified.

- **Process Assessment**—Section 3 describes a process assessment that will examine how well the weatherization network and Program operated in PY 2006 in delivering weatherization services, and if the Program is exploiting leveraging and partnership opportunities. An in-depth assessment of the approaches used to conduct/perform audits, client education, training, and monitoring will be performed.

- **Special Technical Studies**—Section 4 describes special technical studies that will be performed to determine the performance of five specific weatherization measures (air sealing, duct sealing, space-heating system tune-up, space-heating system replacements, and refrigerators) as well as the overall impact measures are having on air-conditioning electricity use in the hot climate region.

- **Synthesis Study**—Section 5 describes how results from the evaluation work performed under Sections 2–4 will be synthesized to address how well the Program is meeting its overall goals, the extent the Program is serving the weatherization needs of the low-income community, and how the Program's and weatherization network's performance can be improved.

- **Schedule**—Section 6 outlines a schedule for the evaluation.

It should be noted that the Office of Management and Budget (OMB) under the terms of the Paperwork Reduction Act must approve most of the sampling plans and survey instruments associated with this evaluation. Therefore, the sampling plans and survey instruments presented in this preliminary evaluation plan may be modified during the OMB review process. However, once approved by OMB, they will not be subject to any substantive modifications.

1.3 EVALUATION PLAN REVIEW AND INPUT

In addition to convening the Network Committee to obtain external review and input on the preliminary evaluation plan (see Section 1.1.1), ORNL also convened an Experts Committee and a Veterans Committee to provide input on the evaluation's design. The Experts Committee was comprised of 12 members with expertise in weatherization, evaluations, energy field testing and analysis, and non-energy impacts analysis. The committee met all day by conference call on May 23, 2005 to provide input on sampling approaches, energy metering techniques, data collection surveys, energy and non-energy impact analysis methods, and standardization of information. The Veterans Committee was comprised of three key personnel responsible for the design, implementation, and successful completion of the 1989 National Evaluation: Jeanne Van Vlandren, Marilyn Brown, and Linda Berry. The committee provided insight into the design and implementation of the 1989 National Evaluation and provided lessons learned based on this previous work.

ORNL, in conjunction with DOE, also convened a Peer Review Panel to review the preliminary evaluation plan. The Peer Review Panel was comprised of seven members with expertise in weatherization, energy programs, and program evaluation. The committee met by teleconference and in-person for two days on October 17 and 18, 2006 to provide input on the preliminary evaluation plan.

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2. IMPACT ASSESSMENT

The impact assessment portion of the evaluation will address many of the questions identified in the evaluation design matrix (see Table 1.2):

- **Context**—Questions 3, 4, and 6;
- **Implementation**—Questions 1, 2, and 4; and
- **Outcomes**—Questions 1–6, 8, and partially 9.

These questions deal with characterizing the weatherization network, the market that the Program serves, and the households served by the Program; identifying the services delivered by the Program and their costs; determining the Program's energy and non-energy benefits and cost effectiveness; and understanding factors that impact savings, cost effectiveness, and other key Program metrics such as number of units weatherized.

In addition, the impact assessment will address five of the high priority and consensus goals identified by the Network Planning Committee (see Items 1–4 and 9 in Section 1.1.1):

- **Energy savings analysis**—report energy savings by various subgroups and include measured savings from propane and fuel-oil heated houses in the evaluation;

- **Baseload measures**—include savings for all end uses in the measured savings from the Program;

- **Non-energy impacts**—quantify non-energy impacts produced by the Program;

- **Cost effectiveness**—determine impacts of alternative per household investment levels on cost effectiveness; and

- **Hot Climate Region**—place special emphasis on the hot climate region and on cooling measures as part of this Program evaluation.

The impact assessment will be performed by executing five integrated studies that focus on the performance of the Program in PY 2006:

1. **Program characterization**—characterize the low-income population eligible for and in need of the Program and, for PY 2006, characterize the segment of this population served by the Program, the housing units and clients served, the weatherization and other services performed by the Program, and the Program's expenditures and funding sources;

2. **Energy and costs savings**—establish the total and per household energy and cost savings (heating, cooling, and baseload) being achieved nationally and by climate region under the Program in PY 2006 by the principal building types served and primary fuel types used;

3. **Non-energy impacts**—ascertain the non-energy impacts attributable to the Program in PY 2006 (especially those benefits addressing health and safety) and the value of those impacts from the client, utility, and societal perspectives;

4. **Program cost effectiveness**—estimate the cost effectiveness of the Program in PY 2006 on a national and climate region basis and understand the impact alternative per household investment levels can have on cost effectiveness and other Program metrics; and

5. **Explanatory factors**—identify how measures and process variables affect energy savings and cost effectiveness.

Each of these studies is described below, including an outline of the data that needs to be collected to perform the study and how these data will be analyzed. A final report will be written for each study that includes all the details of the study; a final report will also be written for the impact assessment that draws all the findings from the separate studies together.

2.1 PROGRAM CHARACTERIZATION

The impact assessment will collect key data on the Program's implementation and weatherization processes to characterize:

- the low-income population eligible for and in need of the Program and the segments of the national low-income weatherization market that are being served by the Program;

- the weatherization network and its operation, especially the organizations administering the Program at the state and agency level (e.g., organization features and structure, staffing, operational processes, funding levels);

- the housing units (including descriptors of condition, state of repair, health and safety issues, and type of heating and cooling equipment installed), the clients served by the Program, and how they were selected;

- the types of audit and diagnostic procedures used on the houses, when the diagnostics were performed (relative to when measures were installed), and who performed the diagnostics (e.g., auditor, crew, inspector);

- the measures installed in the weatherized units (including repairs made, health and safety issues addressed, and client education provided), the installation methods employed, and who installed them (contractor versus in-house crew);

- other Program services performed on the weatherized houses and how they were delivered; and

- the Program's expenditures, expenditures per household, and funding sources.

The data that will be collected and the analysis that will be performed to study the characteristics of the Program are presented below.

2.1.1 Data and Sampling Frames

Data from the following three national data bases will be used to characterize the eligible low-income population:

- the Residential Energy Consumption Survey (RECS),
- the Current Population Survey (CPS) of the Census, and
- the U.S. Department of Housing and Urban Development's American Housing Survey (AHS).

A list of the data fields that will be used from these data bases is provided in Table 2.1.

Each state and the District of Columbia will complete an "All States PY 2007 Survey" (see Appendix E) at the end of their PY 2006 (August to October 2007). As part of this survey, the following information will be obtained from all states on their PY 2006 activities:

- general characteristic information on each state,
- PY 2006 funding and expenditure details,
- compiled characteristic data at the state level on housing units weatherized in PY 2006,
- characterization data on state staff experience and activity in PY 2006, and
- characterization data on training and monitoring performed at the state level in PY 2006.

All ~900 agencies that are used to implement the Program will be surveyed using the "All Agencies PY 2007 Survey" (see Appendix G) at the end of their PY 2006 (August to October 2007) to collect information on

- PY 2006 funding and expenditure details, and
- compiled characteristic data at the agency level on housing units weatherized in PY 2006.

Although agencies supply similar information to their respective states, this information will be collected from the agencies to get the information directly from the original source and to make sure the data are accurate and consistent across all states and agencies.

The 400 agencies included in the billing data sample (see Section 2.2.1) will be administered a "Subset of Agencies PY 2007 Survey" (see Appendix H) at the end of their PY 2006 (August to October 2007). It is expected that the agencies will be compensated by DOE for their time to complete this survey. As part of this survey, the following information will be obtained:

- general characteristic information on each agency,
- characterization data on agency staff experience and activity in PY 2006,
- characterization data on how the agencies implemented client selection in PY 2006, and
- characterization data on house audits, client education, training, and monitoring performed at the agency level in PY 2006.

Table 2.1. RECS, CPS, and AHS data fields

Low-income status—Defined by LIHEAP eligibility maximums (i.e., higher of 150 percent of poverty or 60 percent of state median income)
State
Census region
Housing type
Tenure (ownership)
Primary space heating fuel type
House energy features—Presence of wall insulation, storm windows, etc.
Children—Presence of at least one child in the household as defined by Program regulations
Elderly—Presence of at least one elderly person in the household as defined by Program regulations
Handicapped—Presence of at least on handicapped person in the household as defined by Program regulations
Single parent
Ethnicity
Income—For the household
Nature of income—Fixed or not
Source of income
Energy consumption—Total, heating, cooling, and baseload that are nominal and weather adjusted
Energy expenditures—CPI adjusted; high energy expenditures as defined by Program regulations
Energy burden—Calculated from income and energy expenditures, with high energy burden as defined by Program regulations
Participation in public assistance programs—LIHEAP, Food Stamps, Temporary Assistance for Needy Families (TANF), Section 8, Public Housing, Medicaid, and Supplemental Security Income (SSI)

For each weatherized housing unit or weatherized building included in the billing data and submetered samples (see Sections 2.2.1 and 4.6), the following data will be collected from the agencies using the "Housing Unit Information Survey" in Appendix K or the "Building Information Survey" in Appendix L:

- detailed housing unit/building and occupant characteristics,
- identification of the diagnostics performed,
- diagnostic data measured by the agencies,
- identification of the measures installed, and
- costs for measures installed and other work performed.

The billing data sample includes only those housing units or buildings that use natural gas or electricity as their primary heating fuel. In order to fully characterize all housing units and buildings served by the Program (not just those heated by natural gas or electricity), information will be collected from the same 400 agencies used in the billing data sample on 25% of the housing units and buildings from each agency whose primary heating fuel is NOT natural gas or electricity using the "Housing Unit Information Survey" in Appendix K or the "Building Information Survey" in Appendix L.

The data requested in the “Housing Unit Information Survey” in Appendix K and the “Building Information Survey” in Appendix L are typically maintained in the records of each agency, so no additional information will need to be collected by the agencies. Agencies that store these data electronically will likely be able to provide it on all the housing units and/or buildings they weatherize rather than the 33% sample required for units and buildings heated by natural gas or electricity (see Section 2.21.) or the 25% sample required for units and buildings heated by other fuels. These data will be collected at the end of the agency’s PY 2006 (August to October 2007). It is expected that the agencies will be compensated by DOE for their time to complete these surveys.

As described in Section 2.2.1, control groups for the submetered samples will be developed from the same agencies. The same detailed housing unit/building and occupant characteristics collected for the weatherized submetered group will be collected for the control group from the agencies.

2.1.2 Low-Income Weatherization Market Analysis

The low-income weatherization market will be characterized by developing descriptive statistics on key attributes of the eligible population using data from RECS, CPS, and AHS. Households with incomes of 60% or less of state median income will be the focus of this analysis. The whole low-income population will be characterized as well as five subsets of the population allowed by DOE to receive priority service: households with elderly, children, or handicapped, and houses with high energy expenditures or high energy burdens. Other subsets of houses that may be studied separately if there is sufficient data in the databases include “low-efficiency” houses (e.g., houses with no attic insulation), fixed income houses, and/or houses whose occupants receive a majority of their income from Social Security. The key attributes that will be studied include:

- housing characteristics (housing type, tenure),
- type of primary heating fuel,
- demographics (elderly, children, handicapped, single parent, and ethnicity)
- income,
- energy usage (total, heating, cooling, and/or baseload),
- energy burden,
- energy expenditures, and
- participation in other public assistance programs.

These attributes will be presented nationally and by climate region in terms of means, medians, distributions, and other characteristics. They will also be cross-tabulated by other key attributes. Comparisons will be made between the low-income population and the national population, and between findings from this evaluation and the 1989 National Evaluation to identify changes since 1989.

A literature review will be conducted to explore the impact of energy expenditures on households eligible for the Program as well as on households with incomes above the program eligibility limit that might also have difficulty paying their energy bills. This literature review will examine the issue of energy affordability across different income categories and provide a description of the population in need of assistance in order to place the objectives of the Program in their appropriate context.

Using data collected from all states and agencies nationwide via the web-based survey, all the units weatherized by the Program in the program year will be characterized by the following key attributes:

- classification as DOE or non-DOE units,
- housing type,
- primary heating fuel,
- tenure,
- climate region,
- participation in other federal assistance programs,
- income,
- ethnicity,
- single-parent, and
- priority traits of occupants and houses for weatherization.

These attributes will be presented nationally and by climate region in terms of means, medians, distributions, and cross-tabulations with other key attributes. These results will then be compared to the characterization of the eligible population to identify the segments of the eligible population and eligible housing stock being served by the Program. Results will be presented in relative percentages and proportions nationally and by climate regions.

2.1.3 State and Agency Characterization Analysis

Local and state agencies will be characterized by key attributes including:

- agency type and size,
- funding (both DOE and non-DOE),
- how funding is allocated by function (e.g., intake, auditing, training, weatherization, quality assurance monitoring),
- number of units weatherized (total and by funding source, with tagging to avoid duplicated counts),
- number of units on a waiting list,
- number of units referred to other programs,
- number of units receiving on-site services from non-energy programs, and
- number of staff/employees by role, tenure, training, experience, and those needing certification.

The scope and scale of agency involvement with other energy, housing, and low-income programs will be characterized and described. The location and status of the state agencies administering the Program within their state government organizations will be described, and the relationship of the state agencies to other energy, housing, and low-income programs will be characterized and described. Descriptive statistics will be presented nationally and by climate region in terms of totals, means, medians, and distributions as appropriate.

2.1.4 Detailed Program Characterization and Implementation Analysis

The approaches used to audit houses, provide client education, train crews and agencies, and monitor agencies will be thoroughly characterized as part of the in-depth analysis to be performed on audits and client education under the impact assessment portion of this evaluation (see Sections 3.3–3.6). Results from these characterization analyses will be used and integrated with the other characterizations being described in this section.

The client selection process will be characterized by the outreach and marketing methods used to get clients to apply for the Program (i.e., how a waiting list is developed) and the methods used to select clients for weatherization from among the qualified applicants (i.e., from clients on a waiting list). These characterizations will be presented nationally and by climate region.

Using the detailed data collected on the housing units that will be used in the energy analyses, the houses and occupants weatherized under the program will be further characterized by key attributes, including:

- building characteristics (e.g., building type, tenure, floor area, age, number of stories, condition/state of repair, health and safety problems present),
- equipment characteristics (e.g., primary and supplemental heating fuels, central heating system, air conditioning type), and
- occupancy characteristics (e.g., number of occupants; number of children, elderly, and/or handicapped; income; energy burden).

The key attributes will be characterized nationally and by climate region, primary heating fuel, and dwelling type. Distributions will be examined and reported as appropriate. Results will be integrated into the market analysis described in Section 2.1.2.

The frequency that measures are installed in weatherized houses will be reported by eight major categories: air and duct leakage, insulation, window and doors, space heating equipment, cooling equipment, baseload, client education, and health and safety/repair. Subcategories will further refine these categories and capture different implementation approaches. For example:

- the insulation category will be broken down into attic, wall, and floor insulation, and wall insulation will be further divided into high density and standard installation techniques;
- the baseload category will be broken down into specific water heater measures, lighting, and refrigerators;

- the client education category will be divided by different client education approaches; and

- health and safety/repairs will be reported by replacements of roofs, floors, doors, and windows, installation of smoke and CO detectors, electrical system repairs, replacement of unsafe space heaters, replacement of broken air conditioners, and plumbing repairs.

These frequencies will be reported nationally and by climate region, primary heating fuel, dwelling type, and other subgroups. The frequency that different measures are installed by contractors versus crews will also be tabulated.

The frequency that diagnostic techniques are used in weatherized houses will be reported for various techniques (e.g., blower doors, infrared cameras). These frequencies will be reported nationally and by climate region, primary heating fuel, dwelling type, and other subgroups. For each technique, frequencies will also be tabulated on when the diagnostics were performed (e.g., during the audit, at time of measure installation, during final inspection) and who performed the diagnostics (e.g., auditor, crew member, inspector).

2.1.5 Program Funding and Costs Analysis

Using agency- and state-level data, financial resources used for weatherization at the local level (both DOE and leveraged, non-DOE) will be characterized, as well as how those resources are combined to weatherize individual units by unduplicated counts. These data will be presented nationally and by climate region. Performance requirements for non-DOE funding sources will be analyzed to determine how these compare and relate to requirements for the DOE program. A similar analysis has recently been performed for the Program by Economic Opportunity Studies (Power, 2003). The evaluation will build upon this analysis, or the analysis performed Meg Power will be expanded outside the formal evaluation budget to meet the needs of the evaluation.

Using house-level cost data collected on the houses used in the energy savings analyses, the average installation costs (labor plus materials) per house will be determined nationally and by:

- climate region,
- building type,
- fuel type,
- tenure (ownership),
- type of installer (contractor or in-house crew),
- funding source, and
- possibly other categories.

Distributions will be examined and reported as appropriate. Prices paid for materials and measures will be assessed against market rates. Average per house labor and material costs will be examined separately in a similar manner, as will material costs for individual measures (labor costs per individual measure will only be studied if consistent, quality data can be obtained from agencies, which is not anticipated).

2.1.6 Hot Climate Analysis

Previous evaluations indicate that Program energy savings tend to be smaller in hot climates than in cold climates (Brown et al. 1993), with a wide range of explanations proposed. For example, it is often speculated that Program homes in hot climates need substantial structural, non-energy related repairs and health-and-safety improvements more frequently than in other climate regions because the condition of the housing stock is poorer, unvented gas space heaters are widely used, and other reasons. Therefore, more funds (or a higher percentage of funds) are spent on addressing these conditions rather than being spend on energy savings measures. Because of the smaller than expected energy benefits and the many proposed explanations, special emphasis will be placed on the Program characterization analysis presented in Sections 2.1.2–2.1.5 to identify characteristics that make the hot climate region unique.

2.2. ENERGY AND COST SAVINGS

The two primary foci will be to estimate the:

- total annual energy savings achieved by the Program from all units weatherized by the Program in PY 2006 (all fuels combined—natural gas, fuel oil, propane, electricity, etc.—representing a combination of all space-heating, cooling, and baseload energy uses in the houses); and

- average annual energy savings (calculated separately by electricity savings and energy savings for all non-electric primary space-heating fuels combined) achieved per household by the Program in PY 2006 nationally and by climate region, housing type, primary space-heating fuel type, and the five client groups that the Program is specifically instructed to focus on (i.e., the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden).

In addition, the cost savings associated with the above energy savings will be calculated using regionally-dependent fuel costs and the estimated energy and cost savings for PY 2006 will be compared to results from the 1990 National Evaluation and from the metaevaluations performed between 1990 and 2005. Although average energy and cost savings will be calculated in this study by region, housing type, and primary space-heating fuel type, a full analysis of factors affecting energy consumptions and savings will be performed as described in Section 2.5.

Energy savings will be estimated based on a sample of housing units or buildings selected from each state in the nation. Billing data will be collected and analyzed on a majority of the housing units/buildings sampled, although “monitored” data will be collected on some housing units and buildings. Energy savings estimated for individual housing units or buildings will be used to develop state and then national estimates. Details are provided below.

2.2.1 Sampling Frame and Data

The following information will be needed to design and implement the energy analysis sampling frames described in this section:

- DOE funding received by each agency for PY 2006;
- identification of agencies that weatherize a significant number of large multifamily units, large multifamily buildings heated by fuel oil, single-family houses heated by fuel oil, single-family houses heated by propane, or mobile homes heated by propane; and
- identification of agencies whose housing units or buildings are served by natural gas and electric utilities that will be cooperative in providing billing data for the evaluation.

This information will be collected as part of the “All States PY 2006 Survey” (see Appendix D) administered to all states and the “All Agencies PY 2006 Survey” (see Appendix F) administered to all agencies as soon as the evaluation can be implemented (July 2007).

Billing Data Sample—Natural gas and electricity billing data will be collected on a sample of single-family houses, mobile homes, and both small and large multifamily housing units weatherized by 400 agencies in PY 2006. For each agency, all units whose primary heating fuel was natural gas or electricity will be sampled if utility account data and other information are stored electronically and can be easily provided by the agency; otherwise 33% of such units will be sampled (total number of units estimated to be 10,339). Natural gas billing data will be collected on those units whose primary heating fuel was natural gas. Electricity billing data will be collected from all the sampled units. Billing data will be collected for at least 12 months before and 12 months after their weatherization date. Billing data on a comparable number of control houses will also be collected.

The sample size of 400 agencies and 10,339 housing units was selected so that the nationwide total annual energy savings (and average energy savings per housing unit) attributable to the Program can be estimated to within ~15% of its actual value at a 90% confidence level after non-response and attrition are taken into account (see Appendix M for a detailed justification for this sample size). Agencies and hence their housing units are being sampled rather than sampling housing units directly from among all agencies nationwide because of the cost that would be involved in working cooperatively with ~900 separate agencies. The 400 agencies will be selected in two steps: the number of agencies to be selected from each state will be determined, and then agencies within each state will be selected.

The selection of the 400 agencies will be stratified by state because such stratification provides the following benefits:

- it controls for differences in geography, climate, housing stock, fuel types, and other factors;

- it controls for the fact that each state administers its program differently (i.e., savings for homes or agencies are likely to be similar to other homes or agencies in the same state rather than a different state);

- each state will have at least one agency included in the sample; and

- data provided by states that wish to contribute resources to extend the survey in their states can be easily incorporated into the analysis, and the benefit to the state from doing so can be clearly seen.

The number of individual agencies that will be selected from each state will be in proportion to the "size" of the weatherization activity that occurs in each state. For the evaluation, "size" will be defined as the amount of DOE Program funding received by the state in PY2006. So, for example, if a state received 10% of the Program's available PY 2006 funding, then 30 agencies (10% of 300) would be selected from that state. The number of agencies needed in a state will be rounded up to 2 even if its numerical proportion is 1.5 or less to ensure that an agency from each state is included in the sample, standard deviations can be calculated for each state, and the 14 hot climate states are adequately represented (it is anticipated that this will be applicable in just three states). It should be stressed that the evaluation is not interested in comparing states, but that stratification by states is being pursued to improve the sampling randomization and to minimize the sampling error.

Agencies will be selected within a state using PPS sampling, with size again defined as the amount of DOE Program funding received by the agency in PY 2006. PPS sampling is a standard statistical method that will select agencies that are representative of the entire state but which will select larger agencies (i.e., agencies that receive more DOE Program funding) with a higher probability than smaller agencies. This sampling approach leads to estimates of totals that are more accurate than estimates based on simple random sampling (i.e., equal probability sampling).

In finalizing the selection of the 400 agencies, input received from the agencies regarding the cooperation they expect from their local natural gas and electric utilities in providing billing data on weatherized houses will be considered. If an agency feels that their utilities will not be cooperative, inclusion of that agency in the evaluation will just lead to loss of houses because billing data will not be able to be collected. In this case, another agency will be selected to replace the agency originally selected to reduce the potential for non-response. Information on expected utility cooperation will be collected using the "All Agencies PY 2006 Survey" (see Appendix F) administered to all agencies as soon as the evaluation can be implemented (July 2007).

In general, 33% of the housing units and buildings weatherized by each agency and whose primary heating fuel is natural gas or electricity will be randomly selected for inclusion in the sample. If an agency is able to provide utility account information on all the natural gas and electrically heated units or buildings it weatherized in PY 2006 because such data are stored electronically, then all such units and buildings weatherized by the agency will be included in the billing data sample provided this places no undue burden on the agency. If, after the 400 agencies and the estimated 10,339 housing units are selected, it is determined that additional housing units or buildings are needed to ensure coverage of important subgroups (such as multifamily buildings, rural housing, or housing units from the 14 hot climate states), then additional housing units will be selected from the 400 agencies as needed. As a minimum, seven housing units will be selected from each agency to ensure that three housing units remain for each agency after non-response and attrition is considered.

For each house and building included in the billing data sample, the names of the electric and gas (if applicable) utilities, account numbers, weatherization period, and waiver (release) forms will be collected from the agencies along with the other housing unit and building information described in Section 2.1.1 using the "Housing Unit Information Survey" (see Appendix K) or the "Building Information Survey" (see Appendix L).

The evaluation team will collect the actual electricity and natural gas billing data directly from the utilities (at least 12 months of bills before weatherization and 12 months of bills after weatherization), although agency assistance may be needed. Natural gas billing data will be collected on those housing units and buildings whose primary heating fuel was natural gas. Electricity billing data will be collected on all housing units and buildings sampled (i.e., those whose primary heating fuel was electricity and those whose primary heating fuel was natural gas). For multifamily buildings, natural gas and electricity bills will be collected for all master meters as well as all meters serving the individual apartment units. In collecting the billing data, utilities will be asked to provide data for the address regardless of occupancy changes and to note when occupancy changes occurred as these data will be used in the study of non-energy impacts (see Section 2.3.1). The following will be done in order to improve the response rate for the billing data requests:

- contact an appropriate person at each utility to identify and smooth out the process,
- plan the billing data requests so that data for multiple housing units and buildings are requested from a utility at one time,
- request billing data at regular intervals to reduce the chance that the utilities will not be able to provide data because it has been archived and no longer readily accessible, but limit the number of such requests so that utilities have to provide data just several times during the course of the evaluation, and
- solicit assistance from utility regulatory commissions and similar organizations as needed.

A control group for the billing data sample will be developed using housing units and buildings weatherized by the same agencies in PY 2007 and/or that are on the waiting lists of the same agencies during PY 2007. Such a control group will have characteristics that are similar to the weatherized group because they are houses and buildings served by the same agencies, client self selection that led to applying for weatherization assistance will be the same, and the selection process used by the agencies will be the same. The number of control housing units and buildings selected from each agency will be approximately the same as the number of weatherized units sampled from that agency. Controls will be selected from each agency throughout PY 2007 so that pre- and post-weatherization periods for the control units will similar to those for the weatherized units. Controls will be randomly selected within each agency after considering building type and primary heating fuel so that these general characteristics closely match those for the weatherized group. The use of LIHEAP participants who received benefits during PY 2006 is not recommended because occupant, housing, and other characteristics of these participants can be quite different from the housing units and clients served by the Weatherization Program.

Fuel-Oil and Propane Monitored Samples—Various samples of weatherized houses and buildings heated by either fuel oil or propane will be "monitored" so that their heating energy savings can be calculated. Houses and buildings heated by these fuels are an important class of units weatherized by the Program. However, their heating energy savings cannot usually be estimated from delivery records routinely kept by the fuel suppliers because the records are often incomplete and/or inaccurate, only a few deliveries are made each year, and tanks are not topped off at each delivery. In addition, some occupants use their LIHEAP payment or other funds to fill their tank at the beginning of the winter, but resort to secondary heating sources when the tank runs out because they cannot afford to refill it during the winter.

As explained in Section 2.2.2, the fuel-oil and propane monitored samples are being developed to test the hypothesis that the energy savings in houses and buildings heated by these fuels are essentially the same on average as the savings that occur in houses and buildings heated by natural gas; therefore, sample sizes identified below are sufficient to test this hypothesis with a probability of at least 0.90 of detecting a difference as small as or larger than 20% of the mean natural gas pre-weatherization consumption (see Appendix M for a detailed justification of these sample sizes). Larger sample sizes would be needed if the intent was to measure the actual energy savings within a stated statistical accuracy.

Monitoring will be accomplished in these houses and buildings in one of two ways:

- Submeters will be installed on the space heating equipment so that space-heating fuel use is measured directly. This approach may provide the more accurate data and allow a more sophisticated analysis to be performed compared to the alternative approach, but is also likely to be more costly because of costs associated with purchasing, installing, reading, and removing instrumentation. If submetering is pursued, indoor and outdoor temperatures will be monitored in each submetered house or building, and pre- and post-weatherization diagnostic measurements (house air leakages, duct leakages, furnace efficiencies, refrigerator energy consumptions, and water flow rates) may be made at the time meters are installed and removed. Indoor temperature data will be used to perform the energy analysis as well as to quantify non-energy impacts as described in Section 2.3.2. All diagnostic measurements except for the measurement of water flow rates would be used to study specific weatherization measures as described in Sections 4.1–4.5; water flow rate would be used in the study of non-energy impacts as discussed in Section 2.3.1.

- Special arrangements will be made with the occupants and local fuel oil and propane suppliers of houses and buildings sampled to fill the fuel tanks at the start and end of the winter and before/after weatherization, deliver fuel more frequently during the winter (perhaps every week), always fill the tank at each delivery, and keep accurate records of the amount of fuel delivered. This approach will be sufficient to provide the minimum data needed to estimate pre- and post-weatherization fuel consumptions and savings, although the accuracy of these estimates may be less than the accuracy that could be achieved with submetered data. To implement this monitoring method, fuel oil and propane suppliers will likely have to be paid to provide this more frequent and thorough service.

Both monitoring approaches do not address the potential issue that some occupants may resort to the use of secondary fuels in the middle of the winter because they cannot afford to refill their tank during the winter. Payments may have to be made to occupants or fuel suppliers to ensure an adequate supply of fuel for the house during the monitoring period, although such problems were not encountered in monitoring fuel oil use as part of the 1989 National Evaluation (Levins and Ternes, 1994).

Four groups of houses will be monitored:

1. **Single-family homes heated by fuel oil**—64 weatherized and 64 control homes from 16 agencies located in the 9 northeast states and perhaps adjacent states of Ohio, West Virginia, Maryland, and Delaware will be monitored. Homes and agencies will be limited to those in the nine northeast states and four adjacent states because this is where fuel-oil heated homes are predominately located.

2. **Large multifamily buildings heated by fuel oil**—24 weatherized buildings will be monitored, which represents about 360 weatherized housing units assuming 15 units per building on average. These buildings will likely be limited to those in the states of New York, New Jersey, Vermont, and perhaps Ohio; these states are four of the top ten states that weatherize large multifamily buildings and that are in the northeast where fuel oil is more likely used. A set of control buildings will not be monitored because of the small sample size and the difficulty in obtaining "comparable" control buildings.

3. **Single-family homes heated by propane**—64 weatherized and 64 control homes from 16 agencies located across the U.S. will be monitored. State and agency selections will be based on the frequency that propane is used in weatherized single-family homes. Special consideration will be given to ensure that an adequate number of agencies and houses from the 14 hot climate states are included in the sample.

4. **Mobile homes heated by propane**—64 weatherized and 64 control mobile homes from 16 agencies located across the U.S. will be monitored. Mobile homes and agencies will be limited to those in the 10 states that weatherize the most mobile homes (representing 50% of all mobile home completions) or the 25 states that weatherize the most mobile homes (representing 85% of all mobile home completions). State and agency selections will be based on the frequency that propane is used in weatherized mobile homes. Special consideration will be given to ensure that an adequate number of agencies and homes from the 14 hot climate states are included in the sample.

In all four monitored samples, attempts will be made to select agencies from the 400 agencies that have been selected as part of the billing data sample described earlier in this section to facilitate data collection and integration of the energy savings calculated by the monitoring with those calculated using billing data.

In monitoring the large multifamily buildings, the buildings will have to be monitored for a year before weatherization and a year after weatherization for either monitoring approach (submetering or enhanced delivery data) to capture the heating and baseload components of these consumptions. In monitoring the two single-family groups and the mobile home group, the length of the monitoring will depend on the monitoring approach and the climate regions the housing units are located in:

- If submetering is pursued, weatherization measures could be installed in weatherized houses that are located in the cold and most likely the moderate climate regions in the middle of the winter so that three months of pre-weatherization data and three months of post-weatherization data can be collected over one winter season. This reduces monitoring costs and only delays the weatherization of homes selected for use as controls by at most a few months. In addition, half of the homes could be monitored one winter and the remaining half of the homes could be monitored the following winter to reduce costs associated with monitoring equipment. Submetered housing units located in the hot climate regions would likely have to be monitored for a winter before weatherization and a winter after weatherization because the winters are not sufficiently long or intense enough to allow a split-winter design to be used.

- If the monitoring approach used in these houses is to collect more accurate and frequent delivery data, then data collection for a year before weatherization and a year after weatherization will likely be required unless housing units are located in the cold and possibly moderate climate regions and deliveries as frequently as every week can be arranged (in which case just one winter of data collection might be needed as in the submetering approach).

Based on the schedule constraints outlined in Section 6, the monitoring cannot occur until the winters of 2007-2008 and 2008-2009. Therefore, houses and buildings from PY 2007 and possibly PY 2008 will be monitored rather than PY 2006 as for the billing data sample. Savings measured for these PY 2007 and 2008 housing units will be used as a proxy for savings that would have occurred in similar houses in PY 2006 and in estimating the total PY 2006 savings as outlined below.

2.2.2 Energy Analysis

Energy savings for individual housing units and buildings normalized to a typical weather year will be estimated using data and approaches that depend on the building type (see Appendix N for a detailed definition and description of the building types that will be used in the evaluation) and whether billing data or submetered data were collected. Weather-normalized saving estimates for individual houses and buildings will then be used to estimate the total annual energy savings or average annual per household energy savings for the Program. Energy saving estimates will be converted to cost savings using known fuel costs.

Energy Analyses Using Billing Data—Billing data collected on housing units or buildings will be analyzed using three different methods:

- the Princeton Scorekeeping Method (PRISM) as outline in more detail in Appendix O;
- the ORNL Aggregate Method as outlined in Appendix P; and

- a third method based on a review of the state-of-the-art techniques such as Statistically Adjusted Engineering (SAE) models, Analysis of Covariance (ANOVA) models, Conditional Demand Analysis (CDA), and fixed-effect models (Hall, 2006; Hall 2004).

In houses or buildings that use natural gas as the primary space-heating fuel, two analyses will be performed using each of the three methods: one to determine the weather-normalized savings in the space-heating fuel and another to determine the weather-normalized electricity savings.

PRISM is the analysis method used in the 1989 National Evaluation. The Experts Committee and Peer Review Panel (see Section 1.3) recommended using methods other than PRISM to supplement and/or serve as an overall check on the PRISM analysis (especially in the hot climate region where attrition has been high in previous studies and statistically significant savings have been difficult to measure). Simple methods such as using simple degree-day adjustments or summing up seasonal usage were suggested to reduce model failures when PRISM is used and to avoid the subsequent bias that can be introduced. The ORNL aggregate model was selected as a primary alternative method that will be used because, like PRISM, it identifies baseload consumption and allows uncertainties in estimated parameters and calculated values to be determined with a statistical basis. A second alternative method will be selected after a review of the state-of-the-art.

Energy Analysis Using Submetered Data—If submetered energy use data were collected on a housing unit or building, energy analyses as outlined in Appendix O will be used. In general, pre- and post-weatherization energy use models will be developed for each housing unit or building by regressing weekly or daily energy consumption (the dependent variable) versus the temperature difference between indoors and outdoors for each consumption period (the independent variable); annual, weather-normalized, pre- and post-weatherization energy consumptions and energy savings will then be calculated using the regression models, historical weather for each home or building location, and a standard indoor temperature (e.g., 68 or 70°F) or the actual indoor temperatures. In houses or buildings that do not use electricity as the primary space-heating fuel (i.e., are heated using natural gas, propane, fuel oil, etc.), two analyses will be performed: one to determine the savings in the space-heating fuel and another to determine the electricity savings.

Annual Program Energy Savings—The total annual energy savings achieved by the Program in PY 2006 will be estimated using the weather-normalized saving estimates for the individual houses and buildings sampled and a statistical approach that is based on how these houses and buildings were sampled. As outlined below, the total annual energy savings achieved by each state in PY 2006 will be estimated and then these state values will be summed to calculate the total annual energy savings estimate for the Program. State savings are being estimated as an intermediate value to estimating the Program savings because the selection of agencies and hence housing units and buildings was stratified by state. Also, the best estimator for savings achieved in housing units and by agencies within a state are savings measured in other housing units and by other agencies within that same state because of differences in how states implement the Program (e.g., what measures are installed, how measures are installed, etc.). The total energy saving estimates for each state and the Program will be calculated on both a site and source basis.

For each state, the cells in Table 2.2 will be filled in and summed to calculate the total annual energy savings estimate for the state as follows:

- The savings estimate for each cell involving natural gas or electricity use will be calculated using the weather-normalized savings estimates for the individual houses and buildings sampled in the state along with appropriate weighting factors (which are based on how the agencies were sampled, the size of the agencies, the number of houses sampled, the number of houses weatherized in the state, etc.). Weather-normalized savings estimates for the individual housing units and buildings will be those calculated using PRISM, the ORNL Aggregate Method, the third method chosen, or a combination of these, especially for cell entries based on normalized annual consumptions (NACs) that cannot be well determined, such as in analyzing the electricity use in homes where electricity is not the primary heating fuel or fuel use in homes in hot climates with little heating load).

- For cells involving fuel oil and propane, energy savings will be estimated based on the results of the fuel-oil and propane monitored samples. The fuel-oil and propane monitored samples will test the hypothesis that the energy savings in houses and buildings heated by these fuels are essentially the same on average as the savings that occur in houses and buildings heated by natural gas. If the hypothesis is true, then the weather-normalized average savings that occur in houses and buildings heated by natural gas will be used to develop estimates for the fuel/oil/kerosene and propane cells. If the hypothesis is not true, then a relationship (i.e., ratio) between the average savings that occur in houses and buildings heated by natural gas and those heated by fuel oil and propane will be developed and used to develop estimates for the fuel-oil and propane cells. It should be noted that the housing units used in the fuel-oil and propane monitored samples will be weatherized under PY 2007 and possibly 2008; thus, they will serve as a proxy for savings that would have occurred in similar homes in PY 2006.

- For the “other” cells, engineering estimates will be made based on savings measured for other cells in that state. It is anticipated that engineering estimates will only be required for cells that represent a small percentage of the units weatherized in a state because of the breadth of the proposed sampling plan.

The Network Planning Committee felt that it was important to calculate electricity savings on all sampled houses (in part to address space cooling especially in the hot climate region) and to include savings from baseload energy uses in the total Program energy savings estimate. The analysis approach presented above accomplishes this. Electricity consumptions and savings will be estimated in all sampled houses and buildings (not just those that are electrically heated). The analysis of natural gas and electricity billing data includes baseload uses as well as space-heating and space-cooling.

The average annual energy savings per household achieved by the Program will be estimated in a manner similar to that for the total annual energy savings described above except that savings will be normalized by the number of units weatherized. Average energy savings will be

Table 2.2. Total annual Program energy savings

Building type/ Primary space-heating fuel	Number of units served by the Program	Non-electric fuels (Btu)	Electricity (kWh)	Total (Btu)	
				Site	Source
Single-family:					
Natural gas					
Electricity					
Fuel oil					
Propane					
Other					
Mobile home:					
Natural gas					
Electricity					
Fuel oil					
Propane					
Other					
Small multifamily:					
Natural gas					
Electricity					
Fuel oil					
Propane					
Other					
Large multifamily:					
Natural gas					
Electricity					
Fuel oil					
Other					
Total					

calculated on both an absolute and percent basis, and separately by electricity and all other primary space-heating fuels combined. Average annual per household energy savings will be calculated by climate region, housing type, primary space-heating fuel type, and various combinations of these categories as well as by the five client groups that the Program is specifically encouraged to focus on (i.e., the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden). Four climate regions consistent with those used in the 1989 National Evaluation will be used: cold climate, moderate climate, hot-humid climate, and hot-dry climate).

The total annual energy savings and the average annual per household energy savings described above will be calculated two ways when PRISM results are used. First, results will be calculated using just those houses or buildings that have typical indicators of model reliability—coefficient of determination (R^2) and coefficient of variance (CV) of the NAC—that pass standard PRISM criteria (or equivalent for the submetered models). This is consistent with past evaluations and is done to eliminate from the analysis houses and buildings that have models with poor predictive ability. Second, because of concerns that elimination of such houses and buildings introduces bias into the results, additional results will be calculated using those houses that pass a more relaxed set of criteria and/or a minimum set of criteria (essentially all houses and buildings). In all cases, a "flatness index" available in PRISM will be used to pass additional houses and buildings that would otherwise fail the PRISM criteria. The flatness index identifies houses and buildings with neither a strong heating or cooling signal (R^2 is very low) but with a NAC that is well determined. This occurs, for example, in examining the space-heating fuel use in a house in a warm climate that has little heating load, the electricity use of a house in a cold climate that has little cooling load, and the electricity use of a house in any climate without an air conditioner. Also, in all cases, outliers will be identified, data quality will be carefully checked, and outliers possibly screened.

In calculating the total annual energy savings and the average annual per household savings as described above, occupancy changes (and the subsequent large fluctuation in energy consumption that may result) will not cause a house or building to be removed from the analysis. The Program is intended to increase the energy efficiency of low-income housing, and occupancy changes occur naturally in such houses. This is consistent with the approach taken in the 1989 National Evaluation but somewhat atypical of other weatherization evaluations. If desired and deemed necessary, separate analyses with and without occupancy changes will be performed. One concern in automatically dropping such housing units is that large sample attrition may result because low-income housing can have high turnover rates. Another concern is that bias could be introduced because housing units with occupancy changes may have different energy-related characteristics than housing units without occupancy changes and the characteristics and behaviors of movers could be different than those of don't move.

The total annual energy savings and the average annual per household savings calculated above will be calculated with and without adjustments for savings in a comparable set of control homes and buildings (i.e., both gross and net results will be presented). Inclusion of a control group (i.e., adjustment of savings for weatherized housing units by the savings for the control group) allows estimation of energy consumption changes that would have occurred in the absence of the

Program and controls for factors such as occupant behavior and fuel prices that influence housing-unit energy consumption.

The Network Planning Committee wanted to measure baseload electricity savings separate from space-heating and/or space-cooling savings to establish and validate reasonable expectations for electric baseload measures and provide information pertinent to electric utilities and ratepayer issues. As currently planned, such sampling and analysis will be limited to the study of electricity savings from refrigerator replacements (see Section 4.5) because the costs that would be required to study other baseload measures (e.g., lighting replacements, water heating measures) is to high to be justified.

The Network Planning Committee wanted to accommodate states that wanted to determine the savings in their specific state using data collected under this evaluation and supplemental data collected specifically for that state. The evaluation approach presented in this section easily allows for this since data are being collected in each state and savings are built up by state. Additional funding will be provided by the state or from some other source to determine the additional data collection needed to perform a state-level analysis, develop the necessary sampling plans and survey instruments, collect the additional data, analyze the additional data together with information already collected under this evaluation in the state, and write a report for the state. The supplemental information collected for an individual state will be incorporated into the analysis performed for the national evaluation by using it, together with data collected in that state under the evaluation, to develop state values.

Cost Savings—The energy savings estimated above will be converted to cost savings using best available fuel cost data that are based on the actual costs incurred by the weatherized homes used in the analysis previously discussed in this section. Average published fuel cost data are unlikely to match the climate regions being used in the evaluation and are likely representative of all households rather than just low-income households. Therefore, fuel cost data obtained for the homes in the energy analyses should be used to convert energy savings into cost savings. Special care will be taken in converting energy savings into cost savings if costs were especially volatile over the Program year.

Sensitivity Analysis—After all energy and cost savings are calculated, a quick sensitivity analysis will be conducted to see how out-year estimates of energy and costs savings for the PY 2006 houses might change in response to variation in key driving factors such as changing demographics in the houses, loss of housing stock, volatility in fuel costs in PY 2006 and beyond, new technology, and climate change. The results of this analysis will be used in the sensitivity analyses performed for non-energy impacts (see Section 2.3.1) and cost effectiveness (see Section 2.4).

2.2.3 Attribution Methodology

While the Program is the major driving force behind the weatherization of low-income homes in the United States, the Program's resources are leveraged by several other parties and programs, including LIHEAP, PVE, public benefits funds, states, utilities, and non-profit organizations. It is important to properly attribute energy savings and energy cost savings among the set of parties that, along with DOE, contribute financial and in-kind resources to weatherize low-income homes.

This evaluation will develop a methodology to attribute energy savings and energy cost savings to the set of parties based on well-known concepts found in the field of decision analysis. Generally, the methodology will be based on concepts used in multi-criteria decision making, which include decision matrices and evaluation criteria. Specifically, the methodology will categorize weatherization into a set of activities and functions (program management, outreach and marketing, client selection, audit and measure selection, measure installation, and training). Contributions of the parties to these activities and functions will be estimated using information collected from all the states as part of the "All States PY 2007 Survey" (see Appendix E) and from the 400 agencies included in the billing data sample as part of the "Subset of Agencies PY 2007 Survey" (see Appendix H). Influences of these activities and functions on energy savings and cost savings will be estimated by a panel of experts. Using these two sets of estimates and a decision matrix approach, attributing energy savings and cost savings appears to be fairly straightforward technically. If the panel of experts feels that the influences of the activities and functions on savings varies by known state characteristics (e.g., states with high utility weatherization involvement versus those without), then the analysis could be performed by categories of states to build up the appropriate national attribution values.

It can be anticipated that the challenges to implementing an attribution methodology will not be technical but will be more process-oriented. For example, one important question relates to who should be involved in making the two sets of estimates described above (although an approach is outlined above). Following questions then are how should the estimates be generated if several parties are involved and how should disagreements about the estimates among parties be resolved. Lastly, the scale of the attribution methodology needs to be carefully considered. It can be assumed that the methodology will be developed with a national context. However, various parties may request that the methodology be applied on a state-by-state basis. This latter approach may require considerably more data collection and would certainly require much more effort to generate the two sets of estimates for every state.

2.3 NON-ENERGY IMPACTS

As part of the impact assessment, the non-energy impacts (NEIs) attributable to the Program that affect the clients served, rate-payers and utilities, and society will be ascertained. Table 2.3 shows the primary non-energy impacts that have been identified to date and that will be quantified in this evaluation. Schweitzer and Tonn (2002) identified most of these non-energy impacts as being applicable to the Program and provide a detailed discussion of each. It is important to note that the evaluator will have the flexibility to consider new impacts, new metrics, and new values for existing metrics, provided this does not involve the collection of primary data not previously approved by OMB under the terms of the Paperwork Reduction Act (PRA).

In addition to quantifying the non-energy impacts identified in Table 2.3, the number of actions taken by weatherization providers to improve health and safety (e.g., fix broken flues, replace cracked heat exchangers) will be reported as part of this evaluation to further document the non-energy impacts produced by the Program.

Table 2.3 indicates whether each of the primary non-energy impacts will be described (quantified) by a monetized or non-monetized value:

- **Monetized value**—For most of the Program-generated non-energy impacts, a monetary value (annual dollar value and lifetime net present dollar value) will be calculated nationally (and possibly by climate region) from client, utility/ratepayer, and societal perspectives using a computer model or some other mechanism for performing the necessary calculations. The major inputs for these calculations are household-level data gathered under this national evaluation, a large set of performance metrics that describe key Program outputs, and a set of monetized metrics that convert performance measures into dollar values. The dollar value of each monetized impact is calculated by taking the number of relevant household-level activities reported, multiplying that number by the appropriate performance metric, and multiplying that product by the matching monetized metric. Ideally, both a point estimate and a confidence interval will be calculated for each impact, in recognition of the uncertainty surrounding these estimates. It is important to note that the monetized value will represent the net economic value of the impact as both costs and benefits associated with the impact will be addressed. It is also important to note that monetized values will be calculated only where a specific identifiable expense is avoided or incurred, or a clear monetary impact is obtained. Subjective approaches to calculating the dollar value of non-energy impacts (e.g., using willingness-to-pay or relative-valuation approaches) will not be used in this evaluation.

- **Non-monetized value**—For a sizable minority of Program-generated non-energy impacts, all of which fall under the broad umbrella of "safety, health, and comfort," a non-monetary value will be calculated. Most of these non-monetary values will come from surveys of occupant perceptions but some will come from direct measurement of key factors such as indoor air temperature and humidity levels. In calculating the value for these non-monetized impacts, the performance metrics will be calculated directly from the relevant household-level data.

Table 2.3 shows the household-level data used as a basis for calculating each non-energy impact, as well as the performance metric and the monetized metric (where applicable) associated with each specific impact.

Under the impact assessment, data will be collected to update some of the performance and monetized metrics needed before calculating values for the monetized non-energy impacts. In updating these metrics, both costs and benefits will be considered so that net economic values are developed. In addition, household-level data will be collected and analyzed to directly calculate values for the non-monetized impacts. The required data collection and analyses are described more fully below.

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
I. Utility/Ratepayer Impacts				
A. Payment-Related Impacts				
1. Rate subsidies avoided	Monetized	Number of households weatherized	Average reduction in number of subsidized units of energy sold per weatherized household	Cost to utility per subsidized unit of energy sold
2. Lower bad debt write-off	Monetized	Number of households weatherized	Average reduction in amount of bad debt written-off by utility per weatherized household	Same as Performance Metric
3. Reduced carrying cost on arrearages	Monetized	Number of households weatherized	Average dollar reduction in arrearage per weatherized household	Interest due utility per dollar of arrearage
4. Fewer notices and customer calls	Monetized	Number of households weatherized	Average reduction in number of notices sent and calls made to customers, per weatherized household	Average cost to utility per notice sent and call made
5. Fewer shut-offs and reconnections for delinquency	Monetized	Number of households weatherized	Average reduction in number of customer shut-offs and reconnections made by utility, per weatherized household	Average cost to utility per shut-off and reconnection
6. Reduced collection costs for delinquent payments	Monetized	Number of households weatherized	Average reduction in number of collections made by utility per weatherized household	Average cost to utility per collection
B. Service Provision Impacts				
1. Fewer emergency gas service calls	Monetized	Number of households weatherized	Average reduction in number of emergency service calls made per weatherized household	Average cost to utility per service call

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
2. Transmission and distribution loss reduction	Monetized	Electricity savings (in kWh) in weatherized houses	Average amount of electricity lost in transmission and distribution, per kWh sold	Average cost to utility per unit of electricity lost
3. Insurance savings	Monetized	Number of households weatherized	Average reduction in utility's cost for insurance to cover household fires and explosions, per weatherized household	Same as Performance Metric
4. Shifted utility fixed costs	Monetized	Number of households weatherized	Average energy savings in weatherized houses	Change in fuel cost per unit of energy savings to cover fixed costs
II. Impacts to Participating Households				
A. Affordable Housing Impacts				
1. Water and sewer savings	Monetized	Number of water-saving devices installed in weatherized houses	Average water savings (in gallons) per device installed	Cost of water and sewer service per gallon of water
2. Property value impacts	Monetized	Number of households weatherized	Average cost of structural repairs per weatherized household	Same as Performance Metric
3. Avoided shut-offs and reconnections	Monetized	Number of households weatherized	Average reduction in number of shut-offs and reconnections, per weatherized household	Average cost to customer per shut-off (for "lost rent" and restart fee)
4. Reduced mobility	Monetized	Number of households weatherized	Average reduction in number of moves per weatherized household	Average cost per move
5. Reduced transaction costs	Monetized	Number of households weatherized	Average number of hours required to become familiar with energy-saving products per household	Average cost per hour of time (use minimum wage for this calculation)

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
B. Safety, Health, and Comfort Impacts				
1. Fewer fires	Monetized	Number of households weatherized	Average reduction in number of fires per weatherized household	Average monetary loss to household (property, injury, and death) per fire
	Non-monetized	Occupant perceptions of household fire safety before and after weatherization	Perceived changes in safety of heating system and electrical wiring in weatherized houses	Not applicable
2. Changes in frequency of health problems	Non-monetized	Occupant perceptions of general health and safety before and after weatherization	Perceived change in health problems in weatherized houses	Not applicable
	Monetized	Number of households weatherized	Average reduction in number of workdays lost due to health problems per weatherized household	Average cost to household per lost work day
	Non-monetized	Occupant reports on incidence of symptoms or occurrences of specific health problems before and after weatherization	Change in incidence of symptoms or occurrences of specific health problems in weatherized houses	Not applicable

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
3. Enhanced prevention and treatment of health problems	Non-monetized	Occupant reports on number of times food purchases were not made in order to pay utility bills before and after weatherization	Reduction in number of times food could not be purchased due to size of utility bill in weatherized houses	Not applicable
	Non-monetized	Occupant reports on access to health care and medication before and after weatherization	Change in access to health care and medication in weatherized houses	Not applicable
4. Changes in indoor air quality	Non-monetized	Measured CO levels before and after weatherization	Measured change in CO levels in weatherized houses	Not applicable
	Non-monetized	Measured levels of indoor airborne mold spores relative to outdoor levels before and after weatherization	Measured change in level of indoor airborne mold spores relative to outdoor levels in weatherized houses	Not applicable
	Non-monetized	Measured levels of indoor airborne pollen relative to outdoor levels before and after weatherization	Measured change in level of indoor airborne pollen relative to outdoor levels in weatherized houses	Not applicable

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
	Non-monetized	Occupant perceptions of odors that could indicate a problem with indoor air quality	Perceived change in frequency of odors within weatherized houses	Not applicable
5. Changes in household moisture levels	Non-monetized	Measured levels of indoor humidity before and after weatherization	Measured change in humidity levels in weatherized houses	Not applicable
6. Decreased incidence of hypothermia and hyperthermia	Monetized	Number of households weatherized	Average reduction in number of times emergency medical care is sought due to heat stress or overexposure to cold per weatherized household	Average cost of emergency medical care at hospital, emergency room, or urgent care facility
	Non-monetized	Occupant reports on incidence of students' disrupted study due to excessive heat or cold before and after weatherization	Change in incidence of students' disrupted study in weatherized houses	Not applicable
7. Improved food safety	Non-monetized	Measured temperature in refrigerator before and after weatherization	Measured change in refrigerator temperature in weatherized houses	Not applicable

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
	Non-monetized	Occupant reports on number of incidents of gastrointestinal problems and food poisoning before and after weatherization	Change in incidence of gastrointestinal problems and food poisoning in weatherized houses	Not applicable
8. Improved household safety and security	Monetized	Number of households weatherized	Average reduction in number of times emergency medical care is sought for injuries from tripping and falling in the home	Average cost of emergency medical care at hospital, emergency room, or urgent care facility
	Monetized	Number of households weatherized	Average reduction in number of times emergency medical care is sought for burns from scalding from domestic hot water	Average cost of emergency medical care at hospital, emergency room, or urgent care facility
	Non-monetized	Occupant perceptions of security of home from criminal intrusion before and after weatherization	Perceived change in security from criminal intrusion in weatherized houses	Not applicable
	Monetized	Number of households weatherized	Average reduction in number of break-ins per weatherized household	Average value of items stolen in break-in
9. Change in presence of environmental hazards	Non-monetized	Measured levels of asbestos and radon in houses before and after weatherization	Measured change in levels of asbestos and radon in weatherized houses	Not applicable

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
	Non-monetized	Reports on incidence of poisoning from household chemicals before and after weatherization	Change in number of poisonings from household chemicals in weatherized houses	Not applicable
	Non-monetized	Occupant reports on level of household infestation with vermin before and after weatherization	Change in level of vermin infestation in weatherized houses	Not applicable
10. Improved comfort	Non-monetized	Occupant perceptions of indoor comfort (temperature and draftiness) before and after weatherization	Perceived improvement in indoor comfort (temperature and draftiness) in weatherized houses	Not applicable
	Non-monetized	Measured indoor air temperature before and after weatherization	Measured change in indoor air temperature in weatherized houses	Not Applicable
11. Improved appearance	Non-monetized	Occupant perceptions of appearance of dwelling before and after weatherization	Perceived improvement in appearance of weatherized dwellings	Not Applicable
12. Reduced noise inside dwelling	Non-monetized	Occupant perceptions of noise level within dwelling before and after weatherization	Perceived reduction in noise within weatherized dwellings	Not applicable

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
III. Societal Impacts				
A. Environmental Impacts				
1. Air emissions: CO_2	Monetized	Units of energy saved in weatherized houses	Pounds of CO_2 emitted per unit of energy saved	Value of CO_2 emission reduction in dollars per pound
2. Air emissions: SO_x	Monetized	Units of energy saved in weatherized houses	Pounds of SO_x emitted per unit of energy saved	Value of SO_x emission reduction in dollars per pound
3. Air emissions: NO_x	Monetized	Units of energy saved in weatherized houses	Pounds of NO_x emitted per unit of energy saved	Value of NO_x emission reduction in dollars per pound
4. Air emissions: CO	Monetized	Units of energy saved in weatherized houses	Pounds of CO emitted per unit of energy saved	Value of CO emission reduction in dollars per pound
5. Air emissions: CH_4	Monetized	Units of energy saved in weatherized houses	Pounds of CH_4 emitted per unit of energy saved	Value of CH_4 emission reduction in dollars per pound
6. Air emissions: PM	Monetized	Units of energy saved in weatherized houses	Pounds of PM emitted per unit of energy saved	Value of PM emission reduction in dollars per pound
7. Air emissions: heavy metals	Monetized	Units of energy saved in weatherized houses	Pounds of heavy metals emitted per unit of energy saved	Value of heavy metal emission reduction in dollars per pound
8. Fish impingement	Monetized	Units of electricity saved in weatherized houses	Number of fish impinged at power plants per unit of electricity saved	Dollar value per impinged fish

Table 2.3. Non-energy impacts and the household-level data and metrics required to calculate their value

Impact Categories and Specific Impacts	Type of Value Calculated	Household-Level Data (used as basis for calculating the value of impacts)	Performance Metric (to be multiplied by household-level data for monetized impacts and calculated from household-level data for non-monetized impacts)	Monetized Metric (to be multiplied by performance metric unless the two are identical)
9. Waste water and sewage in electricity production	Monetized	Units of electricity saved in weatherized houses	Amount of waste water and sewage (in gallons) produced per unit of electricity saved	Cost per gallon of treating waste water and sewage
B. Social Impacts				
1. Avoided unemployment impact	Monetized	Dollars spent to weatherize client homes	Average number of unemployed workers given jobs per dollar spent on weatherization	Average cost of unemployment benefits paid per unemployed worker
C. Economic Impacts				
1. Direct and indirect employment	Monetized	Dollars spent to weatherize client homes	Average number of direct and indirect jobs created per dollar spent on weatherization	Taxes paid (local, state, and federal) and dollars spent locally, per job created
2. Lost rental	Monetized	Number of rental households weatherized	Average amount of unpaid rent per weatherized rental household before and after weatherization	Same as Performance Metric
3. National security	Monetized	Units of source energy saved in weatherized houses	Average proportion of source energy used for residential purposes that is imported	"Premium" paid in higher prices and disturbance to economy per unit of imported energy

It should be noted that critical care will be taken to avoid double counting of any non-energy impact and to make sure that measured impacts are truly attributable to the Program (e.g., by use of control groups). In addition, the non-energy impacts addressed in this evaluation will not include the impact of market transformation, which can be thought of as additional energy savings that "spill over" from direct program effects. The possible differences between non-energy impacts achieved in urban and rural areas will also not be examined in this evaluation.

2.3.1 Monetized Data Collection and Analysis

The coefficients for the performance metrics and monetized metrics that are needed to calculate the monetary values of selected non-energy impacts will come from either previous research on non-energy impacts or from new data gathered for this evaluation (either primary data generated under the evaluation or data from secondary sources). The default values for the performance and monetized metric coefficients will be those used in ORNL's recent review of Weatherization Program non-energy impacts (Schweitzer and Tonn 2002). The default values will be replaced with new, updated values that reflect current conditions for the Program if:

- coefficients from newer studies or computerized models are judged to be superior,
- existing coefficients do not adequately represent program impacts nationwide or the net economic value of the impact, or
- the impact was quantified with a new household level variable.

To the extent possible, existing coefficients will be used, and new ones developed, that disaggregate non-energy impacts by geographic and/or climate region. It is likely (and acceptable) that region-specific coefficients will be used for some non-energy impacts and not for others. In addition, the type of housing units to which the available data apply (e.g., single-family dwellings, mobile homes, multifamily units) will be tracked and, where appropriate (and data allowing), separate coefficients for different housing types will be developed.

Table 2.4 identifies the monetized non-energy impacts for which new performance and/or monetized metrics will be developed under the evaluation. Table 2.4 also shows the factors considered in determining where new data are needed. In essence, the determination was guided by the amount of uncertainty surrounding current metrics, the potential magnitude of their value, and how closely the metric is tied to primary Program purposes. It is possible that subsequent examination of existing performance and monetized metric coefficients will lead to a conclusion that other new coefficients are also needed. As noted earlier, new impacts, new metrics, and new values for existing metrics can be added, provided this does not involve the collection of primary data not previously approved by OMB.

The data to be collected for each monetized non-energy impact to update its performance and/or monetized metric is described below as well as the methods that will be used to collect and analyze those data:

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
I. Utility/Ratepayer Impacts					
A. Payment-Related Impacts					
1. Rate subsidies avoided	Average reduction in number of subsidized units of energy sold per weatherized household (L)	Cost to utility per subsidized unit of energy sold (L)	L	N	
2. Lower bad debt write-off	Average reduction in amount of bad debt written-off by utility per weatherized household (L)	Same as Performance Metric (L)	M	N	
3. Reduced carrying cost on arrearages	Average dollar reduction in arrearage per weatherized household (L)	Interest due utility per dollar of arrearage (L)	L	N	
4. Fewer notices and customer calls	Average reduction in number of notices sent and calls made to customers, per weatherized household (L)	Average cost to utility per notice sent and call made (L)	L	N	
5. Fewer shut-offs and reconnections for delinquency	Average reduction in number of customer shut-offs and reconnections made by utility, per weatherized household (L)	Average cost to utility per shut-off and reconnection (L)	L	N	
6. Reduced collection costs for delinquent payments	Average reduction in number of collections made by utility per weatherized household (H)	Average cost to utility per collection (M)	L	N	

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
B. Service Provision Impacts					
1. Fewer emergency gas service calls	Average reduction in number of emergency service calls made per weatherized household (L)	Average cost to utility per service call (L)	M	N	
2. Trans-mission and distribution loss reduction	Average amount of electricity lost in transmission and distribution, per kWh sold (L)	Average cost to utility per unit of electricity lost (L)	L	N	
3. Insurance savings	Average reduction in utility's cost for insurance to cover household fires and explosions, per weatherized household (M)	Same as Performance Metric (M)	L	N	
4. Shifted utility fixed costs	Average energy savings in weatherized houses (L)	Change in fuel cost per unit of energy savings to cover fixed costs (M)	L	N	Monetized Metric
II. Impacts to Participating Households					
A. Affordable Housing Impacts					
1. Water and sewer savings	Average water savings (in gallons) per device installed (M)	Cost of water and sewer service per gallon of water (H)	M	N	Performance and Monetary Metrics
2. Property value impacts	Average cost of structural repairs per weatherized household (L)	Same as Performance Metric (L)	M	N	Performance Metric (data collected in samples)
3. Avoided shut-offs and reconnections	Average reduction in number of shut-offs and reconnections, per weatherized household (L)	Average cost to customer per shut-off (for “lost rent” and restart fee) (L)	L	Y	

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
4. Reduced mobility	Average reduction in number of moves per weatherized household (H)	Average cost per move (M)	M	N	Performance and Monetary Metrics
5. Reduced transaction costs	Average number of hours required to become familiar with energy-saving products per household (L)	Average cost per hour of time (use minimum wage for this calculation) (M)	L	N	
B. Safety, Health, and Comfort Impacts					
1. Fewer fires	Average reduction in number of fires per weatherized household (M)	Average monetary loss to household (property, injury, and death) per fire (M)	M	Y	Performance and Monetary Metrics
	Perceived changes in safety of heating system and electrical wiring in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
2. Changes in frequency of health problems	Perceived change in health problems in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Average reduction in number of workdays lost due to health problems per weatherized household (H)	Average cost to household per lost work day (L)	M	Y	Performance Metric

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
	Change in incidence of symptoms or occurrences of specific health problems in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
3. Enhanced prevention and treatment of health problems	Reduction in number of times food could not be purchased due to size of utility bill in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Change in access to health care and medication in weatherized houses	Not applicable	Not applicable	Y	Household-level Data
4. Changes in indoor air quality	Measured change in CO levels in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Measured change in level of indoor airborne mold spores relative to outdoor levels in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Measured change in level of indoor airborne pollen relative to outdoor levels in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
	Perceived change in frequency of odors within weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
5. Changes in household moisture levels	Measured change in humidity levels in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
6. Decreased incidence of hypothermia and hyperthermia	Average reduction in number of times emergency medical care is sought due to heat stress or over exposure to cold per weatherized household (H)	Average cost of emergency medical care at hospital, emergency room, or urgent care facility (L)	M	Y	Performance and Monetary Metrics
	Change in incidence of students' disrupted study in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
7. Improved food safety	Measured change in refrigerator temperature in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Change in incidence of gastrointestinal problems and food poisoning in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
8. Improved household safety and security	Average reduction in number of times emergency medical care is sought for injuries from tripping and falling in the home (H)	Average cost of emergency medical care at hospital, emergency room, or urgent care facility (L)	M	Y	Performance and monetary Metrics
	Average reduction in number of times emergency medical care is sought for burns from scalding from domestic hot water (H)	Average cost of emergency medical care at hospital, emergency room, or urgent care facility (L)	M	Y	Performance and Monetary Metrics
	Perceived change in security from criminal intrusion in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Average reduction in number of break-ins per weatherized household (H)	Average value of items stolen in break-in (H)	M	Y	Performance and Monetary Metrics
9. Change in presence of environmental hazards	Measured change in levels of asbestos and radon in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Change in number of poisonings from household chemicals in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Change in level of vermin infestation in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
10. Improved comfort	Perceived improvement in indoor comfort (temperature and draftiness) in weatherized houses (H)	Not applicable	Not applicable	Y	Household-level Data
	Measured change in indoor air temperature in weatherized houses (H)	Not Applicable	Not applicable	Y	Household-level Data
11. Improved appearance	Perceived improvement in appearance of weatherized dwellings (H)	Not Applicable	Not applicable	N	Household-level Data
12. Reduced noise inside dwelling	Perceived reduction in noise within weatherized dwellings (H)	Not applicable	Not applicable	Y	Household-level Data
III. Societal Impacts					
A. Environmental Impacts					
1. Air emissions: CO2	Pounds of CO2 emitted per unit of energy saved (M)	Value of CO2 emission reduction in dollars per pound (H)	H	N	Performance and Monetary Metrics
2. Air emissions: SOx	Pounds of SOx emitted per unit of energy saved (M)	Value of SOx emission reduction in dollars per pound (H)	M	N	Performance and Monetary Metrics
3. Air emissions: NOx	Pounds of NOx emitted per unit of energy saved (M)	Value of NOx emission reduction in dollars per pound (H)	H	N	Performance and Monetary Metrics

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
4. Air emissions: CO	Pounds of CO emitted per unit of energy saved (M)	Value of CO emission reduction in dollars per pound (H)	M	N	Performance and Monetary Metrics
5. Air emissions: CH4	Pounds of CH4 emitted per unit of energy saved (M)	Value of CH4 emission reduction in dollars per pound (H)	M	N	Performance and Monetary Metrics
6. Air emissions: PM	Pounds of PM emitted per unit of energy saved (M)	Value of PM emission reduction in dollars per pound (H)	M	N	Performance and Monetary Metrics
7. Air emissions: heavy metals	Pounds of heavy metals emitted per unit of energy saved (M)	Value of heavy metal emission reduction in dollars per pound (H)	H	N	Performance and Monetary Metrics
8. Fish impingement	Number of fish impinged at power plants per unit of electricity saved (L)	Dollar value per impinged fish (L)	L	N	
9. Waste water and sewage in electricity production	Amount of waste water and sewage (in gallons) produced per unit of electricity saved (M)	Cost per gallon of treating waste water and sewage (M)	M	N	Performance and Monetary Metrics
B. Social Impacts					
1. Avoided unemployment impact	Average number of unemployed workers given jobs per dollar spent on weatherization (L)	Average cost of unemployment benefits paid per unemployed worker (L)	M	N	
C. Economic Impacts					

Table 2.4. Impacts, metrics, and factors required to determine need for new data

Impact Categories and Specific Impacts	Performance Metric and Uncertainty (L, M, H)	Monetized Metric and Uncertainty (L, M, H)	Potential Magnitude of Monetized Value (L, M, H)	Metric is Closely Tied to Program Purposes (Y, N)	New Data to Collect for This Study
1. Direct and indirect employment	Average number of direct and indirect jobs created per dollar spent on weatherization (M)	Taxes paid (local, state, and federal) and dollars spent locally, per job created (L)	H	N	Performance Metric
2. Lost rental	Average amount of unpaid rent per weatherized rental household before and after weatherization (L)	Same as Performance Metric (L)	L	N	
3. National security	Average proportion of source energy used for residential purposes that is imported (L)	"Premium" paid in higher prices and disturbance to economy per unit of imported energy (H)	H	Y	Performance and Monetary Metrics

- **Shifted utility fixed costs—Monetized Metric: Change in fuel cost per unit of energy savings to cover fixed costs.** Information will be collected from the literature on how fuel cost prices increase as a result of reduced consumption to cover utility fixed costs.

- **Water and sewer savings—Performance Metric: Average water savings (in gallons) per device installed; Monetized Metric: Cost of water and sewer service per gallon of water.** For the performance metric, information will be collected from the literature on the amount of water saved through the installation of low-flow showerheads and faucet aerators. From those secondary sources, average water savings per device will be calculated. For the monetary metric, primary data on the cost of water and sewer service (i.e., costs per unit of consumption) will be collected from a nationwide sample of 30 to 50 water utilities serving the houses used in the energy study by examining published information on their web sites. From this, average costs will be calculated for the entire nation and, if possible, for individual geographic and/or climate regions. Utilities will be chosen so that rates are representative of climate regions and housing types.

- **Property value impacts—Performance Metric: Average cost of structural repairs per weatherized household.** Information on the dollar value of the structural repairs performed for each PY 2006 weatherized unit will be collected as part of the Program characterization study (see Section 2.1). Summing the value of repairs performed on *all* units and dividing by the number of dwellings weatherized will yield the average cost of structural repairs per weatherized household. An alternative Performance Metric to evaluate property value impacts might be to collect information from realtors or appraisers to determine the increase in property value based on the amount of structural repairs performed.

- **Reduced mobility—Performance Metric: Average reduction in number of moves per weatherized household; Monetized Metric: Average cost per move.** *If* the billing data gathered for the billing data sample indicate when the occupants of a dwelling move, the average number of moves per household will be calculated for the treatment group in the year following weatherization and compared to the average number of moves during that same period for the control group (using an appropriate statistical procedure). If the billing data do not identify when occupants moved, program participants and a control group of non-participants will be surveyed via telephone regarding the number of times they changed residences in the year after the weatherization period. As before, the mean number of moves for the treatment and control groups will be compared. Only the post-weatherization period will be studied because it is expected that prospective participants will move much less frequently than non-participants during the *pre*-weatherization period because of the process of applying, and waiting, to be weatherized. The average cost of moving for a typical low-income family will be gathered from secondary sources.

- **Fewer fires—Performance Metric: Average reduction in number of fires per weatherized household; Monetized Metric: Average monetary loss to household per fire.** Data on weatherization-induced changes in the number of fires will be gathered using an "Occupant Survey" conducted via telephone. The survey will be administered to the occupants of 940 housing units weatherized in PY 2007 and 529 non-weatherized control units, all selected from the agencies included in the billing data sample. The "Occupant

Survey” will be administered immediately after each house is audited and again a year after weatherization, with an incentive provided to the occupants to maximize the response rate. See Appendix I for the contents of the survey and Appendix M for a detailed justification of the sample size. Additional data on the reduction in fires will be taken from reliable secondary sources. Augmenting survey findings through the use of national statistics is important when examining relatively rare events such as fires. The average monetary loss per fire will also be collected from secondary sources. The most difficult aspect of quantifying monetary loss is assigning an acceptable value to the loss of a human life.

- **Changes in frequency of health problems—Performance Metric: Average reduction in number of work days lost per weatherized household due to health problems.** Occupants of the same weatherized and control units mentioned above will be surveyed over the phone using a portion of the “Occupant Survey” to determine the number of days they missed work during the pre- and post-weatherization periods due to health problems. Net change in number of lost work days from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Decreased incidence of hypothermia and hyperthermia—Performance Metric: Average reduction in number of times emergency medical care is sought due to heat stress or overexposure to cold per weatherized household; Monetized Metric: Average cost of emergency medical care at hospital, emergency room, or urgent care facility.** Occupants of the previously-referenced 940 weatherized units and 529 control units will be surveyed via telephone using a portion of the “Occupant Survey” to determine the number of times a household member sought emergency medical care due to heat stress or overexposure to cold during the pre- and post-weatherization periods. Changes between the two periods will be compared for the treatment and control groups using an appropriate statistical procedure. The average cost of emergency medical care at a hospital, emergency room, or urgent care facility will be gathered from secondary sources.

- **Improved household safety and security—Performance Metric: Average reduction in number of times emergency medical care is sought for injuries from tripping and falling in the home; Monetized Metric: Average cost of emergency medical care at hospital, emergency room, or urgent care facility.** Once again, the “Occupant Survey” will be administered to the same weatherized and control units described above. During the pre-weatherization period and again in the post-weatherization period, the subjects will be asked to report the number of times a household member has sought emergency medical care for injuries from tripping and falling in the home. Net change from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure. Additional data on the frequency of serious trip and fall injuries will be taken from reliable secondary sources. The average cost of emergency medical care at a hospital, emergency room, or urgent care facility will also be gathered from secondary sources.

- **Improved household safety and security—Performance Metric: Average reduction in number of times emergency medical care is sought for burns from scalding from**

domestic hot water in weatherized houses; Monetized Metric: Average cost of emergency medical care at hospital, emergency room, or urgent care facility. The "Occupant Survey" will be administered to the same weatherized and control units described above. The subjects will be asked to report the number of times a household member sought emergency medical care as a result of burns from scalding hot water from a faucet or showerhead in their home during the pre- and post-weatherization periods. Changes between the two periods will be compared for the treatment and control groups using the same general approach described above. As noted previously, the average cost of emergency medical care at a hospital, emergency room, or urgent care facility will be gathered from secondary sources.

- **Improved household safety and security—Performance Metric: Average reduction in number of break-ins per weatherized household: Monetized Metric: Average value of items stolen in break-in.** For both the performance and monetary metric, the necessary data will be collected through the previously-described "Occupant Survey." In both the pre- and post-weatherization periods, the subjects will be asked to report the number of break-ins to their residence during the previous year and the value of the items stolen during those incidents. An appropriate statistical procedure will be used to compare changes from the pre- to post-weatherization period for the treatment and control groups.

- **ALL air emissions—Performance Metrics: Pounds of substances (CO_2, SO_x, NO_x, CO, CH_4, PM, heavy metals) emitted per unit of energy saved; Monetized Metrics: Value of substances emitted in dollars per pound.** Necessary data pertaining to these metrics can be collected from secondary sources. Specifically, a literature review will be conducted regarding the amount of each relevant substance typically emitted per unit of energy saved. This review will focus on emissions for those plants that are "on the margin," meaning that their fuel consumption is most likely to be cut when energy use is reduced. Getting region-specific numbers for these factors should be relatively easy. Using those numbers, emissions reductions will be calculated from the energy savings findings (see Section 2.2). To address the monetary value of the emissions reductions, a search will be carried out for information on the values established through emissions trading for each substance. It should be noted that getting good, up-to-date information on the monetary metrics is even more important than gathering data on the performance metrics because the former is surrounded by greater uncertainty.

- **Waste water and sewage—Performance Metric: Amount of waste water and sewage produced per unit of electricity; Monetized Metric: Cost per gallon of treating waste water and sewage.** Necessary data pertaining to these metrics will be gathered through a literature review.

- **Direct and indirect employment—Performance Metric: Average number of direct and indirect jobs created per dollar spent on weatherization.** Secondary sources on economic multipliers will be used to calculate the average number of direct and indirect jobs created per dollar spent on weatherization in the geographic areas under study. Input/output models utilizing the best available data could be useful for this purpose. To the extent possible, the analysis should attempt to identify the "net" impact, which is the effect the Weatherization

Program had on employment minus the employment effect that might have resulted from the same magnitude of expenditure on likely alternative projects.

- **National security—Performance Metric: Average proportion of source energy used for residential purposes that is imported; Monetized Metric: "Premium" paid in higher prices and disturbance to economy per unit of imported energy.** Data on energy imports will be derived from the most up-to-date secondary sources. The value of the imported energy "premium" will be taken from a study currently being performed by ORNL researchers.

Once the full data collection effort is complete and new coefficients are developed, an analysis will be performed to calculate values for all monetized non-energy impacts. In the final report for this study, each coefficient used to calculate the total monetized value of non-energy impacts will be described and why it was selected will be explained. Impacts will be reported separately for each major category shown in Tables 2.3 and 2.4 (Utility/Ratepayer Impacts, Impacts to Participating Households, and Societal Impacts) and a *total* impact for all categories combined will also be given.

After all monetized impacts are calculated, a quick sensitivity analysis will be conducted to see how out-year estimates of non-energy impacts might change in response to variation in key driving factors and assumptions made in the calculations such as changing demographics in the houses, loss of housing stock, energy prices, discount rates, new technology, and climate change. This analysis will use the results of a prior sensitivity analysis of how energy savings change in response to variance in the same driving factors (see Section 2.2.2). The results of this analysis will be used in the sensitivity analyses performed for cost effectiveness (see Section 2.4).

Additional analyses will be performed to explore the effects of specific agency actions on various monetized health- and safety-related impacts. This can be done by (1) performing regression analysis to search for relationships between various impacts and agency actions (e.g., installation of smoke alarms, security measures) that have the potential to affect health and safety; and (2) doing a literature review on the relationships between selected agency actions and health effects.

2.3.2 Non-Monetized Data Collection and Analysis

In determining the value for all non-monetized impacts, performance metrics will be calculated directly from the relevant household-level data shown in Table 2.3. The appropriate performance metric for each non-monetized non-energy impact is identified in Table 2.4. The methods that will be used to collect and analyze the relevant data for each non-monetized impact are described below. As with the monetized non-energy impacts, results specific to geographic region, climate region, and/or housing type will be developed to the extent possible.

For most of the non-monetized impacts described below, occupants of 940 housing units weatherized in PY 2007 and 529 control units from the agencies included in the billing data sample will be surveyed over the phone using a portion of the "Occupant Survey" (see Appendix I for the survey and Appendix M for a detailed justification for this sample size). The survey will be administered immediately after each house is audited and again a year after weatherization, with an incentive provided to improve the response rate.

The other main data collection approach used for the study of non-monetized health, safety, and comfort impacts is the direct measurement of key factors in a sample of 309 weatherized housing units and 59 control dwellings. See Appendix M for a justification of this sample size. To reduce data collection costs, an effort will be made to select some houses that are already being studied for the fuel-oil, propane, and air conditioning studies (see Sections 2.2.1 and 4.6), provided that can be done without skewing the sample. In each of the units selected for the direct measurement study, the following will be measured during both the pre- and post-weatherization period: carbon monoxide levels; level of airborne mold spores inside and outside the dwelling; level of airborne pollen indoors and outside; indoor humidity level; temperature inside the refrigerator; asbestos and radon levels; and indoor air temperature. Pre-weatherization measurements will be taken after the audit is performed, and post-weatherization measurements will be taken at the appropriate time following the installation of all weatherization measures.

- **Fewer fires—Performance Metric: Perceived changes in safety of heating system and electrical wiring in weatherized houses.** Using the "Occupant Survey" described above, program participants and a control group of non-participants will be asked for their perceptions of the safety of their dwelling's heating system and electrical wiring before and after the period in which weatherization work is performed. Net change in perceptions from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Changes in frequency of health problems—Performance Metric: Perceived change in health problems in weatherized houses.** Program participants and a control group of non-participants will be surveyed using the "Occupant Survey" regarding the perceived condition of their (and their family's) health in the pre- and post-weatherization periods. An appropriate statistical procedure will be used to compare the change from the pre- to post-weatherization period for the weatherized and control groups.

- **Changes in frequency of health problems—Performance Metric: Change in incidence of symptoms or occurrences of specific health problems in weatherized houses.** Through the "Occupant Survey," program participants and non-participants will be asked to report the frequency with which they experience certain health problems or the principal symptoms of those problems during the pre-weatherization period and again during the post-weatherization period. Subjects will be asked specifically about occurrences of asthma, other respiratory problems, colds, and flu. They will also be asked to report symptoms of these and other conditions such as exposure to allergens, mold, and CO. Those symptoms include wheezing, shortness of breath, coughing, congestion, headaches, and nausea.

- **Enhanced prevention and treatment of health problems—Performance Metric: Reduction in number of times food could not be purchased due to size of utility bill in weatherized houses.** The "Occupant Survey" will ask weatherization clients and a control group about the frequency with which they have foregone the purchase of food in order to pay utility bills and the frequency will which they have not paid utility bills in order to purchase food. The same questions will be asked during the pre- and post-weatherization periods, and any changes from the former to the latter will be calculated. The net change from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Enhanced prevention and treatment of health problems—Performance Metric: Change in access to health care and medication in weatherized houses.** The "Occupant Survey" will ask residents of weatherized and non-weatherized households questions about the trade-offs they have made between paying utility bills and purchasing prescription medicines that are similar to the questions described above for food purchases. As in that subject area, changes from the pre- to post-weatherization period will be compared for the weatherized and control groups. In addition, the two groups (weatherized and not weatherized) will be compared in terms of how their number of visits to emergency rooms and to their primary physician or other primary health care provider has changed from the pre- to post-weatherization period. The frequency with which respondents report not having a primary care physician or other primary health care provider will also be examined.

- **Changes in indoor air quality—Performance Metric: Measured change in CO levels in weatherized houses.** Equipment will be installed in 309 weatherized housing units and 59 control units to measure carbon monoxide (CO) levels during both the pre- and post-weatherization period. The non-weatherized houses will be measured at the same time as the weatherized units to control for any possible changes in outdoor temperature or other climatic conditions. Net change in CO levels from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure. In addition, descriptive statistics will be generated showing the frequency with which dangerously high levels of CO were found during the pre-weatherization period and the appropriate statistical test will be used to calculate the frequency with which those high concentrations were reduced to safe levels in weatherized units.

- **Changes in indoor air quality—Performance Metric: Measured change in level of indoor airborne mold spores relative to outdoor levels in weatherized houses.** In the same housing units for which CO concentrations will be measured, the levels of airborne mold spore contamination will also be quantified by comparing the number and species of mold found indoors to those found immediately outside the dwelling. These measurements will be taken both before and after weatherization, and the change in indoor-to-outdoor ratios between those two periods will be calculated. The non-weatherized units will be measured at the same time as the weatherized units and careful attention will be paid to the season in which the measurements are taken. Net change in indoor-to-outdoor mold spore ratios from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Changes in indoor air quality—Performance Metric: Measured change in level of indoor airborne pollen relative to outdoor levels in weatherized houses.** Levels of airborne pollen will be measured in the same housing units for which the concentrations of CO and indoor mold spores will be examined. As with those other items, measurements will be taken both before and after weatherization and the change in indoor-to-outdoor ratios from the pre- to post-weatherization periods will be compared for the weatherized and control groups. Once again, the non-weatherized units will be measured at the same time as the weatherized units and careful attention will be paid to the season in which the measurements are taken.

- **Changes in indoor air quality—Performance Metric: Perceived change in frequency of odors within weatherized houses.** The "Occupant Survey" will ask a sample of weatherization participants and non-participants for their perceptions of how often there are odors inside their home that could indicate a problem with indoor air quality. The occupants will be asked to describe the situation separately for the winter and the summer, and the survey will be administered both before and after weatherization. Net change from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Changes in household moisture levels—Performance Metric: Measured change in humidity levels in weatherized houses.** Relative humidity will be measured in the same housing units for which the concentrations of CO, indoor mold spores, and pollen will be examined, during both the pre- and post-weatherization periods. The non-weatherized units will be measured at the same time as the weatherized units and careful attention will be paid to the season in which the measurements are taken. Net change in humidity levels from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Decreased incidence of hypothermia and hyperthermia—Performance Metric: Change in incidence of students' disrupted study in weatherized houses.** The "Occupant Survey" will ask how frequently household residents find it hard to study at home because of excessive heat or cold. The net change in frequency of study disruption from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

- **Improved food safety—Performance Metric: Measured change in refrigerator temperature in weatherized houses.** The change in the internal temperature of refrigerators will be measured in the same housing units for which CO, indoor mold spores, pollen, and relative humidity will be examined. Temperatures will be taken inside the refrigerator both before and after weatherization and the net change in refrigerator temperature from the pre- to post-weatherization period will be calculated from the treatment and control group data using an appropriate statistical procedure. In addition, descriptive statistics will be generated showing the frequency with which unsafe temperatures were found inside refrigerators during the pre- weatherization period and the appropriate statistical test will be used to calculate the frequency with which those high temperatures were reduced to safe levels in weatherized units.

- **Improved food safety—Performance Metric: Change in incidence of gastrointestinal problems and food poisoning in weatherized houses.** The "Occupant Survey" will ask people in weatherized and non-weatherized households whether they have experienced serious gastrointestinal problems in the previous month or have suffered from food poisoning dung the past six months. These same questions will be asked both before and after weatherization, and the changes will be compared for the weatherized and control groups.

- **Improved household safety and security—Performance Metric: Perceived change in security from criminal intrusion in weatherized houses.** Using the "Occupant Survey," program participants and a control group of non-participants will be asked for their perceptions of how secure their home is from intrusion by criminals both before and after weatherization. The change over time will be compared for the weatherized and control groups using an appropriate statistical procedure.

- **Change in presence of environmental hazards—Performance Metric: Measured change in levels of asbestos and radon in weatherized houses.** In the same dwellings for which CO and other factors will be measured, the levels of asbestos and radon will be measured during both the pre- and post-weatherization periods and net change will be calculated as described previously. In addition, descriptive statistics will be generated showing the frequency with which unsafe levels of asbestos and radon were found during the pre- weatherization period and the appropriate statistical test will be used to calculate the frequency with which those high concentrations were reduced to safe levels in weatherized units.

- **Change in presence of environmental hazards—Performance Metric: Change in number of poisonings from household chemicals in weatherized houses.** Through the "Occupant Survey," subjects in both weatherized and non-weatherized dwellings will be asked to report whether the members of their household had been poisoned during the past year and, if so, to identify the substance with which they had been poisoned. Net change from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure. Additional data on the frequency of poisoning from household chemicals will be taken from reliable secondary sources.

- **Change in presence of environmental hazards—Performance Metric: Change in level of vermin infestation in weatherized houses.** The "Occupant Survey" will solicit information from both weatherization participants and non-participants on the extent to which their dwelling is infested with rats, cockroaches, and other vermin. This question will be asked both before and after weatherization. The net change in this factor from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups.

- **Improved comfort—Performance Metric: Perceived improvement in indoor comfort in weatherized houses.** A sample of Program participants and a control group of non-participants will be asked about their perceptions of the indoor comfort of their dwelling unit during the pre- and post-weatherization period, via the "Occupant Survey." Comfort will include both indoor temperature and draftiness, as in the 1989 Weatherization Program national evaluation, as well as the floor area or number of rooms that can be conditioned. Responses will be solicited during both the heating and cooling seasons. Net change from the pre- to post-weatherization period will be determined using an appropriate statistical procedure.

- **Improved comfort—Performance Metric: Measured change in indoor air temperature in weatherized houses.** Equipment will be installed in the previously-mentioned 309 treatment dwellings and 59 control units to measure indoor winter and, if possible, summer air temperatures during both the pre- and post-weatherization periods. The non-weatherized houses will be measured at the same time as the weatherized units to control for any possible changes in outdoor temperature or other climatic conditions, and careful attention will be paid to the season in which the measurements are taken. Net change from the pre- to post-weatherization period will be determined by comparing change from the treatment and control groups using an appropriate statistical procedure.

- **Improved appearance—Performance Metric: Perceived improvement in appearance of weatherized dwellings.** Using the "Occupant Survey," a sample of Program participants and a control group of non-participants will be asked for their perceptions of the appearance of their dwellings both before and after weatherization. Changes from the pre- to post-weatherization period will be compared for the treatment and control groups.

- **Reduced noise inside dwelling—Performance Metric: Perceived reduction in noise within weatherized dwellings.** The "Occupant Survey" will ask a sample of weatherization participants and non-participants for their perceptions of the noise level within their dwellings both before and after weatherization. Once again, net change from the pre- to post-weatherization period will be determined by comparing change for the treatment and control groups using an appropriate statistical procedure.

As described above, the magnitude of each non-monetized impact will be calculated separately. In addition, the effects of specific agency actions on various non-monetized health- and safety-related impacts will be explored. This can be done by (1) performing regression analysis to search for relationships between various impacts and agency actions (e.g., plumbing repairs, improved ventilation) that have the potential to affect health and safety; and (2) doing a literature review on the relationships between selected agency actions and health effects.

2.4. COST EFFECTIVENESS

The impact assessment will determine the cost effectiveness of the Program as implemented in PY 2006 on a national basis and by climate region, housing type, primary space-heating fuel type, and the five client groups that the Program is specifically instructed to focus on (the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden). The cost effectiveness of the Program in PY 2006 will then be compared to results from the 1989 National Evaluation and from the metaevaluations performed between 1990 and 2005. It should be noted that, although cost effectiveness will be calculated by climate region, housing type, and type of primary space-heating fuel, a full analyses of factors affecting cost effectiveness will be performed as described in Section 2.5.

The cost effectiveness of the Program will be calculated using appropriate methods for coordinated programs (Brown and Hill, 1994; Hill and Brown, 1994). Cost effectiveness will be calculated using the total costs spent on the house from all funding sources as collected and analyzed in Section 2.1, the energy cost savings calculated in Section 2.2, and the monetary values of the non-energy impacts (which may include both benefits and costs) estimated in Section 2.3. Cost effectiveness will be determined using savings-to-investment ratio (SIR), the same indicator as used in the 1989 National Evaluation. Standard formulas for this indicator will be used. Cost effectiveness will be examined from three perspectives as done in the 1989 National Evaluation:

- **Installation perspective**—savings are limited to energy savings (all heating, cooling, and baseload energy savings combined), and investments (i.e., costs) are limited to installation expenditures (on-site labor and materials),

- **Program perspective**—savings are limited to energy savings, but investments are expanded to include management and overhead costs along with installation expenditures, and

- **Societal perspective**—savings include both energy savings and monetary values for non-energy impacts (which may include both benefits and costs and, therefore, are net economic values), and investments include installation, management, and overhead expenditures.

The average lifetime of measures needed in the calculation of SIR will be determined by weighting the individual lifetimes of each measure (as determined from secondary sources) by the frequency of its installation and relative energy savings. The monetary values of the non-energy impacts used in the calculations will be the net present value of the impact and, thus, will already have taken into account the lifetime of the impact and how the impact varies over time. Real discount rates and fuel escalation rates as recommended by the Department of Commerce will be used in the calculations.

A sensitivity analysis will be performed to determine the impact of key assumptions used in the calculation of SIR. These key assumptions include energy savings, fuel costs, measure lifetime, real discount rate, fuel escalation rate, and the monetary value of non-energy impacts. A risk analysis modeling approach will be used that allows the uncertainty in model inputs to be defined by probability distributions so that distributions of likely SIR outcomes can be developed. Results from the sensitivity analysis performed specifically for energy savings (see Section 2.2.2) and non-energy impacts (see Section 2.3.1) will be used in this analysis.

As part of the cost effectiveness analysis, the impact alternative per-household investment levels can have on Program cost effectiveness and other key Program metrics such as number of units weatherized and average energy savings should be examined (i.e., examine if there are investment levels that optimize the SIR at an agency or state level and, if so, how this subsequently impacts the number of units weatherized by the agency or state and the average energy savings per weatherized unit). The analysis method to determine this impact is not specified. However, in addition to reviewing the relevant research, insight into the impact of household investment levels might be obtained by two possible methods:

- Calculating SIRs for different expenditure categories of weatherization jobs (e.g., those costing between $1,500 and $2,000, between $2,000 and $2,500, etc.) and then comparing the means of each category using appropriate statistical methods. Information on the houses used in the billing data sample would be sufficient to perform such an analysis

- Using an audit program such as the Weatherization Assistant (Gettings, 2006). A significantly large number (perhaps 100) of real or typical houses could be modeled for a real or example agency to identify all the measures with an SIR greater than 1.0 for each house and estimate the cost and SIR for each of these individual measures. The cost effectiveness and average investment level for this agency can be calculated for a fixed budget sufficient to install all the measures with an SIR greater than 1.0 in just say the first 50 houses as well as perform all administration functions associated with these 50 houses (e.g., intake, auditing, and post-weatherization inspections). The cost effectiveness and average investment level for the agency would then be recalculated as the SIR cutoff used to determine which measures are installed in each house is raised (or the average investment level per house is decreased), such that fewer measures are installed in these first 50 houses but measures with high SIRs are installed in additional houses until the same fixed budget is expended. If desired, houses used in the billing data sample could be modeled such that the model predictions could be calibrated to actual energy data. The analysis could be repeated using different costs to perform the administrative functions to gain insight into how the optimal SIR cutoff and average investment level changes as these fixed costs change.

2.5 EXPLANATORY FACTORS

Although average energy and cost savings will be calculated in the impact assessment by climate region, housing type, and primary space-heating fuel type (see Sections 2.2 and 2.4), a full analysis of factors that explain variations in energy savings and cost effectiveness will also be performed. The impact assessment will assess how the energy savings achieved by the Program and the cost-effectiveness of the Program are affected by the various organizational features and operational processes of the Program, the households the Program serves, the measures installed, and the environment in which the Program operates. Some specific factors that will be examined include:

- household pre-weatherization energy consumption,
- installation of particular weatherization measures,
- key house characteristics (e.g., type, size),
- key occupant characteristics (e.g., age, disability),
- fuel prices,
- climate zone,
- training methods for weatherization crews,
- type of audit used,

- client education approach used,
- monitoring procedure employed,
- total investment levels,
- funding sources,
- low and high *material* expenditures (as opposed to total expenditures, which include labor costs),
- weatherization using only DOE funds versus funds from multiple sources,
- air leakage reduction,
- duct leakage reduction, and
- increased furnace steady-state efficiency.

A broad range of potential explanatory variables will be examined using regression analysis. In addition, average savings associated with and without a single factor will be compared using all houses, and mean savings for explanatory factors will be compared between high-saving and low-saving houses. Those factors that explain the most variation and are controllable by state and local weatherization agencies will be given the most attention, because results in those areas can suggest potentially valuable changes in program implementation. Special emphasis will be placed in these analyses on identifying variables that explain why the performance in the hot climate region is unique. Details on these analyses are provided below.

2.5.1 Regression Analysis

The primary analytical approach that will be used to study explanatory factors will be regression analysis. The regression analysis will explore the relationships between household energy savings and cost-effectiveness and a broad variety of factors with the potential to explain variations in those two performance measures, including many of those identified above. When examining the possible influence of pre-weatherization energy use, how much of the observed relationship is due to the regression-to-the-mean phenomenon will be identified.

Hypotheses will be developed concerning *a priori* expectations of the influences of each independent (explanatory) variable on the dependent variables (savings and cost-effectiveness). Energy savings will be measured in absolute terms, as a percentage of pre-weatherization whole-house energy use, and as a percentage of the pre-weatherization energy used for space-heating. Cost-effectiveness will be defined as energy savings divided by the cost required to achieve it. The results of the regression analyses will be examined and significant beta coefficients of the proper sign will provide support for the hypotheses. Insignificant variables will be dropped from the regression models.

Separate regression analyses will be run for houses heated by natural gas, electrically-heated houses, and houses heated by non-metered fuels (fuel oil and propane). Within those categories, the factors influencing energy savings and those influencing cost-effectiveness will be examined separately. For all dwellings other than those heated with electricity, further analyses will be performed to focus on factors affecting savings of the primary heating fuel only, baseload electricity only, and both fuels (heating and baseload electricity) combined.

Houses Heated by Natural Gas—As part of the regression analysis, a large multiple regression model will be run that includes all potential explanatory variables. It is likely that this will be a "stepwise" regression, in which independent factors are added to the model in the order of their explanatory significance. In addition, a series of simple regressions will probably be conducted using one independent variable at a time, and a factor analysis will likely be done to examine what sets of explanatory variables are associated with each other.

The above analyses will be run first using energy savings as the dependent variable and then again using cost-effectiveness as the dependent variable. Actually, the analysis of energy savings will consist of three different analyses, one for each of the above-mentioned definitions of savings (absolute household savings, household savings as a percentage of pre-weatherization whole-house energy use, and household savings as a percentage of the pre-weatherization energy used for space-heating). Further complexity will be added by the fact that energy savings will be first defined as savings of the primary heating fuel only, then as baseload electricity savings, and finally as savings of *both* fuels (heating and baseload electricity) combined.

Once the above analyses are run for *all* weatherized households, they will be run again for relevant subsets of households. These subsets will include, but are not limited to, different geographic and/or climate regions, agency sizes, and housing types.

Finally, regression analysis will be run using average household savings and cost-effectiveness *per weatherization agency* as the dependent variable. The same independent variables and analytical procedures listed above will be used. The theory behind undertaking this analysis is that using agency averages is likely to reduce the variability of results.

Electrically-Heated Houses—The regression analyses conducted for electrically-heated homes will be the same as those described above for gas-heated homes except that they will be run only for the primary heating fuel because the dwellings involve use electricity both for heating and baseload purposes.

Houses Heated with Non-Metered Fuels (Fuel Oil and Propane)—The regression analyses conducted for homes heated by non-metered fuels will be exactly the same as those described for gas-heated homes.

2.5.2 Cross-Tabulation Results

Average savings associated with a single factor (e.g., savings in houses that received wall insulation compared to houses that did not) will be compared for all houses and by subgroups of houses depending on primary heating fuel. Mean values for key explanatory factors (e.g., floor area, pre-weatherization energy use, installation of attic insulation) for high-saving and low-saving houses and for high-saving and low-saving agencies will also be calculated and compared.

2.5.3 Data

This analysis of explanatory factors will use pre-weatherization energy consumptions and energy savings as described in Section 2.2, and cost effectiveness calculated for individual houses as described in Section 2.4. This analysis will also draw upon data on house, occupant, and program characteristics as described in Section 2.1. Information on some potential explanatory factors will be gathered for all weatherized houses, while data on other factors will be collected from a subset of houses if they are not available for all dwellings served by the program. Average data for a number of factors will be calculated for all weatherization agencies and some additional information will be collected from a selected group of agencies.

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3. PROCESS ASSESSMENT

The process assessment portion of the evaluation will address many of the questions identified in the evaluation design matrix (see Table 1.2) that the impact assessment did not address:

- **Context**—Questions 1, 5, and 7-11; and
- **Implementation**—Questions 3 and 5.

These questions include identifying the missions and associated objectives of the Program and the organizations that the Program works with; understanding how the weatherization network works and the role of the Program in serving the low-income weatherization market; investigating the leveraging and partnership opportunities for the Program; and determining how well the Program is delivering services and how essential elements of the Program (such as auditing, client education, training, and monitoring) can be improved.

In addition, the process assessment will address the four high priority and consensus goals identified by the Network Planning Committee that the impact assessment did not address (see Items 5–8 in Section 1.1.1). These deal with computerized audits, client education, training, and monitoring. The Network Planning Committee was interested in:

- understanding how states and agencies address these components of the weatherization process,
- evaluating the quality and effectiveness of different approaches,
- determining how different approaches affect energy savings and cost effectiveness, and
- understanding which approaches work and do not work.

This evaluation is being designed to make a good faith effort to respond to the Network Planning Committee's interests. However, because of resource limitations, a definitive answer may not be obtained for each of these questions as they apply to each of the four subject areas. Determining the impact of each subject area on energy savings and cost effectiveness is particularly difficult to measure directly, although the regression analyses described in Section 2.5 will provide some insight. For client education and training, the effect of the various methods on absorbed or retained knowledge of clients or weatherization crews, respectively, will be determined through regression analysis, allowing the impact on energy savings and cost effectiveness to be inferred (much like it can inferred that reductions in house air leakage leads to increased energy savings). Referring back to the detailed descriptions presented in Section 1.1.1, the following are not being addressed under this evaluation:

- Computerized audits—the incremental benefits and cost effectiveness of moving from a priority list to a computerized audit approach, and ultimately which approach is better and/or more cost effective.

- Client education—its impacts and effects on longevity of measures, and the incremental benefits and cost effectiveness of moving from minimum approaches (e.g., dropping off a pamphlet) to more in-depth education.

- Training—if training funds are being spent expeditiously.

- Monitoring—the impact on energy savings and cost effectiveness.

The process assessment will be implemented by performing an overall study of program operations and implementation and conducting a set of case studies to examine high-performing weatherization agencies. Additional detail will be provided by an in-depth field study that focuses on four critical program elements: computerized energy audits, client education, training, and monitoring.

Each of these three studies is described below, including an outline of the data that need to be collected and how these data will be analyzed. A final report will be written for each study that includes all the details of the study. A synthesizing report will also be written that draws together all the findings from the separate studies.

3.1 PROGRAM OPERATIONS AND IMPLEMENTATION

This assessment will aim to understand the context in which the Program operates by:

- identifying the legislative goals (missions and associated objectives) of the Program and determining the Program's ability to meet these goals;

- identifying how states implement the Program relative to the logic model developed for the Program (see Section 1.1.2);

- determining how well DOE manages and administers the Program;

- determining how well the Program and the weatherization network is delivering its services to the low-income weatherization market;

- identifying the leveraging and partnership opportunities the Program is exploiting (i.e., identifying the degree to which states and agencies coordinate the implementation of the Program with other federal, state, utility, and other programs) and determining if the Program's regulations are enhancing and/or inhibiting leveraging and partnership opportunities; and

- determining the role the Program plays in the larger low-income energy assistance effort.

3.1.1 Data and Surveys

Information on process improvement will be collected from all states as part of the "All States PY 2007 Survey" (see Appendix E) and from the 400 agencies involved in the billing data energy savings portion of the impact assessment (see Section 2.2.1) as part of the "Subset of Agencies PY 2007 Survey" (see Appendix H). Both surveys will also ascertain their views of how DOE manages and administers the Program and will collect detailed input on how the states and agencies implement house audits, client education, training, and monitoring as previously described in Section 2.1.1. The state survey will also collect information that define state "implementation models.". These surveys will be implemented after each state and agency completes PY 2006 (August to October 2007).

DOE will be surveyed using the "DOE PY 2007 Survey" (see Appendix C) to collect information on staffing, costs, and their enforcement of state and local agency data collection, storage, and data mining capabilities. This survey will be given when PY 2006 is complete for all states (October 2007).

Open-ended interviews will be held with DOE and a subset of states and agencies over the phone or by one or more group meetings by April 2008 to solicit needed process information for this study. The sampling plan and survey instruments associated with this data collection will need to be developed; however, the survey instrument should include the following information:

- major strengths/positive traits at each implementation level (DOE, state, and agency),
- major weaknesses at each level,
- major barriers to effective operation posed by each level and outside partners,
- adequacy of current resources,
- suggested reallocation of current resources,
- suggested allocation of additional resources,
- coordination,
- communications, and
- Program administration.

Occupants from 940 housing units weatherized in PY 2007 from the 400 agencies included in the billing data sample will be surveyed using a portion of the "Occupant Survey" (see Appendix I) to determine their perceptions on how well Program services were delivered (see Appendix M for a detailed justification for this sample size). This portion of the "Occupant Survey" will be implemented immediately after these housing units are weatherized in PY 2007, with an incentive provided to the occupants to maximize the response rate. These surveys will be conducted over the telephone and will collect information such as the timeliness of the work performed (e.g., audit, measure installation, inspection), if agency staff showed up at scheduled times, the condition in which workers left the house following their work (e.g., cleanliness, debris removal), and the courtesy of the agency personnel. A "Program Services Agency Survey" (see Appendix J) will be administered at the same time as the "Occupant Survey" to agency staff and crews that worked on these houses to collect equivalent information on their perceptions of how well they delivered Program services to these houses. It is expected that the agencies will be compensated by DOE for the time it takes their staff and crews to complete this survey.

3.1.2 Analysis

The mission and objectives of the Program and DOE's management structure and responsibilities will be described. This will include a summary of:

- the Program's legal authorities and regulatory framework;

- the goals, objectives, and key measures of performance as viewed by Congress, the Department, and the Administration; and

- Federal, state, and local responsibilities as described by regulation and by network participants.

In addition, particular attention will be paid to the treatment of leveraging under the Program's rules and regulations.

An analysis will be performed of the management structure, responsibilities, and resources for each of the Program's management levels (i.e., headquarters, regions, state, and local agencies). This analysis will focus on the operation at each management level, the allocation of human and funding resources to various functions, and how each management level perceives the adequacy of those resources for each function within and between management levels. A secondary focus of this analysis will be on the perceived barriers to effective operations posed by each management level on other management levels and by each management level with outside partners.

Organizational activities relating to how well Program services were delivered will be identified, and a measurable indicator for each activity will be developed (e.g., if audit was performed on time, if measures were installed when scheduled). Information collected from all or a subset of agencies on all or a subset of the houses they weatherized will be used to determine average values for these indicators.

Approximately five typical models of how states administer and implement the Program will be developed based on information collected from the state survey and from reviewing state weatherization plans submitted to DOE. How well these models work, and how well they fit the theory and logic of the Program, will be discussed using the logic model developed for the Program (see Section 1.1.2) as a guide. Lessons learned from the various approaches, model dependencies, and key issues and administrative concerns affecting model effectiveness should be identified.

A literature review of evaluations conducted on utility low-income weatherization programs will be performed so that the issue of systematic differences in savings per dollar spent between utility programs and the DOE Program, if any, can be discussed. Reasons for any identified differences will be discussed, including the Program's case management approach to addressing customers' needs versus the utilities' emphasis on just installing measures (that are cost effective), and the Program's requirements to address health and safety issues.

The occupant's perceptions on how well Program services were delivered will be analyzed and compared to the perceptions provided by the agency staff and crews.

The role of the Program in the overall low-income energy assistance effort will be assessed by drawing together information from the impact assessment on the Program characteristics (see Section 2.1) with information collected and analyzed in this study. Program characteristics that will be used include information on the national low-income population, the segment of the market currently being served by the Program, and the characterization of the local and state agencies and the scope of their programs.

3.2 PROCESS ASSESSMENT CASE STUDIES

Six to ten case studies of high-performing agencies will be conducted to explore factors affecting energy savings and cost-effectiveness and examine administration approaches such as implementation models and leveraging. High-performing agencies will be defined based on multiple criteria such as high average energy savings achieved by the agency, high agency-level savings-to-investment ratio, significant use of leveraging funds, and quality administration and management practices. Case studies cannot be chosen based on measured values for some or all of these criteria because the case studies will be initiated before the impact assessment is completed. Consequently, high-performing agencies will be identified based on input received from DOE using the "DOE PY 2006 Survey" (see Appendix B) and all states using the "All States PY 2006 Survey" (see Appendix D), with supplemental information provided by recent state-level studies of the Program. These surveys will be conducted as soon as the evaluation can be implemented (July 2007).

Case studies will be conducted in each of the four climate regions. These case studies will take a "whole agency" approach to understanding all the factors that influence exemplary performance and all components of administrative implementation. To the extent possible, the case studies will also examine the impact weatherization has had on the health of clients. Case study work will include review of records, field observations, and interviews with agency staff, crews, and clients. The field observations should pay particular attention to the quality of the housing stock and the degree to which the housing stock needs repair, as this is an important issue often raised concerning high and poor performance especially in the hot climate region. The data collected and the observations made in the course of the case studies will be examined, separately and across cases, to produce insights on the factors responsible for exemplary agency performance. In addition, when the impact and other studies are completed, the performance of the "high-performing" agencies used in the case studies with regard to energy savings, cost effectiveness, and other variables will be compared to each other and to the population of agencies as a whole to determine if the selected agencies were truly high performers.

The sampling plan and survey instruments needed to implement and perform the case studies of high-performing agencies will need to be developed. However, Table 3.1 provides a preliminary list of data that should be collected and analyzed as part of the case studies.

Table 3.1. Preliminary list of case study data

Average energy savings per household
Average per-household energy savings as a percentage of pre-weatherization energy use
Average per-household energy savings as a percentage of pre-weatherization energy used for space-heating
Average cost-effectiveness
Average pre-weatherization energy consumption
Types and frequency of measures installed and/or average package of weatherization measures installed
Average dwelling unit characteristics (type, size, etc.)
Average occupant characteristics
Average fuel prices
Average climate zone
Average expenditures
Average funding sources and levels
Methods for training weatherization crews
Types of audit used
Client education approaches used
Monitoring procedures
Other relevant agency characteristics and operational procedures
Participant perspectives on important factors influencing performance
Organizational characteristics
Staff background, skills, and training
Leadership
Agency leveraging and partnering
Cost controls
Implementation (client education, intake, diagnostics, audit procedures, etc.)

3.3 AUDITS, CLIENT EDUCATION, TRAINING, AND QUALITY ASSURANCE

The implementation of audits, client education, weatherization crew training (both in-house and contractor crew personnel), and agency final inspection practices as associated with single-family houses and mobile homes will be assessed through a combination of characterization and field study. Client education will be further assessed through case studies and by conducting a client education test/survey, and weatherization crew training will be further assessed through case studies and by conducting a training survey of weatherization staff. State-level monitoring of agencies will be assessed only through characterization.

The study of audits, client education, weatherization crew training, and agency- and state-level quality assurance will be performed by:

Audit Implementation

- identifying the approaches used by states and agencies and the skill level and/or personnel requirements needed to perform them,
- determining whether the approaches were effectively applied, and
- determining the difference in skill level and/or personnel requirements needed to employ a priority list compared to using a computerized audit on each house.

Client Education

- identifying the approaches used by states and agencies to educate clients about energy use and efficiency,
- determining which approaches resulted in the greatest knowledge retention on the part of the clients,
- determining how demographics of the weatherized households impact the effectiveness of the education provided,
- identifying who is most effective at delivering client education, and
- determining the expertise required of the educator to produce best results.

Weatherization Crew Training

- identifying the approaches used by states and agencies to train weatherization crews;
- determining which approaches result in the greatest knowledge on the part of the weatherization crews,
- determining the impact of the source of training on the training effectiveness;
- determining the impact of the various training approaches on trainee satisfaction and responsiveness;
- identifying the impact of the various approaches on the variety and depth of training provided;
- identifying the approaches used by states and agencies to train weatherization crews about non-energy issues, such as lead safe weatherization and carbon monoxide; and
- determining which approaches to the training on non-energy issues were most effective.

Quality Assurance

- identifying the approaches used by states and agencies to inspect and monitor weatherization work and practices, and
- determining which approaches were most effective at finding problems.

3.3.1 Characterization Data

Information on agency's PY 2006 auditing, client education, weatherization crew training, and inspection procedures and practices will be collected from the 400 agencies that are part of the billing data sample (see Section 2.2.1). These data will be collected from the agencies as part of the "Subset of Agencies PY 2007 Survey" (see Appendix H) at the end of their PY 2006 (August to October 2007). It is expected that the agencies will be compensated by DOE for their time to complete this survey. The survey will collect the following data:

Auditing

- approaches used by agencies to implement audits;
- how long agencies have been using the various approaches;
- for priority lists, how and when the list was generated;
- skill level and/or personnel requirements needed to perform the various audits;
- experience of field staff in implementing the auditing approaches;
- time and costs associated with implementing different auditing approaches, broken into different auditing steps (e.g., traveling to/from house, time in home collecting field data, entering data into computer and running computer if using computerized audit, determining final set of measures);
- how field data are collected for each auditing approach; and
- agencies' satisfaction with the various auditing approaches.

Client Education

- approaches used by agencies to implement client education;
- what exactly is being taught, to whom, and by whom;
- how long agencies have been using the various approaches;
- skill level and/or personnel requirements needed to implement the various approaches;
- experience of field staff in implementing the client education approaches;
- time and costs associated with implementing different client education approaches, broken into different components (e.g., time in home with clients, materials costs); and
- agencies' satisfaction with the various client education approaches.

Weatherization Crew Training

- approaches used by agencies to train weatherization crews;
- approaches used by states and agencies to train weatherization crews about non-energy issues, such as lead safe weatherization and carbon monoxide;
- how long agencies have been using the various approaches;
- skill level and/or personnel requirements needed to provide training;
- time and costs associated with implementing different training approaches; and
- agency and field staff satisfaction with the various training approaches.

Agency Final Inspections

- approaches used by agencies to inspect their weatherization activities;
- what they inspect and how they inspect;
- how long agencies have been using the various approaches;
- skill level and/or personnel requirements needed to conduct inspection activities;
- experience of inspectors;
- time and costs associated with implementing different inspection approaches, broken into different steps (e.g., traveling to/from house, time in home collecting field data, entering data into computer, analyzing data);
- how field data are collected for each inspection approach;
- types and frequency of quality problems encountered;
- follow-up activity performed when agencies find quality problems; and
- agencies' satisfaction with the various auditing approaches.

In addition, information will be collected from all states on their training practices and monitoring procedures as part of the "All States PY 2007 Survey" (see Appendix E) administered at the end of their PY 2006 (August to October 2007). The survey will collect the following information for training:

- subjects that state staff received training on and that state staff provided to its agencies,
- the types of state staff that received and provided training,
- methods used to receive and provide training, and
- the credentials of trainers.

The following information will be collected from states regarding their monitoring practices:

- approaches used by states to monitor weatherization activities;
- what they monitor and how they monitor;
- how many homes are included in the monitoring and how many times per year monitoring occurs;
- how long states have been using the various approaches;
- skill level and/or personnel requirements needed to conduct monitoring activities;
- experience of field staff in monitoring;
- time and costs associated with implementing different monitoring approaches, broken into different steps (e.g., traveling to/from the agency, time in home or agency collecting field data, entering data into computer, analyzing data);
- how field data are collected for each monitoring approach;
- types and frequency of quality problems encountered;
- follow-up activity performed when states find quality problems; and
- states' satisfaction with the various auditing approaches.

3.3.2 Client Education and Weatherization Staff Surveys

Occupants from 940 weatherized housing units weatherized in PY 2007 from the 400 agencies included in the billing data sample and 529 primary control units will be surveyed twice over the phone using a portion of the "Occupant Survey" (see Appendix I) to test their energy knowledge and collect some behavioral and demographic data. A supplemental control group consisting of 30 households will also be surveyed once to control for the possibility that both the primary control group and the weatherized group might change their energy-related behavior as a result of things they learn by taking the energy knowledge test the first time. The energy knowledge test will cover general client-related knowledge about energy use and energy efficiency, and subjects that are generally taught as part of client education approaches. Occupants surveyed will be offered an incentive to maximize the response rate.

The occupants of the 940 weatherized homes and the 529 primary control homes will be the same as those used as part of the study of non-energy impacts (see Sections 2.3.1 and 2.3.2). The survey will be administered to occupants of the 940 weatherized homes immediately after each house is audited (i.e., before client education is provided), and again a year after weatherization (i.e., a year after client education was provided). Occupants of the 529 primary control homes will be surveyed at approximately the same time as the occupants of the weatherized homes, and occupants of the 30 supplemental control homes will be surveyed just when the post-weatherization surveys are administered.

The 940 weatherized homes will be randomly selected from lists of homes provided by each agency. The primary control group will be developed using households that receive LIHEAP grants. For each agency, a list of LIHEAP recipients will be identified and houses selected after matching them to characteristics of the weatherized homes being surveyed. Matching criteria will be based on what information is available on the LIHEAP recipients but should include housing type, ownership, and possibly house size and energy use. The supplemental control group will be developed in a similar manner. Survey respondents should be compensated for their time.

Weatherization staff from the 400 agencies included in the billing data sample will be surveyed over the phone in calendar year 2008 using the Weatherization Staff Survey (see Appendix Q) to collect demographic data, compile training histories, obtain their feedback on the effectiveness of the training they have received, and to test their knowledge on a wide range of weatherization practices. The survey will be administered to just those staff directly involved in weatherization and will include both in-house agency staff and contractor staff. The survey will be administered to a total of 813 staff; 271 staff from each of the following three groups: auditor/inspector, foreman/crew leader, and crew member/technician. Agencies will identify the staff meeting these definitions and the category they belong in. The evaluation team will then randomly select the staff to be surveyed. It is expected that the agencies will be compensated by DOE for the time it takes their staff and crews to complete this survey.

3.3.3 Field Study Design and Data

The details concerning the sampling plan and survey instruments needed to perform the field study will need to be developed. Because of the schedule constraints outlined in Section 6, homes included in the field study will be ones weatherized in PY 2007. These houses will be sampled from 25 of the 400 agencies used in the energy savings component of the impact assessment (see Section 2.2). Only one agency per state will be selected to help ensure that a variety of audit, client education, training, and quality assurance approaches are encountered in the field study. Climate region and type of audit used (i.e., priority list or computerized audit) will be specifically considered in the agency/state selection process to ensure that all climate regions are represented and a mix of audit approaches are studies. Once agencies are selected, approaches to client education, training, and quality assurance should be checked and agencies reselected if a variety of approaches are not represented. Information on audits, client education, training, and quality assurance will be collected as soon as the evaluation can be implemented (July 2007) as part of the “DOE PY 2006 Survey” (see Appendix B), the “All States PY 2006 Survey” (see Appendix D), and the “All Agencies PY 2006 Survey” (see Appendix F). Houses will be selected from within each agency after stratifying by building type (i.e., single-family and mobile home).

Ideally, 200 homes slated for weatherization will be included in the field study. A two-person team (a weatherization/technical expert and a social scientist) will accompany the local weatherization agency as it implements the weatherization process on eight homes from start to finish. This process includes the initial audit performed on the house, the actual weatherization of the house, the education of the clients, and the final site inspection performed by the agency for quality assurance.

In general, the weatherization experts will evaluate auditing approaches, quality of work performed in the field by weatherization crews, and quality of monitoring approaches. They need to have a good understanding of weatherization-related skills (auditing, diagnostics, and measure installation), house construction and repair skills, and house health and safety issues.

The social scientists will be on-site to observe the weatherization crews, the audits, client education, actual weatherization activities, and other activities on-site. In this way, the social scientists will observe the entire gamut of crew activities and will begin to understand how different tasks influence each other and how crew interactions affect the accomplishment of tasks. The social scientists will be trained on the Program and weatherization activity so that they will be able to make their observations within the context of the Program. The social scientists will also be teamed with a weatherization expert, so they will receive additional insight into weatherization and the Program from working with the expert in the field. The skills, qualifications, and experience of the social scientists needed to perform this work will need to be carefully outlined.

Because the weatherization process on an individual house can span several or more months and would require several house visits, the ideal approach outline above may be realistic only in or near large metropolitan areas. The chances of finding qualified weatherization experts and social scientists, both of whom live in the area and can schedule frequent site visits to homes, is probably greater in large metropolitan areas. Therefore, an alternative approach will be to send the two-person team to an agency for two or more weeks (perhaps two visits per agency) to observe the complete weatherization process, but applied to different homes (e.g., homes that the team visits to observe the installation of weatherization measures would not be the same houses they observed getting audited).

The following information will be collected during the field study:

At Time Audit Is Performed

The weatherization expert will verify the information collected by the auditor, identify challenges posed by the housing units in weatherizing them, develop expectations about what a crew ought to do in a unit, and make additional measurements and observations. The audit method used on the house will be identified, and detailed input and output information for the audit the agency performed will be collected (i.e., audit input and set of recommendations). Cost and time data associated with the field audits will also be collected. Other influential factors, such as the type and condition of the home and fuel type, will also be recorded if the data do not already exist. The expert should pay particular attention to the quality of the housing stock and the degree to which the housing stock needs repair, as this is an important issue often raised concerning high and poor performance, especially in the hot climate region.

The social scientist will “observe” audit activities that take place at each participating home. These observations will focus on how audits are conducted, interactions between auditors and clients, and interactions among members of the auditing team. The social scientist will also survey the audit crews to collect data about their audit training, years of experience, and other education.

<u>During Weatherization of the House</u>
The weatherization expert will obtain a list of the measures initially identified for installation in each home. While the crews weatherize the house, the weatherization expert will observe how the crew installs each weatherization measure, identify any unusual installation challenges, and judge the quality of the work (i.e., note how well the crew performed its work and addressed each installation challenge). At some time the weatherization expert will also collect house and occupant data from the agency on each house visited using the “Housing Unit Information Survey” (see Appendix K) or the “Building Information Survey” (see Appendix L).

The social scientist will observe the weatherization crew performing their work. Such observations can provide information on how crews apply their collective knowledge, how they interact with clients, how well they treat the homes and its contents, how well they practice lead safe weatherization (in pre-1950 homes), and how well they deal with carbon monoxide issues in homes. The social scientist will also conduct in-person surveys of the weatherization crews to determine the training they received, years of experience, and other educational and demographic characteristics that might influence the crew’s ability to do the job. The surveys can also contain some questions to test the knowledge of the crew members in key areas. Additional information should be collected about the crews (contractor or not, number in crew, costs).

<u>When Client Education is Provided</u>
Social scientists will observe and document the client education process and approaches, note any physical manifestations of attempts by clients to change their energy use behavior, and conduct in-person surveys of client educators regarding their own training, years of experience, and other education.

<u>At the Time of Final Inspection</u>
The weatherization expert will obtain a list of the measures actually installed from the agencies. The weatherization expert will verify the information collected by the inspector, make additional measurements and observations, record what was installed, and judge the quality of the work. Cost and time data associated with the final inspection will also be collected.

The social scientist will observe inspection activities that take place at each participating home. These observations will focus on how inspections are conducted, interactions between inspectors and clients, and interactions among members of the inspection team. The social scientist will also survey the inspection crews to collect data about their inspection training, years of experience, and other education.

3.3.4 Case Studies

Two to three innovative client education programs (agency level but perhaps state level too) and two to three innovative training programs (state level but perhaps agency level too) will be identified using information collected as soon as the evaluation can be implemented (July 2007) from DOE as part of the "DOE PY 2006 Survey" (see Appendix B) and from all states using the "All States PY 2006 Survey" (see Appendix D). Interviews will be conducted as part of the case studies with all key participants, including state and agency officials, people who designed the education and training programs, client educators, trainers, crews, clients, and staff from other relevant organizations (e.g., environmental and low-income advocacy groups). Information will also be collected about how the programs took shape, the challenges involved with implementing innovative approaches, and anticipated future steps. The details concerning the sampling plan and survey instruments needed to implement and perform the client education and training case studies will need to be developed.

3.3.5 Audit Implementation Evaluation Approach and Analysis

The purpose of this analysis is to assess the effectiveness of different energy auditing methods (i.e., computerized audits and priority lists) used to determine what energy efficiency measures should be installed in homes. It is difficult to determine how any particular home *ought* to be weatherized. Measures actually installed in homes are not always the measures recommended just by energy auditing tools because energy auditing tools only address energy efficiency measures. Numerous factors influence the measures installed in a home, including the baseline energy efficiency of the home, any need for repairs, the existence of serious health risks (e.g., emissions of carbon monoxide into the home), and the skill level of the weatherization installers (i.e., whether weatherization crews are qualified to install a measure or not).

Descriptive statistics will be calculated that describe and compare the implementation of the audit approaches, including the frequency of field audit approaches, the characteristics of the crews implementing various types of audits, and costs associated with implementing various types of audits. The impact of the quality of the housing stock on audit recommendations should also be noted.

The field study will be used to determine whether the energy auditing method used by the local agency was implemented correctly and if the proper recommendations were made based on that audit approach. The technical weatherization expert visiting each house will use data collected on that house plus their own observations made in the home to make this determination by re-applying the field audit approach to ascertain whether it was properly applied by the field audit crew. These data include identifying the audit method used on each house, the set of recommended measures suggested by the method as determined by the local agency, and the measures actually implemented in each home to allow for adjustments to be made as dictated by other conditions found in the home.

An alternative, compare-and-contrast assessment method is an optional method that could be performed under this assessment at greater cost to address the issue raised by the Network Committee (see Section 1.1.1) concerning the incremental benefits and cost effectiveness of moving from a priority list to a computerized audit approach. In this method, multiple auditing approaches would be applied to a set of study homes. The auditing method used by the local agency would be reviewed and assessed by an expert as described above. In addition, a second auditing method—a priority list if a computerized audit was used by the agency or a computerized audit if the agency used a priority list—would be applied to the home by the same expert to generate an alternative set of recommended measures that could have been installed on the home. The expert would then compare and contrast the outputs of both methods as applied to the same home.

The field study will allow social scientists to observe and document the auditing process in many different homes. Observations will focus on the implementation of the audit and auditor and client interactions.

It is recommended that a workshop be convened after all the data are collected to qualitatively evaluate the audit methods. The weatherization experts who conducted the audit evaluation exercises would be invited to attend as well as the social scientists and some weatherization crew staff. The workshop participants will be asked numerous questions, including:

- Which approaches were most effective?
- What are the benefits and costs of the approaches?
- What were the biggest differences among the methods in the sample homes?
- What is the cost effectiveness of the incremental investment of doing computerized audits over priority lists (or vice versa)?
- How did “human” factors influence the use of the methods?
- How does the quality of the housing stock impact audits?

The discussions and conclusions made during the workshop will be compiled into a project report.

3.3.6 Client Education Evaluation Approach and Analysis

As part of the weatherization process, the opportunity is often taken to educate clients (i.e., people living in the weatherized homes) about their use of energy, equipment operation, energy-related maintenance, and/or energy-efficient products. This assessment will identify the various approaches to client education, which may take on many different forms, and evaluate the effectiveness of client education.

Descriptive statistics will be calculated concerning client education approaches and characteristics of the educators.

Generally, education can be deemed effective if recipients retain what was taught them over a period of time. In this context, education may also have led to changes in behavior with regard to energy use. To evaluate the effectiveness of client education, the baseline knowledge of the weatherization clients and what they gained from the energy educational experience will be determined using information collected from the client education survey/test. Mean scores for each client education approach will be calculated. Regression models will be estimated with mean scores of post-weatherization knowledge as the dependent variable and with client education approach, previous knowledge, demographics, and characteristics of the client educators as the independent variables. The beta coefficients of the regression models would suggest which variables best explain variation in the scores. Based on the results of this comprehensive regression model, separate models may be developed by client education approach and/or climate region. Results will be compared to those of the primary control group to check against the baseline knowledge about energy and to control for learning about energy that may be taking place outside of the weatherization process. In addition, results will be compared to those of the supplemental control group to discern any behavior changes that might have been induced by the act of taking the pre-weatherization survey.

The field study will allow social scientists to observe and document the client education process in many different homes. Observations will focus on the delivery of client education and educator and client interactions. Social scientists will also be able to note any physical manifestations of attempts on the part of the clients to change their energy use behavior.

The case studies of two to three innovative client education programs will highlight exceptional approaches and provide insight into subject matter and training approaches that are particularly effective.

3.3.7 Agency Crew Training Evaluation Approach and Analysis

The purpose of this analysis is to assess the effectiveness of weatherization crew training (both in-house agency and contractor staff). Effectiveness will be judged by the quality of the work observed in the field, feedback received from a sample of weatherization staff, and how well a sample of staff performs on a weatherization knowledge test. However, it should be noted that it is the crew's knowledge base and how that knowledge is applied that most affects the quality of work done in a home, not necessarily the training received by any one individual.

Descriptive statistics will be calculated concerning types and frequency of training approaches, years of experience, and other demographic characteristics of crews using information collected from the states, agencies, and weatherization staff.

A composite score on each individual staff member's weatherization knowledge will be developed based on the knowledge test administered to a sample of weatherization staff. Regression analysis will be used to identify staff-related and agency-related training factors that explain staff knowledge (measured by composite score and answers on specific questions). Examples of possible explanatory training factors include the number of training hours received by the individual, the type of training received, and the amount of funds spent by the agency on training. Other factors that could possibly influence staff knowledge (e.g., age, years of weatherization experience) will be controlled for in the regression analysis.

The field study will be used to access the quality of work performed and, hence, the effectiveness of training. The weatherization expert visiting each home before, during, and after weatherization will develop indices of work quality with respect to the installation of weatherization measures (and probably for different categories of measures), practice of lead safe weatherization, and the handling of carbon monoxide issues. In other words, expectations will be developed about what crews ought to have done in a home and then what was actually done in the home will be compared to the expectations. The weatherization expert will pay special attention to weatherization challenges posed by the homes to the crews and will observe how the crews may have dealt with the challenges. Indices that describe a crew's level of training will also be developed and calculated. Inter-rater designs can be implemented to ensure validity of both indices. Regression models for each work area can be estimated using work quality indices as the dependent variables and training received and other characteristics of the crew as independent variables. The beta coefficients of the regression model would suggest which variables best explain variation in the scores. Based on the results of this comprehensive regression model, separate models may be developed by training approach.

The field study will allow social scientists to observe and document the weatherization process in many different homes. Observations will focus on how weatherization knowledge is applied in the field. Observations will also be make on how the weatherization crew works as a team and interactions between the client and the weatherization crew.

It is recommended that a workshop be convened after all the data are collected to qualitatively evaluate training methods. Since this study component involves the same weatherization experts and social scientists, and possibly weatherization staff, who would attend the audit component workshop, it is suggested that one workshop cover both topics. The workshop participants will be asked numerous questions, including:

- Which approaches were most effective?
- What is the impact of the source of training on the training effectiveness?
- What methods work best in training contractors versus in-house staff?
- What is the impact of the various training approaches on trainee satisfaction and responsiveness?
- What is the impact of the various approaches on the variety and depth of training provided?
- Which approaches were most effective?
- How was collective knowledge applied, misapplied, and/or not applied in the field?

The case studies of two to three innovative training programs will highlight exceptional approaches and provide insight into subject matter and training approaches that are particularly effective.

3.3.8 Monitoring Evaluation Approach and Analysis

The purpose of this analysis is to document the approaches used by states and agencies to monitor and verify the quality of their weatherization programs and work and to evaluate the effectiveness of the various approaches. An effective quality assurance program will reveal any problems, lead to improvements in the overall quality of weatherization activities, and minimize misspent funds (e.g., money spent on energy conservation measures that were not installed).

The monitoring performed by a state is quite different from that performed by its agencies. The state monitors the work performed by the agencies. This may include reviewing the agency's administration procedures; verifying that the agency is adhering to rules, policy, and law; examining costs and purchases; reviewing inventory; and visiting homes weatherized by the agencies to verify the installation of measures and their quality. At the agency level, agencies usually send an inspector to the house after all weatherization work is complete to ensure that all measures were installed, that the measures were installed correctly, and that there are no remaining issues with the house.

As a first step, a group of state and agency weatherization leaders will be convened to generally discuss the issue of quality assurance monitoring. From this discussion, the most important issues and challenges can be ascertained, along with approaches to state- and agency-level monitoring.

Descriptive statistics will be calculated which convey the state of quality assurance undertaken by the states and agencies. This will include the frequency of monitoring and inspection approaches, types and frequency of quality assurance problems encountered (e.g., badly installed measures, inaccurate audits, misspent funds), and follow-up activity performed as a result of findings.

For the agency-level inspection activity, the field study will allow the weatherization expert to determine whether the agency's inspector properly inspected the weatherized homes and found all problems associated with the work performed. The social scientist's observations will provide insight into how the inspector worked and interacted with the client.

For the states, a standard quality assurance protocol will be developed based upon well-known methods and techniques used for industrial quality assurance and financial and corporate auditing. The protocol will specify how many units should be monitored for quality based on the total number of units weatherized and how many more units need to be inspected if quality standards are not met. The percentage of weatherized homes that were monitored out of the total number of homes weatherized will be determined for each state and compared to the standard quality assurance protocol to determine whether enough homes were monitored to find quality problems and whether appropriate follow-up measures were taken. In addition, expectations for effective responses to quality problems will be developed and compared to the actual actions taken.

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4. SPECIAL TECHNICAL STUDIES

Several special technical studies will be performed to determine, to the extent possible, the performance of five individual measures (air sealing, duct sealing, space-heating system tune-ups, space-heating system replacements, and refrigerator replacements) as well as the overall impact measures are having on air-conditioning electricity use in the hot climate region. These special studies address the seventh and partially the ninth outcomes questions identified in evaluation design matrix (see Table 1.2). These studies also address the Network Planning Committee's desire to isolate the direct effect of specific measures when possible and to place special emphasis on the hot climate region and cooling measures as part of this Program evaluation (see Items 1 and 9 in Section 1.1.1, respectively).

4.1 AIR SEALING

Air sealing will be evaluated because it is a fundamental weatherization measure performed on almost all houses addressed by the Program. Although equipment (such as blower doors) and procedures have been developed to ensure that cost-effective air sealing is performed, there is still large potential for spending money on air sealing that is not effective.

Whole house air leakage rates are routinely measured by agencies using blower doors before and after air sealing weatherization work is performed on single-family houses, mobile homes, and perhaps some small multifamily housing units. These measurements are made during the initial audit, while performing the work, and/or during the final inspection. These agency-made measurements, along with data characterizing the housing units, the air sealing approach used to seal the house, and air sealing costs, will be collected on as many homes used in the billing data sample, fuel-oil and propane monitored sample, and hot climate submetered sample as possible to determine the direct impact air sealing is having on the weatherized houses. It is estimated that data on 4,000 housing units could be collected and available for analyses.

The following analyses will be performed:

- A change in air leakage rate for each housing unit will be calculated using the pre- and post-weatherization data.

- Average pre- and post-weatherization air leakage rates and changes will be calculated nationally and by building type, climate region, and approaches to air sealing (e.g., auditor only, crew only, or both use the blower door; an expenditure guideline based on pre-weatherization leakage rate is or is not used). Comparisons will be made among building types, climate regions, and air sealing approaches using standard statistical methods such a t-tests and analysis of variance to determine if variations exist.

- Average post-weatherization rates will be analyzed to determine just how tight agencies get houses and how these values compare to values often used by agencies to set goals (e.g., a minimum value based on 15 cfm per person or 0.35 air changes per hour, 1500 cfm50).

- Regression analyses will be performed to determine how air leakage reductions vary by pre-weatherization leakage rates and by expenditures for air sealing work (if detailed air sealing cost data for labor and materials can successfully be collected from agencies).

- Multiple regression techniques will be used to determine how pre- and post-weatherization air leakage rates and air leakage reductions (dependent variables) are impacted by independent variables such as building type, climate region, air sealing approaches, house characteristics, air sealing expenditures, and pre-weatherization air leakage rate.

In all these analyses, the impact of other measures that can reduce whole house air leakage (e.g., duct sealing, dense-pack wall insulation) may have to be accounted for to isolate the air sealing impact.

The analyses described above makes use of agency-collected data. The limitation of this is that air sealing approaches that do not involve the use of a blower door cannot be evaluated because agency-collected blower door readings are not made in these houses. Depending on how the fuel-oil and propane monitored sample for the energy study (see Section 2.2.1) and the air conditioning sample (see Section 4.6.1) are implemented and available budgets, independent air leakage measurements may be able to be made in these houses to supplement the agency-collected measurements.

4.2 DUCT SEALING

Duct sealing will be evaluated because it is a primary weatherization measure with large savings potential that can be implemented relatively inexpensively, especially in mobile homes.

The impacts of duct sealing will be analyzed in a manner similar to that for air sealing; however, there are two complicating factors. First, duct leakage measurements are not made as regularly as air leakage measurements (even in houses in which the ducts are sealed), so there will be many fewer houses in the sample. Second, duct leakage measurements can be based on either blower door measurements, duct blower measurements, or pressure pan measurements. This will require separate analyses for each method (provided there is a sufficient number of houses for each measurement method). Pressure pan measures are perhaps most common, especially in mobile homes, and thus the more likely of the three measurements methods to have sufficient data for analysis.

Duct leakage rates measured by agencies on single-family houses, mobile homes, and perhaps some small multifamily housing units will be collected on as many housing units participating in the billing data sample, fuel-oil and propane monitored sample, and hot climate submetered sample as possible. These measurements are made by agencies during the initial audit, while performing the work, and/or during the final inspection. These measurements, along with data characterizing the housing units, the duct sealing approach used to seal the ducts, and duct sealing costs, will be used to determine the direct impact duct sealing is having on the weatherized houses. It is estimated that data on 500 housing units could be collected and available for analyses.

The following analyses will be performed:

- A change in duct leakage rate for each housing unit will be calculated using the pre- and post-weatherization data.
- Average pre- and post-weatherization duct leakage rates and changes will be calculated nationally and by building type, climate region, and approaches to duct sealing (e.g., duct measurement made using a blower door, duct blower, or pressure pan; auditor only, crew only, or both make and use duct measurements). Comparisons will be made among building types, climate regions, and duct sealing approaches using standard statistical methods such as t-tests and analysis of variance to determine if variations exist.
- Average post-weatherization rates will be analyzed to determine just how tightly agencies seal ducts and how these values compare to values often used by agencies to set goals (e.g., cfm25 duct leakage equal to 10% of floor area).
- Regression analyses will be performed to determine how duct leakage reductions vary by pre-weatherization duct leakage rates and expenditures for duct sealing work (if detailed duct sealing cost data for labor and materials can successfully be collected from agencies).
- Multiple regression techniques will be used to determine how pre- and post-weatherization duct leakage rates and duct leakage reductions (dependent variables) are impacted by independent variables such as building type, climate region, air sealing approaches, house characteristics, heating and cooling system characteristics, duct sealing expenditures, and pre-weatherization duct leakage rate.

The analyses described above makes use of agency-collected data. The limitation of this is that duct sealing approaches that do not involve the use of blower door, duct blower, or pressure pan measurements cannot be evaluated because agency-collected blower door readings are not made in these houses. Depending on how the fuel-oil and propane monitored sample for the energy study (see Section 2.2.1) and the air conditioning sample (see Section 4.6.1) are implemented and available budgets, independent duct leakage measurements may be able to be made in these houses to supplement the agency-collected measurements.

4.3 HEATING SYSTEM TUNE-UP

The benefit of a heating system tune-up will be evaluated because it is an essential element of comprehensive heating system work. Only the energy-related benefit due to a change in steady-state efficiency from a tune-up will be evaluated because steady-state efficiency measurements are often made by agencies, so no additional data collection needs to be performed. Other energy benefits that might be obtained from a tune-up, such as reduced cycling due to control adjustments, will not be evaluated because measurements quantifying these benefits are not routinely made by agencies. In addition, non-energy benefits obtained from tune-ups, such as finding cracked heat exchangers and correcting CO problems, will not be the focus of this study although they will be characterized as part of the impact assessment (see Section 2.1.4).

The change in steady-state efficiency resulting from a heating system tune-up will be analyzed in a manner similar to that for air sealing and duct sealing. As with duct sealing, heating system tune-ups are not regularly performed in all weatherized houses, so there will be many fewer houses in the sample than for air sealing. In addition, flue-gas analysis measurements needed to calculate the steady-state efficiency are not always well documented by agencies (especially post-weatherization measurements), which will further decrease the number of houses in the sample.

Flue-gas analyses are performed before and after a heating system is tuned up and/or as part of the tune-up itself by some agencies in all building types (during the initial audit, while performing the work, and/or during the final inspection). Measurements made during a flue gas analysis (CO_2 or O_2, inlet and outlet temperature and/or net stack temperature, smoke number for oil system only, and steady-state efficiency) will be collected on as many houses and buildings participating in the billing data sample, fuel-oil and propane monitored sample, and hot climate submetered sample as possible. Other date that will be collected includes housing unit characteristics, the tune-up approach used, and tune-up costs. It is important to note that this study will not determine whether the tune-ups performed were justified or not because they might have been justified for reasons other than improvements in steady-state efficiency. However, steady-state efficiency is an important determinant of overall heating system efficiency, so the study will be evaluating an important and direct impact tune-ups have on annual furnace efficiency and energy use. It is estimated that data on 500 housing units could be collected and available for analyses.

The following analyses will be performed:

- A pre- and post-weatherization steady-state efficiency will be calculated or verified for each housing unit or building as well as the change in steady-state efficiency.

- Average pre- and post-weatherization steady-state efficiencies and changes will be calculated nationally and by building type, climate region, and approaches to tune-ups (e.g., crew or contractor performs the tune-up, tune-up performed with or without flue-gas analysis). Comparisons will be made among building types, climate regions, and tune-up approaches using standard statistical methods such as t-tests and analysis of variance to determine if variations exist.

- Average post-weatherization steady-state efficiencies will be analyzed to determine just how high the steady-state efficiency can be improved in existing systems.

- Regression analyses will be performed to determine how steady-state efficiency changes vary by pre-weatherization steady-state efficiency and expenditures for heating system tune-ups (if detailed tune-up cost data for labor and materials can successfully be collected from agencies).

- Multiple regression techniques will be used to determine how pre- and post-weatherization steady-state efficiencies and efficiency changes (dependent variables) are impacted by independent variables such as building type, climate region, tune-up approaches, heating system characteristics, fuel type, tune-up expenditures, and pre-weatherization efficiency.

The analyses described above makes use of agency-collected data. The limitation of this is that approaches to space-heating tune-ups that do not involve the use of a flue gas analysis and, hence, the measurement of steady-state efficiency cannot be evaluated because flue-gas measurements are not made in these houses. Depending on how the fuel-oil and propane monitored sample for the energy study (see Section 2.2.1) and the air conditioning sample (see Section 4.6.1) are implemented and available budgets, independent flue gas analysis measurements may be able to be made in these houses to supplement the agency-collected measurements. Because of the self-selectivity of using just data already being collected by the agencies, analysis results will be compared to a literature review and the potential bias in the results discussed.

4.4 HEATING SYSTEM REPLACEMENT

The benefits of a heating system replacement will be evaluated because it is a measure that is being more frequently performed under the Program, especially when utility partners are involved who have a stake in this. Although many feel that replacing a heating system is becoming more cost effective in their climate region, it remains a measure that is often justified for health and safety reasons. Only the energy-related benefit due to a change in steady-state efficiency from a heating system replacement will be evaluated because steady-state efficiency measurements are often made by agencies, so no additional data collection needs to be performed. Other energy benefits that might be obtained from a heating system replacement, such as reduced cycling from installation of a properly sized system, will not be evaluated because measurements quantifying these benefits are not routinely made by agencies. In addition, non-energy benefits obtained from heating system replacements, such as removing cracked heat exchangers from homes and correcting CO problems, will not be the focus of this study although they will be characterized as part of the impact assessment (see Section 2.1.4).

The change in steady-state efficiency resulting from a heating system replacement will be analyzed in a manner similar to that for heating system tune-ups. As with tune-ups, heating system replacements are not regularly performed in all weatherized houses, so there will be many fewer houses in the sample than for air sealing. In addition, flue-gas analysis measurements needed to calculate the steady-state efficiency are not always well documented by agencies (especially post-weatherization measurements), which will further decrease the number of houses in the sample. However, it is anticipated that data will be collected on space-heating system replacements that involve the installation of both 80% and 90% efficiency units and that occurred in all climate regions (or at least the cold and moderate climate regions) which will allow a comparison of performance and cost.

Flue-gas analyses are performed before and after a heating system is replaced by some agencies in all building types (during the initial audit, while performing the work, and/or during the final inspection). Measurements made during a flue gas analysis (CO_2 or O_2, inlet and outlet temperature and/or net stack temperature, smoke number for oil system only, and steady-state efficiency) will be collected on as many houses and buildings participating in the billing data sample, fuel-oil and propane monitored sample, and hot climate submetered sample as possible. Other data that will be collected includes housing unit characteristics, the type and rated efficiency of heating system installed, the justification for replacement, and replacement costs. It is important to note that this study will not determine whether the heating system replacements were justified or not because they might have been justified for reasons other than improvements in steady-state efficiency. However, steady-state efficiency is an important determinant of overall heating system efficiency, so the study will be evaluating an important and direct impact heating system replacements have on annual heating system efficiency and energy use and understand when and why replacements occur. It is estimated that data on 250 housing units from all four climatic regions could be collected and available for analyses.

The following analyses will be performed:

- A pre- and post-weatherization steady-state efficiency will be calculated or verified for each housing unit or building as well as the change in steady-state efficiency.

- Average pre- and post-weatherization steady-state efficiencies and changes will be calculated nationally and by building type, climate region, rated efficiency of the replacement unit (nominally 80% and 90% AFUE), and reasons for replacement (e.g., health and safety, inefficiency as indicated by a flue-gas analysis, system not currently working, inefficiency based on appearance or age). Comparisons will be made among building types, climate regions, and replacement approaches using standard statistical methods such as t-tests and analysis of variance to determine if variations exist.

- Average post-weatherization steady-state efficiencies will be analyzed to determine just what the steady-state efficiencies of replacement systems really are and how they related to their rated efficiency (nominally 80% and 90% AFUE).

- Regression analyses will be performed to determine how steady-state efficiency changes vary by pre-weatherization steady-state efficiency, rated efficiency of the replacement unit, and expenditures for heating system replacements (if detailed replacement cost data for labor and materials can successfully be collected from agencies).

- Multiple regression techniques will be used to determine how pre- and post-weatherization steady-state efficiencies and efficiency changes (dependent variables) are impacted by independent variables such as building type, climate region, replacement reasons, heating system characteristics, rated efficiency of the replacement unit, fuel type, replacement expenditures, and pre-weatherization efficiency.

- Information on the original justification for the replacement heating system will be analyzed by tabulation, t-tests, etc. to determine when and why replacements occur.

- The costs for 80% and 90% replacement units will be compared.

The analyses described above makes use of agency-collected data. The limitation of this is that replacements cannot be evaluated for agencies that do not make flue-gas measurements and, hence, steady-state efficiency measurements. Depending on how the fuel-oil and propane monitored sample for the energy study (see Section 2.2.1) and the air conditioning sample (see Section 4.6.1) are implemented and available budgets, independent flue gas analysis measurements may be able to be made in these houses to supplement the agency-collected measurements. Because of the self-selectivity of using just data already being collected by the agencies, analysis results will be compared to a literature review and the potential bias in the results discussed.

4.5 REFRIGERATORS

The performance of refrigerator replacement programs will be evaluated because replacing refrigerators is a relatively new measure that is a very important part of the Program's new emphasis on baseload measures. Refrigerator replacements are being performed more frequently by agencies, especially in cooperation with electric utilities and state efficiency programs.

The assessment will focus on determining:

- for refrigerators that were replaced, if the decision to replace the unit was correct, and
- for refrigerators that were not replaced, how often such refrigerators should have been replaced.

4.5.1 Refrigerator Data, Metering, and Sampling

Refrigerator energy use will be monitored in 330 housing units divided among 60 agencies (5 to 6 housing units per agency) across the U.S. to provide the data needed for this study (see Appendix M for a detailed justification of this sample size). Monitoring will be performed in 198 housing units that the agencies have determined to need a new refrigerator (3 to 4 housing units per agency) and in 132 housing units where the existing refrigerator will not be replaced (2 to 3 housing units per agency). The 60 agencies selected for this sample will be a sub-sample of the 400 agencies selected as part of the billing data sample (see Section 2.2) and will be 60 agencies that perform refrigerator replacements. All building types—single-family homes, mobile homes, small multifamily housing units, and large multifamily housing units—will be included in the sample.

Each agency will be provided with the metering needed to monitor the electricity use of one refrigerator (and possibly the air temperature surrounding the refrigerator depending on instrumentation costs and available funds). A statistical-based sampling procedure will be developed to choose which housing units refrigerator energy use will be monitored in from each agency after dividing the housing units into those that will receive a new refrigerator and those that will not. On the first housing unit, the agency will:

- **2 to 4 weeks before a new refrigerator is expected to be installed or the house weatherized**—install the metering on the existing refrigerator and collect some basic characterization data on the existing refrigerator and its installation;

- **At the time a new refrigerator is installed or at the time the home is weatherized**—record/save the metering data on the existing unit, make sure the metering gets connected to the new refrigerator and re-zeroed (or remains installed on the existing refrigerator if it is not replaced when the house is weatherized but gets re-zeroed after the initial data is saved or recorded), and collect some basic characterization data on the new refrigerator and its installation if one is installed; and

- **2 to 4 weeks after a new refrigerator is installed or the house weatherized**—record/save the metering data and remove the metering from the refrigerator.

The metering will then be installed on the second housing unit and the process continued until refrigerator energy use in 5 to 6 housing units is monitored at an agency. In connecting the metering to the new refrigerator, the meter should not be installed (or zeroed) until the new refrigerator has had time to cool down and reach steady-state operating conditions. A one to two day waiting period is preferred; if this is too burdensome on the agencies, then perhaps the new refrigerator could be installed early in the day and the meter installed (or zeroed) just before the weatherization crew leaves the house at the end of the day.

Each agency will provide a description of the method it uses to select refrigerators for replacement (e.g., age of the unit, short-term metering), the input/output used to apply this method to each monitored refrigerator (e.g., the savings predicted by the selection method), the cost of the refrigerator replacements, and a description of where the refrigerator was located in the housing unit. The agency will also provide the following on the existing and replacement refrigerators: make and model, nameplate or rated energy use, and other characteristics (e.g., size, presence of ice maker, manufactured date). House and household characteristics collected on each house as described in Section 2.1 will be used in the analysis as needed.

4.5.2 Refrigerator Energy and Cost-Effectiveness Analysis

The monitored data before and after replacement will be used to estimate the annual energy use of the existing and new refrigerators by scaling the monitored electricity use data to a year. Adjustments for the air temperature will be made using procedures established in prior research projects depending on the availability of temperature data, the accuracy of such adjustments, and the final determination of the need for such adjustments.

The electricity savings of each refrigerator will be calculated using the calculated annual energy consumptions of the existing and replacement units. The following analyses will then be performed:

- Average pre- and post-weatherization consumptions and savings will be calculated nationally and by building type, climate region, and approaches to selecting refrigerators for replacement. These savings achieved by the Program will be compared to savings reported for utility or state programs, or state-initiated weatherization evaluations. Comparisons will be made among building types, climate regions, and selection approaches using standard statistical methods such as t-tests and analysis of variance to determine if variations exist.

- Average consumptions of the replacement units will be analyzed to determine how efficient the replacement units really are and how these consumptions compare to values used in decision making. Comparisons will also be made between measured and estimated savings, and measured consumption and nameplate or rated values.

- Regression analyses will be performed to determine how savings vary by the energy consumption of the existing units. Multiple regression techniques will be used to determine how pre- and post-weatherization electricity consumptions and savings (dependent variables) are impacted by independent variables such as building type, climate region, selection approaches, refrigerator characteristics, demographic characteristics, and pre-weatherization electricity consumption.

- Energy savings and costs will be used to determine the cost effectiveness of the replacements individually and in aggregate, and to determine if the decision to replace the refrigerator was correct.

In homes that did not receive a new refrigerator, the annual energy use of the existing unit will again be estimated by scaling the monitored data before weatherization to a year and making adjustments for the air temperature. Comparisons will be made between measured consumptions and nameplate or rated values, and between consumptions estimated under the evaluation with those estimated by the agency using their selection procedure. The energy savings that could have been achieved by replacing the existing unit with a new unit will be estimated using data on replacement units monitored as part of this study. The cost effectiveness of such replacements will be estimated to determine if the decisions to not replace the existing refrigerators were correct. Comparisons will be made among building types, climate regions, and selection approaches using standard statistical methods such as t-tests and analysis of variance to determine if variations exist.

4.6 AIR CONDITIONING ELECTRICITY SAVINGS

Air conditioning electricity use is an important energy use in hot climate homes and becoming more prevalent in the moderate and even cold climates as well. Therefore, it needs to be understood so that Program improvements can be made. Air conditioning electricity use in the hot climate region will be evaluated to determine:

- how much electricity is used for space cooling in eligible hot-climate houses;

- how much air conditioning electricity use is being saved by the Program in these homes from the combination of weatherization measures installed; and

- how air conditioning energy use and savings vary by building type, type of cooling equipment (central versus window units), and the five client groups that the Program is specifically encouraged to focus on (the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden).

This study will focus on air conditioning energy use in the hot climate regions (rather than include the moderate and cold climate regions as well) because of budget constraints. With the limited funding available, the study will attempt to get a definitive understanding of air conditioning use in the regions where it is most prevalent before spending resources on climates where it is less prevalent. It should be easier to understand air conditioning energy use in the hot climate regions where it is used more, and lessons learned from the hot climate region should be transferable to at least some extent to other regions.

It should be noted that this study is not intended to specifically study the energy savings achieved from air conditioner replacements and/or air conditioner tune-ups; rather, the study is focusing on how much electricity is used to air condition low-income houses in the hot-climate states before weatherization and how much that electricity use is reduced due to all the weatherization measures currently being installed in such houses (such as infiltration reduction, duct sealing, insulation, and window improvements in addition to any air conditioner equipment tune-ups and replacements). Although some of the houses used in the study may receive air conditioner replacements or tune-ups (allowing the performance of these measures to be studied to some extent), there is no guarantee that these measures will be performed in all or even a majority of the study houses (air conditioner replacements and tune-ups may be commonly performed under the current Program in a few but not most hot-climate states). The sampling frame for a study focusing on the performance of air conditioner replacements and/or tune-ups would be different from the sampling frame proposed for this study because houses that will receive such measures would have to be targeted. The performance of air conditioner replacements and/or tune-ups cannot be studied as for heating system replacements or tune-ups because a diagnostic similar to a flue gas analysis that provides a measurement of the system's steady-state efficiency is not routinely performed by agencies on air conditioners.

4.6.1 Air-Conditioning Sample Frame and Data

Although house electricity use and savings are being analyzed under the impact assessment using billing data (see Section 2.2), air conditioning end use cannot readily be discerned from billing data; therefore, 132 single-family houses and mobile homes that will be weatherized in the 14 hot climate states will have their air conditioning electricity use submetered (see Appendix M for a detailed justification of this sample size). A similar number of control houses will also be monitored. These homes will be sampled from approximately 33 agencies (4 weatherized and 4 control houses per agency, and at least 2 agencies per state). In addition to measuring the electricity use of each piece of air conditioning equipment, hourly indoor temperature (at the thermostat for central air conditioners and perhaps in each room with a window air conditioner), outdoor temperature, and humidity/wet bulb temperature will be monitored in each house. As an option, primary space-heating fuel use may also be submetered to improve and shed light on the savings in primary heating fuel measured using billing data in the impact assessment (see Section 2.2).

Attempts will be made to select the 33 agencies from the 400 agencies that have been selected as part of the billing data sample (see Section 2.2) and that are in the 14 hot climate states to facilitate data collection and integration of the energy savings calculated by the submetering with those calculated using billing data. Agencies will be selected randomly, with at least two agencies selected from each of the 14 states and the remaining agencies distributed among the 14 states in proportion to the “size” of the weatherization activity that occurs in each state (amount of DOE PY 2006 funding). Four houses will be randomly selected within each agency after dividing the houses into four strata: centrally-cooled single-family detached houses, single-family houses that are cooled by room air conditioners, centrally-cooled mobile homes, and mobile homes that are cooled by room air conditioners.

A full summer will be needed for both the pre- and post-weatherization periods in order to understand the air conditioning electricity use in each period. A full winter will also be needed for both the pre- and post-weatherization periods if submetering of the primary space heating fuel is pursued. Issues concerning delayed weatherization, especially in the control group, will need to be dealt with.

House and occupant data will be collected on each house from the agency using the “Housing Unit Information Survey” (see Appendix K) or the “Building Information Survey” (see Appendix L). In addition, the following pre- and post-weatherization diagnostic measurements may be made at the time meters are installed and removed for use in other special technical studies (see Sections 4.1–4.4): house air leakages, duct leakages, and furnace efficiencies. Other data that needs to be collected are identified below:

- air conditioner type (central, window units, none),
- number of window units (if applicable),
- nameplate capacity of each air conditioner (if applicable),
- electric utility account number,
- electric billing data on all houses for at least 12 months before and 12 months after weatherization (meter read date, consumption, codes accompanying each reading if possible, and change of occupancy if possible), and
- assessment of the quality of the housing stock and the need for repairs.

4.6.2 Air-Conditioning Analysis

The air conditioning electricity use data will be analyzed by regressing weekly or daily consumption versus the temperature difference between the indoors and outdoors for the pre- and post-weatherization periods. Annual, weather-normalized pre- and post-weatherization energy consumption will be calculated using the regression models, historical weather for each home location, and both an assumed typical indoor temperature for each house (e.g., 70°F) and the house-specific average indoor temperatures measured in each house for both the pre- and post-weatherization periods (i.e., a different temperature for each period). Uncertainty statistics and indicators of model reliability comparable to PRISM will also be calculated.

Since hot-climate houses are being submetered to measure air-conditioning energy use and savings, there may be an opportunity to submeter the heating energy use in the these homes as well. Although the consumption and savings of the primary space-heating fuel will be estimated in the impact assessment using billing data and several analysis methods including PRISM (see Section 2.2), such conventional energy savings studies have a poor track record at measuring statistically significant savings in hot climates and previous evaluations indicate that Program energy savings tend to be smaller in hot climates than in cold climates (Brown et al. 1993). A supplemental study based on submetering could improve the confidence in heating energy use and savings estimates in hot climates and possibly shed light on why savings occur or don't occur.

Indoor temperature measurements will be analyzed to determine whether houses are heated to the extent assumed by weatherization audits. The analysis would reveal the building management characteristics of households that energy savings similar to audit predictions and the characteristics of those with lower savings. The results will be useful for improving audit prediction capabilities.

The quality of the housing stock should be assessed and compared to that observed in other climates. The quality of the housing stock and the degree to which the housing stock needs repair is an important issue often raised concerning high and poor performance especially in the hot climate region.

5. SYNTHESIS

After the impact assessment, process assessment, and special technical studies have been performed, results from these studies will be drawn together via a synthesis study to address remaining questions identified in the evaluation design matrix (see Table 1.2):

- **Context**—Question 2,
- **Implementation**—Question 7, and
- **Outcomes**—Questions 11-13.

Specifically, the synthesis study will determine:

- if the Program has the capacity and structure (e.g., funding, staffing) to meet its legislative missions and objectives,
- how well the Program is meeting its legislative missions and objectives,
- if the states and local agencies are fulfilling their obligations under federal regulations and state plans,
- the extent to which the Program is serving the weatherization needs of the low-income community and meeting the needs of the national low-income weatherization market, and
- the ways that the weatherization network's performance can be improved to guide the Program into the next decade.

The Program objectives as set by legislation will be identified in the impact assessment (see Section 3.1). One or more measurable indicators will be developed under the synthesis study for each identified objective and an expected value for each indicator will be established based on the legislative intent. Evaluation data and results from the previous studies will be used to determine an actual value for each indicator, and the actual value of each indicator will be compared to the expected value to determine if the legislative intent is being met. The key Program objectives that will be examined include:

- the number of clients served by the Program,
- the extent that the Program focused on low-income persons who are particularly vulnerable as defined by DOE (i.e., households with elderly, persons with disabilities, children, high residential energy use, and high energy burden), and
- the spending of Program financial resources according to federal regulations (e.g., adherence to spending limits for training, overhead, and the whole house; following rules concerning materials purchased and measures installed with Program funds).

Using results from the impact and process assessments, a determination will be made as to whether states and agencies are fulfilling their obligations under federal regulations and state plans (e.g., units weatherized, average household expenditures, expenditures for training and overhead).

The extent to which the weatherization needs of low-income households are being met by the Program will be assessed by examining from the previous studies the households being served by the Program compared to the larger low-income population, the breadth of activity performed nationally under the Program and differences in this activity by climate region, and the energy impacts of this activity and the quality of the jobs performed.

The results and findings from the previous three study areas (i.e., impact assessment, process assessment, and special technical studies) will be brought together and examined to develop recommendations for how the Program and the weatherization network's performance can be improved. In addition to synthesizing and distilling findings about Program outcomes and processes concerning PY 2006, this study will develop insights useful for guiding the Program into the next decade. Trends into the future of many variables relevant to the Program will be assessed, including demographics, energy prices and availability, housing stock, residential energy technologies, possibly new energy and environmental legislation, restructuring of the electric utility industry, and workforce. Recommendations will address the full breadth of the Program and the network's operation, including the delivery of the Program, communications within the network, and coordination with other programs and reporting of this coordination to DOE. Recommendations should also be developed on how a longer-term, more continuous evaluation of the Program could be implemented by DOE so that the longer-term outcomes of the Program and the long-term persistence of energy savings could be more fully addressed (see Section 1.1.3). The standardized data collection needed to support such an effort should also be addressed. Two groups will be consulted to help develop the recommendations:

- **Network Committee**—The Network Committee will be re-convened to consider the evaluation's findings and trends into the future. The Committee will identify those trends that could most impact the Program in the next decade and also make recommendations to the Program with respect to guiding the program into the next decade.

- **Expert Panel**—An Expert Panel will be formed to solicit the opinions of about a dozen policy and public administration experts (most are expected to be academics). Through an iterative process, the Expert Panel members will provide (1) their opinions and insights about the evaluation's findings and their reactions to the opinions and insights of others, (2) their responses to policy-oriented and program administration questions and their reaction to the responses of others, and (3) their recommendations and their reaction to the recommendations proposed by others. A well-run expert-panel process will find areas of consensus and disagreement amongst the panel members. This expert panel process will be run remotely (i.e., without convening the participants in one place), both to minimize expenses and also to maximize the time allowed to the panelists to provide answers, consider the inputs of the other panelists, and provide their reactions to the opinions of the panel.

The results of the discussions of the Network Committee and the Expert Panel will be compiled into a separate report and delivered to DOE for its use.

6. SCHEDULE

A schedule for the evaluation is shown in Figure 6.1. It should be noted that the intent of the evaluation is to measure and evaluate PY 2006 activities, where PY 2006 runs from April 2006 until September 2007.

The timely implementation of the data collection aspects of this preliminary evaluation plan depends upon receiving approval of the national evaluation from OMB in a timely manner. DOE and the ORNL evaluation team are in the process of obtaining OMB's approval. The first notice on the intent to perform the evaluation was listed in the Federal Register in January 2007. In March 2007, a second notice will be placed in the Federal Register, and the sampling plans and survey instruments associated with the evaluation will also be submitted to OMB for approval. It is anticipated that OMB approval will be obtained in May 2007.

While OMB approval is sought, ORNL will issue a Request for Proposals to implement the evaluation. It is anticipated that a winning proposal will be selected in May 2007 and a contract in place in June 2007. Therefore, it is anticipated that the evaluation will be fully underway in July 2007.

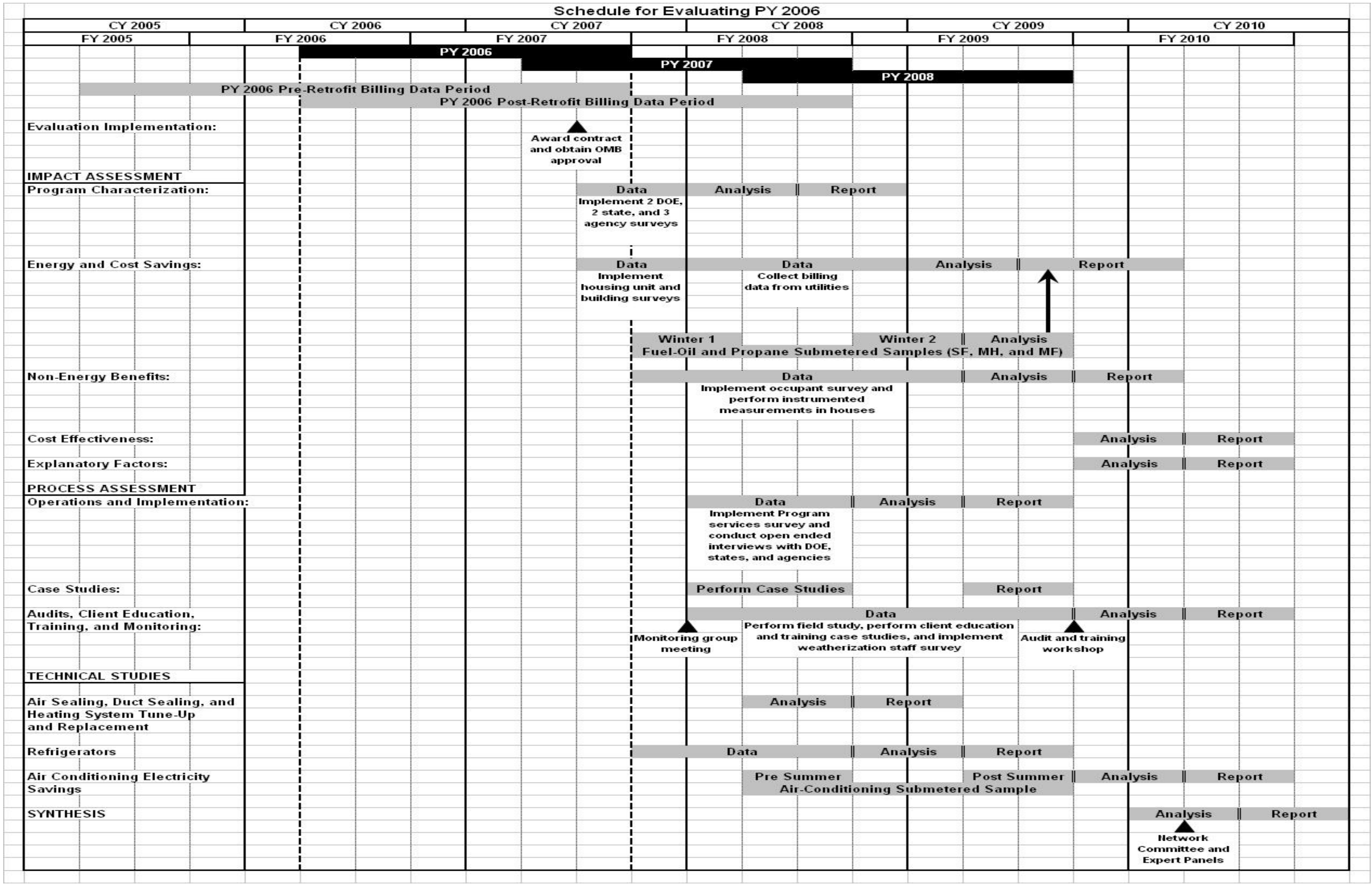

Figure 6.1. Evaluation schedule

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APPENDIX A. NETWORK PLANNING COMMITTEE MEMBERS

State Representatives
Jeff Ackermann, Colorado
Peggy Colvin, Texas
Patrick Costello, New York
Jeff Dockter, Wyoming
Dan Elliott, Oregon
Cherry Ivey, Georgia
Jules Junker, Vermont
Tim Lenahan, Ohio
Jim Newton, Iowa
Larry Palmer, Arkansas
Kane Quenemoen, Montana
Clarice Sabree-Sylla, New Jersey
Howard Sage, North Dakota
Carl Saueressig, Wisconsin
Bob Scott, West Virginia
Mo Srour, District of Columbia
Evans Taylor, North Carolina

Federal Representatives
Rob DeSoto, Central Region
Jean Diggs, Headquarters
Melissa Gallagher-Rogers, Headquarters
Mike Gonzalez, Headquarters
Mike Peterson, Midwest Region

Local Agency Representatives
Kip Bowmar, Kentucky
Gene Brady, Pennsylvania
Dave Finet, Washington
Landon Halverson, Utah
David Hepinstall, New York
Bob Jackson, Missouri
Elliott Jacobson, Massachusetts
Bob Jones, Wisconsin
Kathy O'Neill, Pennsylvania
Thomas Richert, Iowa
Sallie Surface, North Carolina
Ben Watts, North Carolina

Other Members
Bob Adams, National Association For State Community Services Programs (NASCSP)
Russell Clark, Citizen's advocate, Arizona
Katherine Foote, Central Region Contractor
Ed Gerardot, Indiana Training Center
Alex Moore, D&R International
Meg Power, National Community Action Foundation (NCAF)
Bill Van der Meer, Pennsylvania Training Center

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APPENDIX B. DOE PY 2006 SURVEY

The “DOE PY 2006 Survey” will be administered to DOE as soon as the evaluation can be implemented (July 2007). Information collected from this survey will be used to identify high-performing agencies for case study (see Section 3.2), agencies for the field study of audits, client education, training, and monitoring (see Section 3.3.3), and states/agencies with innovative client education and training programs for case study (see Section 3.3.4).

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DOE PY 2006 SURVEY

1. Please identify those states that have especially innovative and/or effective client education programs.

2. Please identify those states that have especially innovative and/or effective programs for training weatherization staff and/or contractors.

3. Please identify those states that have especially innovative and/or effective programs for monitoring how well their subgrantee programs are managed and administered (also known as "administrative monitoring").

4. Please identify those states that have especially innovative and/or effective programs for inspecting weatherized units (also known as "technical monitoring" or Quality Assurance)

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APPENDIX C. DOE PY 2007 SURVEY

DOE will be surveyed using the "DOE PY 2007 Survey" to collect information needed for the Program operation and implementation portion of the process assessment (see Section 3.1.1). Information will be collected on staffing, costs, and their enforcement of state and local agency data collection, storage, and data mining capabilities. This survey will be given when PY 2006 is complete for all states (October 2007).

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DOE PY 2007 SURVEY

PROGRAM CHARACTERIZATION

1. Please report the total amount of Weatherization Assistance Program funds allocated by DOE in PY 2006. $__________

2. Of the total funding described in Question 1, how much was used for program administration by DOE headquarters and its contractors $________________ and how much was passed on to the states? $_________________

3. What was DOE's target for the total number of dwelling units to be weatherized in PY 2006 under the Weatherization Assistance Program? ________________

PROGRAM OPERATIONS AND IMPLEMENTATION

1. Please report the amount of FY 2006 DOE funds used to support the following Weatherization Assistance Program functions performed by DOE headquarters staff and its contractors:

Type of Administrative Function	In-house Expenditures ($)	Contractor Expenditures ($)	Total Expenditures ($)
Management/administration			
Planning			
Budgeting and reporting			
State plan review			
Monitoring and approval			
Training and technical assistance			
Regulation and guidance			
Other			
TOTAL			

Note: *The sum of the numbers reported in the Total Expenditures column should equal the amount reported in the first part of Question 2 in the Program Characterization section, which is the amount of total Weatherization Assistance Program funding used for program administration by DOE headquarters and its contractors.*

2. Please report the amount of full time equivalent (FTE) staff time used to perform the following Weatherization Assistance Program functions by DOE headquarters staff and its contractors in FY 2006:

Type of Administration Function	**In-house Staff (FTE)**	**Contractor Staff (FTE)**	**Total Staff (FTE)**
Management/administration			
Planning			
Budgeting and reporting			
State plan review			
Monitoring and approval			
Training and technical assistance			
Regulation and guidance			
Other			
TOTAL			

3. Please report the total amount of FY 2006 DOE funds used to support the following Weatherization Assistance Program functions performed at the DOE Project Management Centers:
   - Management/Administration ___________
   - Planning ___________
   - Budgeting and reporting ___________
   - State plan review ___________
   - Monitoring and approval ___________
   - Training and technical assistance ___________
   - Regulation and guidance ___________
   - Other ___________

4. Please report the total amount of full time equivalent (FTE) staff time used to perform the following Weatherization Assistance Program functions at the DOE Project Management Centers:
   - Management/Administration ___________
   - Planning ___________
   - Budgeting and reporting ___________
   - State plan review ___________
   - Monitoring and approval ___________
   - Training and technical assistance ___________
   - Regulation and guidance ___________
   - Other ___________

APPENDIX D. ALL STATES PY 2006 SURVEY

The "All States PY 2006 Survey" will be administered to all states and the District of Columbia as soon as the evaluation can be implemented (July 2007). Collected information will be used to design and implement the billing data and submetered energy analysis samples (see Section 2.2.1), select high-performing agencies for case studies (see Section 3.2), finalize the agencies selected for the field study of audits, client education, training, and monitoring (see Section 3.3.3), and select agencies with innovative client education and training programs for case study (see Section 3.3.4).

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ALL STATES PY 2006 SURVEY

1. Please identify your state. ______________________________

2. It is important to collect information about the weatherization of homes beyond the standard single family homes that are heated with natural gas or electricity. Please provide the following information about each of the local agencies (subgrantees) that you fund to provide weatherization services in your state:

Local Agency (Subgrantee) Name	**PY 2006 DOE Funds**	**Indicate where you expect a specific local agency to weatherize a substantial number of dwelling units of a particular type in Program Year 2006, by checking the appropriate boxes below**				
		Large multi-family	**Large multi-family heated with fuel oil**	**Single-family heated with fuel oil**	**Single-family heated with propane**	**Mobile home heated with propane**

3. Please provide the following information about each of the local agencies (subgrantees) that you fund to provide weatherization services in your state:

Local Agency (Subgrantee) Name	Indicate where you expect a specific local agency to have the following characteristics in Program Year 2006, by checking the appropriate boxes below				
	Average energy savings substantially higher than the state norm	Innovative and/or particularly effective client education program	Innovative and/or particularly effective program for training weatherization staff and/or contractors	Innovative and/or particularly effective program for inspecting weatherized units (Quality Assurance)	Innovative and/or large program of leveraging DOE funds to gain non-DOE funds for weatherization

APPENDIX E. ALL STATES PY 2007 SURVEY

Each state and the District of Columbia will complete the "All States PY 2007 Survey" at the end of their PY 2006 (August to October 2007). Collected information will be used to characterize the Program (see Section 2.1.1), attribute energy savings and energy cost savings measured in this evaluation to DOE and other parties involved in the cooperative weatherization process, (see Section 2.2.3), obtain information on process improvement needed for the Program operation and implementation portion of the process assessment (see Section 3.1.1), and collect characterization information needed for the field study of training and monitoring (see Section 3.3).

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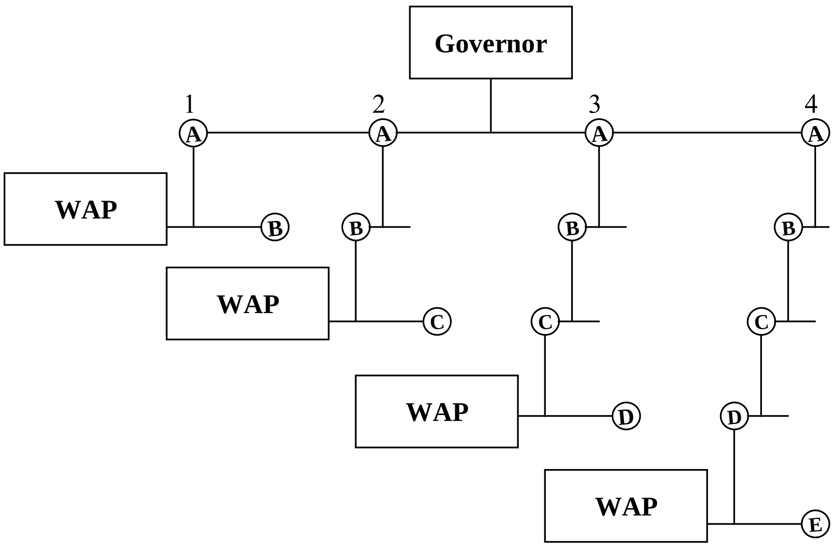
ALL STATES PY 2007 SURVEY

PROGRAM CHARACTERIZATION

1. Please identify your state: ___________________________________

2. Which of the following best characterizes the organization of the WAP Program in your state? Please circle the *number* corresponding to the organizational structure that best describes the current line of responsibility for the Weatherization Assistance Program in your state. Fill in the names of the relevant agencies in the right of the chart below.



Name of Agencies

A ________________

B ________________

C ________________

D ________________

E ________________

IF THE ORGANIZATION IN YOUR STATE DIFFERS FROM THE EXAMPLE ABOVE, PLEASE GIVE A BRIEF DESCRIPTION BELOW:

____
____
____
____

3. Is the head of your State's Weatherization Program a civil servant, political appointee, or elected official? _____

4. Does the head of your State's Weatherization Program *report to* a civil servant, political appointee, or elected official? _____

5. For how many years has the current head of your State's Weatherization Program served in that capacity? _____

6. How many different people (including the current head) have led your State's Weatherization Program over the last 10 years? _____

7. What agency, office, or department is responsible for reviewing the performance of your State's Weatherization Program? _____

8. Please list other important housing and/or energy-related programs for low-income residents that are administered by the same office that is in charge of your state's Weatherization Assistance Program.

____
____
____

9. What weatherization program data did your state require its weatherization agencies to provide in PY2006? Check all that apply
1) Number of homes weatherized
2) Number of homes weatherized for high priority categories
3) DOE weatherization funds expended
4) Non-DOE weatherization funds expended
5) Descriptive statistics on demographics of households weatherized
6) Descriptive statistics on weatherization measures installed in households weatherized
7) Descriptive statistics on energy use/savings of households weatherized
8) Copy of audits performed on the households weatherized
9) Other _______________

10. For each of the data categories listed in Question 9, indicate the format in which the agencies were suppose to provide the data by checking the appropriate box in the following table:

Data format	**Data category**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Paper hardcopy									
Excel files or other computerized spreadsheet files									
Microsoft Access or other computerized database files									
Microsoft Word or other computerized word processing files									
Other ________________									

11. How frequently were the agencies suppose to provide the data?
1) Weekly
2) Monthly
3) Quarterly
4) Annually
5) Other _____________

12. Overall, how would you rate the quality of the data received from the agencies?
1) Very high
2) High
3) Neither high nor low
4) Low
5) Very low

13. Does your state analyze data provided by the weatherization agencies to: (Check all that apply)
1) Generate descriptive statistics
2) Look for trends
3) Support state-level strategic planning about its weatherization program
4) Other ___________________

13a. If no checks are made, why does your state not analyze data from the weatherization agencies?
1) No Need
2) Too difficult because the records are not computerized
3) We do not have the staff who know how to analyze data
4) Other _________

14. Does DOE provide guidance to your state about how to collect, store, and/or analyze its weatherization program data?
1) Yes
2) No

14a. If Yes, what is this guidance? ____

14b. If Yes, how useful is this guidance?
1) Extremely useful
2) Very useful
3) Somewhat useful
4) Slightly useful
5) Not at all useful

15. What data does your state provide to DOE about its weatherization program? Check all that apply
1) Number of homes weatherized
2) Number of homes weatherized for high priority categories
3) DOE weatherization funds expended
4) Non-DOE weatherization funds expended
5) Descriptive statistics on demographics of households weatherized
6) Descriptive statistics on weatherization measures installed in households weatherized
7) Descriptive statistics on energy use/savings of households weatherized
8) Copy of audits performed on the households weatherized
9) Other ________________

16. Please provide the following information about ALL low-income dwelling units weatherized by your state in Program Year 2006 and ALL weatherization funding that you received in that same year. *Note that a DOE unit is one on which a DOE-approved energy audit or priority list has been applied and for which the measures installed (not counting health and safety measures) have an SIR of 1.0 or greater, and on which DOE funds were directly used. Units receiving some funds from non-DOE sources can be counted as DOE units, provided they meet the previously-stated criteria.*

	Number of Units Weatherized in PY 2006		
Type of Unit Weatherized	**DOE Units**	**Non-DOE Units**	**TOTAL Units**
Owner-occupied single family site built			
Single-family rental site built			
Multi-family (5 or more units per building)			
Owner-occupied mobile home			
Renter-occupied mobile home			
Shelter			
TOTAL UNITS			
Source of PY 2006 Weatherization Funding Received by State	**PY 2006 Funds Supporting Weatherization of Units ($)**		
	DOE Units	**Non-DOE Units**	**TOTAL Units**
DOE		*Not Applicable*	
LIHEAP			
Petroleum Violation Escrow (PVE)			
Public Benefit Funds (PBF)			
State			
Local			
Utility			
Program Income			
Landlord Contribution			
Other (Specify)			
TOTAL FUNDS			

17. Of the total funding used to support weatherization of your state's Program Year 2006 DOE units (shown at the bottom of the second column in the table for Question 16), how much was spent on each of the categories shown below?

Type of Expenditure	PY 2006 Funds Supporting Weatherization of DOE Units (in $)
Funds used for program administration and related functions by state and its contractors	
Funds passed on to local agencies (subgrantees)	
TOTAL FUNDS	

18. Of the Program Year 2006 funds used for program administration and related functions for DOE units (shown in top row of table for Question 17), how much was used by in-house and contractor staff to support each of the following functions?

Type of Administrative Function	In-house Expenditures ($)	Contractor Expenditures ($)	Total Expenditures ($)
Management/administration			
Planning			
Financial/accounting			
Clerical/support			
Outreach			
Field monitoring/auditing			
Training			
Evaluation			
Other (specify)			
TOTAL ADMINISTRATIVE FUNDING			

19. Please indicate the approximate amount of time spent on the following administrative functions by the in-house and contractor staff working on your state's weatherization efforts in Program Year 2006. Enter the approximate number of full-time equivalent (FTE) employees for each category [e.g., if one person works half time providing training and half time on outreach, you should enter 0.5 FTE in the appropriate box (in-house or contractor) for each of those items.]

Type of Administrative Function	**In-house Staff (FTE)**	**Contractor Staff (FTE)**	**Total Staff (FTE)**
Management/administration			
Planning			
Financial/accounting			
Clerical/support			
Outreach			
Field monitoring/auditing			
Training			
Evaluation			
Other (specify)			
TOTAL			

20. For the in-house and contractor staff working on your state's weatherization program in each of the following functional areas in Program Year 2006, please indicate the average length of their weatherization-related experience:

	In-house Staff (average years of experience)	**Contractor Staff (average years of experience)**
Management/administration		
Planning		
Financial/accounting		
Clerical/support		
Outreach		
Field monitoring/auditing		
Training		
Evaluation		
Other (specify)		

21. For the in-house and contractor staff working on your state's weatherization program in each of the following functional areas, please indicate the approximate number of full-time equivalent (FTE) employees who joined and who left the program in Program Year 2006:

	In-house Staff Joining Program in PY 2006 (FTE)	**Contractor Staff Joining Program in PY 2006 (FTE)**	**Total Staff Joining Program in PY 2006 (FTE)**	**In-house Staff Leaving Program in PY 2006 (FTE)**	**Contractor Staff Leaving Program in PY 2006 (FTE)**	**Total Staff Leaving Program in PY 2006 (FTE)**
Management/ administration						
Planning						
Financial/ accounting						
Clerical/ Support						
Outreach						
Field monitoring/ Auditing						
Training						
Evaluation						
Other (specify)						
TOTAL						

22. For which of the following functional areas were there certification or licensing requirements in Program Year 2006 for the in-house or contractor staff serving your state's weatherization program?

	Certification or Licensing Requirement for In-house Staff	**Certification or Licensing Requirement for Contractor Staff**
Management/administration		
Planning		
Financial/accounting		
Clerical/support		
Outreach		
Field monitoring/auditing		
Training		
Evaluation		
Other (specify)		

23. The Federal Regulations governing the Weatherization Assistance Program define children as "dependents not exceeding 19 years or a lesser age set forth in the State plan." What age is used in your state's definition of children? _____

24. What is the median residential energy expenditure by low-income households in your state for the most recent year for which records are available? _____
To what year does that number apply? _____

25. What is the median energy burden (residential energy expenditures divided by annual income) for low-income households in your state for the most recent year for which records are available? _____
To what year does that number apply? _____

26. What are the income guidelines for households to be eligible for your state's weatherization program?
(1) 100% of Federal Poverty Guidelines
(2) 125% of Federal Poverty Guidelines
(3) 150% of Federal Poverty Guidelines
(4) 185% of Federal Poverty Guidelines
(5) More than 185% of Federal Poverty Guidelines
(6) 60% of state median income
(7) Other: ________________________

PROGRAM OPERATIONS AND IMPLEMENTATION

1. Using the following scale, how adequate was the Program Year 2006 funding received by your state from ALL funding sources for weatherizing the stock of eligible low-income dwelling units in your state in a timely fashion? _____

   1= Very Inadequate; 2=Inadequate; 3=Neither Inadequate nor Adequate;
   4= Adequate; 5=Very Adequate

Please answer Questions 2-6 using the following five-point scale:

   1=very low quality ; 2= low quality; 3= moderate quality;
   4= high quality; 5= very high quality

2. What was the quality of the administrative support and assistance that your state received from DOE and its contractors in Program Year 2006? _____
   2a. If (1 or 2), why was the quality very low or low? ______________

3. What was the quality of the training that your state received from DOE and its contractors in Program Year 2006? _____
   3a. If (1 or 2), why was the quality very low or low? ______________

4. What was the quality of the support and assistance on client education that your state received from DOE and its contractors in Program Year 2006? _____
   4a. If (1 or 2), why was the quality very low or low? ______________

5. What was the quality of the support and assistance on coordinating the Weatherization Assistance Program with other funding sources and related programs that your state received from DOE and its contractors in Program Year 2006? _____
   5a. If (1 or 2), why was the quality very low or low? ______________

6. What was the quality of the *technical* support that your state received from DOE and its contractors in Program Year 2006? _____
   7a. If (1 or 2), why was the quality very low or low? ______________

7. Using the following scale, how flexible were the program rules that governed your state's weatherization efforts in Program Year 2006? _____

   1= Very Inflexible; 2=Inflexible; 3=Neither Inflexible nor Flexible;
   4= Flexible; 5=Very Flexible

   7a. In the future, how should the program rules change?
   (1) Become much more flexible
   (2) Become more flexible
   (3) Stay about the same
   (4) Become more inflexible
   (5) Become much more inflexible

8. Please describe any important political issues faced by your state's weatherization program in Program Year 2006.
   ____
   ____
   ____
   ____

Please answer Questions 9-15 using the following five-point scale:

1= Very Unimportant; 2=Unimportant; 3=Neither Unimportant nor Important;
4= Important; 5=Very Important

9. How important is improving administrative support and assistance from DOE and its contractors in improving your state's ability to deliver low-income weatherization services? _____

10. How important is improving training from DOE and its contractors in improving your state's ability to deliver low-income weatherization services? _____

11. How important is improving assistance on client education from DOE and its contractors in improving your state's ability to deliver low-income weatherization services? _____

12. How important is improving assistance from DOE and its contractors on coordinating the Weatherization Assistance Program with other funding sources and related programs in improving your state's ability to deliver low-income weatherization services? _____

13. How important is improving *technical* support from DOE and its contractors in improving your state's ability to deliver low-income weatherization services? _____

14. How important is greater flexibility in DOE's program rules and regulations in improving your state's ability to deliver low-income weatherization services? _____

15. How important is increased weatherization funding in improving your state's ability to deliver low-income weatherization services? _____

16. How important is improving data and information systems for managing the delivery of weatherization services? __________

TRAINING

1. On which of the following subjects did the in-house or contractor staff working on your state's weatherization efforts receive training in Program Year 2006 from DOE, your state, or other entities? *Check all that apply.*
    - Diagnostic procedures ______
    - Management ______
    - Planning ______
    - Evaluation ______
    - Client education ______
    - Insulation for single family dwellings ______
    - Insulation for multi family dwellings ______
    - Insulation for mobile homes ______
    - HVAC for single family dwellings ______
    - HVAC for multi family dwellings ______
    - HVAC for mobile homes ______
    - Infiltration measures for single family dwellings ______
    - Infiltration measures for multi family dwellings ______
    - Infiltration measures for mobile homes ______
    - Other weatherization topics for single family dwellings ______
    - Other weatherization topics for multi family dwellings ______
    - Other weatherization topics for mobile homes ______
    - Auditing/estimating for single family dwellings ______
    - Auditing/estimating for multi family dwellings ______
    - Auditing/estimating for mobile homes ______
    - Monitoring/quality control ______
    - Financial topics ______
    - Outreach and communications ______
    - Fire safety ______
    - Indoor air quality ______
    - Measures to increase security of housing unit ______
    - Measures to reduce common household hazards ______
    - Mold ______
    - Lead ______
    - Other health and safety (please specify) ______________________ ______
    - Other (please specify) _____________________________________ ______

2. On which of the following diagnostic procedures did the in-house or contractor staff working on your state's weatherization efforts receive training in Program Year 2006 from DOE, your state, or other entities? *Check all that apply.*

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

3. Please indicate the functions performed by the in-house and contractor weatherization staff in your state who received training in Program Year 2006 from DOE, your state, or other entities. *Check all that apply.*
    - Management/administration ______
    - Planning ______
    - Financial/accounting ______
    - Clerical/support ______
    - Outreach ______
    - Field monitoring/auditing ______
    - Training ______
    - Evaluation ______
    - Other (please specify) ____ ______

4. Please indicate the number of your state's in-house or contractor weatherization staff who received training by attending the following events in Program Year 2006?

Training events	**Number of in-house and contractor staff**		
	Classroom training only	**Field training only**	**Both classroom and field training**
National Weatherization Program conference			
Affordable Comfort Conference			
Other national conference			
Regional weatherization conference			
State weatherization conference			
Other state conference			
State/regional training center class			
Manufacturer's training school class			
Utility training class			
Class sponsored by your state and taught at some central location (e.g., state office, local agency)			
Class not sponsored by your state (e.g., another state, trade organization)			
In-person expert visit to state (e.g., peer exchange, consultant)			
Web cast		NA	NA
Conference call		NA	NA
Other (please specify: _______________)			

5. Which of the following types of personnel were used to provide weatherization training to your state's in-house or contractor staff in Program Year 2006 at training events other than national, regional, and state conferences (i.e., for just the events in the last 9 rows of the table for Question 4)? *Check all that apply.*
   - DOE staff ______
   - DOE contractor ______
   - State staff ______
   - State contractor ______
   - Staff from another state ______
   - State training center staff ______
   - Local agency staff from your state ______
   - Agency staff from another state ______
   - Manufacturer representative ______
   - Utility staff ______
   - Representative from trade organization ______
   - Consultant ______
   - Other (please specify) ____ ______

6. For each broad subject listed in the left-most column of the following table, put a check mark in the appropriate cell(s) to indicate which training method(s) you believe are most effective for imparting key skills and information in that area to your state's in-house or contractor weatherization staff:

Subject	Conferences	Classes	In-person expert visits	Web casts	Conference calls	Other (specify)
Management						
Weatherization skills and methods						
Auditing/Estimating/ Measure selection						
Monitoring and quality control						
Financial topics						
Outreach and communications						
Health and safety						
Diagnostic procedures						
Client education						
Other (specify)						

7. On which of the following subjects did your state provide training to your state's local weatherization agencies or their contractors in Program Year 2006? *Check all that apply.*
    - Diagnostic procedures ______
    - Management ______
    - Client education ______
    - Insulation for single family dwellings ______
    - Insulation for multi family dwellings ______
    - Insulation for mobile homes ______
    - HVAC for single family dwellings ______
    - HVAC for multi family dwellings ______
    - HVAC for mobile homes ______
    - Infiltration measures for single family dwellings ______
    - Infiltration measures for multi family dwellings ______
    - Infiltration measures for mobile homes ______
    - Other weatherization topics for single family dwellings ______
    - Other weatherization topics for multi family dwellings ______
    - Other weatherization topics for mobile homes ______
    - Auditing/estimation for single family dwellings ______
    - Auditing/estimation for multi family dwellings ______
    - Auditing/estimation for mobile homes ______
    - Monitoring/quality control ______
    - Financial topics ______
    - Outreach and communications ______
    - Fire safety ______
    - Indoor air quality ______
    - Measures to increase security of housing unit ______
    - Measures to reduce common household hazards ______
    - Mold ______
    - Lead ______
    - Other health and safety (please specify) ______
    - Other (please specify) ________________________________ ______

8. On which of the following diagnostic procedures did your state provide training to your state's local weatherization agencies or their contractors in Program Year 2006? *Check all that apply.*

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

9. Which of the following types of personnel did your state use to provide training to your state's local weatherization agencies or their contractors in Program Year 2006? *Check all that apply.*
   - DOE staff _____
   - DOE contractor _____
   - State staff _____
   - State contractor _____
   - Staff from another state _____
   - State training center staff _____
   - Local agency staff from your state _____
   - Agency staff from another state _____
   - Manufacturer representative _____
   - Utility staff _____
   - Representative from trade organization _____
   - Consultant _____
   - Other (please specify) ___________________________________ _____

10. What types of credentials or experience were required of the personnel your state used to provide training to your state's local weatherization agencies or their contractors in Program Year 2006? *Check all that apply.*
   - Technical certification _____
   - Extensive weatherization field experience _____
   - Construction experience _____
   - Extensive management experience _____
   - Extensive experience with financial matters _____
   - Other (please specify) ___________________________________ _____

10a. Using the scale below, please indicate how important each credential is for trainers to have?

1= Very Unimportant; 2=Unimportant; 3=Neither Unimportant nor Important;
4= Important; 5=Very Important

- Technical certification _____
- Extensive weatherization field experience _____
- Construction experience _____
- Extensive management experience _____
- Extensive experience with financial matters _____
- Other (please specify) ___________________________________ _____

11. How many of your state's in-house or contractor weatherization staff acted as instructors at the following training events that your state provided (e.g., funded, organized) to your state's local weatherization agencies or their contractors in Program Year 2006?
    - State weatherization conference _____
    - Other state conference _____
    - State/regional training center class _____
    - State-sponsored class taught at central location _____
    - In-person expert visit (e.g., peer exchange, consultant) _____
    - Instruction given to individual agency during an agency visit _____
    - Web cast _____
    - Conference call _____
    - Other (please specify) ____ _____

12. How many of your state's local weatherization agency staff or their contractors received training from the following types of events provided (e.g., funded, organized) by your state in Program Year 2006?
    - State weatherization conference _____
    - Other state conference _____
    - State/regional training center class _____
    - State-sponsored class taught at some central location _____
    - Visit to another agency _____
    - In-person expert visit (e.g., peer exchange, consultant) _____
    - Instruction given to individual agency during an agency visit _____
    - Web cast _____
    - Conference call _____
    - Other (please specify) ____ _____

13. Please indicate the functions performed by your state's local weatherization agency staff and contractors to whom your state provided training in Program Year 2006. *Check all that apply.*
    - Management/administration _____
    - Planning _____
    - Financial/accounting _____
    - Clerical/support _____
    - Outreach _____
    - Intake/eligibility determination _____
    - Auditing/estimation _____
    - Performing weatherization jobs _____
    - Supervising weatherization jobs _____
    - Monitoring/inspecting completed jobs _____
    - Client education _____
    - Other (please specify) ____ _____

14. For each broad subject listed in the left-most column of the following table, put a check mark in the appropriate cell(s) to indicate which training method(s) you believe are most effective for imparting key skills and information in that area to your local weatherization agencies or their contractors:

Subject	Conf.	Classes	Visiting other agency	In-person expert visit	Instruction given to individual agency	Web casts	Conference calls	Other (specify)
Management								
Weatherization skills and methods								
Auditing/Estimating/ Measure selection								
Monitoring and quality control								
Financial topics								
Outreach and communications								
Health and safety								
Diagnostic procedures								
Client education								
Other (specify)								

15. In what areas do you think weatherization crews in your state are well trained? Check all that apply.
(1) Diagnostic procedures
(2) Management
(3) Client education
(4) Insulation for single family dwellings
(5) Insulation for multifamily dwellings
(6) Insulation for mobile homes
(7) HVAC for single family dwellings
(8) HVAC for multifamily dwellings
(9) HVAC for mobile homes
(10) Infiltration measures for single family dwellings
(11) Infiltration measures for multifamily dwellings
(12) Infiltration measures for mobile homes
(13) Other weatherization topics for single family dwellings
(14) Other weatherization topics for multifamily dwellings
(15) Other weatherization topics for mobile homes
(16) Auditing/estimating for single family dwellings
(17) Auditing/estimating for multifamily dwellings
(18) Auditing/estimating for mobile homes
(19) Monitoring/quality control
(20) Financial topics
(21) Outreach and communications
(22) Fire safety
(23) Indoor air quality
(24) Measures to increase security of housing unit
(25) Measures to reduce common household hazards
(26) Mold
(27) Lead
(28) Other health and safety (please specify)
(29) Other (please specify)

16. In what areas do you think weatherization crews in your state are poorly trained? Check all that apply
(1) Diagnostic procedures
(2) Management
(3) Client education
(4) Insulation for single family dwellings
(5) Insulation for multifamily dwellings
(6) Insulation for mobile homes
(7) HVAC for single family dwellings
(8) HVAC for multifamily dwellings
(9) HVAC for mobile homes
(10) Infiltration measures for single family dwellings
(11) Infiltration measures for multifamily dwellings
(12) Infiltration measures for mobile homes
(13) Other weatherization topics for single family dwellings
(14) Other weatherization topics for multifamily dwellings
(15) Other weatherization topics for mobile homes
(16) Auditing/estimating for single family dwellings
(17) Auditing/estimating for multifamily dwellings
(18) Auditing/estimating for mobile homes
(19) Monitoring/quality control
(20) Financial topics
(21) Outreach and communications
(22) Fire safety
(23) Indoor air quality
(24) Measures to increase security of housing unit
(25) Measures to reduce common household hazards
(26) Mold
(27) Lead
(28) Other health and safety (please specify)
(29) Other (please specify)

17. Overall, how well trained are your state's weatherization crews?
(1) Very well trained
(2) Well trained
(3) Neither well nor poorly trained
(4) Poorly trained
(5) Very poorly trained

MONITORING

1. About how many people in each category monitored local weatherization efforts in your state in Program Year 2006? *{Note: do not include people who do quality assurance at the local agency level for the local agencies.}*
    - State staff ______
    - State contractors ______
    - Local agency staff ______
    - Local agency contractors ______
    - Independent parties appointed by the state ______
    - Other (please specify) ______________________________________ ______

2. Which of the following types of post-weatherization quality control inspection did your state perform on weatherized dwelling units in Program Year 2006? *Check all that apply.*
    - Visual inspection of installed measures ______
    - 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 ______
    - Other (specify)____ ______

3. For how many years has your state performed each type of post-weatherization quality control inspection listed below? If your state does not use a particular approach, leave that item blank.
    - Visual inspection of installed measures ______
    - 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 ______
    - Other (specify)____ ______

4. Using the following scale, how difficult was it for your state to perform each of the following types of post-weatherization quality control inspection in Program Year 2006? If your state did not use a particular approach, leave that item blank.

   1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy;
   4= Easy; 5=Very Easy

   - Visual inspection of installed measures ______
   - 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 ______
   - Other (specify)____ ______

5. Using the following scale, please rate the effectiveness of each type of post-weatherization quality control inspection performed by your state in Program Year 2006. If your state did not use a particular approach, leave that item blank.

   1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
   4= Effective; 5=Very Effective

   - Visual inspection of installed measures ______
   - 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 ______
   - Other (specify)____ ______

6. Approximately how many hours did it take to perform a typical post-weatherization quality control inspection in Program Year 2006, by the major components listed below?
    - Scheduling _____
    - Travel _____
    - On-site work _____
    - Post-inspection analysis and write-up _____
    - Other _____
    - TOTAL of all components _____

7. What types of credentials or experience were required of your post-weatherization quality control inspectors in Program Year 2006? *Check all that apply.*
    - Technical certification _____
    - Extensive experience performing pre-weatherization audits _____
    - Extensive experience performing weatherization work _____
    - Extensive experience supervising weatherization work _____
    - Construction experience _____
    - Other (please specify) ____________________________________ _____

8. On average, how many years of experience did your post-weatherization quality control inspectors have in each of the following areas in Program Year 2006?
    - Performing pre-weatherization audits _____
    - Performing weatherization work _____
    - Supervising weatherization work _____
    - Working in construction _____
    - Performing post-weatherization inspections _____
    - Other (please specify) ____________________________________ _____

9. On how many dwelling units did your state perform post-weatherization quality control inspections in Program Year 2006? _____
   9a. Of those inspected, how many were found to have a problem? _____

10. For those dwelling units for which post-weatherization quality control inspections were performed by your state in Program Year 2006, typically how many days after weatherization completion did the inspection take place? _____

11. In those cases where a Program Year 2006 post-weatherization quality control inspection revealed a problem with the job performed, what action was most commonly taken in response to that finding? *Check one.*
    - Sent original crew back to correct problem _____
    - Sent different crew to correct problem _____
    - Sent crew supervisor to correct problem _____
    - Sent someone from state office to correct problem _____
    - No action taken _____
    - Other (please specify) ____________________________________ _____

12. What *other* actions were taken in Program Year 2006 in response to the discovery of a problem with the weatherization job performed? *Check all that apply.*
    - Sent original crew back to correct problem _____
    - Sent different crew to correct problem _____
    - Sent crew supervisor to correct problem _____
    - Sent someone from state office to correct problem _____
    - No action taken _____
    - Other (please specify) ___________________________________ _____

13. In Program Year 2006, how many dwelling units required some additional work as a result of the findings of your state's post-weatherization quality control inspections? _____
    13a. Of those requiring some additional work, how many had work done that probably resulted in more energy savings? _____

14. What were the three most common problems found in the dwelling units inspected by your state in Program Year 2006?
    ____
    ____
    ____

14a. Please indicate the number of houses that had problems in the following areas:
(1) Insulation for single family dwellings
(2) Insulation for multifamily dwellings
(3) Insulation for mobile homes
(4) HVAC for single family dwellings
(5) HVAC for multifamily dwellings
(6) HVAC for mobile homes
(7) Infiltration measures for single family dwellings
(8) Infiltration measures for multifamily dwellings
(9) Infiltration measures for mobile homes
(10) Health and safety issues
(11) Other weatherization topics for single family dwellings
(12) Other weatherization topics for multifamily dwellings
(12) Other weatherization topics for mobile homes

15. Which of the following monitoring tasks did your state perform in Program Year 2006 to check on the administration of local weatherization efforts? *Check all that apply.*
    - Verification of number of dwelling units weatherized ______
    - Verification of clients' income eligibility ______
    - Verification of average expenditure per weatherized unit ______
    - Verification of material expenditures ______
    - Verification that installed measures had an SIR of 1.0 or greater ______
    - Examination of vehicle costs ______
    - Examination of other equipment costs ______
    - Examination of training and technical assistance (T&TA) costs ______
    - Examination of administrative costs ______
    - Examination of material inventory ______
    - Interviews with agency staff ______
    - Interviews with agency contractor staff ______
    - Interviews with agency clients ______
    - Other (please specify) ____________________________________ ______

16. For how many years has your state performed each type of monitoring task listed below? If your state does not perform a particular task, leave that item blank.
    - Verification of number of dwelling units weatherized ______
    - Verification of clients' income eligibility ______
    - Verification of average expenditure per weatherized unit ______
    - Verification of material expenditures ______
    - Verification that installed measures had an SIR of 1.0 or greater ______
    - Examination of vehicle costs ______
    - Examination of other equipment costs ______
    - Examination of training and technical assistance (T&TA) costs ______
    - Examination of administrative costs ______
    - Examination of material inventory ______
    - Interviews with agency staff ______
    - Interviews with agency contractor staff ______
    - Interviews with agency clients ______
    - Other (please specify) ____________________________________ ______

17. Using the following scale, how difficult was it for your state to perform each of the following types of monitoring tasks in Program Year 2006? If your state did not perform a particular task, leave that item blank.

    1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy;
    4= Easy; 5=Very Easy

    - Verification of number of dwelling units weatherized ______
    - Verification of clients' income eligibility ______
    - Verification of average expenditure per weatherized unit ______
    - Verification of material expenditures ______
    - Verification that installed measures had an SIR of 1.0 or greater ______
    - Examination of vehicle costs ______
    - Examination of other equipment costs ______
    - Examination of training and technical assistance (T&TA) costs ______
    - Examination of administrative costs ______
    - Examination of material inventory ______
    - Interviews with agency staff ______
    - Interviews with agency contractor staff ______
    - Interviews with agency clients ______
    - Other (please specify) ____________________________________ ______

18. Using the following scale, please rate the effectiveness of each of the following types of monitoring task performed by your state in Program Year 2006. If your state did not perform a particular task, leave that item blank.

    1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
    4= Effective; 5=Very Effective

    - Verification of number of dwelling units weatherized ______
    - Verification of clients' income eligibility ______
    - Verification of average expenditure per weatherized unit ______
    - Verification of material expenditures ______
    - Verification that installed measures had an SIR of 1.0 or greater ______
    - Examination of vehicle costs ______
    - Examination of other equipment costs ______
    - Examination of training and technical assistance (T&TA) costs ______
    - Examination of administrative costs ______
    - Examination of material inventory ______
    - Interviews with agency staff ______
    - Interviews with agency contractor staff ______
    - Interviews with agency clients ______
    - Other (please specify) ____________________________________ ______

19. Approximately how many hours, on average, did it take to monitor the administration of a local agency's weatherization efforts in your state in Program Year 2006? ____

20. What types of credentials or experience were required of those who monitored the administration of local weatherization efforts in your state in Program Year 2006? *Check all that apply.*
    - Technical certification _____
    - Extensive experience performing pre-weatherization audits _____
    - Extensive experience performing weatherization work _____
    - Extensive experience supervising weatherization work _____
    - Construction experience _____
    - Extensive management experience _____
    - Extensive finance experience _____
    - Extensive experience administering local weatherization programs _____
    - Other (please specify) ____________________________________ _____

21. On average, how many years of experience did your administrative monitors have in each of the following areas in Program Year 2006?
    - Management _____
    - Finance _____
    - Administration of local weatherization programs _____
    - Other (please specify) ____________________________________ _____

22. For how many agencies did your state monitor the administration of local weatherization efforts in Program Year 2006? _____

23. On average, how many visits were made to each local weatherization agency that was monitored? _____

24. For how many of the local weatherization agencies monitored in your state in Program Year 2006 was a problem found? _____

25. In those cases where state monitoring of the administration of local weatherization efforts in Program Year 2006 revealed a problem, what action was taken in response to that finding? *Check all that apply.*
    - Sent written report to local agency _____
    - Made presentation to local agency _____
    - Sent someone from state office to help correct problem _____
    - Sent state contractor to help correct problem _____
    - No action taken _____
    - Other (please specify) _____________________________________ _____

26. What were the three most common problems found in the local weatherization agencies monitored in your state in Program Year 2006?

____
____
____

26a. In which areas were problems found? Check all that apply.

- Verification of number of dwelling units weatherized _____
- Verification of clients' income eligibility _____
- Verification of average expenditure per weatherized unit _____
- Verification of material expenditures _____
- Verification that installed measures had an SIR of 1.0 or greater _____
- Examination of vehicle costs _____
- Examination of other equipment costs _____
- Examination of training and technical assistance (T&TA) costs _____
- Examination of administrative costs _____
- Examination of material inventory _____
- Interviews with agency staff _____
- Interviews with agency contractor staff _____
- Interviews with agency clients _____
- Other (please specify) ________________________________ _____

27. Did the observation of problems with the quality of weatherization work lead to changes in weatherization training for local agency staff?
(1) Yes
(2) No

27a. If Yes, what changes were made? _______________

28. Does your state observe weatherization training sessions to help identify potential problem areas for monitoring in the field?
(1) Yes
(2) No

28a. If Yes, briefly describe how your in-field monitoring activities are affected by your training session observations. ____
____

ATTRIBUTION OF SAVINGS

1. There are many components of a successful weatherization program and many possible sources of program support. For each weatherization program component listed in the following table, please estimate how much each source of support contributed to your state's ability to perform the tasks and functions associated with that component in Program Year 2006. Keep in mind that the contribution from a given source may not be directly proportional to the dollars spent, because the magnitude of any given contribution can also be affected by the effort expended and expertise contributed.

   Please estimate the PY 2006 contributions from the various sources of support as percentages. For each weatherization program component (the columns in the table below), the sum of the contributions from all relevant sources should equal 100%. This means that every cell in the table's bottom row (labeled "TOTAL") should contain the number 100.

	Weatherization Program Components		
Source of Support	**Program Management**	**Outreach and Marketing**	**Training**
DOE			
LIHEAP			
Petroleum Violation Escrow (PVE)			
Public Benefit Funds (PBF)			
State			
Local			
Utility			
Program Income			
Landlord Contribution			
Other (specify)			
TOTAL			

APPENDIX F. ALL AGENCIES PY 2006 SURVEY

The “All Agencies PY 2006 Survey” will be administered to all agencies as soon as the evaluation can be implemented (July 2007). Collected information will be used to design and implement the billing data and submetered energy analysis samples (see Section 2.2.1) and the field study of audits, client education, training, and monitoring (see Section 3.3.3).

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ALL AGENCIES PY 2006 SURVEY

1. What is the primary method that your agency is using in Program Year 2006 to select weatherization measures for clients' dwelling units (excluding health, safety, and repair measures and general heat waste measures)?
   - 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 ______
   - Other (specify) ____ ______

2. If your agency used a calculation procedure for at least some dwelling units, what was the name of the procedure or procedures employed. *Check all that apply.*
   - AK Warm ______
   - EA-3 ______
   - EASY ______
   - EA-QUIP ______
   - HomeCheck ______
   - Meadows ______
   - REES ______
   - REM/Rate ______
   - SMOC-ERS ______
   - TIPS ______
   - TREAT ______
   - Weatherization Assistant (NEAT/MHEA) ______
   - WXEOR ______
   - Other (specify) ____ ______

3. Which of the following client education approaches did your agency use in Program Year 2006? *Check all that apply.*
    - Provide literature at time of client intake ______
    - Provide video or DVD at time of client intake ______
    - Prove in-person instruction at time of client intake ______
    - Provide literature at time of audit ______
    - Provide video or DVD at time of audit ______
    - Provide in-person instruction at time of audit ______
    - Provide literature at time of weatherization ______
    - Provide video or DVD at time of weatherization ______
    - Provide in-person instruction at time of weatherization ______
    - Provide literature at separate client education visit ______
    - Provide video or DVD at separate client education visit ______
    - Provide in-person instruction at separate client education visit ______
    - Provide literature at time of inspection ______
    - Provide video or DVD at time of inspection ______
    - Prove in-person instruction at time of inspection ______
    - Group training class ______
    - Other (please specify) ____ ______

4. From which of the following sources did your agency obtain needed skills and/or information in Program Year 2006? *Check all that apply.*
    - National Weatherization Program conference ______
    - Affordable Comfort Conference ______
    - Other national conference ______
    - Regional weatherization conference ______
    - State weatherization conference ______
    - Other state conference ______
    - State/regional training center class ______
    - Manufacturer's training school class ______
    - Utility training class ______
    - State sponsored class taught at central location (e.g., local agency, state office)______
    - Class not sponsored by state (e.g., another state, trade organization) ______
    - Visiting another agency ______
    - Instruction received by just your agency during an agency visit ______
    - In-person expert visit to your agency (e.g., peer exchange, consultant) ______
    - Web cast ______
    - Conference call ______
    - Other (please specify) ____ ______

5. Which of the following types of post-weatherization quality control inspection is your agency performing in Program Year 2006? *Check all that apply.*
   - Visual inspection of installed measures _____
   - 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 _____
   - Other (specify) ____ _____

6. Provided you were able to provide your natural gas utility with a customer release authorization form, how cooperative do you expect your local natural gas utilities to be in providing natural gas billing data on houses weatherized by your agency in Program Year 2006?
   _____ Yes for all natural gas utilities
   _____ Yes for most natural gas utilities
   _____ Yes for some natural gas utilities
   _____ No for all natural gas utilities
   _____ Don't know

7. Do you expect your local electric utilities to be cooperative in providing electricity billing data on houses weatherized by your agency in Program Year 2006?
   _____ Yes for all electric utilities
   _____ Yes for most electric utilities
   _____ Yes for some electric utilities
   _____ No for all electric utilities
   _____ Don't know

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APPENDIX G. ALL AGENCIES PY 2007 SURVEY

All ~900 agencies that are used to implement the Program will be surveyed using the "All Agencies PY 2007 Survey" at the end of their PY 2006 (August to October 2007) to collect information on PY 2006 funding and expenditure details, compiled characteristic data at the agency level on housing units weatherized in PY 2006, and other information needed for the Program characterization study (see Section 2.1.1).

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ALL AGENCIES PY 2007 SURVEY

1. Please identify your state. ____

2. Please identify your local agency. ____

3. For how many years has the current head of your local Weatherization Program served in that capacity? _____

4. How many different people (including the current head) have led your local Weatherization Program over the last 10 years? _____

5. What agency, office, or department is responsible for reviewing the performance of your local Weatherization Program? _____

6. How many layers of management or supervision are there between your weatherization crews and the head of your local Weatherization Program? _____

7. Please provide the following information about ALL low-income dwelling units weatherized by your agency in Program Year 2006 and ALL weatherization funding that you received in that same year. *Note that a DOE unit is one on which a DOE-approved energy audit or priority list has been applied and for which the measures installed (not counting health and safety measures) have an SIR of 1.0 or greater, and on which DOE funds were directly used. Units receiving some funds from non-DOE sources can be counted as DOE units, provided they meet the previously-stated criteria.*

Type of Unit Weatherized	**Number of Units Weatherized in PY 2006**		
	DOE Units	**Non-DOE Units**	**TOTAL Units**
Owner-occupied single family site built			
Single-family rental site built			
Multifamily (5 or more units per building)			
Owner-occupied mobile home			
Renter-occupied mobile home			
Shelter			
TOTAL UNITS			
Source of PY 2006 Weatherization Funding Received by Agency	**PY 2006 Funds Supporting Weatherization of Units ($)**		
	DOE Units	**Non-DOE Units**	**TOTAL Units**
DOE		*Not Applicable*	
LIHEAP			
Petroleum Violation Escrow (PVE)			
Public Benefit Funds (PBF)			
State			
Local			
Utility			
Program Income			
Landlord Contribution			
Other (Specify)			
TOTAL FUNDS			

8. Of the total funding used to support weatherization of your agency's Program Year 2006 DOE units (shown at bottom of second column in table for Question 7), how much was spent on each of the categories shown in the following table?

Type of Expenditure	PY 2006 In-house Expenditures (in $)	PY 2006 Contractor Expenditures (in $)	PY 2006 Total Expenditures (in $)
Agency's program management costs (including auditing, inspection, training, other administrative expenditures, vehicles, and equipment)		*Not applicable*	
Material costs			
Fully-loaded labor costs (including insurance, worker's comp, social security, and vacation) for installation of weatherization measures and travel to and from job site			
Contractor's overhead and profit (if not included in material or labor costs)	*Not applicable*		
TOTAL FUNDS			

9. Please disaggregate your agency's Program Year 2006 program management costs (shown at top of second column in table for Question 8) by the categories shown in the following table.

Type of Program Management Expenditure	PY 2006 Costs (in $)
Intake and eligibility determination	
Audits and assessments	
Inspections	
Crew management/supervision	
Financial/accounting	
Clerical/support	
Other administrative functions	
Vehicles	
Equipment	
Training	
TOTAL	

10. Of all the DOE units weatherized by your agency in Program Year 2006 (shown in second column of table in Question 7), how many used each of the following as their main heating fuel (i.e., the fuel providing most of the heat for the dwelling unit) in the winter prior to weatherization?
    - Natural gas ______
    - Fuel oil ______
    - Electricity ______
    - Propane/LPG ______
    - Kerosene or coal oil ______
    - Wood ______
    - Other (please specify) ____ ______

11. Of all the DOE units weatherized by your agency in Program Year 2006 (shown in second column of table in Question 7), how many housed members of the following high-priority client populations?
    - Children (according to your state's definition of that term) ______
    - Elderly (age 60 and older) ______
    - Disabled ______
    - Native American ______

12. Of all the DOE units weatherized by your agency in Program Year 2006 (shown in second column of table in Question 7), how many met your state's definition of having "high energy expenditures" __________ and "high energy burden"___________?

13. Was there a significant distinction between households weatherized by your agency in Program Year 2006 as DOE units and those weatherized as non-DOE units? _____

    If so, what distinguished the two types of units from each other?
    ____
    ____
    ____

14. What were the major differences between the rules and conditions governing your weatherization of DOE and non-DOE units?
    ____
    ____
    ____

15. How many homes are on your wait list for weatherization? _________

16. On average, how long is a home on the wait list before it is weatherized? _____

17. Given the rate at which your agency weatherizes homes, how many years would be needed to weatherize all the homes in your designated area that need to be weatherized? _____

APPENDIX H. SUBSET OF AGENCIES PY 2007 SURVEY

The 400 agencies included in the billing data sample (see Section 2.2.1) will be administered the "Subset of Agencies PY 2007 Survey" at the end of their PY 2006 (August to October 2007). The information that is collected will be used to characterize the agencies (see Section 2.1.1), attribute energy savings and energy cost savings to DOE and other parties involved in weatherization (see Section 2.2.3), study Program operations, implementation, and improvement (see Section 3.1.1), and characterize in detail how agencies perform audits, client education, training, and inspections (see Section 3.3.1). It is expected that the agencies will be compensated by DOE for their time to complete this survey.

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SUBSET OF AGENCIES PY 2007 SURVEY

PROGRAM CHARACTERIZATION

1. Please identify your state. ____

2. Please identify your local agency. ____

3. Which of the following best characterizes your organization? (Please check the one answer that best applies):
   A. Community Action Agency ______
      1. Local government agency ______
      2. Private non-profit organization ______
      3. County government agency ______
   B. Local Government Agency (other than CAA) ______
   C. Community-Based Organization (other than CAA) – please specify
      ____ ______
   D. Other (please specify) ____ ______

4. Please list other important housing and/or energy-related programs for low-income residents that are administered by your agency:
   ____
   ____
   ____
   ____
   ____

5. Did your agency receive any non-DOE funds for low-income weatherization in PY2006?
1) Yes
2) No (go to Question 11)

6. What were the sources of these non-DOE funds? Check all that apply
1) LIHEAP
2) Petroleum Violation Escrow (PVE)
3) Public Benefit Funds (PBF)
4) State
5) Local
6) Utility
7) Program Income
8) Landlord Contribution
9) Other (Specify)

7. For the sources checked in Question 6, were there any restrictions/constraints imposed by the funding sources on how the monies could be spent?
1) Yes
2) No

7a. If Yes, then what were the restrictions related to? Check all that apply
1) Housing types
2) Occupant types
3) Measure types
4) Fuel types
5) Time period
6) Geographic region
7) Rules
8) Matching funds needed
9) Maximum expenditure per house
10) Amount that could be spent on administration/overhead
11) Other: ___________________________

7b. If Housing types was checked in Question 7a, then what types of housing could be addressed using the funds with housing-type restrictions? Check all that apply
1) Site built homes
2) Mobile homes
3) Small multifamily buildings (2 to 4 units)
4) Large multifamily buildings (5 units or more)
5) Rural housing
6) Urban housing
5) Other: ________________________________

7c. If Occupant types was checked in Question 7a, then what types of occupants could be addressed using the funds with occupant-type restrictions? Check all that apply
1) Elderly
2) Children
3) Handicapped
4) Sick or ill (i.e., occupants with certain medical conditions)
5) Other: __________________________

7d. If Measure types was checked in Question 7a, then what measures could be installed using the funds with measure-type restrictions? Check all that apply
1) Air sealing
2) House insulation
3) Windows
4) Doors
5) Space-heating system replacement
6) Space-heating system repair or tune-up
7) Air conditioner replacement
8) Air conditioner repair or tune-up
9) HVAC thermostat
10) Duct systems (e.g., installation, insulation, repair, sealing)
11) Water heater replacement
12) Water heater repair or insulation
13) Water flow devices (e.g., showerheads, faucet aerators)
14) Lighting
15) Refrigerators
16) Other appliances
17) Client education
18) Health and safety repairs
19) Other: ____

7e. If Fuel types was checked in Question 7a, then houses with what types of fuel could be addressed using the funds with fuel-type restrictions? Check all that apply
1) Electrically heated
2) Natural gas
3) Propane
4) Oil
5) Other: ________________________

8. Did your agency experience delays or other difficulties in spending any of these non-DOE funds?
1) Yes
2) No

9. Did your agency encounter any of the following problems in spending non-DOE funds in general? Check all that apply
1) Our agency could not easily increase the number of homes weatherized during the year in order to better spend non-DOE funds
2) Our agency required the expenditure of DOE weatherization funds before non-DOE funds were expended
3) We had inadequate staff and accounting systems to manage the receipt and expenditure of non-DOE funds
4) Guidance received from DOE and/or our state made it difficult to expend non-DOE funds in a timely manner
5) Other ___________________

10. The following is a list of factors that could possibly cause delays or other difficulties in spending funds from individual non-DOE sources. Indicate the funding source(s) for which these factors applied, if any, by checking the boxes in the following table. [Note: The funding source associated with each number is shown in Question 6.]

Factors causing delays or other difficulties	Non-DOE funding source								
	1	2	3	4	5	6	7	8	9
It took a long time to get a contract in place with this funding source									
By the time the funds were available to expend, there was only a few months left to expend the funds									
The availability of funds from this source was unpredictable									
This funding source was very slow to authorize the expenditure of funds									
This funding source only authorized small amount of expenditures at a time									
Oversight of the spending of funds from this non-DOE source imposed substantial burden on our agency									
Accounting procedures for funds from this non-DOE funding source imposed substantial burden on our agency									
The housing units we weatherized did not require the measures/work that this funding source was intended to pay for									
We did not have the staff needed to spend these funds									
We could not get the training staff needed to spend these funds									
We could not get equipment or materials need to spend these funds									
Other: ______________________________									

Go to Question 12.

11. Why did your agency not receive any non-DOE funds for weatherization in PY2007? Check all that apply

1) Not interested
2) We did not have the resources to go after non-DOE funds
3) We did not have the resources to spend more funds
4) Our local utility or utilities did not provide any funding
5) Our state did not provide or authorized any funding
6) Our local government or governments did not provide any funding
7) Other _________________

12. When selecting DOE units to weatherize from the pool of eligible applicants, did your agency give priority to specific households based on any of the following characteristics in Program Year 2006? *Check all that apply.*

- Dwelling unit characteristics ______
- Type of heating system ______
- Fuel type ______
- Geographic location ______
- Presence of children ______
- Presence of elderly occupants ______
- Presence of disabled occupants ______
- High energy expenditures ______
- High energy burden ______
- Energy consumption ______
- Anticipated cost of weatherization ______
- Anticipated savings ______
- Occupant being a renter ______
- Landlord or other contributions ______
- Amount of time on waiting list ______
- Referral from, or participation in, another program ______
- Other (please specify) ____ ______

13. In Program Year 2006, did your agency set targets and actively solicit participation by dwelling units of the types shown below?

Type of dwelling unit	**Set targets for number of dwelling units of this type to weatherize (yes/no)**	**Actively sought participation by households residing in this type of dwelling unit (yes/no)**
Owner-occupied single family site built		
Single-family rental site built		
Multifamily (5 or more units per building)		
Owner-occupied mobile home		
Renter-occupied mobile home		
Shelter		

14. How are data about households that have applied for weatherization services collected?
1) Households fill out forms when they apply for weatherization services
2) The state provides the household data
3) Auditors collect the data at the time the home is audited
4) Other __________

15. Are your household records computerized?
1) Yes
2) No

15a. If No, why not?
1) No need
2) Cannot afford computers
3) Do not have staff with the required computer skills
4) Other _______________

16. Does your agency analyze household data to: (Check all that apply)
1) Generate descriptive statistics
2) Look for trends
3) Support agency strategic planning about its weatherization program
4) Other ____________________

16a. If no items are checked, why doesn't your agency analyze household data?
1) No Need
2) Too difficult because the records are not computerized
3) We do not have the staff to analyze data
4) Data are not of sufficiently high quality
5) Other _________

17. How are data needed for audits collected?
1) Weatherization crews fill out paper forms in the field and/or in the office
2) Weatherization crews have laptop computers to enter data in the field
3) Weatherization crews keep notes in the field and then enter the data into computers back at the office
4) Other _________

18. Are your audit records computerized?
1) Yes
2) No

18a. If No, why not?
1) No need
2) Cannot afford computers
3) Do not have staff with the required computer skills
4) Other _______________

19. Does your agency analyze audit data to: (Check all that apply)
1) Generate descriptive statistics
2) Look for trends
3) Support agency strategic planning about its weatherization program
4) Other ____________________

19a. If no items are checked, why doesn't your agency analyze audit data?
1) No Need
2) Too difficult because the records are not computerized
3) We do not have the staff to analyze data
4) Data are not of sufficiently high quality
5) Other _________

20. How are data about weatherization measures installed in homes collected?
1) Weatherization crews fill out paper forms and turn them in
2) Weatherization crews have laptop computers to enter data in the field
3) Weatherization crews keep notes in the field and then enter data into computers at the office
4) Other _________

21. Are your weatherization records computerized?
1) Yes
2) No

21a. If No, why not?
1) No need
2) Cannot afford computers
3) Do not have staff with the required computer skills
4) Other ______________

22. Does your agency analyze weatherization data to: (Check all that apply)
1) Generate descriptive statistics
2) Look for trends
3) Support agency strategic planning about its weatherization program
4) Other ____________

22a. If No, why does your agency not analyze weatherization data?
1) No Need
2) Too difficult because the records are not computerized
3) We do not have the staff to analyze data
4) Data are not of sufficiently high quality
5) Other _________

23. Are energy use records (e.g., utility bills) collected for weatherized houses?
1) Yes
2) No (Go to Question 27)

24. How are energy use records collected for weatherized houses?
1) The records are provided by the local utility or utilities
2) The records are provided by the state
3) We ask the households for their energy bills
4) Other _________

25. Are your household energy use records computerized?
1) Yes
2) No

25a. If No, why not?
1) No need
2) Cannot afford computers
3) Do not have staff with the required computer skills
4) Other ______________

26. Does your agency analyze household energy use data to: (Check all that apply)
1) Generate descriptive statistics
2) Look for energy use trends
3) Support agency strategic planning about its weatherization program
4) Other __________

26a. If No, why does your agency not analyze household energy use data?
1) No Need
2) Too difficult because the records are not computerized
3) We do not have the staff to analyze data
4) Data are not of sufficiently high quality
5) Other _________

27. Does your state impose any specific requirements on how your agency collects, stores, and uses household energy use, weatherization, and/or household data?
1) Yes
2) No

27a. If Yes, What are the requirements? ___________________

28. Does your state provide any training to help your agency collect, store and use household energy use, weatherization, and/or household data?
1) Yes
2) No

28a. If Yes, What training is provided by your state? ___________________

29. Does your state require your agency to provide aggregated household characteristics data for those households that received weatherization services?
1) Yes
2) No

30. Does your state require your agency to provide aggregated weatherization activity data?
1) Yes
2) No

31. Does your state require your agency to provide aggregated household energy use data for those homes that received weatherization services?
1) Yes
2) No

32. In Program Year 2006, how many of the households served by your agency registered a complaint regarding the quality or nature of the weatherization job performed on their dwelling unit? ____________

33. How many of the dwelling units weatherized by your agency in Program Year 2006 required some additional work as a result of complaints filed by client households? __________

34. Of all the DOE units weatherized by your agency in Program Year 2006, how many did you refer to other programs for additional services (e.g., nutrition; family counseling) unrelated to household energy consumption? ____________

35. How many income-qualified dwelling units were on your agency's waiting list:
    at the start of Program Year 2006 ____________
    at the end of Program Year 2006 _____________

36. Please list the number of dwelling units that your agency could not weatherize in Program Year 2006 due to housing condition (i.e., the number you had to "walk away from").
____

37. Please list the number of dwellings that your agency could not weatherize in Program Year 2006 because they had previously been weatherized? ___________

38. Please list the number of dwellings that your agency could not weatherize in Program Year 2006 because occupants did not meet income-eligibility requirements? __________

39. Of the dwelling units that your agency could not weatherize in Program Year 2006, how many did you refer to other energy-related programs? ___________

40. Please indicate the approximate amount of time spent on the following functions by in-house and contractor staff working on your agency's weatherization efforts in Program Year 2006. Enter the approximate number of full-time equivalent (FTE) employees for each category [e.g., if one person works half time providing training and half time on client education, you should enter 0.5 FTE in the appropriate box (in-house or contractor) for each of those items.]

	In-house Staff (FTE)	**Contractor Staff (FTE)**	**Total Staff (FTE)**
Management/administration			
Planning			
Financial/accounting			
Clerical/support			
Outreach			
Intake/eligibility determination			
Auditing/estimation			
Performing weatherization jobs			
Supervising weatherization jobs			
Monitoring/inspecting completed jobs			
Client education			
Other (specify)			
TOTAL			

41. For the in-house and contractor staff working on your agency's weatherization program in each of the following functional areas in Program Year 2006, please indicate the average length of their weatherization-related experience:

	In-house Staff (average years of experience)	**Contractor Staff (average years of experience)**
Management/administration		
Planning		
Financial/accounting		
Clerical/support		
Outreach		
Intake/eligibility determination		
Auditing/estimation		
Performing weatherization jobs		
Supervising weatherization jobs		
Monitoring/inspecting completed jobs		
Client education		
Other (specify)		

42. For the in-house and contractor staff working on your agency's weatherization program in each of the following functional areas, please indicate the approximate number of full-time equivalent (FTE) employees who joined and who left the program in Program Year 2006:

	In-house Staff Joining Program in PY 2006 (FTE)	**Contractor Staff Joining Program in PY 2006 (FTE)**	**Total Staff Joining Program in PY 2006 (FTE)**	**In-house Staff Leaving Program in PY 2006 (FTE)**	**Contractor Staff Leaving Program in PY 2006 (FTE)**	**Total Staff Leaving Program in PY 2006 (FTE)**
Management/ Administration						
Planning						
Financial/ accounting						
Clerical/ Support						
Outreach						
Intake/eligibility determination Auditing/ Estimation						
Performing weatherization jobs						
Supervising weatherization jobs						
Monitoring/ inspecting completed jobs						
Client education						
Other (specify)						
TOTAL						

43. For which of the following functional areas were there certification or licensing requirements in Program Year 2006 for the in-house or contractor staff serving your state's weatherization program?

	Certification or Licensing Requirement for In-house Staff	**Certification or Licensing Requirement for Contractor Staff**
Management/administration		
Planning		
Financial/accounting		
Clerical/support		
Outreach		
Intake/eligibility determination		
Auditing/estimation		
Performing weatherization jobs		
Supervising weatherization jobs		
Monitoring/inspecting completed jobs		
Client education		
Other (specify)		

44. Which of the following approaches did your agency use in Program Year 2006 to market your weatherization services to low-income households?

- Targeted mailings to potential clients ______
- Targeted mailings to landlords of potential clients ______
- Visits to potential clients ______
- Visits to landlords of potential clients ______
- Advertising with other social service agencies ______
- Advertising in local newspapers or magazines ______
- Radio advertising ______
- Television advertising ______
- Posting information on website ______
- Other (please specify) ____ ______

45. Who is responsible for leading the marketing/outreach efforts described above? CHECK ALL THAT APPLY

- Agency management ______
- In-house outreach coordinator ______
- Contractor outreach coordinator ______
- In-house communications staff ______
- Contractor communications staff ______
- Other in-house staff (please specify) ___________________________ ______
- Other contractor staff (please specify) __________________________ ______

PROGRAM OPERATIONS AND IMPLEMENTATION

1. Using the following scale, how adequate was the Program Year 2006 funding received by your agency from ALL funding sources for weatherizing the stock of eligible low-income dwelling units in your local jurisdiction in a timely fashion? _____

   1= Very Inadequate; 2=Inadequate; 3=Neither Inadequate nor Adequate;
   4= Adequate; 5=Very Adequate

Please answer questions 2-6 using the following five-point scale:

   1=very low quality ; 2= low quality; 3= moderate quality;
   4= high quality; 5= very high quality

2. What was the quality of the administrative support and assistance that your agency received from the state and its contractors in Program Year 2006? _____
   2a. If (1 or 2), why was the quality very low or low? ______________

3. What was the quality of the training that your agency received from the state and its contractors in Program Year 2006? _____
   3a. If (1 or 2), why was the quality very low or low? ______________

4. What was the quality of the training that your agency received from *DOE* and its contractors in Program Year 2006? _____
   4a. If (1 or 2), why was the quality very low or low? ______________

5. What was the quality of the support and assistance on client education that your agency received from the state and its contractors in Program Year 2006? _____
   5a. If (1 or 2), why was the quality very low or low? ______________

6. What was the quality of the support and assistance on coordinating the Weatherization Assistance Program with other funding sources and related programs that your agency received from the state and its contractors in Program Year 2006? _____
   6a. If (1 or 2), why was the quality very low or low? ______________

7. What was the quality of the *technical* support that your agency received from the state and its contractors in Program Year 2006? _____
   7a. If (1 or 2), why was the quality very low or low? ______________

8. Using the following scale, how flexible were the program rules that governed your agency's weatherization efforts in Program Year 2006? _____

   1= Very Inflexible; 2=Inflexible; 3=Neither Inflexible nor Flexible;
   4= Flexible; 5=Very Flexible

8a. In the future, how should the program rules change?
(1) Become much more flexible
(2) Become more flexible
(3) Stay about the same
(4) Become more inflexible
(5) Become much more inflexible

9. Please describe any important political issues faced by your agency's weatherization program in Program Year 2006.

____
____
____
____

Please answer questions 10-17 using the following five-point scale:

1= Very Unimportant; 2=Unimportant; 3=Neither Unimportant nor Important;
4= Important; 5=Very Important

10. How important is improving administrative support and assistance from the state and its contractors in improving your agency's ability to deliver low-income weatherization services? _____

11. How important is improving training from DOE, the state, and their contractors in improving your agency's ability to deliver low-income weatherization services? _____

12. How important is improving assistance on client education from the state and its contractors in improving your agency's ability to deliver low-income weatherization services? _____

13. How important is improving assistance from the state and its contractors on coordinating the Weatherization Assistance Program with other funding sources and related programs in improving your agency's ability to deliver low-income weatherization services? _____

14. How important is improving *technical* support from the state and its contractors in improving your agency's ability to deliver low-income weatherization services? _____

15. How important is greater flexibility in the state's program rules and regulations in improving your agency's ability to deliver low-income weatherization services? _____

16. How important is increased weatherization funding in improving your agency's ability to deliver low-income weatherization services? _____

17. How important is improving data and information systems for managing the delivery of weatherization services? __________

AUDIT

1. What was the primary method that your agency used in Program Year 2006 to select weatherization measures for clients' dwelling units (excluding health, safety, and repair measures and general heat waste measures)?
   - 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 _____
   - Other (specify) ____ _____

2. For how many years has your agency used the weatherization measure selection method indicated above? _____

3. What types of credentials or experience were required of your staff or contractors who were engaged in measure selection in Program Year 2006? *Check all that apply.*
   - Technical certification _____
   - Extensive weatherization work experience _____
   - Extensive weatherization supervision experience _____
   - Construction experience _____
   - Other (specify) ____ _____

4. On average, how many years of experience did your staff or contractors engaged in measure selection in Program Year 2006 have in each of the following areas?
   - Performing weatherization work _____
   - Supervising weatherization work _____
   - Working in construction _____
   - Performing pre-weatherization audits _____

5. Approximately how many hours did it take to select weatherization measures for a typical dwelling unit served by your agency in Program Year 2006, by the major components listed below?
   - Preparation/scheduling _____
   - Travel _____
   - On-site auditing _____
   - Post-audit analysis and write-up _____
   - Other _____
   - TOTAL of all components _____

6. If your agency used a priority list for at least some dwelling units in Program Year 2006, use the following scale to describe how difficult it was for your staff or contractors to use that priority list. _____

   1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy; 4= Easy; 5=Very Easy

7. If your agency used a priority list in Program Year 2006, use the following scale to describe how effective you found that list. _____

   1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
   4= Effective; 5=Very Effective

8. If your agency used a calculation procedure for at least some dwelling units in Program Year 2006, what was the name of the procedure or procedures employed. *Check all that apply.*
   - AK Warm _____
   - EA-3 _____
   - EASY _____
   - EA-QUIP _____
   - HomeCheck _____
   - Meadows _____
   - REES _____
   - REM/Rate _____
   - SMOC-ERS _____
   - TIPS _____
   - TREAT _____
   - Weatherization Assistant (NEAT/MHEA) _____
   - WXEOR _____
   - Other (specify) ____ _____

9. If your agency used a calculation procedure in Program Year 2006, use the following scale to describe how difficult it was for your staff or contractors to use the applicable procedure(s). If your agency did not use a particular procedure, leave that item blank.

   1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy; 4= Easy; 5=Very Easy
   - AK Warm _____
   - EA-3 _____
   - EASY _____
   - EA-QUIP _____
   - HomeCheck _____
   - Meadows _____
   - REES _____
   - REM/Rate _____
   - SMOC-ERS _____
   - TIPS _____
   - TREAT _____
   - Weatherization Assistant (NEAT/MHEA) _____
   - WXEOR _____
   - Other (specify) ____ _____

10. If your agency used a calculation procedure in Program Year 2006, use the following scale to describe how effective you found the applicable procedure(s). If your agency did not use a particular procedure, leave that item blank.

1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
4= Effective; 5=Very Effective

- AK Warm ______
- EA-3 ______
- EASY ______
- EA-QUIP ______
- HomeCheck ______
- Meadows ______
- REES ______
- REM/Rate ______
- SMOC-ERS ______
- TIPS ______
- TREAT ______
- Weatherization Assistant (NEAT/MHEA) ______
- WXEOR ______
- Other (specify) ____ ______

11. If your agency used a calculation procedure for at least some dwelling units in Program Year 2006, did your state allow the installation of general heat waste measures (low-cost/no-cost weatherization activities) in those units without the need for an energy justification? _____

12. If the answer to Question 11 is yes, indicate which of the following general heat waste measures your agency was allowed to install in Program Year 2006. *Check all that apply.*

- Weatherstripping ______
- Caulking ______
- Insulation for plugging air leaks ______
- Low-flow shower heads ______
- Low-flow faucet aerators ______
- Air filters ______
- Glass patching ______
- Lighting ______
- Hot water tank insulation (water heater wrap) ______
- Water pipe insulation ______
- Other (specify) ______

13. What was the *primary* justification used by your agency in Program Year 2006 for performing work specifically targeted at reducing air infiltration (i.e., air sealing work)? *Check only one.*
    - Work should be performed where the air leakage rate as measured by a blower door test is greater than a minimum number (e.g., minimum ventilation guideline) calculated for the dwelling unit in question ______
    - Work should be performed to address occupant complaints ______
    - All *significant* air leakage sites should be sealed ______
    - Air sealing work should be performed on all dwelling units ______
    - Other (specify) ______

14. What *other* justifications were used by your agency in Program Year 2006 for performing work specifically targeted at reducing air infiltration (i.e., air sealing work)? *Check all that apply.*
    - Work should be performed where the air leakage rate as measured by a blower door test is greater than a minimum number (e.g., minimum ventilation guideline) calculated for the dwelling unit in question ______
    - Work should be performed to address occupant complaints ______
    - All *significant* air leakage sites should be sealed ______
    - Air sealing work should be performed on all dwelling units ______
    - Other (specify) ______

15. What was the *primary* method used by your agency in Program Year 2006 to identify air leakage sites to seal? *Check only one.*
    - Auditor identified air leakage sites visually and communicated relevant information to crew ______
    - Auditor identified air leakage sites using a blower door and/or pressure diagnostics and communicated relevant information to crew ______
    - Crew identified air leakage sites visually ______
    - Crew identified air leakage sites using a blower door and/or pressure diagnostics ______
    - Other (specify) ______

16. What *other* methods were used by your agency in Program Year 2006 to identify air leakage sites to seal? *Check all that apply.*
    - Auditor identified air leakage sites visually and communicated relevant information to crew ______
    - Auditor identified air leakage sites using a blower door and/or pressure diagnostics and communicated relevant information to crew ______
    - Crew identified air leakage sites visually ______
    - Crew identified air leakage sites using a blower door and/or pressure diagnostics ______
    - Other (specify) ______

17. In Program Year 2006, at what point did your agency stop performing air sealing work on a given dwelling unit? *Check all that apply.*
    - When all identified air leakage sites were sealed _____
    - When all *significant* air leakage sites were sealed _____
    - When the air leakage rate as measured by a blower door test dropped below a minimum number calculated for the dwelling unit in question _____
    - When a blower door test indicated that the most recent infiltration reduction measure installed in the dwelling unit was not cost effective _____
    - Other (specify) ____ _____

18. Did your agency do duct sealing work in Program Year 2006? _____

19. If the answer to Question 18 is yes, how did your agency determine when duct sealing work was needed for a particular dwelling unit? *Check all that apply.*
    - All houses with ducts received duct sealing measures _____
    - Ducts were sealed in those cases where leakage sites were visible _____
    - Ducts were sealed when a blower door test indicated the presence of leaks _____
    - Ducts were sealed when duct diagnostics (blower door subtraction, duct blower, or pressure pan measurements) indicated that the leakage rate was greater than a minimum number calculated for the dwelling unit in question _____

20. What methods were used by your agency in Program Year 2006 to identify duct leakage sites to seal? *Check all that apply.*
    - Auditor identified duct leakage sites visually and communicated relevant information to crew _____
    - Auditor identified duct leakage sites using a blower door and communicated relevant information to crew _____
    - Auditor identified duct leakage sites using duct diagnostics and communicated relevant information to crew _____
    - Crew identified duct leakage sites visually _____
    - Crew identified duct leakage sites using a blower door _____
    - Crew identified duct leakage sites using duct diagnostics _____
    - Other (specify) ____ _____

21. In Program Year 2006, at what point did your agency stop performing duct sealing work on a given dwelling unit? *Check all that apply.*
    - When all identified duct leakage sites were sealed _____
    - When a blower door test indicated no more flow from the ducts _____
    - When the duct leakage rate as measured by duct diagnostics dropped below a minimum number calculated for the dwelling unit in question _____
    - Other (specify) ____ _____

22. If your agency was allowed to replace refrigerators for weatherization clients in Program Year 2006, how did you determine when a particular refrigerator should be replaced? *Check all that apply.*

- Energy use of existing refrigerator was metered _____
- Energy use of existing refrigerator was assumed base on rated/nameplate value_____
- Non-energy criteria were used (e.g., age, color, physical appearance) _____
- Refrigerator was replaced if it was no longer running or could not maintain desired temperature _____
- Other (specify) _____

22a. If your agency was allowed to replace air conditioners for weatherization clients in Program Year 2006, how did you determine when a particular air conditioner should be replaced? *Check all that apply.*

- Energy use of existing air conditioner was metered _____
- Energy use of existing air conditioner was assumed base on rated/nameplate value _____
- Non-energy criteria were used (e.g., age, physical appearance) _____
- Air conditioner was replaced if it was no longer running or could not maintain desired temperature _____
- Other (specify) _____

23. Which of the following diagnostic procedures did your agency perform in Program Year 2006? *Check all that apply.*

Pressure diagnostics:

- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:

- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:

- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:

- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:

- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:

- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:

- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

24. For how many years has your agency performed each of the diagnostic procedures listed below. If your agency did not use a particular procedure, leave that item blank.

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

25. What types of credentials or experience were required of your staff or contractors who performed diagnostic procedures in Program Year 2006? *Check all that apply.*
   - Technical certification _____
   - Extensive weatherization work experience _____
   - Extensive weatherization supervision experience _____
   - Construction experience _____
   - Other (specify) ____ _____

26. Approximately how many hours did your agency spend on performing diagnostic procedures for a typical dwelling unit served by your agency in Program Year 2006? _____

27. If your agency performed a diagnostic procedure for at least some dwelling units in Program Year 2006, use the following scale to describe how difficult it was for your staff or contractors to use the applicable procedure(s). If your agency did not use a particular procedure, leave that item blank.

1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy; 4= Easy; 5=Very Easy

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ______________________________________ ______

28. If your agency performed a diagnostic procedure for at least some dwelling units in Program Year 2006, use the following scale to describe how effective you found the applicable procedure(s). If your agency did not use a particular procedure, leave that item blank.

1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
4= Effective; 5=Very Effective

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

CLIENT EDUCATION

1. Which of the following client education approaches did your agency use in Program Year 2006? *Check all that apply.*
    - Provide literature at time of client intake ______
    - Provide video or DVD at time of client intake ______
    - Provide in-person instruction at time of client intake ______
    - Provide literature at time of audit ______
    - Provide video or DVD at time of audit ______
    - Provide in-person instruction at time of audit ______
    - Provide literature at time of weatherization ______
    - Provide video or DVD at time of weatherization ______
    - Provide in-person instruction at time of weatherization ______
    - Provide literature at separate client education visit ______
    - Provide video or DVD at separate client education visit ______
    - Provide in-person instruction at separate client education visit ______
    - Provide literature at time of inspection ______
    - Provide video or DVD at time of inspection ______
    - Provide in-person instruction at time of inspection ______
    - Group training class ______
    - Other (please specify) ____ ______

2. Which of the following broad topics did your agency cover with clients in Program Year 2006? *Check all that apply.*
    - Thermostat management ______
    - HVAC system operation/maintenance ______
    - Distribution system adjustment and zoning ______
    - Cooling load reduction ______
    - Windows ______
    - Insulation ______
    - Ventilation ______
    - Mold ______
    - Refrigerator ______
    - Hot water use ______
    - Water heating system operation/maintenance ______
    - Lighting ______
    - Laundry ______
    - Kitchen appliance operation ______
    - Other baseload electric use ______
    - Energy Star ______
    - Safety monitors (e.g., CO monitors, smoke alarm) ______
    - Energy bills ______
    - Other (please specify) ____ ______

3. Which of the following people provided client education for your agency in Program Year 2006? *Check all that apply.*
   a. In-house manager _____
   b. In-house education specialist _____
   c. Contractor education specialist _____
   d. Intake staff person _____
   e. Auditor _____
   f. In-house weatherization crew chief _____
   g. Contractor weatherization crew chief _____
   h. In-house weatherization crew member _____
   i. Contractor weatherization crew member _____
   j. Inspector _____
   k. Other (please specify) ____ _____

4. If in-person instruction was provided by your agency in Program Year 2006, who was your preferred target? *Check all that apply.*
   a. Applicant _____
   b. Other adult member of household _____
   c. Child living in household _____
   d. Adult not living in household _____
   e. Other (please specify) ____ _____

5. If in-person instruction was provided by your agency in Program Year 2006, was it typically provided to a single person ____________ or multiple persons _____________?

6. What types of credentials or experience were required of those who provided client education for your agency in Program Year 2006? *Check all that apply.*
   - College degree _____
   - Technical certification _____
   - Extensive experience in performing weatherization work _____
   - Extensive experience in supervising weatherization work _____
   - Educational background _____
   - Other (please specify) ____ _____

7. For how many years has your agency used each of the client education approaches listed below? If your state does not use a particular approach, leave that item blank.
   - Provide literature at time of client intake ______
   - Provide video or DVD at time of client intake ______
   - Provide in-person instruction at time of client intake ______
   - Provide literature at time of audit ______
   - Provide video or DVD at time of audit ______
   - Provide in-person instruction at time of audit ______
   - Provide literature at time of weatherization ______
   - Provide video or DVD at time of weatherization ______
   - Provide in-person instruction at time of weatherization ______
   - Provide literature at separate client education visit ______
   - Provide video or DVD at separate client education visit ______
   - Provide in-person instruction at separate client education visit ______
   - Provide literature at time of inspection ______
   - Provide video or DVD at time of inspection ______
   - Provide in-person instruction at time of inspection ______
   - Group training class ______
   - Other (please specify) ____ ______

8. Using the following scale, how difficult was it for your staff or contractors to use each of the following client education approaches in Program Year 2006? If your agency did not use a particular approach, leave that item blank.

   1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy; 4= Easy; 5=Very Easy
   - Provide literature at time of client intake ______
   - Provide video or DVD at time of client intake ______
   - Provide in-person instruction at time of client intake ______
   - Provide literature at time of audit ______
   - Provide video or DVD at time of audit ______
   - Provide in-person instruction at time of audit ______
   - Provide literature at time of weatherization ______
   - Provide video or DVD at time of weatherization ______
   - Provide in-person instruction at time of weatherization ______
   - Provide literature at separate client education visit ______
   - Provide video or DVD at separate client education visit ______
   - Provide in-person instruction at separate client education visit ______
   - Provide literature at time of inspection ______
   - Provide video or DVD at time of inspection ______
   - Provide in-person instruction at time of inspection ______
   - Group training class ______
   - Other (please specify) ____ ______

9. Approximately how many minutes were spent in Program Year 2006 on each of the following client education approaches in a typical dwelling on which the approach was used. If your agency did not use a particular approach, leave that item blank.
    - Provide literature at time of client intake ______
    - Provide video or DVD at time of client intake ______
    - Provide in-person instruction at time of client intake ______
    - Provide literature at time of audit ______
    - Provide video or DVD at time of audit ______
    - Provide in-person instruction at time of audit ______
    - Provide literature at time of weatherization ______
    - Provide video or DVD at time of weatherization ______
    - Provide in-person instruction at time of weatherization ______
    - Provide literature at separate client education visit ______
    - Provide video or DVD at separate client education visit ______
    - Provide in-person instruction at separate client education visit ______
    - Provide literature at time of inspection ______
    - Provide video or DVD at time of inspection ______
    - Provide in-person instruction at time of inspection ______
    - Group training class ______
    - Other (please specify) ____ ______

10. Using the following scale, how would you rate the effectiveness of each client education approach used by your state in Program Year 2006? If your agency did not use a particular approach, leave that item blank.

    1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
    4= Effective; 5=Very Effective
    - Provide literature at time of client intake ______
    - Provide video or DVD at time of client intake ______
    - Provide in-person instruction at time of client intake ______
    - Provide literature at time of audit ______
    - Provide video or DVD at time of audit ______
    - Provide in-person instruction at time of audit ______
    - Provide literature at time of weatherization ______
    - Provide video or DVD at time of weatherization ______
    - Provide in-person instruction at time of weatherization ______
    - Provide literature at separate client education visit ______
    - Provide video or DVD at separate client education visit ______
    - Provide in-person instruction at separate client education visit ______
    - Provide literature at time of inspection ______
    - Provide video or DVD at time of inspection ______
    - Provide in-person instruction at time of inspection ______
    - Group training class ______
    - Other (please specify) ____ ______

TRAINING

1. On which of the following subjects did the in-house or contractor staff working on your agency's weatherization efforts receive training in Program Year 2006 from DOE, the state, or other entities (questions concerning your own in-agency training efforts will be asked later)? *Check all that apply.*
    - Diagnostic procedures ______
    - Management ______
    - Client education ______
    - Insulation for single family dwellings ______
    - Insulation for multi family dwellings ______
    - Insulation for mobile homes ______
    - HVAC for single family dwellings ______
    - HVAC for multi family dwellings ______
    - HVAC for mobile homes ______
    - Infiltration measures for single family dwellings ______
    - Infiltration measures for multi family dwellings ______
    - Infiltration measures for mobile homes ______
    - Other weatherization topics for single family dwellings ______
    - Other weatherization topics for multi family dwellings ______
    - Other weatherization topics for mobile homes ______
    - Auditing/estimating for single family dwellings ______
    - Auditing/estimating for multi family dwellings ______
    - Auditing/estimating for mobile homes ______
    - Monitoring/quality control ______
    - Financial topics ______
    - Outreach and communications ______
    - Fire safety ______
    - Indoor air quality ______
    - Measures to increase security of housing unit ______
    - Measures to reduce common household hazards ______
    - Mold ______
    - Lead ______
    - Other health and safety (please specify) ______
    - Other (please specify) ____________________________________ ______

2. On which of the following diagnostic procedures did the in-house or contractor staff working on your agency's weatherization efforts receive training in Program Year 2006 from DOE, the state, or other entities (questions concerning your own in-agency training efforts will be asked later)? *Check all that apply.*

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

3. Please indicate the functions performed by the in-house and contractor weatherization staff in your agency who received training in Program Year 2006 from DOE, the state, or other entities (questions concerning your own in-agency training efforts will be asked later). *Check all that apply.*
   - Management/administration ______
   - Planning ______
   - Financial/accounting ______
   - Clerical/support ______
   - Outreach ______
   - Intake/eligibility determination ______
   - Auditing/estimation ______
   - Performing weatherization jobs ______
   - Supervising weatherization jobs ______
   - Monitoring/inspecting completed jobs ______
   - Client education ______
   - Other (please specify) ____ ______

4. How many of your agency's in-house or contractor weatherization staff were trained at the following events provided by DOE, the state, or other entities in Program Year 2006? (Questions concerning your own in-agency training efforts will be asked later.)
   - National Weatherization Program conference ______
   - Affordable Comfort Conference ______
   - Other national conference ______
   - Regional weatherization conference ______
   - State weatherization conference ______
   - Other state conference ______
   - State/regional training center class ______
   - Manufacturer's training school class ______
   - Utility training class ______
   - State-sponsored class taught at central location ______
   - Class not sponsored by state (e.g., another state, trade organization) ______
   - Visit to another agency ______
   - Instruction received by just your agency during an agency visit ______
   - In-person expert visit to your agency (e.g., peer exchange, consultant) ______
   - Web cast ______
   - Conference call ______
   - Other (please specify) _______________________________________ ______

5. Which of the following types of personnel were used by DOE, the state, or other entities to provide weatherization training to your agency's in-house or contractor staff in Program Year 2006 (questions concerning your own in-agency training efforts will be asked later)? *Check all that apply.*
   - DOE staff ______
   - DOE contractor ______
   - State staff ______
   - State training center staff ______
   - Staff from another state ______
   - Local agency staff from your state ______
   - Agency staff from another state ______
   - Manufacturer representative ______
   - Utility staff ______
   - Representative from a trade association ______
   - State contractor ______
   - Consultant ______
   - Other (please specify) ____ ______

6. For how many years has your agency received training on each of the subjects listed below from DOE, the state, or other entities? If your agency does not receive training on a particular subject, leave that item blank. (Questions concerning your own in-agency training efforts will be asked later.)
    - Diagnostic procedures ______
    - Management ______
    - Client education ______
    - Insulation for single family dwellings ______
    - Insulation for multi family dwellings ______
    - Insulation for mobile homes ______
    - HVAC for single family dwellings ______
    - HVAC for multi family dwellings ______
    - HVAC for mobile homes ______
    - Infiltration measures for single family dwellings ______
    - Infiltration measures for multi family dwellings ______
    - Infiltration measures for mobile homes ______
    - Other weatherization topics for single family dwellings ______
    - Other weatherization topics for multi family dwellings ______
    - Other weatherization topics for mobile homes ______
    - Auditing/estimating for single family dwellings ______
    - Auditing/estimating for multi family dwellings ______
    - Auditing/estimating for mobile homes ______
    - Monitoring/quality control ______
    - Financial topics ______
    - Outreach and communications ______
    - Fire safety ______
    - Indoor air quality ______
    - Measures to increase security of housing unit ______
    - Measures to reduce common household hazards ______
    - Mold ______
    - Lead ______
    - Other health and safety (please specify) ______
    - Other (please specify) ____________________________________ ______

7. Using the following scale, please rate the effectiveness of the training on each of the following subjects that your agency's in-house or contractor staff received from DOE, the state, or other entities in Program Year 2006 (questions concerning your own in-agency training efforts will be asked later). If your agency did not receive training on a particular subject, leave that item blank.

   1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
   4= Effective; 5=Very Effective

   - Diagnostic procedures ______
   - Management ______
   - Client education ______
   - Insulation for single family dwellings ______
   - Insulation for multi family dwellings ______
   - Insulation for mobile homes ______
   - HVAC for single family dwellings ______
   - HVAC for multi family dwellings ______
   - HVAC for mobile homes ______
   - Infiltration measures for single family dwellings ______
   - Infiltration measures for multi family dwellings ______
   - Infiltration measures for mobile homes ______
   - Other weatherization topics for single family dwellings ______
   - Other weatherization topics for multi family dwellings ______
   - Other weatherization topics for mobile homes ______
   - Auditing/estimating for single family dwellings ______
   - Auditing/estimating for multi family dwellings ______
   - Auditing/estimating for mobile homes ______
   - Monitoring/quality control ______
   - Financial topics ______
   - Outreach and communications ______
   - Fire safety ______
   - Indoor air quality ______
   - Measures to increase security of housing unit ______
   - Measures to reduce common household hazards ______
   - Mold ______
   - Lead ______
   - Other health and safety (please specify) ______
   - Other (please specify) ____________________________________ ______

8. On which of the following subjects did your agency provide training to your own in-house or contractor weatherization staff in Program Year 2006? *Check all that apply.*
    - Diagnostic procedures ______
    - Management ______
    - Client education ______
    - Insulation for single family dwellings ______
    - Insulation for multi family dwellings ______
    - Insulation for mobile homes ______
    - HVAC for single family dwellings ______
    - HVAC for multi family dwellings ______
    - HVAC for mobile homes ______
    - Infiltration measures for single family dwellings ______
    - Infiltration measures for multi family dwellings ______
    - Infiltration measures for mobile homes ______
    - Other weatherization topics for single family dwellings ______
    - Other weatherization topics for multi family dwellings ______
    - Other weatherization topics for mobile homes ______
    - Auditing/estimation for single family dwellings ______
    - Auditing/estimation for multi family dwellings ______
    - Auditing/estimation for mobile homes ______
    - Monitoring/quality control ______
    - Financial topics ______
    - Outreach and communications ______
    - Fire safety ______
    - Indoor air quality ______
    - Measures to increase security of housing unit ______
    - Measures to reduce common household hazards ______
    - Mold ______
    - Lead ______
    - Other health and safety (please specify) ______
    - Other (please specify) ____________________________________ ______

9. On which of the following diagnostic procedures did your agency provide training to your own in-house or contractor weatherization staff in Program Year 2006? *Check all that apply.*

Pressure diagnostics:
- Blower door (house air leakage rate) ______
- Zonal pressure measurements ______
- Room-to-room pressure measurements (distribution balancing) ______
- Duct pressure pan measurements ______
- Duct blower measurements (duct air leakage rate) ______

Space-heating system:
- Flue gas analysis (steady-state efficiency measurements) ______
- Heat rise measurements ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Safety inspection ______

Air-conditioning system:
- Refrigerant charge (e.g., superheat, subcooling) ______
- Safety inspection ______

HVAC components and cross-cutting diagnostics:
- Air handler flow rate ______
- Thermostat anticipator current ______
- Worst case draft/spillage (CAZ) ______

Hot-water (water-heating) system:
- Flue gas analysis (steady-state efficiency measurements) ______
- CO measurements in flues ______
- Draft/spillage (normal operation) ______
- Water flow rates (showerheads and faucets) ______
- Safety inspection ______

Other CO measurements:
- CO measurements in equipment rooms ______
- Cooking stove ______
- CO measurements in living areas ______

Other diagnostics and inspections:
- Refrigerator energy use ______
- Exhaust fan air flow rate measurement ______
- Infrared scanning (camera) ______
- Radon testing ______
- Other (please specify) ____________________________________ ______

10. Please indicate the functions performed by the in-house and contractor weatherization staff to whom your agency provided training in Program Year 2006. *Check all that apply.*
    - Management/administration ______
    - Planning ______
    - Financial/accounting ______
    - Clerical/support ______
    - Outreach ______
    - Intake/eligibility determination ______
    - Auditing/estimation ______
    - Performing weatherization jobs ______
    - Supervising weatherization jobs ______
    - Monitoring/inspecting completed jobs ______
    - Client education ______
    - Other (please specify) ____ ______

11. How many of your agency's in-house or contractor weatherization staff were trained at the following events provided by your agency in Program Year 2006?
    - Session at a central location ______
    - Training at your agency ______
    - In-person visits from experts ______
    - Web casts ______
    - Conference calls ______
    - Other (please specify) _______________________________________ ______

12. Which of the following types of personnel did your agency use to provide training to your own in-house or contractor weatherization staff in Program Year 2006? *Check all that apply.*
    - DOE staff ______
    - DOE contractor ______
    - State staff ______
    - State contractor ______
    - Staff from another state ______
    - State training center staff ______
    - Staff from your agency ______
    - Contractor to your agency ______
    - Staff from another local agency in your state ______
    - Agency staff from another state ______
    - Manufacturer representative ______
    - Utility staff ______
    - Representative from a trade association ______
    - Consultant ______
    - Other (please specify) _______________________________________ ______

13. How many of your agency's in-house or contractor weatherization staff acted as instructors at the following types of training events for other in-house or contractor staff associated with your agency in Program Year 2006?
- Session at a central location ______
- Training at your agency ______
- Training at another agency ______
- Web casts ______
- Conference calls ______
- Other (please specify) ____ ______

14. What types of credentials or experience were required of the personnel your agency used to provide training to your own in-house or contractor weatherization staff in Program Year 2006? *Check all that apply.*
- Technical certification ______
- Extensive weatherization field experience ______
- Construction experience ______
- Extensive management experience ______
- Extensive experience with financial matters ______
- Other (please specify) ____ ______

14a. Using the scale below, please indicate how important each credential is for trainers to have?

1= Very Unimportant; 2=Unimportant; 3=Neither Unimportant nor Important;
4= Important; 5=Very Important
- Technical certification ______
- Extensive weatherization field experience ______
- Construction experience ______
- Extensive management experience ______
- Extensive experience with financial matters ______
- Other (please specify) ____ ______

15. For how many years has your agency provided training on each of the following subjects to your own in-house or contractor staff? If your agency does not provide training on a particular subject, leave that item blank.
    - Diagnostic procedures ______
    - Management ______
    - Client education ______
    - Insulation for single family dwellings ______
    - Insulation for multi family dwellings ______
    - Insulation for mobile homes ______
    - HVAC for single family dwellings ______
    - HVAC for multi family dwellings ______
    - HVAC for mobile homes ______
    - Infiltration measures for single family dwellings ______
    - Infiltration measures for multi family dwellings ______
    - Infiltration measures for mobile homes ______
    - Other weatherization topics for single family dwellings ______
    - Other weatherization topics for multi family dwellings ______
    - Other weatherization topics for mobile homes ______
    - Auditing/estimation for single family dwellings ______
    - Auditing/estimation for multi family dwellings ______
    - Auditing/estimation for mobile homes ______
    - Monitoring/quality control ______
    - Financial topics ______
    - Outreach and communications ______
    - Fire safety ______
    - Indoor air quality ______
    - Measures to increase security of housing unit ______
    - Measures to reduce common household hazards ______
    - Mold ______
    - Lead ______
    - Other health and safety (please specify) ______
    - Other (please specify) ____________________________________ ______

16. Using the following scale, please rate the effectiveness of the training on the following subjects that your agency provided to your own in-house or contractor weatherization staff in Program Year 2006. If your agency did not provide training on a particular subject, leave that item blank.

1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
4= Effective; 5=Very Effective

- Diagnostic procedures ______
- Management ______
- Client education ______
- Insulation for single family dwellings ______
- Insulation for multi family dwellings ______
- Insulation for mobile homes ______
- HVAC for single family dwellings ______
- HVAC for multi family dwellings ______
- HVAC for mobile homes ______
- Infiltration measures for single family dwellings ______
- Infiltration measures for multi family dwellings ______
- Infiltration measures for mobile homes ______
- Other weatherization topics for single family dwellings ______
- Other weatherization topics for multi family dwellings ______
- Other weatherization topics for mobile homes ______
- Auditing/estimation for single family dwellings ______
- Auditing/estimation for multi family dwellings ______
- Auditing/estimation for mobile homes ______
- Monitoring/quality control ______
- Financial topics ______
- Outreach and communications ______
- Fire safety ______
- Indoor air quality ______
- Measures to increase security of housing unit ______
- Measures to reduce common household hazards ______
- Mold ______
- Lead ______
- Other health and safety (please specify) ______
- Other (please specify) ____ ______

17. For each broad subject listed in the left-most column of the following table, put a check mark in the appropriate cell(s) to indicate which training method(s) you believe are most effective for imparting key skills and information in that area to your agency's in-house or contractor weatherization staff:

	Confer-ences	Courses and classes	Field training	Classroom training	Agency visits	Web casts	Confer-ence calls	Other (specify)
Subject								
Management								
Weatherization skills and methods								
Auditing/ Estimating								
Monitoring/ quality control								
Financial topics								
Outreach and communications								
Health and safety								
Diagnostic procedures								
Procedures for selecting weatherization measures								
Client education								
Other (specify)								

18. In what areas do you think your agency's weatherization crews are well trained? Check all that apply.
(1) Diagnostic procedures
(2) Management
(3) Client education
(4) Insulation for single family dwellings
(5) Insulation for multifamily dwellings
(6) Insulation for mobile homes
(7) HVAC for single family dwellings
(8) HVAC for multifamily dwellings
(9) HVAC for mobile homes
(10) Infiltration measures for single family dwellings
(11) Infiltration measures for multifamily dwellings
(12) Infiltration measures for mobile homes
(13) Other weatherization topics for single family dwellings
(14) Other weatherization topics for multifamily dwellings
(15) Other weatherization topics for mobile homes
(16) Auditing/estimating for single family dwellings
(17) Auditing/estimating for multifamily dwellings
(18) Auditing/estimating for mobile homes
(19) Monitoring/quality control
(20) Financial topics
(21) Outreach and communications
(22) Fire safety
(23) Indoor air quality
(24) Measures to increase security of housing unit
(25) Measures to reduce common household hazards
(26) Mold
(27) Lead
(28) Other health and safety
(29) Other (please specify)

19. In what areas do you think your agency's weatherization crews are poorly trained? Check all that apply
(1) Diagnostic procedures
(2) Management
(3) Client education
(4) Insulation for single family dwellings
(5) Insulation for multifamily dwellings
(6) Insulation for mobile homes
(7) HVAC for single family dwellings
(8) HVAC for multifamily dwellings
(9) HVAC for mobile homes
(10) Infiltration measures for single family dwellings
(11) Infiltration measures for multifamily dwellings
(12) Infiltration measures for mobile homes
(13) Other weatherization topics for single family dwellings
(14) Other weatherization topics for multifamily dwellings
(15) Other weatherization topics for mobile homes
(16) Auditing/estimating for single family dwellings
(17) Auditing/estimating for multifamily dwellings
(18) Auditing/estimating for mobile homes
(19) Monitoring/quality control
(20) Financial topics
(21) Outreach and communications
(22) Fire safety
(23) Indoor air quality
(24) Measures to increase security of housing unit
(25) Measures to reduce common household hazards
(26) Mold
(27) Lead
(28) Other health and safety
(29) Other (please specify)

20. Overall, how well trained are your agency's weatherization crews?
(1) Very well trained
(2) Well trained
(3) Neither well nor poorly trained
(4) Poorly trained
(5) Very poorly trained

21. What are the barriers that prevent your crews from receiving all the training they need? CHECK ALL THAT APPLY

(1) Lack of training funds
(2) Cannot take crews out of the field long enough for training
(3) Training not available at the right times
(4) Training not available at the right places
(5) Available training is poor in quality

22. Does your agency have any specific training requirements for weatherization staff?
(1) Yes
(2) No

22a. If yes, what are the specific requirements?____

MONITORING

1. Which of the following types of post-weatherization quality control inspection did your agency perform on your weatherized dwelling units in Program Year 2006? *Check all that apply.*
    - Visual inspection of installed measures ______
    - 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 ______
    - Other (specify) ____ ______

2. For how many years has your agency performed each type of post-weatherization quality control inspection listed below? If your agency does not use a particular approach, leave that item blank.
    - Visual inspection of installed measures ______
    - 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 ______
    - Other diagnostic tests ______
    - Identification of unresolved health and safety issues ______
    - Discussion with occupants ______
    - Other (specify) ____ ______

3. Using the following scale, how difficult was it for your in-house or contractor staff to perform each of the following types of post-weatherization quality control inspection in Program Year 2006? If your agency did not use a particular approach, leave that item blank.

   1= Very Difficult; 2=Difficult; 3=Neither Difficult nor Easy; 4= Easy; 5=Very Easy
   - Visual inspection of installed measures ______
   - 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 ______
   - Other diagnostic tests ______
   - Identification of unresolved health and safety issues ______
   - Discussion with occupants ______
   - Other (specify) ____ ______

4. Using the following scale, please rate the effectiveness of each type of post-weatherization quality control inspection performed by your agency in Program Year 2006. If your agency did not use a particular approach, leave that item blank.

   1= Very Ineffective; 2=Ineffective; 3=Neither Ineffective nor Effective;
   4= Effective; 5=Very Effective
   - Visual inspection of installed measures ______
   - 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 ______
   - Other diagnostic tests ______
   - Identification of unresolved health and safety issues ______
   - Discussion with occupants ______
   - Other (specify) ____ ______

5. Approximately how many hours did it take to perform a typical post-weatherization quality control inspection in Program Year 2006, by the major components listed below?
   - Scheduling ______
   - Travel ______
   - On-site work ______
   - Post-inspection analysis and write-up ______
   - Other ______
   - TOTAL of all components ______

6. Which of the following parties were involved in performing your agency's post-weatherization quality control inspections in Program Year 2006? *Check all that apply.*
    - In-house manager ______
    - In-house inspection specialist ______
    - Contractor inspection specialist ______
    - In-house weatherization crew chief ______
    - Contractor weatherization crew chief ______
    - In-house weatherization crew member ______
    - Contractor weatherization crew member ______
    - Other (please specify) ____

    6a. Which party was primarily responsible for post-weatherization quality control inspections?
    - In-house manager ______
    - In-house inspection specialist ______
    - Contractor inspection specialist ______
    - In-house weatherization crew chief ______
    - Contractor weatherization crew chief ______
    - In-house weatherization crew member ______
    - Contractor weatherization crew member ______
    - Other (please specify) ____

7. What types of credentials or experience did your agency's post-weatherization quality control inspectors have in Program Year 2006? *Check all that apply.*
    - Technical certification ______
    - Extensive experience performing pre-weatherization audits ______
    - Extensive experience performing weatherization work ______
    - Extensive experience supervising weatherization work ______
    - Construction experience ______
    - Other (please specify) ____ ______

8. On average, how many years of experience did your agency's post-weatherization quality control inspectors have in each of the following areas in Program Year 2006?
    - Performing pre-weatherization audits ______
    - Performing weatherization work ______
    - Supervising weatherization work ______
    - Working in construction ______
    - Other (please specify) ____ ______

9. For those dwelling units for which post-weatherization quality control inspections were performed by your agency in Program Year 2006, typically how many days after weatherization completion did the initial inspection take place? _____

10. In those cases where a Program Year 2006 post-weatherization quality control inspection revealed a problem with the job performed, what action was most commonly taken in response to that finding? *Check one.*
   - Sent original crew or contractor back to correct problem _____
   - Sent different crew or contractor to correct problem _____
   - Sent crew supervisor to correct problem _____
   - Sent someone from state office to correct problem _____
   - No action taken _____
   - Other (please specify) ____ _____

11. What *other* actions were taken in Program Year 2006 in response to the discovery of a problem with the weatherization job performed? *Check all that apply.*
   - Sent original crew or contractor back to correct problem _____
   - Sent different crew or contractor to correct problem _____
   - Sent crew supervisor to correct problem _____
   - Sent someone from state office to correct problem _____
   - No action taken _____
   - Other (please specify) ____ _____

12. In Program Year 2006, how many of the dwelling units weatherized by your agency required some additional work as a result of the findings of your post-weatherization quality control inspections? _____

12a. Of those requiring some additional work, how many had work done that probably resulted in more energy savings?_____

13. What were the three most common problems found in the dwelling units inspected by your agency in Program Year 2006?

   ____
   ____
   ____

13a. Please indicate the number of houses that had problems in the following areas:
(1) Insulation for single family dwellings
(2) Insulation for multifamily dwellings
(3) Insulation for mobile homes
(4) HVAC for single family dwellings
(5) HVAC for multifamily dwellings
(6) HVAC for mobile homes
(7) Infiltration measures for single family dwellings
(8) Infiltration measures for multifamily dwellings
(9) Infiltration measures for mobile homes
(10) Health and safety issues
(11) Other weatherization topics for single family dwellings
(12) Other weatherization topics for multifamily dwellings
(13) Other weatherization topics for mobile homes

14. In Program Year 2006, did your agency use findings from your post-weatherization quality control inspections to provide feedback to your in-house or contractor crews on workmanship or related issues? ______

15. If the answer to Question 14 is yes, approximately how many times was such feedback provided to weatherization crews in Program Year 2006? ______

16. To what extent does post-weatherization quality control inspection affect the quality of future weatherization work?
(1) No extent
(2) Little extent
(3) Moderate extent
(4) Substantial extent
(5) Very substantial extent

17. Did the observation of problems with the quality of weatherization work lead to changes in weatherization training for your staff?
(1) Yes
(2) No

17a. If Yes, what changes were made? ______________

18. Does your agency observe weatherization training sessions to help identify potential problem areas for monitoring in the field?
(1) Yes
(2) No

18a. If Yes, briefly describe how your in-field monitoring activities are affected by your training session observations.

ATTRIBUTION OF SAVINGS

1. There are many components of a successful weatherization program and many possible sources of program support. For each weatherization program component listed in the following table, please estimate how much each source of support contributed to your agency's ability to perform the tasks and functions associated with that component in Program Year 2006. Keep in mind that the contribution from a given source may not be directly proportional to the dollars spent, because the magnitude of any given contribution can also be affected by the effort expended and expertise contributed.

   Please estimate the PY 2006 contributions from the various sources of support as percentages. For each weatherization program component (the columns in the table below), the sum of the contributions from all relevant sources should equal 100%. This means that every cell in the table's bottom row (labeled "TOTAL") should contain the number 100.

Source of Support	Weatherization Program Components					
	Program Management	**Outreach and Marketing**	**Client Selection**	**Audit and Measure Selection**	**Measure Installation**	**Training**
DOE						
LIHEAP						
Petroleum Violation Escrow (PVE)						
Public Benefit Funds (PBF)						
State						
Local						
Utility						
Program Income						
Landlord Contribution						
Other (specify)						
TOTAL						

APPENDIX I. OCCUPANT SURVEY

Occupants from 940 housing units weatherized in PY 2007 from the 400 agencies included in the billing data sample, 529 primary control units, and 30 supplemental control units will be surveyed over the phone using the "Occupant Survey." Occupants of units weatherized in PY 2007 rather than PY 2006 will be surveyed because of the timing of the implementation of the evaluation. An incentive will be provided to the occupants to maximize the response rate.

The 940 weatherized housing units will be randomly selected from lists of homes provided by each agency. The primary control group will be developed using households that receive LIHEAP grants. For each agency, a list of LIHEAP recipients will be identified and housing units selected after matching them to characteristics of the weatherized housing units being surveyed. Matching criteria will be based on what information is available on the LIHEAP recipients but should include housing type, ownership, and possibly house size and energy use. The supplemental control group will be developed in a similar manner.

There are four parts to the survey: energy consumption behavior/knowledge test, non-energy benefits, health and demographics, and customer satisfaction. The first three parts collect information needed for the study of non-energy impacts (see Sections 2.3.1 and 2.3.2) and client education (see Section 3.3.2). The fourth part collects information on the occupants' perceptions on how well Program services were delivered which is needed to study process improvements as part of the Program operations and implementation study (see Section 3.1.1).

The first three parts of the survey will be administered to the 940 weatherized housing units immediately before weatherization (i.e., after each housing unit is audited but before client education is provided) and again a year after weatherization, and to the 529 primary control housing units at approximately the same time as the occupants of the weatherized housing units. In addition, the first and third parts (energy consumption behavior/knowledge test and health and demographics) will be administered to the 30 supplemental control housing units when the post-weatherization surveys are administered to control for the possibility that both the primary control group and the weatherized group might change their energy-related behavior as a result of things they learn by taking the energy knowledge test the first time. The fourth part (customer satisfaction) will be administered to just the 940 weatherized housing units immediately after the units have been weatherized and inspected by the agencies.

The occupant survey will conducted by phone in the following manner:

- The evaluation team will call each house to initiate the pre-weatherization survey after the agency has informed the evaluation team that the house has been audited. Agencies may have to keep the evaluation team informed on the status of all houses they are working on so that they do not know which houses have been selected to be surveyed. A card with an 800-number could be mailed to the house either before or after the initial contact is attempted by the evaluation team to inform the head of the household that a survey is being performed, allow the head of the household to initiate the phone call, and let the head of the household know that a $40 incentive will be provided to encourage their participation. A household will be considered non-responsive if contact is not made within one week of the initial contact and/or mailing of the card.

- The evaluation team will again call each house to initiate the customer satisfaction portion of the survey after the agency has informed the evaluation team that the house has been inspected. Again, agencies may have to keep the evaluation team informed on the status of all houses they are working on so that they do not know which houses have been selected to be surveyed. A second card with an 800-number could be mailed to the house either before or after this second contact is attempted by the evaluation team to again inform the head of the household about the survey and to let them know that another $40 incentive will be provided to encourage their participation. A household will be considered non-responsive if contact is not made within one week of the initial contact and/or mailing of the card

- One year after weatherization, the households will be contacted a third time to take part in the post-weatherization phase of the occupant survey. The first contact will be made by mail. A card with the exact same design as the first two cards will be mailed to the participating households. The same 800-number will be provided. An incentive of $50 will be offered to complete the survey. Those households that do not respond within a week will be phoned directly. Two follow-up calls will be made to increase response rates.

Overall, this survey implementation plan should ensure a very high response rate. The respondents will be paid for their time, with incentive checks mailed to households within two weeks of participating in each phase of the survey. While there will be no in-person contact for the survey, the mailed cards should become familiar to the respondents so that, by the third implementation of the survey, the respondents should have a high level of trust that the survey will not be a burden and that they will be paid for their participation.

OCCUPANT SURVEY

Part 1. Energy Consumption Behavior

{Note: Please ask these questions of the adult in the household most involved with the weatherization of the home or the head of the household}

Introduction to the Potential Respondent: Good Day. We are calling households such as yours that are going to have their homes weatherized (or have had their homes weatherized) to participate in a survey. Your participation will help the agency that will weatherize (or has weatherized) your home, your state, and U.S. Department of Energy improve their administration of the weatherization program. Your answers will be kept strictly confidential. In appreciation for your participation, we will send your household a debit card worth $40 at the conclusion of this survey.

(If this is the first contact) We will be calling you on two other occasions. We will call you a second time, just after your home has been weatherized. We will also call you about one year after your home has been weatherized. This survey will take about 45 minutes. The second survey will take about 20 minutes. The third survey will take about 40 minutes. We expect to reimburse your household for your time after the second and third surveys as well.

This first set of questions collect information about how energy is used in your home.

1. At what temperature does your household usually keep your home in the winter? [Interviewer: If household keeps different parts of the house at different temperatures, record the temperature in the part of the house where the people are. If, for example, the heat is turned off upstairs during the day because the family is downstairs, record the downstairs temperature. If the respondent doesn't know the temperature, but knows the thermostat setting, record the thermostat setting. Otherwise, probe for the best estimate. Note: these questions and directions are taken directly from RECS.]

1a. During the day when someone is home?
Enter degrees Fahrenheit _______________
Heat Turned Off _______________

1b. During the day when no one is home?
Enter degrees Fahrenheit _______________
Heat Turned Off _______________

1c. During sleeping hours?
Enter degrees Fahrenheit _______________
Heat Turned Off _______________

2. How many bedrooms does your home have? ______________

3. How many other rooms does your home have (e.g., kitchen, dining room, excluding bathrooms)? _________

4. Last winter, did you heat all # (sum of Question 2 and Question 3) rooms?
(1) Yes (go to Question 5)
(2) No

4a. How many of those rooms were not heated last winter?
Enter the number ___________

4b. Were there any other spaces in your home that were not heated last winter? Do not include garages, basements or attics.
(1) Yes
(2) No (go to Question 5)

4c. Please describe what those spaces were.
____
____

5. At what temperature does your household usually keep your home in the summer? [Interviewer: If household keeps different parts of the house at different temperatures, record the temperature in the part of the house where the people are. If, for example, the cooling is turned off upstairs during the day because the family is downstairs, record the downstairs temperature. If the respondent doesn't know the temperature, but knows the thermostat setting, record the thermostat setting. Otherwise, probe for the best estimate.]

5a. During the day when someone is home?
Enter degrees Fahrenheit ______________
Cooling Turned Off ______________

5b. During the day when no one is home?
Enter degrees Fahrenheit ______________
Cooling Turned Off ______________

5c. During sleeping hours?
Enter degrees Fahrenheit ______________
Cooling Turned Off ______________

6. Last summer, did you cool all # (sum of Question 2 and Question 3) rooms?
(1) Yes (go to Question 7)
(2) No

6a. How many of those rooms were not cooled last summer?
Enter the number ___________

6b. Were there any other spaces in your home that were not cooled last summer? Do not include garages, basements or attics.
(1) Yes
(2) No (go to Question 7)

6c.Please describe what those spaces were.

____
____
____
____

7. How often do you find lights left on in rooms that are not occupied?
(1) Never
(2) Almost never
(3) Sometimes
(4) Most of the time
(5) All the time

8. Do members of your household purchase and install compact fluorescent bulbs in your home?
(1) Yes
(2) No (go to Question 9)
(3) I do not know what compact fluorescent bulbs are (go to Question 9)
(4) Don't know (go to Question 9)

8a. How many are currently installed in your home? __________________

9. Does your household use a clothes washer that is within your living space – that is within your home or apartment?
(1) Yes
(2) No (go to Question 10)

9a. In an average week, how many loads of laundry are washed in your washer?
(1) one load or less each week
(2) two to four loads
(3) five to nine loads
(4) ten to fourteen loads
(5) fifteen or more loads
(6) Don't know

9b. Does your household wash only full loads of laundry?
(1) Always
(2) Most of the time
(3) Some of the time
(4) Never
(5) Don't know

9c.What water temperature setting is usually used for the wash cycle of the clothes washer?
(1) Hot
(2) Warm
(3) Cold
(4) Don’t know

9d.What water temperature setting is usually used for the rinse cycle of the clothes washer?
(1) Hot
(2) Warm
(3) Cold
(4) Don’t know

10. Does your household use a clothes dryer that is within your living space – that is within your home or apartment?
(1) Yes
(2) No (go to Question 11)

10a. In an average week, how many loads of laundry are dried in your dryer?
(1) one load or less each week
(2) two to four loads
(3) five to nine loads
(4) ten to fourteen loads
(5) fifteen or more loads
(6) Don’t know

10b. Does your household dry only full loads of laundry?
(1) Always
(2) Most of the time
(3) Some of the time
(4) Never

10c.What setting is usually used for drying your clothes?
(1) More dry
(2) Less dry
(3) Just set the timer

10d. How frequently does your household hang clothes to dry instead of using the clothes dryer?
(1) Very frequently
(2) Frequently
(3) Infrequently
(4) Very infrequently
(5) Never

11. In the last six months, has the temperature of your hot water heater been adjusted?
   (1) Yes, the temperature is much hotter
   (2) Yes, the temperature is hotter
   (3) No adjustment has been made to the temperature
   (4) Yes, the temperature is colder
   (5) Yes, the temperature is much colder

12. Does your heating system have a filter?
(1) Yes
(2) No (go to Question 13)
(3) Don't know (go to Question 13)

   12a. Is the filter in your heating system a High Efficiency Particulate Arresting (HEPA) filter?
   (1) Yes
   (2) No
   (3) Don't Know

   12b.Approximately, how often does someone in your household change (or clean) the air filter in your heating system?
   (1) Monthly
   (2) Every three months
   (3) Every six months
   (4) Once a year
   (5) Once every two years
   (6) Don't change (or clean) it

13. Does your household heat your home with natural gas?
(1) Yes
(2) No (go to Question 14)
(3) We live in an apartment and do not have a separate heating system (go to Question 14)

   13a. Do you know when was the last time your furnace received maintenance service by a furnace contractor to ensure optimum and safe operation?
   (1) Yes
   (2) No (go to Question 14)

   13b. How many years and months ago did this occur? ________________

14. During this past winter, how often have you used your oven to heat your house?
   (1) Never
   (2) Rarely
   (3) Sometimes
   (4) Frequently
   (5) All the time

15. Do you have ceiling fans in your house?
(1) Yes
(2) No (go to Question 16)
(3) Don't know (go to Question 16)

15a. How often do you use the fans in the summer?
(1) Never, they don't work
(2) Never
(3) Rarely
(4) Sometimes
(5) Frequently
(6) All the time

15b. How often do you use the fans in the winter?
(1) Never, they don't work
(2) Never
(3) Rarely
(4) Sometimes
(5) Frequently
(6) All the time

16. Over the past six months, has the number of showers taken per week by household members changed?
(1) Increased a lot
(2) Increased some
(3) No change
(4) Decreased some
(5) Decreased a lot

17. Over the past six months, has the duration of the showers taken by household members changed?
(1) Increased a lot
(2) Increased some
(3) No change
(4) Decreased some
(5) Decreased a lot

18. Do you close the drapes, curtains, shades, and/or blinds during the day to block out the sun during the summer?
(1) Never
(2) Rarely
(3) Sometimes
(4) Frequently
(5) All the time

19. Does your main bathroom have a ventilation fan in it that works?
(1) Yes
(2) No (go to Question 20)
(3) Don't know (go to Question 20)

19a.How often do you or members of your household operate the fan while showering?
(1) Never
(2) Rarely
(3) Sometimes
(4) Frequently
(5) All the time

19b.How long after showering do you or members of your household operate the fan?
(1) Don't turn the fan on for showers
(2) The fan is turned off when leaving the shower area
(3) A few minutes
(4) Several minutes
(5) Until the steam in the shower area is gone
(6) Don't know

20. Do you have a CO (or carbon monoxide) monitor in your house?
(1) Yes
(2) No (go to Question 21)
(3) Don't know (go to Question 21)

20a. Do you know how the CO monitor notifies you if the CO level becomes too high?
(1) Yes
(2) No

20b. Do you know how the CO monitor notifies you if the battery is going bad?
(1) Yes
(2) No
(3) It does not have a battery. It plugs in. (go to Question 21)

20c. Do you know how to change the battery in your CO monitor?
(1) Yes
(2) No

20d. Is the battery in you CO monitor currently working?
(1) Yes
(2) No
(3) Don't know

21. Do you have one or more smoke detectors in your house?
(1) Yes
(2) No (go to Question 22)
(3) Don't know (go to Question 22)

21a. How many smoke detectors are there in your house? __________

21b. How many of these smoke detectors are currently working? _________

21c.Where are the smoke detectors located? CHECK ALL THAT APPLY
(1) Kitchen
(2) Dining Room
(3) Bedroom(s)
(4) Hallway
(5) Garage
(6) Other places _________________

21d. Do you know how a smoke detector notifies you in case of a fire?
(1) Yes
(2) No

21e. Do you know how a smoke detector notifies you if the battery is going bad?
(1) Yes
(2) No
(3) All our smoke detectors plug in. (go to Question 22)

21f. Do you know how to change the battery in a smoke detector?
(1) Yes
(2) No

22. Do you know what the Energy Star® appliance and consumer electronics program is?
(1) Yes
(2) No (go to Question 23)

22a. Has your household bought appliances or consumer electronics that have an Energy Star® label?
(1) Yes
(2) No (go to Question 23)
(3) Don't know (go to Question 23)

22a. What Energy Star® products has your household purchased? PLEASE LIST

____
____
____
____

23. Do you unplug any appliances like TVs, VCRs, stereos, radios, clocks, or computers to save energy when they are turned off?
(1) Yes
(2) No
(3) Don't know

Part 2. Non-Energy Benefits

{Note: Please ask these questions of the adult in the household most involved with the weatherization of the home or the head of the household}

This second set of questions collects information about other aspects of your home and your household's quality of life that could be changed after your home is weatherized.

1. How much outdoor noise do you hear indoors when the windows are closed?
   (1) A great deal
   (2) Some
   (3) Hardly any
   (4) None at all

2. During the winter, how often are there odors inside your home that could indicate a problem with indoor air quality?
   (1) All the time
   (2) Most of the time
   (3) Some of the time
   (4) Hardly ever
   (5) Never

2a. During the summer, how often are there odors inside your home that could indicate a problem with indoor air quality?
   (1) All the time
   (2) Most of the time
   (3) Some of the time
   (4) Hardly ever
   (5) Never

3. Please rate the outside appearance of your home:
   (1) Very attractive
   (2) Attractive
   (3) Neither attractive nor unattractive
   (4) Unattractive
   (5) Very unattractive

4. Which of the following statements best describes the indoor temperature of your home during the winter:

(1) Very cold
(2) Cold
(3) Comfortable (go to Question 6)
(4) Hot
(5) Very hot
(6) Other ________________

5. Why couldn't you keep your home at the temperature you preferred during the winter? CHECK ALL THAT APPLY

[ ] Heating system problem
[ ] Landlord controls the temperature
[ ] Difference of opinion in household
[ ] Fuel shortage
[ ] High cost of fuel/electricity
[ ] Construction problem, such as broken windows or holes in walls or roof
[ ] Parts of home do not fit together well, doors or windows do not close completely
[ ] Other (please specify)
[ ] Not sure

6. How often do you or other members of your household find your home too drafty during the winter? Would you say it is….

(1) All the time
(2) Most of the time
(3) Some of the time
(4) Hardly ever
(5) Never

7. Please rate the indoor temperature of your home during the summer:

(1) Very cold
(2) Cold
(3) Comfortable (go to Question 9)
(4) Hot
(5) Very Hot

8. Why couldn't you keep your home at the temperature you preferred during the summer? CHECK ALL THAT APPLY
[ ] Cooling system problem
[ ] There is no cooling system or air conditioner
[ ] Landlord controls the temperature
[ ] Difference of opinion in household
[ ] Fuel shortage
[ ] High cost of fuel/electricity
[ ] Construction problem, such as broken windows or holes in walls
[ ] Parts of home do not fit together well, doors or windows do not close completely
[ ] Other (please specify)
[ ] Not sure

9. How often do you or other members of your household find your home too drafty during the summer? Would you say it is….
(1) All the time
(2) Most of the time
(3) Some of the time
(4) Hardly ever
(5) Never

10. How would you rate the safety of your home's heating system with respect to catching on fire during the winter?
(1) Very safe
(2) Safe
(3) Neither safe nor unsafe
(4) Unsafe
(5) Very unsafe
(6) Don't know

11. How would you rate the safety of the electrical wiring in your home with respect to causing a fire?
(1) Very safe
(2) Safe
(3) Neither safe nor unsafe
(4) Unsafe
(5) Very unsafe
(6) Don't know

12. How many times has the fire department been called to put out a fire in your home during the past year? ________________

13. Over the past six months, how has the property value of your home changed?
   (1) Very much higher
   (2) Higher
   (3) No change
   (4) Lower
   (5) Very much lower
   (6) Not applicable, don't own the home or live in an apartment
   (7) Don't know

14. How secure is your home from intrusion by criminals?
(1) Very secure
(2) Somewhat secure
(3) Neither secure or insecure
(4) Somewhat insecure
(5) Not secure at all
(6) Don't know

15. How many times has your home been broken into during the past year?
(1) no times (go to Question 16)
(2) one time
(3) two times
(4) three times
(5) more than three times

15a. The last time your home was broken into, what was the approximate value of the items stolen from your home?
(1) zero, nothing was stolen
(2) \$1 to \$250
(3) \$251 to \$1000
(4) \$1001 to \$2000
(5) Over \$2000
(6) Don't know

16. How infested is your home with rats, cockroaches and other vermin?
(1) Extremely infested
(2) Very infested
(3) Somewhat infested
(4) Hardly infested
(5) Not infested at all
(6) Don't know

17. How well do you understand the information on your utility bill other than the amount owed (e.g., information about how much energy your household used during the billing period compared to the same billing period one year ago)?

(1) Very well
(2) Well
(3) Neither well nor not well
(4) Not well
(5) Not well at all
(6) Don’t know

18. How hard is it to have enough money to pay your utility bills?
(1) Very hard
(2) Hard
(3) Neither hard or not hard
(4) Not hard
(5) Not hard at all
(6) Don’t know

19. How many times has your family moved during the past three years?
(1) zero
(2) one
(3) two
(4) three
(5) more than three times
(6) Don’t know

20. Has your household ever had to move in the past because your household could not pay the utility bills?

(1) Yes
(2) No (go to Question 21)
(3) Don’t know (go to Question 21)

20a.Has your household had to move in the past year because your household could not pay the utility bills?

(1) Yes
(2) No
(3) Don’t know

21. Please rate the chances of your household having to move during the next six months because of problems in paying the utility bills:

(1) Very high
(2) High
(3) Medium
(4) Low
(5) Very low
(6) No chance

22. Please rate the chances of your household's moving during the next six months for any reason or combination of reasons:

(1) Very high
(2) High
(3) Medium
(4) Low
(5) Very low
(6) No chance

23. In the past six months, how often has your household been late or made only a partial payment for rent, mortgage, utilities, medicine, or insurance?

(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Don't know

24. Over the past six months, how frequently has your household had to forgo the purchase of prescription medicines in order to pay utility bills?

(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Don't know

25. Over the past six months, how frequently has your household not paid utility bills in order to purchase prescription medicines?

(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Don't know

26. Over the past six months, how many times has a member of your household sought medical care at a hospital, emergency room, or urgent care facility?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Don't know

27. Over the past six months, how frequently has your household had to forgo the purchase of food in order to pay utility bills?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Don't know

28. Over the past six months, how frequently has your household not paid utility bills in order to purchase food?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Don't know

Part 3. Health and Demographics

{Note: Ask these questions of the adult in the household most involved with all the other members of the household because proxy responses are required. This person is typically the head female of the household.}

The following questions ask for information on the health of household members and their work status. This section of the survey ends with a few questions about yourself. Then this survey will be done for today.

1. How many people are in your household, that is people who live in your home for more than six months out of the year? __________

2. Can you please tell me their first names, gender and age?

	First Name	Gender	Age
Person 1.			
Person 2.			
Person 3.			
Person 4.			
Person 5.			
Person 6.			
Person 7.			
Person 8.			
Person 9.			
Person 10.			

[Note: Ask questions 3-36 for: the respondent and the other main adult in the household, if there is one; all children under the age of 15; and all adults over the age of 64. These questions can be asked about additional adults ages 15 to 64 if the number of people in the household in the above categories is less than six. Then, questions can be asked for up to six people.]

3. Is Person X disabled?
(1) Yes
(2) No

4. What is Person X's disability (or disabilities)? ___________________

5. Over the past six months, how would you rate the health of Person X?
(1) Very healthy
(2) Healthy
(3) Neither healthy or unhealthy
(4) Unhealthy
(5) Very unhealthly

6. How many times has Person X seen their primary physician or other primary health care provider during the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all
(6) Do not have a primary physician or other primary health care provider
(7) Don't know

7. Has Person X been diagnosed with asthma by a physician or other health care provider?
(1) Yes
(2) No (go to Question 8)

7a. How many times has Person X sought medical care at a hospital, emergency room, or urgent care facility due to their asthma over the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all (go to Question 8)
(6) Don't know

7b. How many days in total has Person X been hospitalized because of their asthma over the past year?
(1) None
(2) One
(3) Two
(4) Three
(5) Four
(6) More than four days
(7) Don't know

8. How frequently does Person X wheeze, cough, or suffer from shortness of breath?
(1) Very frequently
(2) Frequently
(3) Infrequently
(4) Very infrequently
(5) Not at all
(6) Don't know

9. Does Person X smoke cigarettes or cigars?
(1) Yes
(2) No (go to Question 10)

9a. How would you describe Person X's smoking habit?
(1) Extremely heavy smoker
(2) Heavy smoker
(3) Moderate smoker
(4) Light smoker
(5) Very infrequent smoker
(6) Don't know

10. How many colds has Person X had over the past year? ___________

11. How many times has Person X had the flu over the past year? ___________

12. How many times has Person X sought medical care at a hospital, emergency room, or urgent care facility for a respiratory or breathing problem other than asthma over the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all (go to Question 13)
(6) Don't know

12a. How many days in total has Person X been hospitalized for a respiratory or breathing problem other than asthma over the past year?
(1) None
(2) One
(3) Two
(4) Three
(5) Four
(6) More than four days
(7) Don't know

13. How frequently does Person X experience sneezing, coughing, congestion, or runny nose?
(1) Very frequently
(2) Frequently
(3) Infrequently
(4) Very infrequently
(5) Not at all
(6) Don't know

14. How many times has Person X been sought medical care at a hospital, emergency room, or urgent care facility for heat stress over the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all (go to Question 15)
(6) Don't know

14a. How many days in total has Person X been hospitalized with heat stress over the past year?
(1) None
(2) One
(3) Two
(4) Three
(5) Four
(6) More than four days
(7) Don't know

15. How many times has Person X sought medical care at a hospital, emergency room, or urgent care facility due to overexposure to cold conditions over the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all (go to Question 16)
(6) Don't know

15a. How many days in total has Person X been hospitalized due to overexposure to cold conditions over the past year?
(1) None
(2) One
(3) Two
(4) Three
(5) Four
(6) More than four days
(7) Don't know

16. Has Person X had any serious gastrointestinal problems in the previous month?
(1) Yes
(2) No

17. Has Person X suffered from food poisoning from eating food in your home during the past six months?
(1) Yes
(2) No

18. Has Person X suffered from any other poisoning during the past year?
(1) Yes
(2) No (go to Question 19)

18a.What was Person X poisoned with? ____________________

19. How frequently does Person X suffer from headaches, nausea, and dizziness?
(1) Very frequently
(2) Frequently
(3) Infrequently
(4) Very infrequently
(5) Not at all
(6) Don't know

20. How many times has Person X sought medical care at a hospital, emergency room, or urgent care facility for burns from scalding hot water coming out of a faucet or showerhead in your home over the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all (go to Question 21)
(6) Don't know

20a. How many days in total has Person X been hospitalized due to burns from scalding hot water coming out of a faucet or showerhead in your home over the past year?
(1) None
(2) One
(3) Two
(4) Three
(5) Four
(6) More than four days
(7) Don't know

21. How many times has Person X sought medical care at a hospital, emergency room, or urgent care facility as a result of injuries suffered from tripping and falling in your home during the past year?
(1) Six or more times
(2) 4 or 5 times
(3) 2 or 3 times
(4) 1 time
(5) Not at all (go to Question 22)
(6) Don't know

21a. How many days in total has Person X been hospitalized due to tripping and falling and seriously hurting themselves over the past year?
(1) None
(2) One
(3) Two
(4) Three
(5) Four
(6) More than four days
(7) Don't know

22. Is Person X in school?
(1) Yes
(2) No (go to Question 27)

23. What type of school is Person X mainly attending?
(1) Pre-school or Kindergarten
(2) Elementary School or Middle School
(3) High School
(4) GED Classes
(5) College or Post College
(6) Trade or Vocational School
(7) Other ___________

24. How many days of school has Person X missed during the past year because of illness or injury? _______

25. How many days of school has Person X missed during the past year because of illness or injury of other household members? ___________

26. How frequently does Person X find it hard to study in your home because of excessive heat or cold?
(1) Very frequently
(2) Frequently
(3) Not frequently or infrequently
(4) Infrequently
(5) Very infrequently
(6) Does not study at home

27. (If Person X is 14 years or older) Is Person X employed?
(1) Yes
(2) No (go to Question 35)

28. Is Person X employed full-time or part-time?
(1) Full-time
(2) Part-time

29. Altogether, how many jobs does Person X have right now? ______

30. How many hours per week does Person X usually work at all of Person X's jobs? ______

31. How many days of work has Person X missed during the last year because of illness or injury? _____

32. How many days of work has Person X missed during the last year because of the illness or injury of other household members? ______

33. Does Person X want a job?
(1) Yes (go to Question 35)
(2) No

34. What is the main reason that Person X does not want a job?
(1) Retired
(2) Full-time student
(3) Too ill
(4) Disabled
(5) Too many family responsibilities

[Go to Question 37]

35. Has Person X looked for work during the last 4 weeks?
(1) Yes (go to Question 37)
(2) No

36. What is the main reason Person X was not looking for work during the LAST 4 WEEKS?
DO NOT READ LIST
(1) Believes no work available in line of work or area
(2) Couldn't find any work
(3) Lacks necessary schooling, training, skills or experience
(4) Employers think too young or too old
(5) Other types of discrimination
(6) Can't arrange child care
(7) Family responsibilities
(8) In school or other training
(9) Ill health, physical disability
(10) Transportation problems
(11) Other

[NOTE: Continue asking Questions 3-36 per instructions. If done, go to Question 37]

37. What is your name? ________

38. Which phrase best describes your position in your household?
(1) Head of Household
(2) Co-head of Household
(2) Spouse or Significant Other of the Head of the Household
(3) Other Adult Living in the Household
(4) Other ________________

39. Please describe your race. You can select one or more categories.
(1) White
(2) Black or African American
(3) Hispanic or Latino
(4) Asian
(5) Native Hawaiian or other Pacific Islander
(6) American Indian or Alaska Native
(7) Other
(8)Don't know
(9) Refused

40. How long has your household lived in your current home?
ENTER THE RESPONSE IN YEARS ________________

41. Are you a CITIZEN of the United States?
(1) Yes
(2) No, not a citizen

42. In what country were you born?
(1) United States
(2) Other (Please give name of country:_____________________)

43. In what country was your mother born?
(1) United States
(2) Other (Please give name of country:_____________________)

44. In what country was your father born?
(1) United States
(2) Other (Please give name of country:_____________________)

45. What is the highest level of school you have completed or the highest degree you have received?
(1) Did not attend high school
(2) Some high school but no diploma
(3) High school DIPLOMA or the equivalent (For example: GED)
(4) Some college but no degree
(5) Associate degree in college occupational/vocational or academic program
(6) Bachelor's degree
(7) Advanced college degree

Part 4. Customer Satisfaction

{Note: Ask these questions of the adult in the household most involved with the weatherization of the home or the head of the household}

Good Day. We are calling today to ask you questions about your satisfaction with the weatherization services on your home and any information you may have been provided to help you save energy. There are 41 questions in this survey. The survey should take about 20 minutes. Your answers to the survey will be kept strictly confidential. To thank you for your participation in the survey, we will send you $40.

1. How long have you known about your local weatherization program?
ENTER THE RESPONSE IN YEARS ___________________

2. How did you first find out about your local weatherization program?
(1) A call from the weatherization agency
(2) Information received in the mail from the weatherization agency
(3) Local newspaper
(4) Found the program on the Internet
(5) Relative or friend mentioned the weatherization program
(6) Other _________________________

3. How long ago did you request that your home be weatherized?
ENTER THE RESPONSE IN YEARS ____________________

4. How satisfied are you with the length of time between your request to have your home weatherized and when it actually was weatherized?
    (1) Very satisfied
    (2) Satisfied
    (3) Not satisfied or dissatisfied
    (4) Dissatisfied
    (5) Very dissatisfied

5. How easy was it to request that your house be weatherized?
    (1) Very easy
    (2) Easy
    (3) Not easy or difficult
    (4) Difficult
    (5) Very difficult

6. How easy was it to schedule the initial audit of your home?
(1) Very easy
(2) Easy
(3) Not easy or difficult
(4) Difficult
(5) Very difficult

7. How timely were those who did the initial audit of your home?
(1) Early or On Time
(2) <30 Minutes Late
(3) 30-60 Minutes Late
(4) 1 to 3 Hours Late
(5) More than 4 Hours Late
(6) Did not show up on scheduled day

8. How courteous were those who did the initial audit of your home?
(1) Very Courteous
(2) Courteous
(3) Not Courteous or Rude
(4) Rude
(5) Very Rude

9. How easy was it to schedule the time for the weatherization crew to come to your home?
(1) Very easy
(2) Easy
(3) Not easy or difficult
(4) Difficult
(5) Very difficult

10. How timely was the weatherization crew?
(1) Early or On Time
(2) <30 Minutes Late
(3) 30-60 Minutes Late
(4) 1 to 3 Hours Late
(5) More than 4 Hours Late
(6) Did not show up on scheduled day

11. How courteous was the weatherization crew?
(1) Very Courteous
(2) Courteous
(3) Not Courteous or Rude
(4) Rude
(5) Very Rude

12. How careful of your home and belongings was the weatherization crew?
(1) Very careful
(2) Careful
(3) Neither careful or careless
(4) Careless
(5) Very careless

13. Overall, how clean did the weatherization crew leave your home?
    (1) Very clean
    (2) Clean
    (3) Neither clean nor dirty
    (4) Dirty
    (5) Very dirty

14. Overall, how satisfied are you with final condition your home was left in?
    (1) Very satisfied
    (2) Satisfied
    (3) Not satisfied or dissatisfied
    (4) Dissatisfied
    (5) Very dissatisfied

15. How easy was it to schedule the final inspection of your home?
(1) Very easy
(2) Easy
(3) Not easy or difficult
(4) Difficult
(5) Very difficult

16. How timely were those who did the final inspection of your home?
(1) Early or On Time
(2) <30 Minutes Late
(3) 30-60 Minutes Late
(4) 1 to 3 Hours Late
(5) More than 4 Hours Late
(6) Did not show up on scheduled day

17. How courteous were those who did the final inspection of your home?
(1) Very Courteous
(2) Courteous
(3) Not Courteous or Rude
(4) Rude
(5) Very Rude

18. How satisfied are you with the work performed in your home?
    (1) Very satisfied
    (2) Satisfied
    (3) Not satisfied or dissatisfied
    (4) Dissatisfied
    (5) Very dissatisfied

19. How satisfied are you with any new equipment installed in house?
(1) Very satisfied
(2) Satisfied
(3) Not satisfied or dissatisfied
(4) Dissatisfied
(5) Very dissatisfied

20. Do you feel that other things should have been installed in your home to help you save energy?
(1) Yes
(2) No (go to Question 21)

20a. What other things? ______________________

21. How satisfied are you with the energy savings achieved after having your home weatherized?
(1) Very satisfied
(2) Satisfied
(3) Not satisfied or dissatisfied
(4) Dissatisfied
(5) Very dissatisfied
(6) Too soon to tell
(7) Don't know

22. Did the weatherization agency staff check your home for major repairs?
(1) Yes
(2) No (go to Question 23)

22a. Were major repairs needed in your home?
(1) Yes
(2) No (go to Question 23)

22b. Were major repairs done to your home?
(1) Yes
(2) No
(3) Not yet but expecting repairs to be done

23. Did the weatherization staff ask you about the health of the members of your household?
(1) Yes
(2) No (go to Question 24)

23a. Were any of the members of your household in need of care that they were not receiving at the time?
(1) Yes
(2) No (go to Question 24)

23b. Did the weatherization staff help you to obtain the needed care?
(1) Yes
(2) No

24. Did your weatherization agency refer you to any other housing and/or social service programs?
(1) Yes
(2) No (go to Question 25)

24a. What program or programs? ____________________________

25. Did you file a complaint about the weatherization services provided?
(1) Yes
(2) No (go to Question 26)

25a. What was the complaint about?____________________

25b. How satisfied are you with the resolution of the situation you complained about?
(1) Very satisfied
(2) Satisfied
(3) Not satisfied or dissatisfied
(4) Dissatisfied
(5) Very dissatisfied

25c. How might the agency have done a better job of resolving your complaint?_______

26. Did you get any information on ways to save energy in your home from the people who weatherized your home?
Yes
No (go to Question 33)

27. How much time did the weatherization agency staff talk to you about ways to save energy?
Less than 5 minutes
5 to 14 minutes
15 to 29 minutes
30 to 59 minutes
More than one hour

28. How well did you understand what the weatherization agency staff said to you about saving energy?
(1) Very well (go to Question 30)
(2) Well (go to Question 30)
(3) Neither well or not well (go to Question 30)
(4) Not well
(5) Not well at all

29. Why did you not understand what the weatherization agency staff said?
CHECK ALL THAT APPLY
(1) The staff person did not speak my primary language
(2) The staff person was confusing
(3) The staff person did not speak well
(4) The staff person was hurried
(5) The staff person was boring
(6) I did not get along with the staff person
(7) Other_________________

30. What materials about saving energy did the weatherization agency staff give you? CHECK ALL THAT APPLY
(1) One or more brochures, booklets and manuals
(2) One or more compact discs
(3) One or more videos (including DVD's)
(4) No materials were provided (go to Question 31)

30a. How much time have you spent reading/reviewing the materials about saving energy that the weatherization agency staff gave you?
(1) No time (go to Question 31)
(2) Less than 5 minutes
(3) 5 to 14 minutes
(4) 15 to 29 minutes
(5) 30 to 59 minutes
(6) More than one hour

30b. How well did you understand the energy savings materials that the weatherization agency staff gave you?
(1) Very well
(2) Well
(3) Neither well or not well
(4) Not well
(5) Not well at all

30c. How useful have the energy savings materials been to you?
(1) Very useful
(2) Useful
(3) Neither useful or not useful
(4) Not useful
(5) Not very useful

30d. What about the materials were particularly useful? ___________________

30e. How could the materials have been improved for your use? ____________________

31. How satisfied are you with the ways that the weatherization agency provided you with information about saving energy?
(1) Very satisfied
(2) Satisfied
(3) Not satisfied or dissatisfied
(4) Dissatisfied
(5) Very dissatisfied

32. How could the agency improve the ways that it provides households with information about saving energy? ___________________________________

33. Did you get any information on ways to improve health and safety in your home from the people who weatherized your home?
(1) Yes
(2) No (go to Question 39)

34. How much time did the weatherization agency staff talk to you about ways to improve health and safety?
(1) Less than 5 minutes
(2) 5 to 14 minutes
(3) 15 to 29 minutes
(4) 30 to 59 minutes
(5) More than one hour

35. How well did you understand what the weatherization agency staff said to you about improving health and safety?
(1) Very well (go to Question 37)
(2) Well (go to Question 37)
(3) Neither well or not well (go to Question 37)
(4) Not well
(5) Not well at all

35a. Why did you not understand what the weatherization agency staff said?
CHECK ALL THAT APPLY
(1) The staff person did not speak my primary language
(2) The staff person was confusing
(3) The staff person did not speak well
(4) The staff person was hurried
(5) The staff person was boring
(6) I did not get along with the staff person
(7) Other_________________

36. What materials about improving health and safety did the weatherization agency staff give you? CHECK ALL THAT APPLY
(1) One or more brochures, booklets and manuals
(2) One or more compact discs
(3) One or more videos (including DVD's)
(4) No materials were provided (go to Question 37)

36a. How much time have you spent reading/reviewing the materials about improving health and safety that the weatherization agency staff gave you?
(1) No time (go to Question 37)
(2) Less than 5 minutes
(3) 5 to 14 minutes
(4) 15 to 29 minutes
(5) 30 to 59 minutes
(6) More than one hour

36b. How well did you understand the improving health and safety materials that the weatherization agency staff gave you?
(1) Very well
(2) Well
(3) Neither well or not well
(4) Not well
(5) Not well at all

36c. How useful have the improving health and safety materials been to you?
(1) Very useful
(2) Useful
(3) Neither useful or not useful
(4) Not useful
(5) Not very useful

36d. What about the materials were particularly useful? ____________________

36e. How could the materials have been improved for your use? _____________________

37. How satisfied are you with the ways that the weatherization agency provided you with information about improving health and safety?
(1) Very satisfied
(2) Satisfied
(3) Not satisfied or dissatisfied
(4) Dissatisfied
(5) Very dissatisfied

38. How could the agency improve the ways that it provides households with information about improving health and safety? ____
____

39. What are some of the greatest benefits your household received by participating in the weatherization program? ____
____

40. What suggestions do you have for how the weatherization program can be improved?
____
____

41. Finally, please rate your overall satisfaction with the weatherization program.
   (1) Very satisfied
   (2) Satisfied
   (3) Not satisfied or dissatisfied
   (4) Dissatisfied
   (5) Very dissatisfied

APPENDIX J. PROGRAM SERVICES AGENCY SURVEY

The “Program Services Agency Survey” will be administered to agency staff and crews that worked on the weatherized housing units of the occupants who responded to the Program Satisfaction portion of the “Occupant Survey” (see Appendix I). The survey will be administered at the same time as this portion of the “Occupant Survey” is administered (i.e., immediately after the housing unit has been weatherized and inspected). Information collected will provide insight into the agency’s perceptions of how well they delivered Program services to these houses, so that the agency’s perceptions can be compared to the occupant’s perceptions (see Section 3.1.1).. It is expected that the agencies will be compensated by DOE for the time it takes their staff and crews to complete this survey.

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PROGRAM SERVICES AGENCY SURVEY

The following questions pertain to the weatherization work your agency performed on the following house:

Agency Job Number: ____________________

Client Name: ____

1. How satisfied are you with the length of time between the client's request to have their home weatherized and your notification that their house was accepted into the Program?
   - (1) Very satisfied
   - (2) Satisfied
   - (3) Not satisfied or dissatisfied
   - (4) Dissatisfied
   - (5) Very dissatisfied

2. How satisfied are you with the length of time between the client's request to have their home weatherized and when it actually was weatherized?
   - (1) Very satisfied
   - (2) Satisfied
   - (3)Not satisfied or dissatisfied
   - (4) Dissatisfied
   - (5) Very dissatisfied

3. Please rate how easy it was to schedule your visits to this client's home:

	(1) Very Easy	(2) Easy	(3) Not Easy or Difficult	(4) Difficult	(5) Very Difficult
Energy Audit Crew					
Weatherization Crew					
Inspection Crew					

4. Please rate the timeliness of those who visited this client's home:

	(1) Early or On Time	(2) <30 Min. Late	(3) 30-60 Min. Late	(4) 1 to 3 hours Late	(5) More than 4 Hours Late	(6) Did not show up on scheduled day
Energy Audit Crew						
Weatherization Crew						
Inspection Crew						

5. Please rate the courteousness of those who visited this client's home:

	(1) Very Courteous	(2) Courteous	(3) Not Courteous or Rude	(4) Rude	(5) Very Rude
Energy Audit Crew					
Weatherization Crew					
Inspection Crew					

6. How careful was your weatherization crew in this client's home?
   (1) Very careful
   (2) Careful
   (3) Neither careful or careless
   (4) Careless
   (5) Very careless

7. Did your weatherization crew clean up after each day of work at this client's home?
   (1) Yes
   (2) No

8. Did your weatherization crew remove debris after each day of work at this client's home?
   (1) Yes
   (2) No

9. Overall, how clean did your weatherization crew leave this client's home?
   (1) Very clean
   (2) Clean
   (3) Neither clean nor dirty
   (4) Dirty
   (5) Very dirty

10. Overall, how satisfied are you with final condition your staff left this client's home in?
   (1) Very satisfied
   (2) Satisfied
   (3) Not satisfied or dissatisfied
   (4) Dissatisfied
   (5) Very dissatisfied

11. How satisfied are you with the weatherization measures installed in this client's home?
   (1) Very satisfied
   (2) Satisfied
   (3) Not satisfied or dissatisfied
   (4) Dissatisfied
   (5) Very dissatisfied

12. How satisfied are you with any new equipment installed in this client's home?
    (1) Very satisfied
    (2) Satisfied
    (3) Not satisfied or dissatisfied
    (4) Dissatisfied
    (5) Very dissatisfied

13. Do you feel that other measures should have been installed in this client's home?
    (1) Yes
    (2) No

    13a. If yes, what other measures? ______________________________

14. Did you refer this client to other pertinent housing and/or social service programs?
    (1) Yes
    (2) No

15. How satisfied are you that your agency provided all the services it could to his client?
    (1) Very satisfied
    (2) Satisfied
    (3) Not satisfied or dissatisfied
    (4) Dissatisfied
    (5) Very dissatisfied

16. Did this client file a complaint about the weatherization services you provided?
    (1) Yes
    (2) No

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APPENDIX K. HOUSING UNIT INFORMATION SURVEY

The “Housing Unit Information Survey” will be used to collect information on each of the weatherized housing units included in the billing data sample from the 400 agencies (see Section 2.2.1) and on all housing units (both weatherized and controls) used in the submetered samples (see Sections 2.2.1 and 4.6). A subset of information (utility account information and details on the housing unit and occupants) will be collected from the same 400 agencies on the control housing units being used in the billing data sample (see Section 2.2.1). In addition, the survey will be used to collect information from the same 400 agencies used in the billing data sample on 25% of the housing units from each agency whose primary heating fuel is NOT natural gas or electricity (see Section 2.1.1) as well as housing units used in the field study of audits, client education, training, and monitoring (see Section 3.3.3). This information is being collected to characterize the housing units weatherized under the Program (see Section 2.1), obtain billing records from utilities (see Section 2.2.1), and study audits, client education, training, and quality control inspections (see Section 3.3.3). This information will be collected at the end of the agency’s PY 2006 (August and October 2007). The information to be collected includes:

- utility account information,
- detailed housing unit and occupant characteristics,
- identification of the diagnostics performed,
- diagnostic data measured by the agencies,
- identification of the measures installed, and
- costs for measures installed and other work performed.

The data requested in the “Housing Unit Information Survey” are typically maintained in the records of each agency, so no additional information will need to be collected by the agencies. It is expected that the agencies will be compensated by DOE for their time to complete this survey.

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HOUSING UNIT INFORMATION SURVEY

Use this form to document information on all single-family detached and attached houses, all mobile homes, and those units in small or large multifamily buildings that were weatherized individually (rather than small or large multifamily buildings in which the whole building and all units in the building were weatherized).

Form completed by: ______________________________ Date: _______________

Unit identification number (to be completed by evaluation team): _______________

IDENTIFICATION

Subgrantee (agency) name: ____

State: _______________

Agency job number: ____________________

Occupant name: ______________________________

WEATHERIZATION INFORMATION

Household annual income (as used to determine Program eligibility): $__________ per year

Weatherization dates (not audit or inspection dates):

Started:	__________	__________	__________
Completed:	__________	__________	__________
	(month)	(day)	(year)

If this housing unit was not weatherized in Program Year 2006, then it should not be in the sample and no further information is needed. Please return this form when you return the forms for other housing units.

Was this a "reweatherized" unit? ***(check only one)***

- ☐ Yes
- ☐ No
- ☐ Don't know

Does the housing unit meet your state’s definition for being a high residential energy user? ***(check only one)***

- Yes
- No
- Don’t know

Does the housing unit meet your state’s definition for being a household with a high energy burden? ***(check only one)***

- Yes
- No
- Don’t know

Utility/energy supplier names and account numbers:

	Utility/supplier name	Account number
Electricity	________________________	__________________________
Natural gas	________________________	__________________________

Is a signed fuel release form attached?

- Yes
- No (but in agency file)
- No release form available

HOUSING UNIT

Building type – see definitions at end of form: ***(check only one)***

- Single-family detached house
- Single-family attached house (e.g., side-by-side duplex, townhouse, row house)
- Mobile home
- Small multifamily building (2-4 units per building and not a SF attached house)
- Large multifamily building (5 or more units per building and not a SF attached house)
- Shelter
- Don’t know

If single-family attached, number of units attached (adjacent) to this unit: ***(check only one)***

- 1
- 2
- 3
- 4 or more
- Don’t know

If mobile home, number of rooms that have been added on: ***(check only one)***

- None
- 1
- 2
- 3
- 4 or more
- Don’t know

If single-family detached or attached, number of stories above grade: ***(check only one)***

- 1
- 2
- 3
- 4 or more
- Don’t know

Ownership

- Owner occupied
- Rental
- Other (specify: ______________________)
- Don’t know

Year house/building originally built: ***(check only one)***

- 2000 or later
- 1990 to 1999
- 1980 to 1989
- 1970 to 1979
- 1960 to 1969
- 1950 to 1959
- 1940 to 1949
- 1930 to 1939
- 1920 to 1929
- 1910 to 1919
- 1900 to 1909
- Before 1900
- Don’t know

Conditioned floor area at the time of weatherization: ***(include the basement only if it is intentionally conditioned)***

Heated floor area: __________ ft² ☐ Don’t know

Air conditioned floor area: ___________ft² ☐ Don’t know

Primary fuel used to heat the unit during the winter before weatherization: ***(check only one)***

 Natural gas
 Propane/LPG
 Kerosene (#1 fuel oil)
 Fuel oil (#2 fuel oil)
 Electricity
 Wood
 Coal
 Other (specify: ____________________)
 Don't know

Type of *primary* space-heating system before weatherization: ***(check only one)***

 Central (ducted) warm-air furnace (forced-air or gravity, any fuel including electricity)
 Heat pump
 Built-in electric units (e.g., electric baseboards, ceiling heat)
 Steam or hot water system (e.g., floor or baseboard radiators, convectors)
 Floor, wall, or pipeless (ductless) furnace (e.g., floor or wall furnace)
 Heating stove
 Room heater (nonportable)
 Portable space heater
 None
 Don't know

If small or large multifamily building, was the primary space-heating system shared with other housing units? ***(check only one)***

 Yes
 No
 Don't know

Supplemental fuel used to heat the unit during the winter before weatherization: ***(check all that apply)***

 Natural gas
 Propane/LPG
 Kerosene (#1 fuel oil)
 Fuel oil (#2 fuel oil)
 Electricity
 Wood
 Other (specify: ____________________)
 None
 Don't know

Type of *operable* air conditioning system present before weatherization: ***(check all that apply)***

- Central air conditioner/heat pump
- Window/wall units
- Evaporative cooling system ("swamp coolers")
- None
- Don't know

Number of window/wall air conditioning units: ***(check only one)***

- None
- 1
- 2
- 3
- 4 or more
- Don't know

HOUSEHOLD

Total number of occupants: ***(check only one)***

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9 or more
- Don't know

Check if the housing unit was occupied by at least one person who was: ***(check all that apply)***

- Elderly (60 or older)
- Disabled
- Native American
- A child (as defined by your state)

Number of children (as defined by your state): ***(check only one)***

- None
- 1
- 2
- 3
- 4
- 5 or more
- Don't know

Number of elderly (60 or older): ***(check only one)***

 None
 1
 2
 3
 4
 5 or more
 Don’t know

Number or disabled : ***(check only one)***

 None
 1
 2
 3
 4
 5 or more
 Don’t know

Year moved into housing unit: ***(check only one)***

 2007
 2006
 2005
 2000 to 2004
 1995 to 1999
 1990 to 1994
 1985 to 1989
 1980 to 1984
 1975 to 1979
 1970 to 1974
 1965 to 1969
 1960 to 1964
 1955 to 1959
 1950 to 1954
 Before 1950
 Don’t know

Is the household headed by a single parent? ***(check only one)***

 Yes
 No
 Don’t know

Ethnicity of the head of household: ***(check all that apply)***

- American Indian or Alaska Indian
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic
- Other (specify: ____________________)
- Don’t know

AUDIT

Primary method used to select weatherization measures for this house (excluding health, safety, and repair measures and general heat waste measures): ***(check only one)***

- Priority list
- Calculation procedure (e.g., spreadsheet, computerized audit)
- Other (specify: ____________________)

If a calculation procedure was used, the name of the procedure(s): ***(check all that apply)***

- AK Warm
- EA-3
- EASY
- EA-QUIP
- HomeCheck
- Meadows
- REES
- REM/Rate
- SMOC-ERS
- TIPS
- TREAT
- Weatherization Assistant (NEAT/MHEA)
- WXEOR
- Other (specify: ____________________)
- None (a calculation procedure was not used on this house)

DIAGNOSTICS AND INSPECTIONS

Indicate which of the following diagnostic measurements and inspections were performed on **THIS** housing unit and when they were performed: ***(check all that apply)***

Diagnostic measurement or inspection	**Diagnostic/inspection performed during:**		
	Audit/house assessment	**Measure installation**	**Post-inspection**
Pressure diagnostics:			
Blower door measurement (house air leakage rate)	▯	▯	▯
Zonal pressure	▯	▯	▯
Room-to-room pressures (distribution system balancing)	▯	▯	▯
Duct pressure pan measurements	▯	▯	▯
Duct blower measurement (duct air leakage rate)	▯	▯	▯
Blower door subtraction meas. (duct air leakage rate)	▯	▯	▯
Space-heating system:			
Flue gas analysis (steady-state efficiency measurement)	▯	▯	▯
Heat rise	▯	▯	▯
CO level in flue	▯	▯	▯
CO level of equipment room	▯	▯	▯
Draft/spillage (normal operation)	▯	▯	▯
Worst case draft/spillage (CAZ)	▯	▯	▯
Safety inspection	▯	▯	▯
Air-conditioning system:			
Refrigerant charge (e.g., superheat or subcooling)	▯	▯	▯
Safety inspection	▯	▯	▯
HVAC components:			
Air handler flow rate	▯	▯	▯
Thermostat anticipator current	▯	▯	▯

Hot-water (water-heating) system:			
Flue gas analysis (steady-state efficiency measurement)	☐	☐	☐
CO level in flue	☐	☐	☐
CO level of equipment room	☐	☐	☐
Draft/spillage (normal operation)	☐	☐	☐
Worst case draft/spillage (CAZ)	☐	☐	☐
Hot water temperature	☐	☐	☐
Shower head flow rate	☐	☐	☐
Faucet flow rate	☐	☐	☐
Safety inspection	☐	☐	☐
Other CO measurements:			
Cook stove	☐	☐	☐
Kitchen	☐	☐	☐
Main living area	☐	☐	☐
Other diagnostics and inspections:			
Refrigerator energy use	☐	☐	☐
Exhaust fan air flow rate	☐	☐	☐
Infrared scanning (camera)	☐	☐	☐
Radon testing	☐	☐	☐
Other (specify: ________________________________)	☐	☐	☐
Other (specify: ________________________________)	☐	☐	☐
Other (specify: ________________________________)	☐	☐	☐

Record the diagnostic measurements taken on **THIS** housing unit: ***(fill in all that were taken)***

Diagnostic measurement	**Pre-weatherization**	**Post weatherization**
House air leakage (blower door measurement):		
Air leakage rate	cfm	cfm
House WRT outside pressure difference	Pa	Pa
Duct leakage (pressure pan measurements):		
Sum of pressure pan readings	Pa	Pa
Number of registers included in sum		
House WRT outside pressure difference	Pa	Pa
Duct leakage (duct blower measurements):		
Total duct leakage rate	cfm	cfm
Duct leakage to the outside	cfm	cfm
Duct WRT outside pressure difference	Pa	Pa
Steady-state efficiency (flue gas analysis):		
Primary space-heating system	%	%
Secondary space-heating system	%	%
Hot water heater	%	%

MEASURES INSTALLED

Identify the measures that were installed on **THIS** housing unit: ***(check all that apply)***

Measure	Installed by	
	In-house crew	Contractor
Air sealing work:		
General house caulking and weatherstripping (e.g., doors, windows)	▯	▯
House air sealing emphasizing bypasses (leaks identified by auditor and/or crew without using a blower door)	▯	▯
House air sealing emphasizing bypasses (leaks identified by auditor and/or crew with aid of a blower door)	▯	▯
Air distribution system (duct) sealing and repair	▯	▯
Other non-window air sealing work (specify: ___________________)	▯	▯
Insulation:		
Attic insulation (installed where there was no existing insulation)	▯	▯
Attic insulation (added to existing insulation)	▯	▯
Wall insulation (normal density—two-hole gravity blow technique)	▯	▯
Wall insulation (high density—one-hole tube-fill technique)	▯	▯
Floor insulation	▯	▯
Rim or band joist insulation	▯	▯
Foundation wall insulation	▯	▯
Duct insulation	▯	▯
White roof coat	▯	▯
Skirting	▯	▯
Other insulation (specify: ___________________________________)	▯	▯
Windows:		
New window (justified based on energy savings or SIR)	▯	▯
New window (justified as a needed repair or H&S item)	▯	▯
Window glazings	▯	▯
New window screen	▯	▯
Window lock replacement	▯	▯

Window screen repair	▯	▯
Other window repair (e.g., sashes, frames)	▯	▯
Storm window	▯	▯
Window shading (e.g., awning, film, sun screen)	▯	▯
Other window treatments (specify: ___________________________)	▯	▯
Doors:		
New door (justified based on energy savings or SIR)	▯	▯
New door (justified as a needed repair or H&S item)	▯	▯
Door lock (new or replacement)	▯	▯
Door or door framing repair	▯	▯
Storm door	▯	▯
Other door treatments (specify: ______________________________)	▯	▯
Space-heating systems:		
New space-heating system (justified based on energy savings or SIR)	▯	▯
New space-heating system (justified as a needed repair or H&S item)	▯	▯
Space-heating system repair (e.g., controls, safety items, flues)	▯	▯
Space-heating system tune-up	▯	▯
Vent damper	▯	▯
Intermittent ignition device	▯	▯
Other space-heating system modification (specify: ______________)	▯	▯
Air-conditioning systems:		
New air conditioner (justified based on energy savings or SIR)	▯	▯
New air conditioner (justified as a needed repair or H&S item)	▯	▯
Air conditioner repair	▯	▯
Air conditioner recharge/tune-up	▯	▯
Ceiling or whole-house fans	▯	▯
Other air-conditioning system modification (specify: _____________)	▯	▯

Ventilation:		
Exhaust fan in bathroom	▯	▯
Exhaust fan in kitchen	▯	▯
Whole-house ventilation system	▯	▯
Other ventilation system improvements (specify: ________________)	▯	▯
HVAC accessories:		
New programmable (setback) thermostat	▯	▯
New standard thermostat	▯	▯
Duct vents, grills, or registers	▯	▯
Standard air filter	▯	▯
High efficiency particulate arresting (HEPA) air filter	▯	▯
Other HVAC accessories (specify: ____________________________)	▯	▯
Water-heating system:		
New water heater (justified based on energy savings or SIR)	▯	▯
New water heater (justified as a needed repair or H&S item)	▯	▯
Water-heating system repair	▯	▯
Water-heater tank insulation wrap	▯	▯
Pipe insulation	▯	▯
Low-flow showerhead	▯	▯
Faucet aerators	▯	▯
Water heater temperature reduction	▯	▯
Other water heating system measure (specify: __________________)	▯	▯
Other baseloads:		
Indoor lighting	▯	▯
Outdoor lighting	▯	▯
Refrigerator (justified based on SIR)	▯	▯
Refrigerator (justified as a needed repair or H&S item)	▯	▯
Other baseload measure (specify: _____________________________)	▯	▯

Client education:		
Brochures and booklets	☐	☐
Manuals	☐	☐
Compact disks	☐	☐
Videos or DVDs	☐	☐
<5 minute discussion	☐	☐
5-14 minute discussion	☐	☐
15-29 minute discussion	☐	☐
30-60 minute discussion	☐	☐
>1 hour discussion	☐	☐
Other client education approach (specify: ________)	☐	☐
Other health, safety, and repair:		
Smoke alarm	☐	☐
CO monitor	☐	☐
Attic ventilation	☐	☐
Roof repair	☐	☐
Wall repair	☐	☐
Floor repair	☐	☐
Foundation repair	☐	☐
Ground vapor barrier	☐	☐
Gutter or downspout repair	☐	☐
Grading of lot	☐	☐
Plumbing repair	☐	☐
Sewer repair	☐	☐
Electrical repair	☐	☐
Stair repair	☐	☐
Non-skid material on stairs	☐	☐
Safety gate at stairs	☐	☐
Grab bar in bathroom	☐	☐

Non-skid material in bathtub		
Metal chimney liner		
Lead abatement		
Asbestos abatement		
Removal or safe storage of household poisons		
Other H&S and repair items (specify: ________________________)		

If a new space-heating system was installed and justified as a needed repair or a health and safety item (rather than being justified based on cost effectiveness), please identify the reason you chose to replace it: ***(check all that apply)***

- Cost of repair/retrofit exceeds 50% of replacement cost
- Existing heating system not running
- Existing heating system is old (e.g., at end of life, too old to be repaired/adjusted)
- Switching fuel
- Converting from steam system to hot water system
- Cracked heat exchanger
- Boiler leaking
- Safety switches/controls not operational and can’t be repaired
- Unvented space heater
- Existing heating system not safe to run for other reason (specify: _________________)
- Other: ____

Please identify any cost-effective measures (not repair or health and safety measures) recommended by your audit procedures that you were unable to install in this housing unit because of insufficient funds: ***(check all that apply)***

- ☐ Air sealing
- ☐ Duct sealing
- ☐ Attic insulation
- ☐ Wall insulation
- ☐ Floor/foundation insulation
- ☐ Duct insulation
- ☐ New window(s)
- ☐ Storm windows(s)
- ☐ Door(s)
- ☐ Storm door(s)
- ☐ New space-heating system
- ☐ Space-heating system tune-up
- ☐ New air conditioner(s)
- ☐ Air conditioner tune-up(s)
- ☐ HVAC thermostat
- ☐ New water heater
- ☐ Water heater insulation wrap
- ☐ Water flow devices (e.g., showerheads, faucet aerators)
- ☐ Lighting
- ☐ Refrigerator
- ☐ Other: ____

Provide the costs associated with installing the measures in **THIS** housing unit:

	In-House Crew	**Contractor**	**Total**
Material costs			
Labor costs[1]			
Profit/overhead[2]			
Total			

[1]Crew-based labor costs should be based on the crew's fully loaded hourly rate (rather than the crew's take-home pay rate) which may include costs associated with insurance, etc. These labor costs should include the crew's time for traveling to the job site.

[2]Contractor profit and overhead may already be included in the contractor's material and labor costs.

In the figures provided, do **NOT** include any program management costs such as those associated with intake and eligibility determination, audits and house assessments, final inspections, contractor or crew management/supervision, and program administration. Also, do **NOT** include installation-related overhead costs such as those associated with vehicles, equipment, and training.

Building Type Definitions:

Single-family detached house—House that provides living space for one family or household, is contained within walls that go from the basement (or the ground floor, if there is no basement) to the roof, and has no walls that are shared (or built in contact) with another household. A manufactured house assembled on site is a single-family detached housing unit, not a mobile home.

Single-family attached house—House that provides living space for one family or household, is contained within walls that go from the basement (or the ground floor, if there is no basement) to the roof, has at least one wall that is shared (or built in contact) with an adjacent household, and has an independent outside entrance. An attached house is not divided into more than one housing unit and does not have a household living above or below another one within the walls extending from the basement to the roof to separate any adjacent units. Examples include a house that is a side-by-side duplex, part of a townhouse building, and a row house.

Mobile home—Home that is built on a movable chassis, is moved to the site, and may be placed on a permanent or temporary foundation. If rooms are added to the structure, it is considered a mobile home if the added floor area is less than the mobile home's original floor area; otherwise, it is a single-family detached house. A manufactured house assembled on site is a single-family detached house, not a mobile home.

Small multifamily—Building with two to four housing units (i.e., building that is divided into living quarters for two, three, or four families or households) in which one household lives above or beside another and does not meet the single-family attached house definition. Includes houses originally intended for occupancy by one family (or for some other use) that have since been converted to separate dwellings for two to four families. Typical arrangements in these types of living quarters are separate apartments downstairs and upstairs or one apartment on each of three or four floors.

Large multifamily—Building with five or more housing units (i.e., building that contains living quarters for five or more families or households) that does not meet the single-family attached house definition.

Shelter—Structure whose principal purpose is to house individuals on a temporary basis who may or may not be related to one another and who are not living in nursing homes, prisons, or similar institutional care facilities.

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APPENDIX L. BUILDING INFORMATION SURVEY

The “Building Information Survey” will be used to collect information on each of the weatherized buildings included in the billing data sample from the 400 agencies (see Section 2.2.1) and on all buildings used in the submetered study of multifamily buildings heated by fuel oil (see Section 2.2.1). A subset of information (utility account information and details on the buildings and occupants) will be collected from the same 400 agencies on the control buildings being used in the billing data sample (see Section 2.2.1). In addition, the survey will be used to collect information from the same 400 agencies used in the billing data sample on 25% of the buildings from each agency whose primary heating fuel is NOT natural gas or electricity (see Section 2.1.1) as well as buildings used in the field study of audits, client education, training, and monitoring (see Section 3.3.3). This information is being collected to characterize the buildings weatherized under the Program (see Section 2.1), obtain billing records from utilities (see Section 2.2.1), and study audits, client education, training, and quality control inspections (see Section 3.3.3). This information will be collected at the end of the agency’s PY 2006 (August and October 2007). The information to be collected includes:

- utility account information,
- detailed building and occupant characteristics,
- identification of the diagnostics performed,
- diagnostic data measured by the agencies,
- identification of the measures installed, and
- costs for measures installed and other work performed.

The data requested in the “Building Information Survey” are typically maintained in the records of each agency, so no additional information will need to be collected by the agencies. It is expected that the agencies will be compensated by DOE for their time to complete this survey.

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BUILDING INFORMATION SURVEY

Use this form to document information on small or large multifamily family buildings in which the whole building and all units in the building were weatherized.

Form completed by: ______________________________ Date: _______________

Building identification number (to be completed by evaluation team): _______________

IDENTIFICATION

Subgrantee (agency) name: ____

State: _______________

Agency job number: ____________________

Building name: ______________________________

WEATHERIZATION INFORMATION

Number of housing units in the building: __________

Number of housing units in the building that met eligibility requirements: __________

Weatherization dates (not audit or inspection dates):

Started:	__________	__________	__________
Completed:	__________	__________	__________
	(month)	(day)	(year)

If this building was not weatherized in Program Year 2006, then it should not be in the sample and no further information is needed. Please return this form when you return the forms for other housing units.

Was this a "reweatherized" building? ***(check only one)***

- ☐ Yes
- ☐ No
- ☐ Don't know

Does the building meet your state's definition for being a high residential energy user? ***(check only one)***

- ☐ Yes
- ☐ No
- ☐ Not applicable
- ☐ Don't know

Does the building meet your state’s definition for being a household with a high energy burden? ***(check only one)***

- ☐ Yes
- ☐ No
- ☐ Not applicable
- ☐ Don’t know

Utility/energy supplier names and account numbers for building-level meters:

	Utility/supplier name	Account number for building-level meters
Electricity	______________________	________________________
Natural gas	______________________	________________________
Fuel oil	______________________	________________________
Propane/LPG	______________________	________________________

Is a signed fuel release form attached for these building-level meters?

- ☐ Yes
- ☐ No (but in agency file)
- ☐ No release form available

BUILDING INFORMATION

Building type – see definitions at end of form: ***(check only one)***

- ☐ Single-family detached house
- ☐ Single-family attached house (e.g., side-by-side duplex, townhouse, row house)
- ☐ Mobile home
- ☐ Small multifamily building (2-4 units per building and not a SF attached house)
- ☐ Large multifamily building (5 or more units per building and not a SF attached house)
- ☐ Shelter
- ☐ Don’t know

Number of stories above grade: ***(check only one)***

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5-9
- ☐ 10-19
- ☐ 20 or more
- ☐ Don’t know

Year building originally built: ***(check only one)***

- ▯ 2000 or later
- ▯ 1990 to 1999
- ▯ 1980 to 1989
- ▯ 1970 to 1979
- ▯ 1960 to 1969
- ▯ 1950 to 1959
- ▯ 1940 to 1949
- ▯ 1930 to 1939
- ▯ 1920 to 1929
- ▯ 1910 to 1919
- ▯ 1900 to 1909
- ▯ Before 1900
- ▯ Don't know

Conditioned floor area at the time of weatherization:

Heated floor area: __________ ft² ▯ Don't know

Air conditioned floor area: ___________ft² ▯ Don't know

Primary fuel used to heat the building during the winter before weatherization: ***(check only one)***

- ▯ Natural gas
- ▯ Propane/LPG
- ▯ Kerosene (#1 fuel oil)
- ▯ Fuel oil #2
- ▯ Fuel oil #4
- ▯ Fuel oil #5L
- ▯ Fuel oil #5H
- ▯ Fuel oil #6
- ▯ Electricity
- ▯ Wood
- ▯ Coal
- ▯ Steam (purchased from a central distribution system)
- ▯ Hot water (purchased from a central distribution system)
- ▯ Other (specify: _____________________)
- ▯ Don't know

Type of *primary* space-heating system before weatherization: ***(check only one)***

- ☐ Central (ducted) warm-air furnace (forced-air or gravity, any fuel including electricity)
- ☐ Heat pump
- ☐ Built-in electric units (e.g., electric baseboards, ceiling heat)
- ☐ Steam or hot water system (e.g., floor or baseboard radiators, convectors)
- ☐ Floor, wall, or pipeless (ductless) furnace (e.g., floor or wall furnace)
- ☐ Heating stove
- ☐ Room heater (nonportable)
- ☐ Portable space heater
- ☐ None
- ☐ Don't know

Was the primary space-heating system a central system? ***(check only one)***

- ☐ Yes, a central system that supplied heat to all or most of the units in the building
- ☐ No, each unit had its own heating system
- ☐ Don't know

Supplemental fuel used to heat the unit during the winter before weatherization: ***(check all that apply)***

- ☐ Natural gas
- ☐ Propane/LPG
- ☐ Kerosene (#1 fuel oil)
- ☐ Fuel oil (#2 fuel oil)
- ☐ Electricity
- ☐ Wood
- ☐ Other (specify: ____________________)
- ☐ None
- ☐ Don't know

Type of *operable* air conditioning system present before weatherization: ***(check all that apply)***

- ☐ Central air conditioner/heat pump
- ☐ Window/wall units
- ☐ Evaporative cooling system ("swamp coolers")
- ☐ None
- ☐ Don't know

Number of window/wall air conditioning units: ***(check only one)***

- ☐ None
- ☐ 1-4
- ☐ 5-9
- ☐ 10-19
- ☐ 20-49
- ☐ 50 or more
- ☐ Don't know

HOUSEHOLD

Occupant information:

Unit number	Name of occupant	Household income ($)	Ownership	Unit occupied by at least one person who was: (Y–Yes or N–No)			
				Elderly (60 or older)	Disabled	Native American	A child (as defined by your state)

Ownership:
- O–Owner (e.g., paid in full or buying through a mortgage)
- R–Renter
- P–Occupied without payment
- D–Don't know

Unit number	Electric account number	Natural gas account number	Signed fuel release form (see codes below)

Signed fuel release form:
- A–Attached
- F–Not attached but in agency file
- N–No release form available

Total number of occupants: ***(check only one)***

- 1-4
- 5-9
- 10-19
- 20-49
- 50 or more
- Don't know

AUDIT

Primary method used to select weatherization measures for this building (excluding health, safety, and repair measures and general heat waste measures): **(check only one)**

- Priority list
- Calculation procedure (e.g., spreadsheet, computerized audit)
- Other (specify: ____________________)

If a calculation procedure was used, the name of the procedure(s): **(check all that apply)**

- AK Warm
- EA-3
- EASY
- EA-QUIP
- HomeCheck
- Meadows
- REES
- REM/Rate
- SMOC-ERS
- TIPS
- TREAT
- Weatherization Assistant (NEAT/MHEA)
- WXEOR
- Other (specify: ____________________)
- None (a calculation procedure was not used on this house)

DIAGNOSTICS AND INSPECTIONS

Indicate which of the following diagnostic measurements and inspections were performed on **THIS** building and when they were performed: ***(check all that apply)***

Diagnostic measurement or inspection	Diagnostic/inspection performed during:		
	Audit/house assessment	**Measure installation**	**Post-inspection**
Pressure diagnostics:			
Blower door measurement (building air leakage rate)	☐	☐	☐
Zonal pressure	☐	☐	☐
Room-to-room pressures (distribution system balancing)	☐	☐	☐
Duct pressure pan measurements	☐	☐	☐
Duct blower measurement (duct air leakage rate)	☐	☐	☐
Blower door subtraction meas. (duct air leakage rate)	☐	☐	☐
Space-heating system:			
Flue gas analysis (steady-state efficiency measurement)	☐	☐	☐
Heat rise	☐	☐	☐
CO level in flue	☐	☐	☐
CO level of equipment room	☐	☐	☐
Draft/spillage (normal operation)	☐	☐	☐
Worst case draft/spillage (CAZ)	☐	☐	☐
Safety inspection	☐	☐	☐
Air-conditioning system:			
Refrigerant charge (e.g., superheat or subcooling)	☐	☐	☐
Safety inspection	☐	☐	☐
HVAC components:			
Air handler flow rate	☐	☐	☐
Thermostat anticipator current	☐	☐	☐

Diagnostic measurement or inspection	Diagnostic/inspection performed during:		
	Audit/house assessment	Measure installation	Post-inspection
Hot-water (water-heating) system:			
Flue gas analysis (steady-state efficiency measurement)	☐	☐	☐
CO level in flue	☐	☐	☐
CO level of equipment room	☐	☐	☐
Draft/spillage (normal operation)	☐	☐	☐
Worst case draft/spillage (CAZ)	☐	☐	☐
Hot water temperature	☐	☐	☐
Shower head flow rate	☐	☐	☐
Faucet flow rate	☐	☐	☐
Safety inspection	☐	☐	☐
Other CO measurements:			
Cook stove	☐	☐	☐
Kitchen	☐	☐	☐
Main living area	☐	☐	☐
Other diagnostics and inspections:			
Refrigerator energy use	☐	☐	☐
Exhaust fan air flow rate	☐	☐	☐
Infrared scanning (camera)	☐	☐	☐
Radon testing	☐	☐	☐
Other (specify: ________________________________)	☐	☐	☐
Other (specify: ________________________________)	☐	☐	☐
Other (specify: ________________________________)	☐	☐	☐

Record the diagnostic measurements taken on **THIS** housing unit: ***(fill in all that were taken)***

Diagnostic measurement	Pre-weatherization	Post weatherization
Building air leakage (blower door measurement):		
Air leakage rate	cfm	cfm
House WRT outside pressure difference	Pa	Pa
Duct leakage (pressure pan measurements):		
Sum of pressure pan readings	Pa	Pa
Number of registers included in sum		
House WRT outside pressure difference	Pa	Pa
Duct leakage (duct blower measurements):		
Total duct leakage rate	cfm	cfm
Duct leakage to the outside	cfm	cfm
Duct WRT outside pressure difference	Pa	Pa
Steady-state efficiency (flue gas analysis):		
Primary space-heating system	%	%
Secondary space-heating system	%	%
Hot water heater	%	%

MEASURES INSTALLED

Identify the measures that were installed on **THIS** building: ***(check all that apply)***

Measure	Installed by	
	In-house crew	Contractor
Air sealing work:		
General house caulking and weatherstripping (e.g., doors, windows)	▯	▯
House air sealing emphasizing bypasses (leaks identified by auditor and/or crew without using a blower door)	▯	▯
House air sealing emphasizing bypasses (leaks identified by auditor and/or crew with aid of a blower door)	▯	▯
Air distribution system (duct) sealing and repair	▯	▯
Other non-window air sealing work (specify: ___________________)	▯	▯
Insulation:		
Attic insulation (installed where there was no existing insulation)	▯	▯
Attic insulation (added to existing insulation)	▯	▯
Wall insulation (normal density—two-hole gravity blow technique)	▯	▯
Wall insulation (high density—one-hole tube-fill technique)	▯	▯
Floor insulation	▯	▯
Rim or band joist insulation	▯	▯
Foundation wall insulation	▯	▯
Duct insulation	▯	▯
White roof coat	▯	▯
Skirting	▯	▯
Other insulation (specify: ___________________________________)	▯	▯
Windows:		
New window (justified based on energy savings or SIR)	▯	▯
New window (justified as a needed repair or H&S item)	▯	▯
Window glazings	▯	▯
New window screen	▯	▯
Window lock replacement	▯	▯

Window screen repair	▯	▯
Other window repair (e.g., sashes, frames)	▯	▯
Storm window	▯	▯
Window shading (e.g., awning, film, sun screen)	▯	▯
Other window treatments (specify: ___________________________)	▯	▯
Doors:		
New door (justified based on energy savings or SIR)	▯	▯
New door (justified as a needed repair or H&S item)	▯	▯
Door lock (new or replacement)	▯	▯
Door or door framing repair	▯	▯
Storm door	▯	▯
Other door treatments (specify: ______________________________)	▯	▯
Space-heating systems:		
New space-heating system (justified based on energy savings or SIR)	▯	▯
New space-heating system (justified as a needed repair or H&S item)	▯	▯
Space-heating system repair (e.g., controls, safety items, flues)	▯	▯
Space-heating system tune-up	▯	▯
Vent damper	▯	▯
Intermittent ignition device	▯	▯
Other space-heating system modification (specify: ______________)	▯	▯
Air-conditioning systems:		
New air conditioner (justified based on energy savings or SIR)	▯	▯
New air conditioner (justified as a needed repair or H&S item)	▯	▯
Air conditioner repair	▯	▯
Air conditioner recharge/tune-up	▯	▯
Ceiling or whole-house fans	▯	▯
Other air-conditioning system modification (specify: _____________)	▯	▯

Ventilation:		
Exhaust fan in bathroom	☐	☐
Exhaust fan in kitchen	☐	☐
Whole-house ventilation system	☐	☐
Other ventilation system improvements (specify: ________________)	☐	☐
HVAC accessories:		
New programmable (setback) thermostat	☐	☐
New standard thermostat	☐	☐
Duct vents, grills, or registers	☐	☐
Standard air filter	☐	☐
High efficiency particulate arresting (HEPA) air filter	☐	☐
Other HVAC accessories (specify: ____________________________)	☐	☐
Water-heating system:		
New water heater (justified based on energy savings or SIR)	☐	☐
New water heater (justified as a needed repair or H&S item)	☐	☐
Water-heating system repair	☐	☐
Water-heater tank insulation wrap	☐	☐
Pipe insulation	☐	☐
Low-flow showerhead	☐	☐
Faucet aerators	☐	☐
Water heater temperature reduction	☐	☐
Other water heating system measure (specify: __________________)	☐	☐
Other baseloads:		
Indoor lighting	☐	☐
Outdoor lighting	☐	☐
Refrigerator (justified based on SIR)	☐	☐
Refrigerator (justified as a needed repair or H&S item)	☐	☐
Other baseload measure (specify: _____________________________)	☐	☐

Client education:		
Brochures and booklets	▯	▯
Manuals	▯	▯
Compact disks	▯	▯
Videos or DVDs	▯	▯
<5 minute discussion	▯	▯
5-14 minute discussion	▯	▯
15-29 minute discussion	▯	▯
30-60 minute discussion	▯	▯
>1 hour discussion	▯	▯
Other client education approach (specify: ________)	▯	▯
Other health, safety, and repair:		
Smoke alarm	▯	▯
CO monitor	▯	▯
Attic ventilation	▯	▯
Roof repair	▯	▯
Wall repair	▯	▯
Floor repair	▯	▯
Foundation repair	▯	▯
Ground vapor barrier	▯	▯
Gutter or downspout repair	▯	▯
Grading of lot	▯	▯
Plumbing repair	▯	▯
Sewer repair	▯	▯
Electrical repair	▯	▯
Stair repair	▯	▯
Non-skid material on stairs	▯	▯
Safety gate at stairs	▯	▯
Grab bar in bathroom	▯	▯

Non-skid material in bathtub		
Metal chimney liner		
Lead abatement		
Asbestos abatement		
Removal or safe storage of household poisons		
Other H&S and repair items (specify: ________________________)		

If a new space-heating system was installed and justified as a needed repair or a health and safety item (rather than being justified based on cost effectiveness), please identify the reason you chose to replace it: ***(check all that apply)***

- Cost of repair/retrofit exceeds 50% of replacement cost
- Existing heating system not running
- Existing heating system is old (e.g., at end of life, too old to be repaired/adjusted)
- Switching fuel
- Converting from steam system to hot water system
- Cracked heat exchanger
- Boiler leaking
- Safety switches/controls not operational and can't be repaired
- Unvented space heater
- Existing heating system not safe to run for other reason (specify: _________________)
- Other: ____

Please identify any cost-effective measures (not repair or health and safety measures) recommended by your audit procedures that you were unable to install in this housing unit because of insufficient funds: ***(check all that apply)***

☐ Air sealing
☐ Duct sealing
☐ Attic insulation
☐ Wall insulation
☐ Floor/foundation insulation
☐ Duct insulation
☐ New window(s)
☐ Storm windows(s)
☐ Door(s)
☐ Storm door(s)
☐ New space-heating system
☐ Space-heating system tune-up
☐ New air conditioner(s)
☐ Air conditioner tune-up(s)
☐ HVAC thermostat
☐ New water heater
☐ Water heater insulation wrap
☐ Water flow devices (e.g., showerheads, faucet aerators)
☐ Lighting
☐ Refrigerator
☐ Other: ____

Provide the costs associated with installing the measures in **THIS** building:

	In-House Crew	**Contractor**	**Total**
Material costs			
Labor costs[1]			
Profit/overhead[2]			
Total			

[1]Crew-based labor costs should be based on the crew's fully loaded hourly rate (rather than the crew's take-home pay rate) which may include costs associated with insurance, etc. These labor costs should include the crew's time for traveling to the job site.

[2]Contractor profit and overhead may already be included in the contractor's material and labor costs.

In the figures provided, do **NOT** include any program management costs such as those associated with intake and eligibility determination, audits and house assessments, final inspections, contractor or crew management/supervision, and program administration. Also, do **NOT** include installation-related overhead costs such as those associated with vehicles, equipment, and training.

Building Type Definitions:

Single-family detached house—House that provides living space for one family or household, is contained within walls that go from the basement (or the ground floor, if there is no basement) to the roof, and has no walls that are shared (or built in contact) with another household. A manufactured house assembled on site is a single-family detached housing unit, not a mobile home.

Single-family attached house—House that provides living space for one family or household, is contained within walls that go from the basement (or the ground floor, if there is no basement) to the roof, has at least one wall that is shared (or built in contact) with an adjacent household, and has an independent outside entrance. An attached house is not divided into more than one housing unit and does not have a household living above or below another one within the walls extending from the basement to the roof to separate any adjacent units. Examples include a house that is a side-by-side duplex, part of a townhouse building, and a row house.

Mobile home—Home that is built on a movable chassis, is moved to the site, and may be placed on a permanent or temporary foundation. If rooms are added to the structure, it is considered a mobile home if the added floor area is less than the mobile home's original floor area; otherwise, it is a single-family detached house. A manufactured house assembled on site is a single-family detached house, not a mobile home.

Small multifamily—Building with two to four housing units (i.e., building that is divided into living quarters for two, three, or four families or households) in which one household lives above or beside another and does not meet the single-family attached house definition. Includes houses originally intended for occupancy by one family (or for some other use) that have since been converted to separate dwellings for two to four families. Typical arrangements in these types of living quarters are separate apartments downstairs and upstairs or one apartment on each of three or four floors.

Large multifamily—Building with five or more housing units (i.e., building that contains living quarters for five or more families or households) that does not meet the single-family attached house definition.

Shelter—Structure whose principal purpose is to house individuals on a temporary basis who may or may not be related to one another and who are not living in nursing homes, prisons, or similar institutional care facilities.

APPENDIX M. SAMPLE SIZE JUSTIFICATION

This appendix addresses sample sizes needed for the various WAP evaluation component surveys. Populations to be sampled are discussed in Section M.1. In addition to dependencies on weather, weatherization data tends to be noisy because of complex and frequently changing behavior of occupants. Wide confidence intervals often occur for estimates computed even from relatively large samples. Equivalently, relatively large samples are often required to achieve specified levels of accuracy. The WAP evaluation will require statistical sampling of weatherization agencies and weatherization and control homes and occupants. Statistical sampling of these populations is discussed in Sections M.2 and M.3.

The usual approach taken in justifying a survey sample size is to identify a main quantity to be estimated, to justify a sample size necessary for estimating it, and to argue that additional information to be collected in the survey will be obtained at little or no additional burden to either subjects or analysts. The sample size calculation ordinarily requires (1) a preliminary assessment of the variability of the main quantity to be estimated (for example, a preliminary estimate of its coefficient of variation, and (2) a specification of the accuracy required of the main quantity to be estimated—for example "to within 10% of its true value with 90% confidence." Also, in cases of complex (multi-stage, stratified, probability-sampled, and control-adjusted) designs, as is proposed for the WAP evaluation, sample size formulas for simpler (e.g., simple random sampling) designs are often used as an approximation. The sample design in preliminary/pilot studies is usually much simpler anyway. These approaches are taken below.

Much of the material in these sections will be used directly for the WAP evaluation OMB Paperwork Reduction Act (PRA) submission and Supporting Statement required for surveys employing statistical methods (www.whitehouse.gov/omb/inforeg/83i-fill.pdf). Some of the discussion is therefore written in that context. Section M.4 contains additional notes about topics such as nonresponse that will also have to be addressed in the OMB PRA submission.

M.1 POPULATIONS SAMPLED

The WAP evaluation will require statistical sampling of weatherization agencies. Agency weatherization staff and weatherization and control homes/occupants will be subsampled. WAP management will also be interviewed, and 100% of State weatherization programs will be surveyed. WAP management and State weatherization programs will be sampled completely (i.e., 100%) rather than statistically, because these populations are small and it is expedient to sample them that way. (For PRA purposes, DOE program management interviews are not considered a "collection of information," because the information acquired is to be used for a specific purpose (i.e., the WAP evaluation) rather than general statistical purposes—"'Collection of information' includes questions posed to…employees of the United States, if the results are to be used for general statistical purposes…" [5CFR1320.3].)

A justification for taking a complete sample rather than a statistical subsample of State agencies, which ***is*** required by OMB, is given by OMB (2006): "When the target population is small and each unit is unique, a census is likely to be preferred over a sample survey. For example, when an agency evaluates a Federal program that is implemented by the states (each one perhaps somewhat differently), a census of state program directors may provide higher quality information with little cost difference from a sample survey of a slightly smaller number of states. In this case, there may also be concerns about missing practices of some states that were not included in the sample if a census were not conducted."

Several case studies will also be conducted as components of the WAP evaluation. The case studies will not involve statistical sampling or inference, however, or they will be below the PRA threshold of ten or more observations. They do not require OMB approval because either the sample size will be less than ten or they will be conducted by direct observations by social scientists or weatherization experts of homes or workers during the execution of normal weatherization activities, and such information collections are not subject to the PRA: "'Information' does not generally include items in the following categories...Facts or opinions obtained through direct observation by an employee or agent of the sponsoring agency or through nonstandardized oral communication in connection with such direct observations;" [5CFR1320.3]. Sample sizes for the case-studies will be based on judgment rather than formal statistical calculations.

M.2 AGENCY SAMPLING

M.2.1 Agency sampling for energy benefits (billing data analysis)

As in the 1990 evaluation (Brown et al, 1993), occupant-level energy consumption and dwelling characteristic data will be obtained by first sampling agencies and then acquiring occupant-level data from the agencies. In the 1990 evaluation, 400 agencies were sampled, 361 agencies responded, and one third of the records for the weatherized units and one third of the records for the control units were sub-sampled for each agency that responded (ibid.). This rate applied to single-family detached dwellings as well as mobile homes. To properly determine weatherization savings in multifamily buildings, all units in each selected building must be analyzed. Therefore, multifamily buildings were selected at the rate of one third of buildings.

The 1990 evaluation (ibid.) lead to the following mean ± standard error control-adjusted natural gas and electricity savings estimates per weatherized unit per year:

Primary Heating Fuel	Average Savings per Weatherized Unit	Standard Error of Average	Precision
Natural gas	17.8 MMBtu/year	1.8 MMBtu/year	10%
Electricity	1,830 kWh/year	358 kWh/year	20%

The precision obtained in the 1990 evaluation was subsequently found to adequate for that evaluation and is assumed adequate for the proposed evaluation as well. Thus the basic objective of the proposed study is to update the 1990 evaluation by repeating it today. However, the proposed evaluation will incorporate several minor refinements and additions.

The 1990 evaluation was stratified by agency size and geographic region. The agency size strata were sampled at the same rate except for the largest-size stratum which was certainty (100%)

sampled. Thus, with the exception of the very largest agencies, large agencies had no greater chance of selection than small ones. Yet, in general, the larger the agency, the greater its contribution to total energy savings. In the proposed evaluation probability proportional to size (PPS) sampling with size measured as agency funding will provide a refinement of the 1990 stratification by agency size by allowing agency size to be continuously reflected in the sampling probabilities, with the effect that all agencies will be statistically represented, but larger agencies will be sampled preferentially.[3]

The geographic stratification in the proposed evaluation will also be a refinement of the 1990 study's. The earlier study employed ten climate subregions, which were approximations of standard climate regions based on state boundaries. For the proposed study, in addition to representing all climate zones, it was considered politically advantageous to guarantee representation of all states. (Furthermore some states may commission add-on survey components of their own.) Therefore stratification for the proposed study will be by state.

Although the sampling for the proposed study is thus a refinement of the 1990 sampling, the two studies will still be substantially similar, and the 1990 study is by far the best available source of prior information for the proposed one. For the purpose of sample size calculations, it is reasonable to regard the proposed evaluation as emulating the 1990 study. Therefore 400 agencies will be sampled in the proposed study, as in the 1990 evaluation.

For each sampled agency, houses (or buildings for multifamily buildings) will be randomly sampled. In general, the rate of sampling within agencies will be fixed for all agencies. That rate will be approximately one-in-three and will thus achieve the same overall sample size and precision achieved in the 1990 evaluation. However, the exact sampling rate for each agency will depend on the following factors that must be determined during the course of the study: (1) The target population of weatherized and control units must be restricted to "DOE" units, that is, units weatherized primarily with DOE funds. Agencies weatherize homes using various funding sources (states and utilities also provide funding), and use different bookkeeping methods for counting weatherized units, and in particular, DOE units. The target population of DOE weatherized and control units has to be determined for each agency on a case-by-case basis. Target population sizes are expected be smaller than in the 1990 evaluation, and sampling proportions will be larger to achieve a comparable sample overall size. (2) In the proposed study, more so than in 1990, some agencies will be able to deliver complete sets of data in electronic formats. However, the extent to which this happens and the ease of compliance of agencies with requests for data in general is unclear. Recent interaction with a few agencies has shown that many agencies still rely on paper record keeping and that delivery by an agency of a complete electronic database is still likely to be more the exception than the rule. Nevertheless, agencies that can just as easily deliver all of their data as sample part of it will be asked to do so. (3) As in the 1990 evaluation, some utilities will not comply with requests for data. Utility nonresponse is considered independent of agency weatherization performance, however, and is thus nonbiasing.

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[3]An alternative measure of an agency's size is the number of units it weatherizes. The number of units weatherized is not as good a measure of size, however, because of an accounting feature in the WinSAGA database (see following discussion) in which units weatherized with only one dollar of DOE funding can be counted as DOE weatherized units.

Utility nonresponse is also likely to be lower than in the in the 1990 evaluation, because of advances in electronic bookkeeping.

A listing of weatherization agencies along with their planned dollar allocation and units sampled can be obtained from the WinSAGA (Systems Approach to Grants Administration for Windows) data base.[4] As of 2005, there were 927 agencies. A PPS sample of 400 agencies with the 2005 funding allocation as the measure of PPS size and stratified by state was selected in order to see what the PPS sampling of agencies and one-third subsampling of units would likely translate to in terms of allocation dollars and weatherized units in the actual sample. A ten percent nonresponse rate was assumed. Because of constraints on PPS sampling, the very largest agency had to be sampled with certainty. Thus 361 agencies were actually sampled (as in the 1990 evaluation). Results of the sample are summarized in Table 1.

After deducting the nonresponders, 361 agencies were sampled, which is 39% of the 927. Of course the sample of 361 agencies represents all 927 agencies in a statistical sense. Because size is agency funding allocation, although the sample accounts for 39% of agencies, it accounts for 65% of funding. The sample also accounts for 63% of weatherized units. (The reason for the differences in the funding percentage (65%) and the units percentage (63%) may be related to the way units are counted in the WinSAGA database, with only one dollar of DOE funding necessarily required for a unit to be counted as a DOE unit.)

Table 1 also shows the units actually sampled (17,232) in a one-in-three subsample of units, and, assuming (as in the 1990 evaluation) that 60% of units are gas or electric, the number of units (10,339) potentially available for billing the analyses. Utility nonresponse will depreciate this number. However, the final column in the table shows that if data is obtained for 46% of the units potentially available for billing the analysis, then the number of units sampled will equal the number sampled in the 1990 evaluation. The 46% acquisition rate is reasonable and similar to the corresponding rate in the 1990 evaluation (ibid.).

M.2.2 Agency sampling for program characterization and process assessment

In addition to energy use and savings data, information about the weatherization process and program, also necessary for the evaluation, will be obtained from the 400 sampled agencies. The justification for collecting this additional information is based on the above for the metered fuel (natural gas and electric) savings studies and that the additional burden in collecting/delivering this information from agencies from which energy use and savings data is already being collected is small. Sampled agencies will be asked to provide (1) client lists, (2) weatherized and control unit dwelling data, and (3) staff contact information and functional classifications: crew, supervisor, auditor/inspector. Clients (occupants) will be subsampled as described in Subsection M.3.1. Dwelling data will be used in fuel-metering studies discussed in the remainder of Section M.3. Agency staff members will be subsampled as described next.

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[4]WinSAGA data kindly provided by Christine Askew, Office of the Weatherization and Intergovernmental Program, Energy Efficiency and Renewable Energy, U.S. DOE.

Table M.1 WAP 2005 National and Approximate PPS Sample Totals Size = 2005 Dollar Allocation and 10% Nonresponse

National Agencies (2005 Listing)	Agencies Sampled	Agencies Responding	Percent of National Agencies Responding	2005 National Allocation	Allocation Represented by Responders	Percent Allocation Represented by Responders
929	400	361	39%	$258,231,144	$168,535,723	65%

2005 National Units Planned	Units Represented by Responders	Percent of Units Represented by Responders	Units Subsampled (at 33%)	Gas/Elec Units Subsampled (60% Approx)	Capture Rate To Achieve 1990 Number Usable (4,796)
82,701	51,695	63%	17,232	10,339	46%

M.2.3 Agency staff subsampling

A subsample of agency staff members will be taken from a list compiled from the agency staff contact information. To ensure adequate representation, the sample will be stratified by staff functional classification (crew, supervisor, auditor/inspector) with equal-size strata. A computer assisted telephone interviewing (CATI) survey will be conducted of the sampled staff. Several technical questions will be posed to the staff members to characterize current staff understanding and awareness of weatherization methods and technologies. The primary endpoint of interest is the combined proportion of correct responses and how it relates to staff training experience. The proportion of correct responses is expected also to serve as a baseline for future studies.

Sampling will be implemented by random sampling from staff lists identified by the sampled agencies. As an approximation in reckoning sample sizes, we ignore the agency sampling weights, though they will be accounted for in the data analysis. The proportions of correct responses in each sampling strata (crew, supervisor, auditor/inspector) will be estimated to within five percentage points with 90% confidence. The standard error of the combined proportion of correct responses can be no greater than the standard error of an individual (correct/incorrect) response, which cannot exceed $.5/n^{1/2}$ (maximum standard error of binomial proportion). This will be achieved if $1.645 \times .5/n^{1/2} = .05$, that is, if n = 271, where n is the sample size in each stratum. Nonresponse in this survey is expected to be negligible, because the survey will be of agency employees whose contact information has been provided by the agencies. The total sample size will be $271 \times 3 = 813$.

M.3 OCCUPANT SAMPLING

M.3.1 Occupant sampling for program characterization and process assessment

A CATI survey similar to the agency staff survey will be conducted of weatherization assistance recipients and control subjects on the recipient list but for whom the weatherization work has not yet been performed. Clients served by each agency included in the energy savings study will be surveyed to determine their perceptions on how well program services were delivered and to assess learning about energy conservation through interaction with the agencies. For some of the survey questions, for example, energy conservation education, comparisons with controls will be needed. The weatherization service questions essentially compose a customer satisfaction survey.

Clients, one per sampled household, will be sampled through agencies for identification and contact information (phone numbers). After the clients have been sampled, client lists will be destroyed.[5]

The primary sampling unit is agency, and the 400 agencies sampled for the energy benefits analysis will also be asked for client contact lists. The sample size calculation is based on the approximation that the sampling is simple random (agency sampling weights will be used in the analysis, however). The weatherization group sample size n_w will be determined to ensure, at a 90% level of confidence, a maximum error of .03 (three percentage points) in a binary (e.g., yes/no) response probability. This implies a weatherization group sample size of 752 clients. (Where $Z_{.95} = 1.64$ is the 95th percentile of the standard normal distribution, $Z_{.95}[p(1–p)/n]^{1/2}$ # $Z_{.95}[.5(1–.5)/n_w]^{1/2} = 1.64\times.5/n_w^{1/2}$, which is .03 when n_w =752.) The control group sample size will be determined to ensure, at a 90% level of confidence, a maximum error of .05 (five percentage points) in estimating $p_w - p_c$, the difference between weatherization and control group binary response probabilities. This implies a control group sample size of 423. ($Z_{.95}[p_w (1–p_w)/752 + p_c (1– p_c)/n_c]^{1/2}$ # $Z_{.95}[.5(1–.5)(1/752 + 1/n_c]^{1/2}$, which is .05 when n_c =423.

Because this occupant survey will be conducted in longitudinal installments over several months, attrition is possible, but is not expected to exceed 25% (based on four-year average occupancy). Therefore, an additional 25% of subjects, 188 weatherized and 106 control subjects, will be sampled at the initial stage of the survey to compensate for subjects who move. Otherwise, nonresponse is expected to be small for this survey, because (1) weatherized clients will have benefited from weatherization assistance, (2) control group clients are anticipating that assistance, and (3) both groups will be identified from contact information maintained by the

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[5]Should any agency refuse to comply with the request for a client list, the agency will be asked for a list of its client names only (no contact information). This list will then be sampled, and the agency will be asked for the contact information for only those clients sampled. If the agency refuses to release even the client names, then the agency will be given random strings of three letters representing the first three letters of a last name. The agency will then select from its alphabetized client list the weatherized or control client whose name falls at or closest after the assigned string. (Strings will be selected with probability sampling to represent the frequencies of American surnames. The strings and their corresponding probabilities will be determined from a Census Bureau data (http://www.census.gov/genealogy/names/dist.all.last).

weatherization agencies. Furthermore, a small cash incentive will be used to maximize the response rate ($40 when the survey is completed before weatherization, $40 when the survey is completed immediately after weatherization, and $50 when the survey is completed a year after weatherization). Thus a total of 940 (752 + 188) weatherized and 529 (423 + 106) control occupants will be sampled.

M.3.2 Occupant sampling for single-family fuel-oil-heated homes

For bulk-delivery fuels such as fuel oil and propane billing, delivery amount records are too discrete for energy analyses. In-home metering is required for such bulk fuel studies. In-home metering studies are expensive in comparison with billing-data analysis. However, because weatherization primarily involves insulation and sealing, it is reasonable to assume that weatherization energy savings (though not necessarily dollar cost savings) do not vary much among fuel types. This assumption is supported by the fuel-oil component of the 1990 evaluation (Levins and Ternes, 1994). However, because overall program savings estimates computed under this assumption will obviously depend on it, it is a good idea to test it for the major fuel alternatives to natural gas and electricity, namely fuel oil and propane.

The objective of the fuel-oil (and propane) single-family study then will be to test the hypotheses that the weatherization energy savings for homes heated with these fuels are the same (on average) as the savings for natural gas heated homes. More formally, the null hypothesis H_0: "Mean savings per unit for fuel oil is same as for natural gas," will be tested against the alternative that the mean savings is different, with a probability of at least .90 of detecting a difference of 20% or more of the mean natural gas pre-weatherization NAC.

The study of fuel-oil heated homes conducted as part of the 1990 evaluation (ibid.) will serve as a pilot study for reckoning sample sizes for the fuel-oil as well as the propane single-family components of the proposed evaluation. From the agency sample, a subsample will be selected for the fuel-oil study, using PPS sampling from agencies that weatherize appreciable numbers of single-family fuel-oil-heated homes. The 1990 evaluation was conducted similarly by sampling agencies and subsampling weatherized and control units of the agencies. Because the hypothesis being tested was considered in the previous study, and because the proposed study has an additional component for propane (as well as refrigerators and air conditioners), the proposed fuel-oil study will be a scaled-down version of the 1990 fuel-oil evaluation. The scale factor is suggested as follows.

Let A_N and A_F denote estimates (to be computed) of the average per-unit savings for natural gas and fuel oil respectively. Let SE_N and SE_F denote the standard errors of these estimates. As discussed above, SE_N is expected to be approximately the same for both the proposed study and the 1990 evaluation. Let $f = N_P/N_{90}$, where N_{90} is the number of units sampled in the 1990 fuel-oil study (approximately 300, see below) and N_P is the number of units (to be determined) in the proposed study. Then the standard error of the difference $D = A_N - A_F$ for the proposed study is $SE_D = [(SE_N)^2 + (SE_F)^2/f\,]^{1/2}$.

Again let $Z_{.95} = 1.64$ denote the 95th percentile of the standard normal distribution, and let $T = D / SE_D$. An approximate level 0.1 test of H_0 can be conducted by rejecting H_0 for $| D / SE_D | > Z_{.95}$.

For this test, P(Reject) = 1 – P($-Z_{.95}$ SE_D < D < $+Z_{.95}$ SE_D). For a given true difference Δ, P(Reject) = 1 – P($-Z_{.95}\ SE_D - \Delta < D - \Delta < Z_{.95}\ SE_D - \Delta$) = 1 – P($-Z_{.95} - \Delta / SE_D < (D - \Delta) / SE_D < Z_{.95} - \Delta / SE_D$) = $1 - \Phi(Z_{.95} - \Delta / SE_D) - \Phi(-Z_{.95} - \Delta / SE_D)$, where Φ denotes the cumulative distribution function of the standard normal distribution.

From the 1990 evaluation, the average annual fuel savings (± standard error) are 22.4 (± 2.7) MMBtu. This was for 193 fuel-oil-heated weatherized units and 105 fuel-oil-heated control units (approximately 300 fuel-oil-heated units in all) selected from 41 agencies. The pre-weatherization NAC of natural gas is 137.4 MMBtu (from 1990 evaluation, Brown et al 1990). Taking Δ to be ten percent of the pre-weatherization NAC (estimated), Δ = 13.74 MMBtu. For this Δ, P(Reject) can be computed for various values of *f*. As *f* increases, so does P(Reject). A SAS (Statistical Analysis System) program was written to calculate P(Reject) for each *f*. It turns out that P(Reject) = .90 for *f* = .39. This suggests that a survey 39% as big as the 1990 fuel-oil study is needed for the proposed fuel-oil study: about 75 weatherized and 41 control homes, 116 homes in all, from about 16 agencies. Because the variability of savings (i.e., pre-post differences) of weatherized and control fuel-oil heated homes is about the same (Levins and Ternes, 1994, Table ES.1), it is more efficient to take half weatherized and half control homes, that is, 58 of each rather than 75 and 41. This will be implemented by random sampling from single-family fuel-oil-heated homes identified in the dwelling information data provided by the sixteen subsampled agencies.

As a scaled version of the fuel-oil component of the 1990 evaluation, nonresponse is accounted for in the sample size calculation. However, prior experience (ibid.) with in-home fuel-oil metering studies has shown that metering instruments fail or are damaged about ten percent of the time. This kind of nonresponse can be considered random and nonbiasing. The extent to which this censoring occurred in the 1990 study is unclear from the documentation. Therefore, to ensure an adequate sample size, increasing the sample size by 10% seems advisable. Thus 64 (= 58×1.1) weatherized and control homes will be sampled.

This study will be coordinated with the Occupant Sampling for Air Conditioned and Refrigerator Replacement Homes studies (see Sections M.3.6-7) and the Occupant Sampling for Direct Measurement of Selected Household Factors study (see Section M.3.8) to use common homes where possible without biasing the sampling design.

M.3.3 Occupant sampling for single-family propane-heated homes

The hypothesis discussed above that weatherization savings are the same for fuel-oil and natural-gas heated homes is also reasonable for propane-heated homes. The propane component of the proposed evaluation is intended as check on this hypothesis for propane. As the underlying hypothesis is that the distributions of savings are the same for all three fuel types, it is reasonable to assume that the sample size for the proposed fuel-oil study is also appropriate for the propane study. Therefore, as above for the fuel-oil component, 64 weatherized and 64 control propane-heated units will be sampled for the propane component, from sixteen agencies PPS-subsampled from agencies that weatherize appreciable numbers of single-family propane-heated homes. This will be implemented by random sampling from single-family propane-heated homes identified in the dwelling information data provided by the sixteen subsampled agencies.

This study will be coordinated with the Occupant Sampling for Air Conditioned and Refrigerator Replacement Homes studies (see Sections M.3.6-7) and the Occupant Sampling for Direct Measurement of Selected Household Factors study (see Section M.3.8) to use common homes where possible without biasing the sampling design.

M.3.4 Occupant sampling for multifamily fuel-oil-heated homes

An approach similar to the above approach for single-family fuel-oil-heated homes can be taken for multifamily fuel-oil-heated homes. Preliminary data about multifamily homes is available from the 1990 evaluation. The objective of the multifamily home component of the proposed evaluation will be to test the hypothesis that the weatherization energy savings in fuel-oil and natural-gas heated multifamily homes are the same.

However, multifamily buildings pose a more complicated analysis problem than single-family homes, because (1) there are fewer multifamily buildings than single-family homes, (2) multifamily buildings vary substantially in numbers of individual home units, and (3) to properly understand the effect of weatherization on multifamily buildings, all of the dwelling units in each multifamily building sampled must be analyzed collectively. Because multifamily buildings vary substantially in numbers of individual home units (for example, the thirteen natural gas heated multifamily homes examined in the 1990 study varied from 6 to 80 in numbers of units), consumption and savings per unit will be considered as the metric of interest, rather than savings *per se*.

For single-family fuel-oil heated homes (as discussed above), control-adjusted fuel-oil savings estimated by metering will be compared to control-adjusted natural gas savings (estimated from billing data). Although, from the accuracy alone it may be preferable to use control-adjusted savings (e.g., because of differences in natural gas and fuel-oil prices), savings for control homes tend to be small, and *differences* in control savings therefore tend to cancel out of differences between control-adjusted savings. Therefore, because of the complexity of and smaller sample sizes used for the multifamily fuel-oil component, no control adjustment will be made. That is, in estimating the difference between fuel-oil and natural-gas heated home weatherization savings, only weatherized homes will be compared.

The 1990 evaluation serves as a pilot study. Thirteen natural-gas heated multifamily buildings sampled in the 1990 study had a mean savings of 18.1 ± 4.4 (standard error) MMBtu per unit. The average pre-weatherization consumption per unit for these homes was 82.5 MMBtu. Assuming that the standard error for fuel-oil heated multifamily buildings is the same, the sample size needed to detect with 90% confidence a difference between the natural gas and fuel-oil populations that is 20% of the natural gas pre-weatherization consumption can be calculated. A SAS program similar to the one written for the single-family fuel-oil-heated homes calculation shows that this factor is 1.5, which indicates a sample size of 20 ($= 1.5 \times 13$) for the proposed study. Thus 20 multifamily fuel-oil heated buildings should be sampled. However, prior experience with multifamily building studies has shown that data obtained for them will be inadequate about 20% of the time, and the extent to which this occurred in the 1990 study is unclear from the documentation. Therefore, to ensure an adequate sample size, increasing the sample size by 20% seems advisable. Thus 24 (= 20×1.2) multifamily buildings will be sampled. (Note that this kind of nonresponse can be considered random and nonbiasing.) The sampling will be implemented by random sampling from multifamily fuel-oil-heated homes identified in the dwelling information data from agencies that weatherize multifamily fuel-oil-heated homes. Agency sampling weights will be accounted for in the data analysis.

M.3.5 Occupant sampling for propane-heated mobile homes

Although weatherization savings in mobile homes differs from savings for single-family site-built homes, it is reasonable to regard the savings for propane-heated mobile homes as about the same on average as the savings for natural-gas heated mobile homes. Because of billing data analysis, the natural gas savings is much easier to estimate. Further, the sample size needed to assess the difference (if any) between fuel types in mobile-home energy savings should be about the same as the sample size needed to assess the difference between fuel types in conventional homes. This suggests a sample size of 64 weatherized and 64 control units, from sixteen subsampled agencies, as suggested for the single-family fuel-oil study. This will be implemented by random sampling from propane-heated mobile homes identified in the dwelling information data provided by the sixteen subsampled agencies that weatherize appreciable numbers of propane-heated mobile homes.

This study will be coordinated with the Occupant Sampling for Air Conditioned and Refrigerator Replacement Homes studies (see Sections M.3.6-7) and the Occupant Sampling for Direct Measurement of Selected Household Factors study (see Section M.3.8) to use common homes where possible without biasing the sampling design.

M.3.6 Occupant sampling for air conditioned homes

Because of the wide variability in estimated weatherization savings for warm-climate states, it has been hypothesized that weatherization in warm-climate states does not achieve any air conditioning energy savings at all. In one air conditioner (AC) study (Ternes and Levins, 1992, Table 7.2), for a sample of 22 weatherized homes, the mean AC energy savings was –31 kWh, with a standard error of 167.2 kWh. The mean AC savings for a sample of 19 control homes was 106.7 with a standard error of 112.1. These results are consistent with the hypothesis of no AC savings. This study was done in Oklahoma, but results were similar in a study of AC savings in North Carolina (Sharp, 1994).

The object of the proposed AC study is to test the hypothesis that mean AC savings in warm-climate states are zero (H_0: Mean AC Energy Savings = 0) against the alternative that the mean savings are positive, with a probability of at least .90 of detecting a savings of ten percent of the pre-weatherization AC consumption. The Oklahoma study mean pre-weatherization AC consumption combined estimate from both weatherized and control groups is 1,652.4 kWh, ten percent of which is 165.2 kWh.

The proposed study will be conducted through weatherization agencies, the primary sampling units. As an approximation in reckoning sample sizes, we ignore the agency sampling weights (but they will be accounted for in the analysis). Assuming a level 0.1 one-sided hypothesis test, and using the Oklahoma study for preliminary estimates of the standard error and pre-weatherization AC savings, the sample size necessary for detecting a weatherization effect of 165.2 kWh or more can be estimated as follows.

From the weatherized and control group sample sizes (22 and 19) and standard errors (167.2 kWh and 112.1 kWh), it can be shown (using an F-test) that the sample variances are not significantly different. Therefore a pooled standard deviation will be used, and the same sample size will be assumed for both weatherized and control groups. The pooled standard deviation estimate is $[(22\times21\times(167.2)^2 + 19\times18\times(112.1)^2)/(21 + 18)]^{1/2} = 664.4$. The standard error for weatherized-control-group difference of mean AC savings can therefore be estimated be as $664.4/N^{1/2}$, where N weatherized and N control units are to be sampled (2N units in all).

The usual one-sided normal-theory test at the 0.1 level rejects when the difference of means divided by the standard error (SE) of the difference exceeds the .90 normal quantile $Z_{.90} = 1.28$. For a true mean difference of 165.2 (i.e., ten percent of pre-weatherization NAC). P(Reject) =P[difference/SE > 1.28] = P[(difference – 165.2)/SE + 165.2/SE > 1.28] ≈ P[Z > 1.28 – $165.2/(664.4/N^{1/2})$] = 1 – P[Z <= 1.28 – $(165.2/664.4)N)^{1/2}$]. This implies N = 106. That, is 106 weatherized and 106 control homes will be needed for the air-conditioned study. The sampling will be implemented by random sampling from air conditioned homes identified in the dwelling information data provided by a PPS-subsample of agencies from warm-climate states.

However, prior experience (Ternes and Levins, 1992) with in-home AC metering studies has shown that AC metering instruments may fail or be damaged up to twenty five percent of the time. (Note that this kind of nonresponse can be considered random and nonbiasing.) To ensure an adequate sample size, increasing the sample size by 25% seems advisable. Thus 132 (106×1.25) weatherized and control homes will be sampled in each of the treatment and control groups.

This study will be coordinated with the other Occupant Sampling studies (i.e., of Single-Family Fuel-Oil/Propane Heated Homes (Sections M.3.2-3), Propane-Heated Mobile Homes (Section M.3.5), Refrigerator Replacement Homes (see Section M.3.7), and Direct Measurement of Selected Household Factors (see Section M.3.8)) to use common homes where possible without biasing the sampling design.

M.3.7 Occupant sampling for refrigerator replacement homes

Prior studies (Blasnik 2006, Cavallo and Mapp 2000) have suggested that among agencies that do refrigerator replacements, the decision to replace a refrigerator is incorrect at most about 21% of the time, and the decision ***not*** to replace a refrigerator is incorrect at most about 51% of the time. These results are based on various studies, none with large sample sizes—a total of 115 in the Blasnik (2006) study. Furthermore a 21% rate of unnecessary refrigerator installations would be unacceptably high, and a 51% rate of missed replacement opportunities would also be too high. Therefore it would be useful to more accurately assess these decision error rates.

With an ammeter installed at the time of an energy audit and in place for several weeks after the audit, an assessment can be made about whether a decision made at the time of the audit to keep or replace a refrigerator was correct. One agency can make multiple assessments using the same ammeter at different times. Let R denote "replace," K, "keep" (i.e., don't replace), B, "Bad" (i.e., should be replaced) and G, "good" (i.e., should not be replaced). The objective of the refrigerator study will be to estimate the decision error rates P(G|R) and P(B|K).[6] More formally, the objectives of the refrigerator study are (1) to estimate P(G|R) to within five percentage points with 90% confidence, and (2) to estimate P(B|K) to within 7.5 percentage points with 90% confidence.

The proposed study will be conducted through weatherization agencies, the primary sampling units. As an approximation in reckoning sample sizes, we ignore the agency sampling weights, though they will be accounted for in the analysis. For simple random sampling (SRS) of N homes with refrigerator replacements, if $p \le 0.21$, the variance $p(1–p)/N$ of a binomial random variable with N trials and "success" probability p is maximum at 0.21 (rather than 0.5 for 0 # p # 1). For 90% confidence, a five percentage point margin of error can be achieved with a sample of $N = .21\times(1–.21)\times(1.64/.05)^2 = 180$. For SRS of N homes without refrigerator replacement, the variance of a binomial random (N, p) variable is maximum at 0.5. For 90% confidence, a 7.5 percentage point margin of error can be achieved with a sample of $N = .5\times(1–.5)\times(1.64/.075)^2 = 120$.

It would be a good idea to increase these refrigerator replacement and non-replacement home sample size estimates by 10% to allow for meter malfunction and other miscellaneous losses. Thus 180 + 18 = 198 homes with refrigerator replacement will be sampled, 120 + 12 = 132 homes without replacement will be sampled for the refrigerator study, and 330 (198 + 132) homes in all will be sampled for the refrigerator study.

For agencies that do refrigerator replacements, K and R decisions are both made a substantial proportion of the time. For example, the Iowa Bureau of Weatherization (2005) reports 724 refrigerator replacements (R's) and 1,282 non-replacements (K's) in 2,006 houses worked on. Therefore it will be straightforward to obtain the samples with the specified 180 R's and 120 K's. The sampling will be from agencies that do an appreciable number of refrigerator replacements. Homes will be selected, in order of their selection and identification as K's or R's, by the agencies after they receive the ammeters.

This study will be coordinated with the other Occupant Sampling studies (i.e., of Single-Family Fuel-Oil/Propane Heated Homes (Sections M.3.2-3), Propane-Heated Mobile Homes (Section M.3.5), Air Conditioned Homes (Section M.3.6), and Direct Measurement of Selected Household Factors (Section M.3.8)) to use common homes where possible without biasing the sampling design.

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[6]The probabilities P(G), P(B), P(R|G), P(K|B), which are also of interest, can be estimated from P(G|R) and P(B|K): P(G) = P(R)P(G|R) + P(B)P(B|R), P(B) = 1 – P(G), P(R|G) = P(G|R)P(R)/P(G), and P(K|B) = P(B|K)P(K)/P(B). P(R) and P(K) can be estimated from agency records for numbers of refrigerator replacements and numbers of homes worked on.

M.3.8 Occupant Sampling for Direct Measurement of Selected Household Factors

Carbon Monoxide. Weatherizations in some cases substantially improve indoor CO levels. According to the evaluation design team's health expert, substantial improvement occurs when CO levels are reduced from elevated levels (> 5 ppm) to background levels (≤ 5 ppm). Elevated levels occur in at least five but no more than twenty per cent of weatherized (low-income) homes, of which fewer than half are remediated by weatherizations. Thus fewer than 10 percent of weatherized homes are CO-remediated. The primary objective of this study component will be to provide a statistical estimate of the actual percentage of homes that are CO-remediated. The estimate should be accurate to within three percentage points with 90% confidence. In homes in which CO is measured, at a relatively small additional cost, the following will also be measured: airborne mold spores, airborne pollen, relative humidity, asbestos, radon, and temperatures inside refrigerators. Of these and CO, CO is of primary importance in the context of weatherizations. Thus we let CO data requirements determine the sample size for this evaluation component.

Sampling for this evaluation component will be by random sampling from single-family homes identified in the dwelling information data provided by the agencies. The sample size calculation presented here is based on the approximation that SRS will be used. The agencies themselves will of course be sampled by PPS sampling. Sampling weights will be used in the actual data analysis of the CO component homes to account for the PPS sampling.

The variance of a binomial proportion (for SRS) is p(1-p)/n, where n is the sample size, and p is the true underlying binomial probability. Therefore, when p is .1 (10%), the variance of the binomial proportion is less than or equal to .09/n. This implies that a sample size of 269 (= .09×(1.64/.03)) is needed to estimate the true proportion of CO-improved homes to within 3 percentage points with 90% confidence. However, prior experience with in-home metering equipment suggests that the sample size 269 should be inflated by 15% for damaged meters and other incidental losses. Thus the final sample size of weatherized homes for CO monitoring would be 2691.15 = 309.

The probability of CO remediation in a control home is very small (close to zero), first because CO problems occur in fewer than 20% of low-income homes, and second because without the intervention of a program such as the WAP, CO remediation is unlikely for low-income families. Therefore it would be wasteful to try to estimate the proportion of CO-remediated control homes with the same precision imposed for weatherized homes. Instead CO measurements will be taken for the control group of the indoor temperature study (n=59) discussed below, as a check on the working hypothesis that the percentage of CO remediations in control homes is essentially zero. The absence of any CO remediations in the 59 control homes will be construed as contrary to this hypothesis. The sample size 59 is just adequate to ensure that if the remediation probability for control homes exceeds .05, then with probability .95 one or more control home remediations will be observed in the sample (at which point the working hypothesis would have to be reconsidered).

Indoor Temperature. “Take-back” refers to the idea that after weatherizations, weatherization recipients might turn up their thermostats, taking advantage of the more economical heating achieved through weatherization and possibly consuming more energy than they did beforehand.

If it exists, take-back could seriously affect weatherization savings. (An alternatively theory is that weatherization recipients may become more energy conscious and turn their thermostats down.) Therefore a dual purpose of the Occupant Sampling for Direct Measurement of Selected Household Factors study will be to test the hypothesis H_0 that any pre-post-weatherization changes in indoor temperatures are the same for both the weatherized and control groups—that there is no take-back—against the alternative that there is a mean take-back of ½ degree or more.

Temperature data from the 1990 fuel-oil study (Levins and Ternes, 1994) serves as pilot data for this study component. The mean ± standard error of the post-minus-pre indoor temperature differences for 193 weatherized households was –.089 ± .103º F. The corresponding change for 105 control households was –.126 ± .096º F. The standard deviations of these post-minus-pre indoor temperature differences are 1.434 for the weatherized units and 0.987 for the control units. Minimizing the variance of the weatherized-control difference of pre-post-weatherization differences suggests that, optimally, $2 = (1.434/0.987)^2$ weatherized units should be sampled for each control unit. Using this ratio of weatherized-to-control units, and assuming a true pre-post weatherized-control difference of ½º F, the probability of rejecting H_0 can be estimated for any given total sample size. The sample size for which the probability of rejecting H_0 is .90 turns out to be 160, 109 weatherized and 51 control units. This suggests 109 weatherized and 51 control units for the proposed take-back study.

As a scaled version of the fuel-oil component of the 1990 evaluation, nonresponse is accounted for in this sample size calculation. However, the extent to which nonresponse occurred in the 1990 study is unclear from the documentation. Prior experience with similar in-home thermostat monitoring studies has shown that instruments may fail or be damaged about fifteen percent of the time. Therefore, to ensure an adequate sample size, increasing the sample size by about 15% seems advisable. Thus 125 weatherized and 59 control homes will be needed.

As discussed above, 309 weatherized homes will be sampled for the CO study. As 309 exceeds 125, 309 weatherized homes will be used for the temperature study as well. The control sample size for both studies will be 59, as required for the temperature study. Sampling will be implemented as discussed for the CO study. This study will be also be coordinated with the other Occupant Sampling Studies (i.e., of Single-Family Fuel-Oil/Propane Heated Homes (Sections M.3.2-3), Propane-Heated Mobile Homes (Section M.3.5), Air Conditioned Homes (Section M.3.6), and Refrigerator Replacement Homes (Section M.3.7)) to use common homes where possible without biasing the sampling design.

M.4 ADDITIONAL NOTES

The following notes taken from OMB guidance (OMB 2006) identify several additional issues of key importance in developing the evaluation plan.

M.4.1 Pretest/Pilot Studies

According to OMB (2006), "Agencies should always consider conducting pretests (small trials of the measurement process) or pilot studies (larger trials yielding statistical information) when planning for a new information collection or changing methods and procedures for an ongoing survey. These kinds of tests may provide critical information necessary to ensure the quality of the data and smoothness of operations needed in the full-scale information collection. They can provide essential information to the agency and result in higher data quality than would have been achieved without them and may be the only vehicle for measuring the effects of different changes an agency is considering implementing. Thus, agencies will need to weigh the importance and use of pretests against the time and resources needed to conduct them."

The proposed evaluation uses the 1990 evaluation, which it is intended to emulate, and several other studies (Blasnik, 2006; Cavallo and Mapp, 2000; Levins and Ternes, 1994; Ternes and Levins, 1992) as a pilot studies.

The OMB (2006) guidance continues, "It is important that agencies test their survey questionnaires in all modes that they plan to use to collect information for the full-scale survey (see section on Questionnaire Design). Usability testing of computer survey instruments should also be included as part of questionnaire pretesting to identify problems either interviewers or respondents may have with the instrument...."

The survey instruments for the proposed evaluation are being pre-tested with internal and (fewer than ten) external personnel. They are also being peer-reviewed by subject matter experts.

M.4.2 Influential information

According to OMB (2006, Question 18), information is considered "influential" if "an agency can reasonably determine that dissemination of the information will have or does have a clear and substantial impact on important public policies or important private sector decisions," and agencies should "hold the information they designate as 'influential' to a higher standard of reproducibility and transparency than information that is not defined as influential."

The information collected for the proposed WAP evaluation is thus "influential."

M.4.3 Response rates

According to OMB (2006), "An agency's justification for a survey response rate should reflect, at least in part, the intended use of the data. For example, surveys collecting influential information or information that will otherwise have a substantial impact on an agency's programs or policies should be designed to minimize all sources of survey error (see question #20), including nonresponse bias...Agencies need to document in their ICRs the importance and use of the information and the methods they will use to achieve acceptable response rates for their collections… ICRs for surveys with expected response rates of 80 percent or higher need complete descriptions of the basis of the estimated response rate and a detailed description of steps that will be taken to achieve the expected response rate…"

In general, response rates in the proposed evaluation are expected to be high (much higher than 80%), because weatherization recipient contact information will be provided by weatherization agencies, and because recipients have received weatherization services. For various reasons including legal issues, utilities in the past have not always provided customer billing data requested by agencies. Although this is a form nonresponse, because it is independent of performance by the agencies in weatherizations, it is reasonable to treat it as nonbiasing and therefore not requiring adjustment in the analysis. In general, nonresponse is not expected to be a problem in the analysis of the weatherization data.

The OMB 83-i (www.whitehouse.gov/omb/inforeg/83i-fill.pdf) form requires a description of "methods to maximize response rates and to deal with issues of non-response." Methods that will be employed to accomplish this include

- contacting an appropriate person at each utility to identify and smooth out the data collection process
- planning the billing data requests so that data for multiple housing units and buildings are requested from each utility at the same time
- requesting billing data at regular intervals to reduce the chance that the utilities will not be able to provide data because it has been archived and no longer readily accessible, but limit the number of such requests so that utilities have to provide data just several times during the course of the evaluation
- soliciting assistance from utility regulatory commissions and similar organizations as needed.

M.5 REFERENCES

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APPENDIX N. BUILDING TYPE DEFINITIONS

The energy analyses methods are dependent on the building/housing type. Throughout the evaluation, housing units will be categorized into four building types as defined below:

- **Single-family**—A single-family housing unit, detached or attached, provides living space for one family or household and is contained within walls extending from the basement (or the ground floor, if there is no basement) to the roof. An attached house, such as a townhouse, row house, and duplex, is considered a single-family housing unit as long as it (a) is not divided into more than one housing unit, (b) there is no household living above another one within the walls extending from the basement to the roof to separate the units, and (c) it has an independent outside entrance.

- **Mobile home**—A mobile home is built on a movable chassis, moved to the site, and typically placed on a permanent or temporary foundation. If rooms are added to the structure, it is considered a mobile home if the added floor area is less than the mobile home's original floor area; otherwise, it is a single-family housing unit. A manufactured house assembled on site is a single-family housing unit, not a mobile home.

- **Small multifamily**—A small multifamily housing unit is in a building with two to four housing units (i.e., in a building structure that is divided into living quarters for two, three, or four families or households in which one household lives above or beside another). This category includes houses originally intended for occupancy by one family (or for some other use) that have since been converted to separate dwellings for two to four families. Typical arrangements in these types of living quarters are separate apartments downstairs and upstairs or one apartment on each of three or four floors.

- **Large multifamily**—A large multifamily housing unit is in a building with five or more housing units (i.e., in a building structure that contains living quarters for five or more families or households and in which one household lives above or beside another).

These definitions are consistent with those used in the Residential Energy Consumption Survey conducted by the DOE Energy Information Agency with one exception. Mobile homes with rooms added to the structure are considered to be single-family housing units in RECS in all cases. Mobile homes weatherized by the Program often have small rooms added to them (e.g., small rooms added to the front or back doors, rooms that connect to and extend the living room). Mobile homes with room additions will still be classified as mobile homes in this evaluation as long as the floor area of the additions is less than the floor area of the original mobile home for two reasons. First, these mobile homes are still treated in the Program using the diagnostic approaches, weatherization measures, and installation techniques unique to mobile homes. Second, the majority of Program expenditures are typically directed at improvements to the mobile home structure rather than the room additions. If room additions exceed the floor area of the original mobile home, then the house should be classified as a single-family housing unit.

These definitions are also generally consistent with those used in the 1990 National evaluation. The one uncertainty is with mobile homes because it is not known how mobile homes were defined in the 1990 National evaluation. However, it is believed that the categorization of mobile homes by weatherization agencies is more consistent with the definition developed for this evaluation than the RECS definition. Also, the 1990 National evaluation made a distinction between attached and detached single-family housing units that will not be made in this evaluation.

The Program uses three rather than four categories of housing unit types in its quarterly reporting and other functions. Mobile homes and large multifamily categories are conceptually the same as those defined above for this evaluation. However, the single-family category as defined by the Program includes the small multifamily category as defined for this evaluation. It is important to have a clear definition of small multifamily housing units and a separate category for these units for two reasons:

1. Small multifamily housing units were often mistakenly identified as belonging to the large multifamily housing category by agencies in the 1990 National evaluation. This led to considerable sampling and analysis problems. Providing a separate category for small multifamily housing units should help avoid this identification problem.

2. The energy analysis methods and approaches to be employed to study single family homes are different and/or will be applied differently than those for large multifamily units. The analyses methods and approaches for small multifamily housing units may also be unique because they have characteristics of both of these other two groups of houses.

APPENDIX O. UNIT/BUILDING LEVEL ENERGY ANALYSIS

O.1 SINGLE-FAMILY HOUSES AND MOBILE HOMES

Natural gas billing data will be collected on homes heated by natural gas as part of the comprehensive billing data sample. These data will be analyzed using the Princeton Scorekeeping Method (PRISM, Fels et al., 1995) to calculate annual, weather-normalized pre- and post-weatherization energy consumptions and energy savings for each individual home. Since natural gas can be used in these homes for water heating, cooking, and possibly clothes drying in addition to space heating, these energy consumptions and savings represent both space heating and baseload uses combined (i.e., natural gas consumption and savings for space heating will not be calculated separately from baseload).

The Network Planning Committee felt that the energy consumption and savings of houses heated by fuel oil and propane are critical to the evaluation and need to be measured. Billing/delivery data are usually insufficient for a PRISM type analysis because fuel oil and propane are typically delivered just several times a year to a house at infrequent intervals, and because household storage tanks are not always filled at each delivery (so that the amount of fuel delivered is not necessarily equal to consumption). Therefore, energy use in these homes must be specially monitored by submetering the space heating system or collecting more accurate and frequent delivery data. If submetered fuel oil and propane use along with indoor and outdoor temperatures are collected on houses heated by these fuels in the fuel-oil and propane monitored sample, then an energy use model will be developed for each house by regressing weekly or daily consumptions (the dependent variable) versus the temperature difference between the indoors and outdoors (the independent variables) for each consumption period. Annual, weather-normalized pre- and post-weatherization energy consumptions and energy savings will be calculated using the regression models, historical weather for each home location, and a standard indoor temperature (e.g., 68 or 70°F) or the actual indoor temperature for each house. Uncertainty statistics and indicators of model reliability comparable to those calculated by PRISM will also be calculated. Since fuel oil and propane are not typically used in single-family or mobile homes for water heating or cooling, the annual energy consumptions and savings based on the analysis of submetered fuel oil and propane use typically represent just space-heating use. If more accurate and frequent delivery data are collected, then these data will be analyzed using PRISM or a simply calculating the ratio of energy use to heating degree days for the monitoring period.

Electricity billing data will be collected on all the homes sampled (not just those heated by electricity) as part of the billing data sample, fuel-oil and propane monitored sample, and hot climate submetered sample. These data will be analyzed using PRISM to calculate annual pre- and post-weatherization electricity consumptions and energy savings for each individual home. PRISM's model selection feature will be used to select the best PRISM model for each house (i.e., heating-only, cooling-only, or heating and cooling model). In homes heated by electricity, these electricity consumptions and savings include both space heating and baseload uses in addition to space cooling if employed. In non-electrically heated homes, these energy consumptions and savings include baseload uses, space cooling if employed, and any supplemental space heating that is done using electricity. Electricity consumptions and savings will not be broken down into their separate heating, cooling, and baseload components.

Although the Network Planning Committee felt that submetering and subsequent analysis of a sample of natural gas and electrically heated houses could improve accuracy and add context to the PRISM billing data analysis results, such sampling and analysis is not currently planned because of the costs that would be required.

O.2 LARGE MULTIFAMILY BUILDINGS

The calculation of energy use and savings is complicated in large multifamily buildings for many reasons, including:

- some buildings have central building heating and/or hot water systems while in others each unit has its own heating (central apartment system or in-space heaters) and/or hot water system,
- the whole building is weatherized in some cases while in others only individual units are weatherized,
- some buildings have significant common areas (including recreation rooms, offices, and kitchens) while others have little or none,
- operating ventilation systems are present in some buildings and not in others,
- there are many billing meters in the building (especially those with individual heating systems) so rarely is there a complete and consistent set of data for all the meters (i.e., there is usually some gap in data for at least a few meters),
- occupancy turnover and vacancies can be prevalent, and
- many buildings use fuel oil which has the same problems with the delivery data as with single-family homes (i.e., fuel is delivered at infrequent and/or random intervals and the building storage tanks are not always filled at each delivery).

These complications can manifest themselves at different times during the analysis process, such as in estimating annual consumption, normalizing consumption to a per unit level, and/or aggregating the consumptions of various buildings or units together.

For the reasons outlined above, the process of calculating the energy use and savings in each multifamily building and determining how to include these values in the totals or averages with other multifamily buildings must be developed individually for each building. Although some basic analysis approaches are outlined below for the two primary building types that will be commonly encountered, experienced analysts will need to follow and analyze the data collected on each building individually since cookie-cutter approaches will not work.

O.2.1 Buildings with central building heating systems

In buildings with central building heating systems, a whole building energy analysis is usually required because the weatherization activity in such buildings usually focuses on the central heating system rather than just selected apartment units. A whole building energy analysis will be performed as follows:

1. Depending on which fuel is used by the central building heating system, natural gas billing data for the building's master meter or fuel-oil delivery data will be collected as part of the large multifamily billing data sample. These data will be analyzed using PRISM to calculate annual pre- and post-weatherization energy consumptions and energy savings for the building. These energy consumptions and savings represent either just space heating, space heating and hot water, or space heating and baseload (e.g., hot water, cooking) depending on the fuel and what other systems are connected to the master meter or fuel tank (e.g., central building hot water system, apartment stoves).

   Although fuel-oil delivery data are usually insufficient for a PRISM type analysis in single family homes, there is a greater chance that such data can be analyzed for multifamily buildings, especially if several years of data can be collected, because deliveries may be more frequent (ratio of consumption to tank size may be greater) and/or fills may be more common.

   As part of the monitored sample, fuel oil consumption will be specially monitored in some buildings either through submetering or collecting more accurate and frequent delivery data. Annual pre- and post-weatherization energy consumptions and energy savings for the building will be calculated using these data and PRISM if possible (if data during some non-heating periods can be collected) or using regression models and historical weather for each building (models developed by regressing weekly or daily consumptions versus outdoor temperature or heating degree days).

2. Electricity billing data will be collected from all electric meters (building and apartment level) installed in the sampled buildings (not just those heated by electricity) as part of the billing data sample or fuel-oil and propane monitored sample. Apartment level data will be aggregated for each billing period and then analyzed using PRISM to calculate annual pre- and post-weatherization electricity consumptions and energy savings for each building. Some refinements will be needed to account for missing data and/or apartments for which no billing data can be collected. The building electricity data will be analyzed similarly either separately or by aggregating it with the apartment level data. PRISM's model selection feature will be used to select the best PRISM model for each building (i.e., heating-only, cooling-only, or heating and cooling model). In buildings with central building heating systems, these electricity consumptions and savings include apartment-level baseload uses (possibly including hot water if the building has individual hot water systems in each apartment fueled by electricity), common area electricity consumption, space cooling if employed, and any supplemental space heating that is done using electricity. The electricity consumptions and savings will not be broken down into their separate heating, cooling, and baseload components.

3. Natural gas billing data will be collected from any other building and apartment level natural gas meters installed in the sampled buildings (other than the master meter supplying the central building heating system) as part of the billing data sample or fuel-oil and propane monitored sample. These data will be analyzed using PRISM in a manner similar to that for electric billing data. In buildings with central building heating systems, these natural gas consumptions and savings include apartment-level baseload uses (cooking and possibly hot water if the building has individual hot water systems in each apartment fueled by natural gas) and any common area consumption.

4. Building-level energy consumptions and savings calculated above will be divided by the number of units in the building to calculate unit-level values which will facilitate comparison and aggregation with other buildings. In addition, natural gas and fuel oil consumptions and savings will be added into one value.

The Inverse Modeling Toolkit (IMT) is a software program available from the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for calculating linear, change-point linear, variable-based degree-day, multilinear, and combined regression models (Kissock, Haberl, and Claridge, 2004). As such, it offers an alternative approach to PRISM in the analysis presented above. The use of IMT in this evaluation will be investigated. Depending on analytical difficulties encountered with PRISM in the above analyses and the results of the IMT investigation, IMT will be used to supplement and/or supersede the PRISM analyses as warranted.

O.2.2 Buildings with apartment-level heating systems

In buildings with apartment-level heating systems (e.g., central systems in the apartment, baseboard electric heaters), a whole building energy analysis will be performed if the whole building was weatherized. If just individual units in a multifamily building were weatherized, then the energy analysis will be performed on an apartment or unit basis. These two approaches are described below:

1. In buildings in which the whole building was weatherized, billing data will be collected as part of the large multifamily billing data sample for all building-level and apartment-level electricity meters and natural gas (if present) installed in the building (fuel oil is not usually used in such buildings). For each building, apartment-level and building-level electricity data will be aggregated for each billing period and then analyzed using PRISM to calculate annual building-level pre- and post-weatherization electricity consumptions and energy savings. PRISM's model selection feature will be used to select the best PRISM model for each building (i.e., heating-only, cooling-only, or heating and cooling model). If natural gas is used in the building, the same procedure as used for electricity will be followed to calculate annual building level pre- and post-weatherization natural gas consumptions and energy savings. Some refinements will be needed to account for missing data and/or apartments for which no billing data can be collected.

The electricity consumptions and savings calculated above represent space heating, space cooling, and baseload use (for the apartments and common areas combined) depending on the specific end uses that electricity is used for. Likewise, the natural gas consumptions and savings calculated above can represent space heating and/or baseload use. The energy consumptions and savings will not be broken down into their separate heating, cooling, and baseload components.

Building-level energy consumptions and savings calculated above will be divided by the number of units in the building to calculate unit-level values which will facilitate comparison and aggregation with other buildings. The use of IMT may be used to supplement and/or supersede the PRISM analyses as warranted.

2. In buildings in which just individual units were weatherized, annual energy consumptions and savings will be calculated as if they were single-family dwelling units (see Sect. 3.2.1). Electricity billing data and natural gas billing data (if present) will be collected on such units as part of the large multifamily billing sample. These data will be analyzed using PRISM to calculate annual pre- and post-weatherization energy consumptions and energy savings for the individual dwelling (apartment) units. PRISM's model selection feature will be used to select the best PRISM model for each house when analyzing the electricity data (i.e., heating-only, cooling-only, or heating and cooling model).

   Since natural gas (if present) can be used in these homes for water heating, cooking, and possibly clothes drying in addition to space heating, the natural gas consumptions and savings represent both space heating and baseload uses combined. In units heated by electricity, the electricity consumptions and savings include both space heating and baseload uses in addition to space cooling if employed. In non-electrically heated units, these energy consumptions and savings include baseload uses, space cooling if employed, and any supplemental space heating that is done using electricity. The electricity and natural gas consumptions and savings will not be broken down into their separate heating, cooling, and baseload components.

O.3 SMALL MULTIFAMILY BUILDINGS

Energy consumptions and savings in small multifamily buildings will be analyzed in a manner similar to that for large multifamily buildings (see Section D.2):

- **Small multifamily buildings with central building heating systems or with apartment-level heating systems that were weatherized as a building**—A whole building analysis will be performed because weatherization costs will likely be known at the building rather than unit level. Building level consumptions and savings will then be normalized to a per unit basis by dividing by the number of units in the building.

- **Buildings in which just individual apartments are weatherized**—A unit-level analysis will be performed.

This analysis approach will be applied primarily to electricity and natural gas billing data collected from the comprehensive billing sample. If fuel-oil consumption data are collected on small multifamily buildings as part of the monitored sample, then these data will be analyzed as described for single-family homes (see Sect. 3.2.1).

APPENDIX P. ORNL AGGREGATE MODEL

ORNL's aggregate model applies the basic logic of the PRISM approach to billing and weather databases aggregated over many houses to determine an overall program effect. It was developed and will be used in the national evaluation to support and supplement the PRISM analysis when needed.

Many factors that often occur in the low-income homes that the Program serves can mask weather-related correlations with fuel usage. These include:

- periods of zero or below normal consumption because of service shutoff due to nonpayment, household vacancies, and equipment breakdowns;

- erratic use of heating and/or cooling equipment by occupants;

- undersized heating and/or cooling equipment that runs at full capacity after a threshold outdoor temperature is reached;

- behavioral and occupancy changes; and

- availability of just few months of data for a house before and/or after weatherization

Use of PRISM, which relies on a linear model of the relationship between weather and energy consumption, can lead to high model failure rates at the individual household level (e.g., low R^2, high coefficient of variance on the normalized annual consumption estimate, unrealistic balance point temperature) because of these factors. Excluding large numbers of homes from the statistical analysis due to model failures likely introduces potential sample bias, making the measurement of representative Program impacts difficult because so many homes are eliminated. Although every effort will be made to reduce model failures (e.g., use of PRISM's flatness index, data collection design to ensure a year's worth of data before and after weatherization), an alternative approach is still needed.

The ORNL aggregate model examines and performs weather-normalizations on a group of houses to smooth out the confounding effects that occur at the individual house level. It is a simpler method than PRISM in that it does not assume that a linear model has to fit every house and does not attempt to produce house-specific savings estimates. Its advantages are that it can use "noisy" data and analyze data for a more complete and representative sample of houses. As a result, the ORNL aggregate model focuses on the overall Program (i.e., group) effect, rather than individual household savings, and reduces sample bias due to excessive exclusion of households from the analysis.

PRISM and the ORNL aggregate model can be compared and contrasted as follows:

PRISM	ORNL Aggregate Model
• Assumes a linear model of the relationship between energy consumption and heating degree days for each individual house.	• Assumes a linear model of the relationship between energy consumption and heating degree days for a group of houses.
• For each house, energy consumption and heating degree days for multiple billing periods are used to determine the model coefficients for the house (i.e., α and β).	• For the group of houses, energy consumption and heating degree days over one time period for each house are used to determine the model coefficients for the group of houses (i.e., α and β).
• Regression performed for "all possible" reference temperatures, and reference temperature and subsequent model coefficients chosen that gives the highest model R^2.	• A fixed reference temperature (e.g., 65°F) is used for all houses to calculate heating degree days.
• For group of houses, total or average consumption or savings calculating by adding or average values for individual houses.	• For group of houses, total or average consumption or savings calculated directly from model.

P.1 PRISM

The PRISM model can be written as:

$$e_i = \alpha + \beta \cdot hdd_i(t) \qquad (1)$$

Where:

e_i = average <u>daily</u> energy use (e.g., Btu/day) for billing period i,
α = average <u>daily</u> baseload (non-heating) energy use (e.g., Btu/day),
β = heating slope (e.g., Btu/HDD), and
$hdd_i(t)$ = heating degree days <u>per day</u> for billing period i calculated at balance point temperature t (°F).

Typically, energy consumption data and daily outdoor temperatures corresponding to each billing period are obtained for a house (preferably about 12 monthly billing periods over a year). Knowing the number of days in each billing period, PRISM converts these data into an average daily energy use (e_i) and average daily heating degree days [$hdd_i(t)$] for each billing period and then uses these average daily values to estimate three parameters for the house using linear least-squared regression techniques: the average daily baseload energy use (α), heating slope (β), and balance point temperature (t) that produces the highest correlation coefficient (R^2). The normalized annual energy consumption (NAC) for the house can then be calculated using these estimated parameters as follows:

$$NAC = (\alpha \cdot 365.25) + (\beta \cdot HDD_o(t_o)) \qquad (2)$$

Where:

NAC = normalized annual energy consumption (e.g., Btu), and
$HDD_o(t_o)$ = annual heating degree days calculated at the optimum balance point temperature t_o (°F) estimated by PRISM.

When data are available before and after a house is weatherized, the NAC before weatherization (NAC_{pre}) and after weatherization (NAC_{post}) can be calculated, and the normalized annual energy savings (NAS) for the house can be determined by:

$$NAS = NAC_{pre} - NAC_{post} \qquad (3)$$

Where:

NAS = normalized annual energy savings,
NAC_{pre} = normalized annual energy consumption before weatherization, and
NAC_{post} = normalized annual energy consumption after weatherization.

The average per household savings for a group of houses can be estimated using the NAS calculated for each house individually by:

$$AGS = (\Sigma NAS_i)/n \qquad (4)$$

Where:

AGS = average group savings,
NAS_i = normalized annual energy savings for house i, and
n = number of houses used in the summation.

If data are available for a group of control homes, the net savings of a weatherized group can be calculated by:

$$\text{Net savings} = AGS_{weatherized} - AGS_{control} \qquad (5)$$

Where:

$AGS_{weatherized}$ = average group savings of the weatherized houses, and
$AGS_{control}$ = average group savings of the control houses.

In Eqs. 1-5, statistical uncertainties associated with estimated parameters and calculated values can be determined using normal statistical procedures.

P.2 AGGREGATE PRISM

An aggregate version of PRISM exists in which a linear model of energy use versus heating degree days is fit to a group of houses rather than to houses individually. In this case, each house must have the same number of billing periods and the billing periods must coincide for each house (e.g., bills were read on the 15th of each month for 12 months for each house), and all the houses must be in the same geographic area so that the heating degree days for the houses are the same. The energy consumption data for each billing period are averaged and used with Eq. 1 so that the α and β that are estimated represent an average house in the group. The NAC and the NAS for an average house can be calculated using Eqs. 2 and 3; in this case, the NAS is equivalent to the average group savings calculated using Eq. 4 for houses that were analyzed individually.

P.3 ORNL AGGREGATE MODEL

The PRISM model described by Eq. 1 above could be rewritten slightly as:

$$E_i = \alpha \cdot D_i + \beta \cdot HDD_i(t) \qquad (6)$$

Where:

E_i = energy use (e.g., Btu) for billing period i,
α = average <u>daily</u> baseload (non-heating) energy use (e.g., Btu/day),
D_i = number of days in billing period i,
β = heating slope (e.g., Btu/HDD), and
$HDD_i(t)$ = heating degree days for billing period i calculated at balance point temperature t (°F).

Note that E_i and $HDD_i(t)$ are energy use and heating degree days for billing period i, whereas e_i and hdd_i in Eq. 1 are average <u>daily</u> values for billing period i ($e_i = E_i/D_i$ and $hdd_i(t) = HDD_i(t)/D_i$).
Data for an individual house could be applied to this model as before.

The ORNL aggregate model modifies Eq. 6 so that it can be applied to a group of houses simultaneously rather than to houses individually. The model is:

$$E_i = \alpha \cdot D_i + \beta \cdot HDD_i(65) \qquad (7)$$

Where:

E_i = energy use (e.g., Btu) for house i over some time period,
α = average <u>daily</u> baseload (non-heating) energy use (e.g., Btu/day),
D_i = number of days in the time period for house i,
β = heating slope (e.g., Btu/HDD), and
$HDD_i(65)$ = heating degree days over the time period for house i calculated at a balance point temperature of 65°F.

Note that the subscript i in Eq. 7 identifies different houses, whereas the subscript i in Eq. 6 identifies different billing periods for the same house. Also note that the ORNL aggregate model uses heating degree days calculated at a fixed balance point temperature of 65°F for all houses, whereas PRISM calculates a house-specific balance point temperature.

To apply the ORNL model, the following three values must be known for each house: the energy use over a given time period, the number of days in the time period, and the number of heating degree days in the time period (calculated at the same balance point temperature of 65°F for each house). Typically, monthly billing data for each house are aggregated to obtain a single set of values for the house (e.g., 11 monthly bills for a house are combined so that the energy use, the number of days, and the number of heating degree days in the 11-month period are known for that house). The time periods and the length of the time periods do not need to be the same for each house. Houses do not need to be geographically constrained; houses from one area can be combined with houses from another area as long as the location appropriate heating degree days are calculated for the time period associated with each house and at the same base temperature.

These three values for many houses are used to estimate the average daily baseload energy use (α) and heating slope (β) for an average house in the group using least-squared regression techniques. A NAC for an average house in the group at a selected geographical location can then be calculated by:

$$NAC = \alpha \cdot 365.25 + \beta \cdot HDD_o(65) \qquad (8)$$

Where:

NAC = normalized annual energy consumption (e.g., Btu), and
$HDD_o(65)$ = annual heating degree days for the chosen location calculated at a balance point temperature of 65°F.

By aggregating/totaling billing data for each house over time, some of the variability in the energy data is smoothed out and the influence of weather variations on consumption can be modeled more easily. By analyzing a group of houses in an aggregate manner, unexplained variability seen at the individual house level is removed and a model of an average house that represents the group of houses is produced.

If data are available for the group of houses before and after each one is weatherized, the NAC_{pre} and NAC_{post} for an average house in the group at a selected geographical location can be calculated, and the NAS for such a house can be determine using Eq. 3.

If an average NAC and/or NAS were desired that was representative of all the houses weatherized, covering multiple locations, weighted annual heating degree days could be calculated and used in Eq. 8, or the annual heating degree days for each house could be used in Eq. 8 and the subsequent NACs averaged.

The ORNL aggregate model was presented in simplistic form above. In reality, pre- and post-weatherization differences in energy use can be modeled to avoid the need to model pre- and post-weatherization consumption separately and then subtracting to obtain savings. Energy savings can be modeled as follows:

$$\Delta E_i = E_{i,\,pre} - E_{i,\,post} = [\alpha_{pre} \cdot D_{i,\,pre} + \beta_{pre} \cdot HDD_{i,\,pre}(65)] - [\alpha_{post} \cdot D_{i,\,post} + \beta_{post} \cdot HDD_{i,\,post}(65)] \quad (9)$$

Where:

ΔE_i = energy use difference (e.g., Btu) between pre and post periods for house i,
$E_{i,\,pre}$ = energy use (e.g., Btu) for house i for pre-weatherization period,
$E_{i,\,post}$ = energy use (e.g., Btu) for house i for post-weatherization period,
α_{pre} = average daily baseload energy use (e.g., Btu/day) for pre period,
α_{post} = average daily baseload energy use (e.g., Btu/day) for post period,
$D_{i,\,pre}$ = number of days for house i in pre period,
$D_{i,\,post}$ = number of days for house i in post period,
β_{pre} = heating slope (e.g., Btu/HDD) for pre period,
β_{post} = heating slope (e.g., Btu/HDD) for post period,
$HDD_{i,\,pre}(65)$ = heating degree days for house i calculated at a balance point temperature of 65°F for pre period, and
$HDD_{i,\,post}(65)$ = heating degree days for house i calculated at a balance point temperature of 65°F for post period.

By modeling the difference in energy use, the correlation between pre- and post-weatherization consumption for the same household is dealt with much like in a paired t-test.

The model can be simplified and the statistical variability of the remaining parameters reduced if there is reason to assume that α_{pre} and α_{post} are equal to each other (because weatherization primarily impacts the degree-day parameters) and/or if the bias in making the parameters equal to each other is acceptable. The model can also be expanded to include control adjustments directly and, like PRISM, can include weather adjustment for cooling energy consumption using cooling degree days simultaneously with adjustment for heating energy consumption using heating degree days (although there is no provision for automatically selecting the model as in PRISM). Furthermore, additional terms can be added to the model (e.g., for climate region), with fitting occurring in one stage.

As with PRISM, the statistical uncertainties associated with estimated parameters and calculated values in Eqs. 7-9 can be determined using normal statistical procedures.

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APPENDIX Q. WEATHERIZATION STAFF SURVEY

Weatherization staff from the 400 agencies included in the billing data sample will be surveyed over the phone in calendar year 2008 using the Weatherization Staff Survey to collect information needed for the study of training and its effectiveness (see Section 3.3). The survey will collect demographic data, compile training histories, obtain staff feedback on the effectiveness of the training they have received, and test their knowledge on a wide range of weatherization practices. The survey will be administered to just those staff directly involved in weatherization and will include both in-house agency staff and contractor staff. The survey will be administered to a total of 813 staff; 271 staff from each of the following three groups: auditor/inspector, foreman/crew leader, and crew member/technician. Agencies will identify the staff meeting these definitions and the category they belong in. The evaluation team will then randomly select the staff to be surveyed. It is expected that the agencies will be compensated by DOE for the time it takes their staff and crews to complete this survey.

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WEATHERIZATION STAFF SURVEY

1. What is your primary weatherization job title?
(1) Administrator (End survey)
(2) Auditor
(3) Inspector
(4) Crew leader/foreman
(5) Crew member
(6) Day laborer (End survey)
(7) Other ___________ (End survey)

2. For whom do you work?
   (1) Local weatherization agency
   (2) Private weatherization contractor
   (3) Other _______________

3. How many years have you been working for your current weatherization employer? ________

4. How many years have you been working in low-income weatherization? _________

5. How many years have you had your current job title? _______________

6. Including your weatherization job, how many jobs do you have?
(1) One
(2) Two
(3) More than two

7. Considering all your jobs, do you work full-time or part-time?
(1) Full-time
(2) Part-time

8. Is working for your current weatherization employer your main job?
(1) Yes
(2) No

9. What percentage of your work during an average week is devoted to low-income weatherization?
(1) 1-20%
(2) 21-40%
(3) 41 – 60%
(4) 61 – 80%
(5) 81 – 99%
(6) 100%

10. Do you have health insurance?
(1) Yes
(2) No (go to Question 11)

10a. Who provides your health insurance?
(1) Your current weatherization employer
(2) Your state
(3) You purchase your own insurance
(4) You have insurance through your spouse
(5) Other ____________________

11. What is your income from your weatherization job?
(1) $0-$10,000
(2) $10,001 - $15,000
(3) $15,001 - $20,000
(4) $20,001 - $25,000
(5) $25,001 - $30,000
(6) $30,001 - $40,000
(7) $40,001 - $50,000
(8) $50,001 - $75,000
(9) $75,001 and over

12. How likely would it be that you would be unemployed if you did not have your weatherization job?
(1) Very likely
(2) Likely
(3) Neither likely or unlikely
(4) Unlikely
(5) Very unlikely

13. What do you like about your job weatherizing low-income homes? CHECK ALL THAT APPLY
(1) Good pay
(2) Good health benefits
(3) Steady work
(4) Good boss
(5) Good co-workers
(6) Doing good things for low-income households
(7) Flexible work schedule
(8) Reasonable dress code
(9) Good vacation policy
(10) Other _____________________

14. What reasons might lead you to leave your current weatherization job in the near future? CHECK ALL THAT APPLY
(1) Low pay
(2) Poor health benefits
(3) Inconsistent work schedule
(4) Bad boss
(5) Bad co-workers
(6) On-the-job safety concerns
(7) Inflexible work schedule
(8) Conflicts with low-income residents
(9) Onerous on-the-job personal appearance guidelines
(10) Bad vacation policy
(11) Retirement
(12) Want to move out of the area
(13) Other ______________

15. How many years to you expect to continue working for your current weatherization job employer? _____

16. How many different jobs of all kinds have you had in the last five years? _________

17. How many of the following have you attended in the last five years?
(1) National Weatherization Program Conference ______
(2) Affordable Comfort Conference ______
(3) Other national conference ______
(4) Regional weatherization conference ______
(5) State weatherization conference ______
(6) Other state conference ______
(7) State/regional training center class ______
(8) Manufacturer's training school class ______
(9) Utility training class ______
(10) State-sponsored class taught at central location ______
(11) Class not sponsored by state (e.g., another state, trade organization) ______
(12) Visit to another agency ______
(13) Instruction received by just your agency during an agency visit ______
(14) In-person expert visit to your agency (e.g., peer exchange, consultant) ______
(15) Web cast ______
(16) Conference call ______
(17) Other (please specify) ______

18. Which topics have you been trained on during the past five years? CHECK ALL THAT APPLY
(1) Diagnostic procedures
(2) Management
(3) Client education
(4) Insulation for single family dwellings
(5) Insulation for multifamily dwellings
(6) Insulation for mobile homes
(7) HVAC for single family dwellings
(8) HVAC for multifamily dwellings
(9) HVAC for mobile homes
(10) Infiltration measures for single family dwellings
(11) Infiltration measures for multifamily dwellings
(12) Infiltration measures for mobile homes
(13) Other weatherization topics for single family dwellings
(14) Other weatherization topics for multifamily dwellings
(15) Other weatherization topics for mobile homes
(16) Auditing/estimating for single family dwellings
(17) Auditing/estimating for multifamily dwellings
(18) Auditing/estimating for mobile homes
(19) Monitoring/quality control
(20) Financial topics
(21) Outreach and communications
(22) Fire safety
(23) Indoor air quality
(24) Measures to increase security of housing unit
(25) Measures to reduce common household hazards
(26) Mold
(27) Lead
(28) Other health and safety
(29) Other (please specify)

19. Is there training you want but have not been able to get?
(1) Yes
(2) No (go to 20)

19a. What training do you want but have not been able to get? CHECK ALL THAT APPLY
(1) Diagnostic procedures
(2) Management
(3) Client education
(4) Insulation for single family dwellings
(5) Insulation for multifamily dwellings
(6) Insulation for mobile homes
(7) HVAC for single family dwellings
(8) HVAC for multifamily dwellings
(9) HVAC for mobile homes
(10) Infiltration measures for single family dwellings
(11) Infiltration measures for multifamily dwellings
(12) Infiltration measures for mobile homes
(13) Other weatherization topics for single family dwellings
(14) Other weatherization topics for multifamily dwellings
(15) Other weatherization topics for mobile homes
(16) Auditing/estimating for single family dwellings
(17) Auditing/estimating for multifamily dwellings
(18) Auditing/estimating for mobile homes
(19) Monitoring/quality control
(20) Financial topics
(21) Outreach and communications
(22) Fire safety
(23) Indoor air quality
(24) Measures to increase security of housing unit
(25) Measures to reduce common household hazards
(26) Mold
(27) Lead
(28) Other health and safety
(29) Other (please specify)

19b. Why have you not been able to receive this training? CHECK ALL THAT APPLY
(6) Lack of training funds
(7) Not senior enough
(8) Training not available at the right times
(9) Training not available at the right places
(10) Available training is poor in quality
(11) Don't know

20. Have you gained skill from training and on-the-job weatherization that could be useful in other jobs?
(1) Yes
(2) No (go to Question 21)

20a. What skills? CHECK ALL THAT APPLY
(1) General home repair
(2) General contracting
(3) Financial management
(4) Supervising workers
(5) Other (please specify) _________________

21. Overall, how knowledgeable is your crew?
(1) Very knowledgeable
(2) Knowledgeable
(3) Lacks some knowledge
(4) Lacks a great deal of knowledge
(5) Not part of a crew (go to Question 28)

22. How frequently does your crew work in these areas:

	Very Frequently	Frequently	Infrequently	Very Infrequently	Not at All
(1) Insulation					
(2) HVAC					
(3) Infiltration					
(4) Mold					
(5) Lead					
(6) Other weatherization measures					

23. How frequently does your crew work on these types of dwellings:

	Very Frequently	Frequently	Infrequently	Very Infrequently	Not at All
(1) Single family homes					
(2) Multifamily homes					
(3) Mobile homes					

24. Is your crew trained well enough to deal with most problems found in the homes you are weatherizing?
(1) Yes
(2) No

25. What does your crew do particularly well? CHECK ALL THAT APPLY
(1) Insulation
(2) HVAC
(3) Infiltration
(4) Mold
(5) Lead
(6) Other health and safety measures
(7) Other weatherization measures

26. What does your crew not do particularly well? CHECK ALL THAT APPLY
(1) Insulation
(2) HVAC
(3) Infiltration
(4) Mold
(5) Lead
(6) Other health and safety measures
(7) Other weatherization measures

27. In what area is your crew in most need for training?
(1) Insulation
(2) HVAC
(3) Infiltration
(4) Mold
(5) Lead
(6) Other health and safety measures
(7) Other weatherization measures

28. What is your age? ___________

29. What is your gender?
(1) Male
(2) Female

30. What is the highest level of school you have completed or the highest degree you have received?
(1) Did not attend high school
(2) Some high school but no diploma
(3) High school DIPLOMA or the equivalent (For example: GED)
(4) Some college but no degree
(5) Associate degree in college occupational/vocational or academic program
(6) Bachelor's degree
(7) Advanced college degree

31. Please describe your race. You can select one or more categories.
(1) White
(2) Black or African American
(3) Hispanic or Latino
(4) Asian
(5) Native Hawaiian or other Pacific Islander
(6) American Indian or Alaska Native
(7) Other
(8)Don’t know
(9) Refused

32. Is English your native language?
(1) Yes (go to Question 33)
(2) No

32a. What is your native language? ________________

33. Are you a CITIZEN of the United States?
(1) Yes
(2) No, not a citizen

34. In what country were you born?
(1) United States
(2) Other (Please give name of country:____________________)

35. In what country was your mother born?
(1) United States
(2) Other (Please give name of country:____________________)

36. In what country was your father born?
(1) United States
(2) Other (Please give name of country:____________________)

37. Do you have a criminal record?
(1) Yes
(2) No (Go to Question 39)

38. Are you currently on probation or parole?
(1) Yes
(2) No

I'm now going to ask you a series of questions that address how to weatherize and audit homes. Because of the wide range of weatherization practices employed by different states, you are not expected to know the answer to every question. Therefore, for each question, one possible response is "Don't know."

39. Can a blower door reading at 50 Pa be estimated from a blower door measurement made at 25 Pa?
   a. Yes, and it will be higher.
   b. Yes, and it will be lower.
   c. Yes, and it will be the same.
   d. No, it cannot be estimated.
   e. Don't know.

40. I’m going to read several statements concerning the minimum air leakage rate for a house. After each one, please tell me if you believe the statement is true, if it is false, or if you don’t know.
    a. The minimum air leakage rate for a house cannot be estimated.
    b. The minimum air leakage rate is the same for all houses.
    c. Tightening a house below the minimum air leakage rate may cause moisture and indoor air quality problems in the house.
    d. Tightening a house to the minimum air leakage rate guarantees that the air sealing work was performed cost effectively.

41. Which of the following is a possible major air sealing site:
    a. Joist cavities under a knee wall.
    b. Dropped ceiling.
    c. Plumbing chase.
    d. All of the above.
    e. Don’t know.

42. An opening in a ceiling around a flue can be sealed with:
    a. Cardboard.
    b. Low-temperature caulk.
    c. Sheet metal.
    d. Fiberglass batts.
    e. Don’t know.

43. What parts of a house should be sealed because of air infiltration driven by thermal driving forces (often referred to as the “stack effect”)?
    a. Windows.
    b. Ground floor and attic.
    c. Bedroom doors.
    d. None of the above.
    e. Don’t know.

44. A pressure pan reading of 15 Pa taken on a supply register in a bedroom may indicate that the duct connected to the bedroom is:
    a. Tight.
    b. Leaky.
    c. Blocked.
    d. Flex duct.
    e. Don’t know.

45. Which of the following is NOT a good material to seal ducts with?
    a. Mastic.
    b. Foam.
    c. Caulk.
    d. Masking tape.
    e. Don't know.

46. I'm going to read several statements concerning the installation of attic insulation. After each one, please tell me if you believe the statement is true, if it is false, or if you don't know.
    a. Installation of attic rulers or insulation thickness markers helps ensure that insulation is installed to the correct depth throughout the attic.
    b. Insulation should be blown over soffitt vents to make sure insulation is installed all the way to the edges of the house.
    c. Attic access hatches do not need to be insulated because they are just a small part of the attic.
    d. Existing loose-fill insulation must be raked to a uniform thickness throughout the attic before additional insulation can be blown over it.

47. The presence of which of the following might prevent the installation of attic insulation?
    a. Soffitt vents.
    b. Plumbing vent stack.
    c. Knob-and-tube wiring.
    d. All of the above.
    e. Don't know.

48. Which of the following should be performed <u>AFTER</u> attic insulation is installed:
    a. Repair roof leaks.
    b. Seal attic air leakage sites.
    c. Install additional attic ventilation.
    d. None of the above.
    e. Don't know.

49. The R-value of 5 to 6 inches of blown cellulose insulation in an attic is about:
    a. R-13
    b. R-19
    c. R-30
    d. R-38
    e. Don't know.

50. Before blowing insulation into an existing exterior wall, the wall should be inspected to find:
    a. Moisture damage.
    b. Holes in the wall.
    c. Weak interior surfaces.
    d. All of these.
    e. Don't know.

51. In order to dense pack cellulose insulation into existing wall cavities, one must:
    a. Use a fill tube.
    b. Remove fire blocks and diagonal bracing.
    c. Both of these.
    d. Neither of these.
    e. Don’t know.

52. When installing batt insulation in an uninsulated floor above a crawlspace in a cold or moderate climate, the vapor barrier should be:
    a. Facing up toward the floor.
    b. Facing down toward the ground.
    c. Removed.
    d. Slit.
    e. Don’t know.

53. When installing batt insulation in an uninsulated floor above a crawlspace, the insulation should be supported so that it is:
    a. Fully compressed.
    b. Against the floor.
    c. Both of these.
    d. No support is needed.
    e. Don’t know.

54. Which of the following is NOT a good material to insulate the rim or band joist of a foundation?
    a. Foam board.
    b. Two-part spray foam.
    c. Loose-fill fiberglass.
    d. None of the above.
    e. Don’t know.

55. Fiberglass insulation rather than cellulose insulation is usually recommended to be blown into the belly of a mobile home because fiberglass insulation:
    a. Is lighter, especially if it gets wet.
    b. Air seals better.
    c. Is the only insulation allowed in mobile homes by building codes.
    d. All of the above.
    e. Don’t know.

56. I’m going to read several statements concerning mobile home insulation. After each one, please tell me if you believe the statement is true, if it is false, or if you don’t know.
    a. Additional insulation can be installed in a 2x4 wall of a mobile home even if it is already insulated with a 1 inch fiberglass batt.
    b. When insulating the floor of a mobile home, the existing insulation blanket, belly wrap, and/or rodent barrier must be removed before the floor can be insulated.
    c. When insulating the wing section of a mobile home floor, the floor joist cavity is usually completely filled with insulation.
    d. Insulation can be added to mobile homes with pitched roofs but not flat or bowstring roofs.

57. When insulating the floor of a mobile home, which of the following should be repaired <u>BEFORE</u> the floor is insulated?
    a. Belly wrap.
    b. Water and duct leaks.
    c. Both of these.
    d. Neither of these.
    e. Don’t know.

58. When installing a new window, the window should be caulked to the framing of the house to help reduce:
    a. Air leakage.
    b. Moisture penetration.
    c. Both of these.
    d. Neither of these.
    e. Don’t know.

59. I’m going to read two statements concerning door repair and installation. After each one, please tell me if you believe the statement is true, if it is false, or if you don’t know.
    a. Door weatherstripping is never needed if a storm door is present.
    b. If a newly installed door is difficult to close, no adjustments are necessary because the door frame will eventually adjust to the new door with time.

60. When inspecting a forced-air furnace, which of the following furnace problems can be determined by knowing the age of the system:
    a. Cracked heat exchanger.
    b. Low air flow.
    c. High temperature rise.
    d. None of the above.
    e. Don’t know.

61. While tuning up a forced-air gas furnace, the temperature rise across the system should generally be
    a. Less than 15°F.
    b. Between 40°and 70°F.
    c. Greater than 90°F.
    d. Can be any value.
    e. Don’t know.

62. When performing a flue gas analysis to measure the steady-state efficiency of a gas-fired furnace, measurements should be made when the flue stack temperature?
    a. Is rising.
    b. Levels off.
    c. Reaches 400°F.
    d. Is greater than the supply temperature.
    e. Don’t know.

63. When tuning up a central air conditioner or heat pump, the best method for checking and adjusting the refrigerant charge is to measure the:
    a. Refrigerant flow rate.
    b. Compressor amperage draw.
    c. Superheat or subcooling.
    d. All of the above.
    e. Don’t know.

64. Which of the following can be performed as part of a window air conditioner tune-up:
    a. Clean the fan and coils.
    b. Adjust the charge.
    c. Speed up the compressor.
    d. All of the above.
    e. Don’t know.

65. When installing insulation around an existing gas-fired hot water tank, the insulation should be installed so that it does not:
    a. Block the burner opening.
    b. Slip over time.
    c. Touch the flue.
    d. All of the above.
    e. Don’t know.

66. The top of an electric water heater can be insulated provided that it does not obstruct the pressure relief valve.
    a. True.
    b. False
    c. Don’t know.

67. When replacing an incandescent light bulb with a compact fluorescent bulb, the wattage of the compact fluorescent bulb compared to the wattage of the incandescent bulb should be:
    a. Higher.
    b. Lower.
    c. The same.
    d. Doesn't matter.
    e. Don't know.

68. I'm going to read two statements concerning the replacement of incandescent light bulbs with compact fluorescent bulbs. After each one, please tell me if you believe the statement is true, if it is false, or if you don't know.
    a. A compact fluorescent bulb can always fit where an incandescent light bulb was because they are the same size.
    b. An incandescent light bulb in a storage closet that is turned on 10 minutes a week is not a good place to install a compact fluorescent bulb.

69. In metering a refrigerator to estimate its annual energy use, data should generally be collected for:
    a. 1 to 2 minutes.
    b. 10 to 30 minutes.
    c. 1 to 3 hours.
    d. 1 year.
    e. Don't know.

70. I'm going to read several statements concerning the replacement of refrigerators. After each one, please tell me if you believe the statement is true, if it is false, or if you don't know.
    a. Refrigerators manufactured before 1995 are always cost effective to replace.
    b. The current energy use of an existing refrigerator may be different from its rated value as found on a nameplate or in a database.
    c. In metering a refrigerator to estimate its annual energy use, the test should be repeated if the refrigerator went into a defrost cycle while data were being collected.

71. An important factor that should be considered in estimating the energy use of an existing refrigerator from its rated or nameplate value is its:
    a. Location.
    b. Door seal condition.
    c. Age.
    d. All of the above.
    e. Don't know.

72. Setting the thermostat of a forced-air gas furnace to 80°F rather than 70°F will heat the house:
    a. To a higher temperature.
    b. Faster.
    c. Both of these.
    d. Neither of these.
    e. Don't know.

73. It is usually recommended to set the thermostat of a hot water heater to 130°F or less to reduce:
    a. Energy use.
    b. The potential for scalding (burns).
    c. Both of these.
    d. Neither of these.
    e. Don't know.

74. Where should smoke alarms be installed?
    a. At eye level.
    b. In a corner of a house.
    c. On every floor.
    d. All of the above.
    e. Don't know.

75. Corrective action should generally be taken when the carbon monoxide (CO) level measured in the living room of a house is above what threshold value?
    a. 1 PPM.
    b. 10 PPM.
    c. 100 PPM.
    d. 1000 PPM.
    e. Don't know.

76. What factors impact draft or spillage measurements?
    a. Outdoor temperature.
    b. Furnace fan running.
    c. Both of these.
    d. Neither of these.
    e. Don't know.

77. How does installing attic, wall, and floor insulation impact the potential cost effectiveness of a furnace replacement?
    a. Increases the cost effectiveness.
    b. Decreases the cost effectiveness.
    c. Has no impact on the cost effectiveness.
    d. Eliminates the need for a furnace replacement.
    e. Don't know.

78. The cost effectiveness of installing ceiling insulation is dependent on:
    a. Installation costs.
    b. Fuel costs.
    c. The current amount of ceiling insulation.
    d. All of the above.
    e. Don't know.

79. In a house with an attached garage that is not conditioned, the thermal boundary of the house is usually between the
    a. House and garage.
    b. Garage and outside.
    c. Both of these.
    d. Neither of these.
    e. Don't know.

80. How many inches are there in 5 feet?
    a. 12 inches
    b. 30 inches
    c. 60 inches
    d. 90 inches
    e. Don't know.

81. The floor area of a mobile home that is 10 feet wide and 50 feet long is:
    a. 100 sq. ft.
    b. 500 sq. ft.
    c. 1000 sq. ft.
    d. 5000 sq. ft.
    e. Don't know.

82. Moisture problems in a home may be caused by:
    a. Water leaks.
    b. Poor ventilation.
    c. High indoor humidity.
    d. All of the above.
    e. Don't know.

83. The air barrier/pressure boundary and thermal boundary of a house should be:
    a. In the same place.
    b. In different places.
    c. Are the same thing.
    d. None of the above.
    e. Don't know.

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