5. Measurement Error

This chapter presents information about measurement errors associated with the data collection phase of RECS. Measurement error can contribute to the total error of survey estimates in the form of bias or nonsampling variance. Direct or indirect quantitative information about measurement errors in RECS can be obtained in several different ways.

Special data collection procedures, which generally cost more than standard interviews but are believed to provide more precise information, can be used to collect information for selected households. These procedures often involve various kinds of direct observation and physical measurement, as opposed to merely asking for information from survey respondents. Such procedures include energy assessments in which data on household characteristics are collected by trained technicians. Other examples are the collection of nameplate data in order to obtain more precise information on the characteristics of central air-conditioning units and the collection of information on thermostat settings and temperatures by direct observation rather than by asking respondents to report them. Another useful procedure has been to conduct personal or telephone interviews with "outliers"--i.e., households identified in the data processing phase of the survey as having reported unusual or apparently inconsistent values for selected items. These kinds of procedures are reviewed in the first section.

Comparisons of data for the same household from different sources provide another kind of information about measurement error. Cross-sectional comparisons involve data for a household for the same time period from the household, rental agent, and supplier surveys; longitudinal comparisons involve data for the same household from successive survey years. Weather data assigned to households in a specified geographic area can also come from more than one source. Results from these types of comparisons are presented in the second section.

The level of measurement error can also be affected by the design and format of the survey questionnaire and by the type of training administered to interviewers. Information on these topics is presented in the final section.

RECS estimates of end-use energy consumption within households are obtained indirectly from survey data by allocating total consumption to various uses on the basis of a nonlinear regression model. These estimates and their evaluation through submetering studies are covered in Chapter 7, "Estimation and Sampling Error." Macro-comparisons, that is, comparisons of RECS estimates with comparable data from other surveys conducted by EIA and from surveys conducted by other agencies and organizations, are discussed in Chapter 8, "Comparisons of RECS Estimates with Other Data."

Special Data Collection Procedures

Energy Assessments

In 1979, following the National Interim Energy Consumption Survey (NIECS), an Energy Assessment was undertaken by Technology and Economics, Inc., of Cambridge, Massachusetts, in a subsample of 44 of the NIECS sample households. Trained technicians visited the households, all but two of which were single-family households. They measured floor areas, counted windows, examined insulation and noted the characteristics of space-conditioning equipment and selected appliances. Their observations were compared with the responses to the NIECS interviews (Blumstein, York, and Kemp 1981).

This Energy Assessment was undertaken as a pilot test for a continuing program of assessments that was being considered as a regular part of RECS (Response Analysis Corporation 1980, Part 6). The plan was to perform such assessments for a subsample of the households included in each Household Survey. However, resources available for RECS proved to be insufficient to implement this plan and there have been no further assessments of this type. The generality of the Assessment findings was limited by the use of a small convenience sample, lack of fully standardized procedures, and limited training for the technicians. In addition, the data collection instrument was not designed for direct comparisons with corresponding NIECS data items and there was no followup to reconcile differences between the two sources of information. Nevertheless, the Assessment provided useful information about possible sources of measurement errors in NIECS and subsequent surveys.

There were large differences between the NIECS and Assessment data on square feet of floorspace (Table 5.1). For 14 of the 27 households that had usable measurements from both sources, differences were 25 percent or more of the Assessment values. NIECS respondents had been asked to give their best estimates of floorspace; in the Assessment the technicians made measurements. Some of the discrepancies may have been due to a conceptual difference: NIECS respondents were asked to report square feet of living space, while the Assessment technicians were asked to measure "conditioned space," including only rooms and other enclosed areas with some direct means of heating. On this basis, one might expect the NIECS values to be somewhat larger; nevertheless, for 9 of the 27 households, the NIECS values were 25 percent or more below the Assessment measures.

Despite their limitations, the Assessment findings on floorspace demonstrated that respondent estimates of floorspace were likely to be subject to unacceptably large errors. Consequently, from RECS survey year 1980 on, measurement by survey interviewers has been the preferred method of obtaining information on floorspace. The measurement procedure used in the Assessment was itself not fully satisfactory and has been replaced in RECS by procedures that are believed to be easier to use and more reliable.

Table 5.1. Comparison of NIECS and Energy Assessment Data on Floorspace

Percent Difference $\left(\frac{\text{NIECS - EA}}{\text{EA}} \times 100\right)$	Number of Households		
	NIECS > EA	NIECS < EA	Total
0 to 9.9	8	1	9
10.0 to 24.9	2	2	4
25.0 to 49.9	2	4	6
50.0 and over	3	5	8
Total	15	12	27[a]

[a]There was no space information from one or both sources for 17 of the EA households.
Source: Blumstein, York, and Kemp, *An Assessment of the National Interim Energy Consumption Survey* (1981), Table 8.

Some other findings from the comparison of NIECS and Energy Assessment data were:

- There were many differences between counts of windows, both by type and overall for the household.
- The presence or absence of attic insulation was reported accurately, but there were substantial differences in reports of the thickness of insulation used.
- Reports of fuel used for heating and other purposes were generally in agreement. An exception was fuel used for dryers; of 33 households for which the dryer fuel was reported in both NIECS and the Assessment, there were differences for 7, all of which reported electricity in the Assessment and gas in NIECS.
- Several differences were observed in the numbers of refrigerators and separate food freezers reported and in the characteristics of refrigerators, such as temperature controls and automatic defrost/frost free features.

These findings from comparisons of NIECS and Energy Assessment Data were taken into account in the determination of content and formulation of questions for subsequent surveys.

Collection of Nameplate Data

In the 1990 Household Survey, interviewers were asked, for single family houses with central air-conditioning, to record manufacturer's name, model number, year manufactured, and other information from the nameplate of the outside unit (Hall 1992). The main purpose of collecting this information was to obtain a measure of rated efficiency for each housing unit's central air-conditioning equipment. This was to be done by matching the make and the model year and number against semi-annual directories of equipment characteristics issued by the

Air-conditioning and Refrigeration Institute (ARI). For all successful matches, the seasonal energy efficiency ratio (SEER) for the equipment was entered into the RECS data file.

Table 5.2 shows the results of the attempts to acquire SEER's for central air-conditioning equipment. No nameplate data were obtained for 26.5 percent of the 1,820 households with central air-conditioning, either because they were located in multiunit buildings or because they had responded by mail. Directory matches were attempted for the remaining 1,337 households; SEER's were obtained for only 24.8 percent of those households, or 18.2 percent of all sample households with central air conditioning. The most frequent reasons for failure to find a SEER in the directories were failure to match on manufacturer's name and failure to match on model number.

A subsequent effort was made, for the 331 households for which SEER's had been obtained, to obtain capacity values from the ARI directories. Values were located for 279 (84.3 percent) of these households. In view of the high cost and limited success of the nameplate data collection and matching operations in the 1990 RECS, they were not undertaken in 1993.

Table 5.2. Results of Matching Nameplate Data Against ARI Directories to Obtain Seasonal Energy Efficiency Ratios: 1990 RECS

Outcome of Match	Number of Units	Percent	
		Of Total	Of Attempted Matches
Households with central air conditioning	1,820	100.0	
No match attempted	483	26.5	
Mail questionnaire			
Multi-unit building	99	5.4	
	384	21.1	
Match attempted	1,337	73.5	100.0
Successful, SEER obtained	331	18.2	24.8
No SEER obtained	1,006	55.3	75.2
No match on make			
No model year	574	31.5	42.9
No match on model	23	1.3	1.7
No SEER available[a]	283	15.6	21.2
	126	6.9	9.4

[a]Unit manufactured prior to 1980 or no SEER in directory.
Source: Hall, *Nameplate Data Collection in the 1990 RECS* (1992).

Checking Thermostat Readings

Since 1981, the RECS Household Survey questionnaires have included questions on average temperatures maintained in the home in the wintertime under three conditions: during daytime when someone is home, during daytime with no one home, and during sleeping hours. If respondents say they cannot report temperatures but can give thermostat settings, the latter are accepted. These self-reported temperatures are characterized in the survey reports as follows:

> The self-reported temperatures, especially for some respondents, are impressions of typical temperatures and may not represent actual temperatures, or the averages of actual temperatures in the home. (EIA 1993a, p. 148)

There have been no attempts in RECS to collect information about indoor temperatures or thermostat settings by direct observation. However, a study in a small city in New York State provided some information on the accuracy of self-reported thermostat settings (Luyben 1982). Data were collected for one sample of households by personal interviews and for another sample by telephone. In the telephone survey, respondents were first asked to report their thermostat settings and then to go to their thermostats and check the reported values. The mean of the checked values was significantly higher than the reported values by 0.6 degrees Fahrenheit.

In the personal interviews, the interviewers recorded observed values of thermostat settings and temperature readings. Temperature readings exceeded thermostat settings by a mean of 0.8 degrees. The mean of the observed settings was significantly higher than the mean of the checked settings from the telephone survey households: 68.3 versus 67.0 degrees.

Detection and Evaluation of Outliers

The detection and analysis of outliers can be a useful technique for understanding survey responses, identifying and controlling survey errors, and improving survey processes. Outliers are reported values that lie at the extremes of a univariate or multivariate distribution of variables included in the survey. The analysis of outliers can include recontacts with survey respondents to determine whether there were errors in the values initially reported and whether there were special circumstances to explain the unusual observations.

In March of 1984, in-depth reinterviews were conducted with eight households that had participated in the 1981 RECS and for which data on consumption were available from suppliers (EIA 1984b, Appendix G, Erickson 1984). The method used to identify these eight households as outliers was to impute their consumption of specific fuels, using the regression models normally used to impute missing data on consumption and to compare the imputed values of consumption with the values actually provided by the suppliers. A purposive sample of eight households showing large differences in either direction for consumption of electricity, natural gas, or fuel oil was selected for the interviews. These were households whose consumption appeared to be far out of line with what might have been expected on the basis of housing unit characteristics and household behaviors that had been reported in the initial interviews.

There were two sets of four interviews each. Set A was conducted by a pair of interviewers, and Set B by a single interviewer. All used conventional ethnographic interviewing techniques. Their primary goal was to arrive at an explanation for the unusually high or low consumption, but they also investigated several broad topics, including family interactions, recreation, home improvements and attitudes toward utility companies, nuclear power, conservation, rising costs of energy, and family finances.

The main findings of the eight in-depth interviews are presented in Figure 5.1. The interviewers were successful, for the most part, in finding reasonable explanations for the extreme values in consumption of specific fuels. The explanations proved to be more or less equally divided between reporting errors in the initial RECS interviews (six of the eight households) and unusual circumstances affecting consumption, some of which may not have been fully reflected in the imputation model (also present in six of the eight households).

An important motivation for undertaking these interviews was to determine whether the questionnaire for the 1984 RECS could be expanded to include information that would help to explain patterns of unusually high or low consumption. After the findings were reviewed, no questions were added but consideration was given to other changes in survey procedures, such as improved interviewer training, additional processing steps, and followup interviews. One outcome has been the inclusion of "model-based outlier checks" as a standard part of data processing. In processing the 1990 RECS data, for example, there was a manual review, sometimes involving telephone calls to respondents, of data for all households for which the model-based estimate of fuel consumption was more than three times or less than one-third of the value based on Supplier Survey data (Response Analysis Corporation 1992b, p.7-14).

Another outlier investigation associated with the 1981 RECS had to do with data on temperature settings, a topic that had been included in the questionnaire for the first time in that survey year (Thompson 1982, Day 1982). The survey contractor made telephone calls to 9 respondents who reported maintaining (with a thermostat, radiator valve, or other control) nighttime temperatures higher than their daytime temperatures (presumably a reversal from normal behavior) and to 9 respondents who reported nighttime temperatures substantially lower than their daytime temperatures.

In the first group, nighttime higher than daytime, eight of the nine respondents called changed their responses in ways that reduced the differences; however, all but two of the group confirmed that they purposely maintained higher temperatures at night and provided explanations for that behavior. In the second group, nighttime much lower than daytime, all but one confirmed their original responses, although some said they were uncertain about the precise temperature levels. Most of the explanations involved use of electric blankets or a warm combination of non-electric blankets. The findings suggested that responses to questions about temperatures maintained in the housing unit are subject to sizable response errors.

An analysis of outliers in the 1984 RECS by Latta (1988) suggests the potential power of this method. The goal of Latta's analysis was to improve the nonlinear regression model used to impute missing entries for heated floorspace. He used data for sample housing units with complete information to estimate the parameters of the proposed model and observed that there

were several extreme outliers, units with large differences between reported and imputed values. An examination of the data listings for these units showed substantial clustering by PSU and interviewer, leading to a hypothesis that a few interviewers may have been making systematic errors in identifying which portion of total floorspace was heated. One set of outliers consisted of four townhouse units, each with three floors whose dimensions had been recorded as 7 by 30 feet, a rather unlikely set of measurements. Because this analysis was undertaken well after completion of the 1984 RECS, there was no followup on these particular cases. However, the findings indicate that comparison of reported and imputed values followed by review and followup of outliers is a promising technique for quality improvement.

Comparisons of Individual Household Data from Alternate Sources

The design of RECS provides built-in opportunities to investigate the nature and size of measurement errors through the analysis of multiple observations of the characteristics of individual housing units or households. The longitudinal component of the sample design provides observations for the same housing units at different times. The collection of overlapping data for selected items from three sources--households, rental agents and suppliers--provides duplicate observations for the same housing units at the same time or covering the same time period. The interpretation of data from multiple observations is not necessarily straightforward; the sources of the observations must be carefully considered to decide what they tell us about the effects of response bias or response variability on the survey estimates.

Longitudinal Comparisons

As described in Chapter 2, the RECS samples for 1982, 1984, 1987, and 1990 each contained a subsample of housing units which had been included in the sample in the preceding survey year. Because a large proportion of the questionnaire content is repeated in successive survey years, responses to comparable items for the same unit in the 2 years can be compared. The interpretation of observed differences is not obvious. For some housing unit characteristics, such as year built and type of housing unit (mobile home, single-family detached, etc.), there should be no differences from one survey year to another, so that differences are almost certainly due to errors in data collection or processing. For other housing characteristics, such as appliances, types of fuels used, and even number of rooms, real changes can occur. Real changes in household characteristics, like number of persons and family income, can occur whether or not a different household occupies the housing unit in successive survey years.

Table 5.3 provides information about differences in selected items for housing units that were occupied by the same households in the 1980 and 1982 RECS (Thompson 1985a). In an effort to determine the reasons for individual differences, telephone calls were made to households for which the responses for 1980 and 1982 differed for one or more of the selected items. Only 71 percent of the differences were checked in this way: 12 percent were eliminated to reduce burden on households with more than three items showing differences and 19 percent were associated with households that could not be reached by telephone. Thus, the final column of the table, showing the percent of differences "unexplained," includes some differences for which interviewers and respondents could not provide any explanation and some which were not covered by telephone calls to respondents.

Table 5.3. Differences Between Responses Reported by the Same Household in the 1980 and 1982 RECS

Item	Base[a]	Differences		Percent of differences:		
		Number	%	Explained by Real Change	Explained by Errors[e]	Unexplained
1. Number of windows[b]	1,398	337	24.1	3	65	32
2. Year the house was built[b]	1,296	296	22.8	0	12	88
3. Main home heating equipment[b]	1,394	206	14.8	19	19	62
4. Number of stories[c]	999	145	14.5	1	74	25
5. Year moved in	1,397	194	13.9	0	21	79
6. A/C equipment present	1,398	179	12.8	38	36	26
7. Number of rooms[b]	1,398	165	11.8	9	44	47
8. Use a home freezer	1,395	149	10.7	59	23	18
9. Basement heated or unheated[c]	1,111	110	9.9	8	71	21
10. Number of refrigerators	1,381	128	9.3	45	37	18
11. Full basement/part basement[c]	1,111	96	8.6	0	64	36
12. Availability of natural gas[d]	370	32	8.6	21	33	46
13. Use a clothes dryer	1,397	115	8.2	40	13	47
14. Type of living quarters	1,400	107	7.6	0	63	37
15. Number of bathrooms[b]	1,387	91	6.6	15	41	44
16. Main home heating fuel	1,398	87	6.2	42	24	34
17. Main water heating fuel	1,393	84	6.0	17	19	64
18. Presence of a basement[c]	1,111	45	4.1	3	71	26
19. Main cooking fuel	1,400	40	2.9	0	12	88

[a]Base excludes households for which 1980 RECS response is imputed or unknown and those for which 1982 RECS response is unknown.

[b]Some responses are grouped for these items. For a difference to be counted, it must be >3 windows; the years 1975-79 were combined into one category; hot water pipes and radiators were combined as one heating system; full and 1/2 baths were combined and each counted as one bathroom; the difference between number of rooms must be >1.

[c]Single-family homes.

[d]Single-family or mobile homes that do not use natural gas.

[e]Errors by respondents, interviewers, coders, and data entry operators.

Source: Thompson, *Utility of Paying Respondents: Evidence from the RECS* (1985).

For 9 of the 19 items shown in Table 5.3, real change accounted for at least 10 percent of the observed differences. These are minimum values, because some of the unexplained differences may have resulted from real changes. Such real changes appear to be largely related to the acquisition of new appliances and heating or cooling equipment and to changes in the availability of natural gas, making possible changes in the main heating fuel used.

For 6 of the 19 items, the attempt at reconciliation of differences confirmed that at least half of them resulted from errors in data collection or processing. These were items for which one would expect few, if any, real changes to occur: number of windows, number of stories, type of living quarters, presence of a basement, basement heated or unheated, and full basement or part basement. The general conclusion to be drawn from these findings is that, at the level of the individual housing unit, real changes over time are difficult to distinguish from differences due to measurement errors. Because essentially the same data collection procedures were used in both years, we can also conclude that estimates for some housing unit characteristics, notably number of windows, are subject to high response variability.

Measures of total and heated floorspace were also compared for a subsample of 355 housing units included in the 1980 and 1982 RECS (EIA 1984b, p. 114-115). The results for 300 housing units that had usable square footage data for both years are shown in Table 5.4. Averages for the total and single-family detached units were fairly close for the two survey years. However, the median absolute percent differences between values for individual units for the two years were relatively large, 11.7 percent overall for total square footage. They were larger, at 15.6 percent, for heated square footage, probably because of uncertainties about the interpretation of the concept of a "heated area," possibly also in part because of some real changes in this item.

Longitudinal comparisons of 1982 and 1984 data, also with telephone calls to explain differences, were undertaken following the 1984 RECS. In this instance, only seven topics were selected for analysis: main home heating fuel, main water heating fuel, air- conditioning equipment and fuel, clothes dryers, home freezers, dishwashers, and availability of natural gas. Telephone contacts were successfully completed for 505 (76 percent) of the 668 differences that were found for these seven topics. Real changes explained 42 percent of these differences; virtually all of the rest resulted from errors in the 1982 or 1984 values or, in a few instances, errors in both years (EIA 1987d).

Records for the longitudinal differences for which respondents were successfully contacted are included in the public use files for the 1982 and 1984 RECS. There is a separate record for each difference showing the topic number, a code for the interpretation of the difference (year 1 correct, year 2 correct, neither year correct, real change, or cannot determine) and a code identifying the reason for the error, if one occurred. As noted below, some longitudinal comparisons have been made for 1984-1987, and comparisons are possible for 1987-1990, but no followup contacts were made, following the 1987 or 1990 RECS, to determine reasons for differences.

Table 5.4. Differences in Square Footage Reported for the Same Household in the 1980 and 1982 RECS

Item	Total	Housing Type			
		Single-Family Detached	Mobile Home	Multi-unit Building	Housing Type Responses Differ in 1980 & 1982
Number of cases[a]	300	208	14	70	8
Average Square Feet per Housing Unit					
1980	1,797	2,116	803	1,082	1,503
1982	1,821	2,142	721	1,147	1,282
Median Percent Difference in Square Footage	11.7	11.8	7.2	12.2	11.3
Average Heated Square Footage per Housing Unit					
1980	1,536	1,780	798	966	1,469
1982	1,521	1,751	711	1,039	1,194
Median Percent Difference in Heated Square Footage	15.6	16.9	7.2	14.4	13.4

[a]Units that had good square footage data for both years.
Source: Energy Information Administration, *Consumption and Expenditures* (1982).

Table 5.5 shows results of a comparison of 1984 and 1987 RECS data on type of housing unit for units that were included in both surveys. The final column shows the index of inconsistency for each category. The index of inconsistency is a measure of the percent of total variance for an item that is accounted for by response variance. As a rough rule of thumb, response variance is considered to be low when the index is less than 20, moderate for values between 20 and 50, and high when it is greater than 50. (For further discussion and a formula for calculating the index, see Groves (1989).) The value of the index for the "single family attached" category is at the upper end of the moderate range, indicating that there were frequent difficulties in distinguishing such units from single family detached units and from those in apartment buildings with two to four units.

Table 5.6 shows a comparison, also based on housing units included in both the 1984 and 1987 RECS, for reports on year of construction of the housing unit (Battles 1991a). This tabulation is limited to housing units that were occupied by the same household in 1984 and 1987 and for which the householder was the respondent in both years. The values of the index of inconsistency are in the moderate to high ranges, higher for the most part than the values

observed for type of housing unit in Table 5.5. As one might expect, the values are smaller for the most recent periods. They are also smaller for units built prior to 1940, presumably because the time period covered by that category is much longer.

Table 5.5. Longitudinal Households[a]: Housing Type Reported in 1984 and 1987 RECS

Housing Type Reported in 1984	Housing Type Reported in 1987					Index of Inconsistency
	Mobile Home	Single-Family Detached	Single-Family Attached	Apartment Bldg.		
				2-4 Units	5+ Units	
Mobile Home	**115**	9	0	0	0	7.7
Single-Family Detached	9	**1,265**	16	20	1	9.5
Single-Family Attached	0	26	**53**	14	2	46.7
Apt. Bldg. 2-4 Units	0	10	21	**209**	10	19.2
Apt. Bldg. 5+ Units	0	0	6	10	**269**	5.9

[a]Tabulation excludes 15 cases where it was determined that different housing units had been interviewed and one case where the basement had been converted to an apartment.

Source: Energy Information Administration, *Housing Characteristics* (1987).

Table 5.6. Longitudinal Households[a]: Year of Construction Reported in 1984 and 1987 RECS

Year of Construction Reported in 1984	Year of Construction Reported in the 1987 RECS							Total Units	Index of Inconsis-tency
	Before 1940	1940-1949	1950-1959	1960-1969	1970-1974	1975-1979	1980-1984		
Before 1940	**333**	42	26	22	12	6	1	442	30.4
1940 to 1949	27	**59**	19	7	2	0	2	116	57.7
1950 to 1959	23	15	**134**	34	7	4	2	221	49.3
1960 to 1969	9	11	40	**145**	25	13	4	247	47.8
1970 to 1974	8	6	6	22	**95**	17	7	161	48.2
1975 to 1979	3	0	5	3	26	**114**	9	160	32.7
1980 to 1984	1	0	4	1	3	7	**52**	68	29.8
Total Units	404	133	236	234	170	161	77	1,415	

[a]Housing units occupied by the same household in 1984 and 1987.

Source: Battles, *Effects of the Adjustment of 1990 Census Data on the 1990 RECS Control Totals Obtained from the Current Population Survey* (December 1991).

Cross-Sectional Comparisons

As a result of the multi-stage clustered sample design used in RECS, the sample of housing units sometime contains two or more units from the same multiunit structure. When this occurs, there are some housing unit characteristics, such as the year in which the structure was built and the main space and hot water heating fuels, that one would expect to be the same for every unit in the structure. When differences are found for these characteristics in "inter-case comparisons" of different units in the same structure, they can be taken as indications of response error.

Blumstein, York, and Kemp (1981) used data from NIECS (the 1978 RECS) to make such inter-case comparisons. There were some difficulties in determining which sample housing units came from the same structure, but by matching on structure characteristics and identifiers, the investigators succeeded in identifying 78 structures with more than one sample housing unit. These structures included 305 sample housing units for which interviews were completed. When different responses were found on items, such as year built for housing units in the same structure, the most frequent response was assumed to be the correct one. On this basis, and leaving out responses of "don't know" and those that were missing, the apparent error rates were:

Item	Total	Number of Responses Other Than Most Frequent	Percent Apparently Incorrect
Year Built	274	44	16
Main Heating Fuel	300	15	5
Main Water Heating Fuel	300	24	8

The 16-percent gross error rate for year built is much lower than the rate of 42 percent that can be derived for the data on year built shown in Table 5.6. The data in Table 5.6 were based on a longitudinal rather than a cross-sectional comparison and included all types of housing units, not just those in multiunit structures.

As described in earlier chapters, for housing units in multiunit structures for which one or more fuels are included in the rent, the Rental Agent Survey provides data for selected items that can be compared with data for the same items from the Household Survey. As part of regular data processing operations, the two sets of data are compared. When there are differences, the response considered more likely to be correct is accepted. Except for supplemental heating fuels, this is normally the response given by the rental agent.

Table 5.7 summarizes changes made on the basis of responses from the Rental Agent Surveys for survey years 1981 through 1987. These data suggest what error rates for these items *might have been* if the Rental Agent Surveys had not been conducted and the Household Survey responses had been accepted. They also provide an indication of the level of error for these items for housing units that were eligible for the Rental Agent Survey but for which no information was obtained in that survey. The levels of nonresponse to the Rental Agent Surveys were shown in Chapter 4, Table 4.6.

Table 5.7. Changes Resulting from Comparison of Rental Agent and Household Survey Responses: 1980-1987

Item	Survey Year				
	1980	1981	1982	1984	1987
Main Heating Fuel					
Number of Changes	31	58	31	75	62
Percent of Base[a]	NA	15.8	12.2	14.7	9.2
Main Heating Equipment					
Number of Changes	NA	52	40	68	206
Percent of Base[a]	NA	14.1	15.7	13.3	30.7
Supplemental Heating Fuel					
Number of Changes	27	18	5	41	29
Percent of Base[a]	NA	4.9	2.0	8.0	4.3
Water-Heating Fuel					
Number of Changes	40	82	36	103	120
Percent of Base[a]	NA	21.1	13.2	19.4	14.8
Air-Conditioning Fuel					
Number of Changes	6	1	2	14	61
Percent of Base[a]	NA	16.7	4.5	11.8	39.6
All Items					
Number of Units in Rental Agent Survey	551	466	308	549	856
Percent with >1 Changes	NA	30.0	26.0	32.4	41.8

[a]Base for the first 3 items in the number of units whose rental agents paid for the main heating fuel. For the fourth and fifth items, it is the number whose agents paid for the fuel in question.

NA = Not Applicable.

Source: Energy Information Administration, *Housing Characteristics* (for the years shown).

With two striking exceptions, the proportions of eligible units (those included in the base for each item) whose Household Survey responses were changed based on Rental Agent Survey responses were relatively stable over the years shown. The proportions were lowest for supplemental heating fuel because the household respondent is usually considered to be more knowledgeable for that item. The exceptional cases were main heating equipment and air-conditioning fuel, for which the proportion of changes in the 1987 RECS was substantially greater than in any prior survey year. These changes may have resulted, at least in part, from changes in the questions relating to these two items on the Rental Agent Survey questionnaires. On the 1984 Rental Agent questionnaire there was a single item for main heating equipment, listing 13 possible alternatives. On the 1987 questionnaire, two separate lists of heating equipment were provided, one for units using electricity as the main heating fuel and one for units using any other fuel. For main central air-conditioning fuel, there was a minor change: the response categories on the 1984 questionnaire were electricity, gas from underground pipes, and LPG, in that order, whereas

on the 1987 questionnaire the order was changed to gas from underground pipes, LPG, and electricity. There were no changes for these items on the Household Survey questionnaires.

For the most part, there has been little overlap between the data items collected in the Household and Supplier Surveys. For delivered fuels that are paid for directly by the household, consumption and cost data are collected from the suppliers. For fuels whose costs are included in rent payments, consumption and cost are imputed on the basis of housing unit and household characteristics; this is also done when a sample household is eligible for the Supplier Survey for one or more fuels but a response cannot be obtained from the supplier(s). To evaluate these imputation procedures, some data on consumption for whole buildings containing sample rental units were collected in the 1981 RECS. The findings from that study are described in the section on "Imputation" in Chapter 6.

Following the 1993 RECS, responses to new Household Survey questions about availability of and participation in demand-side management (DSM) programs were evaluated by comparing them with responses to similar questions that had been included in the Supplier Survey. Several kinds of DSM programs are offered by utilities to encourage customers to modify their patterns of energy use, the goals being to reduce overall demand or shift some uses away from peak load periods. The comparisons showed substantial Household Survey underreporting of the availability of DSM programs. Of the households interviewed, 36.1 percent reported that at least one type of DSM program was offered to them by their electric utility, natural gas utility or some other group. By contrast, 80.6 percent of the suppliers providing electricity to the same households reported that they offered some type of DSM program. The proportion of households actually participating in electric or natural gas DSM programs was much smaller, but again there was considerable disagreement between the response to the Household and Supplier Surveys. There were many differences in both directions, but the net result was that participation appears to have been overreported in the Household Survey (EIA 1995d, pp. 152-153).

Alternative Sources of Weather Data

The data record developed for each RECS sample housing unit includes data on weather conditions in the vicinity of the housing unit. Of particular importance are data on heating and cooling degree-days, both for the survey reference year and for a recent 30-year period (current and normal degree-days). Such data have several important uses:

- When supplier data are not obtained for a housing unit for one or more fuels, the data on heating and cooling degree-days are important inputs in the models used to impute consumption of those fuels.

- For all housing units, the data are used as inputs to the models used to estimate end-use consumption.

- In longitudinal analyses, variations in degree-days and departures from normal are important determinants of variations in consumption.

Ideally, degree-day data for each housing unit would be obtained by measurement of temperatures at the site of the housing unit. Because this is not practical, a reasonable alternative is to use data from the more than 4,000 individual weather stations maintained by the National Oceanic and Atmospheric Administration (NOAA). Two basic methods of using these data are possible: (1) For each housing unit, use data from the individual weather station that is closest, in some sense, to that unit, or (2) Use average data based on all stations in the NOAA weather division in which the housing unit is located. NOAA has divided each of the 48 contiguous States into divisions, usually consisting of groups of counties, that have similar weather conditions. As of 1987, there were 345 NOAA divisions, an average of about seven per State.

A priori reasoning suggests that method (1), using the data from the closest individual weather station, would provide more accurate measures of degree-days. Temperatures can vary substantially within a multi-county area, especially when influenced by changes in elevation or proximity to large bodies of water. However, higher costs and some operating problems are associated with method (1). Selection of the "closest" station, taking into account distance and other relevant factors, requires manual processing operations which must be repeated for each survey as new PSU's or SSU's are introduced into the sample. Data are incomplete for some of the individual stations, so that imputation of missing data or substitution of another nearby station may be necessary.

Based on these considerations, EIA elected to use NOAA division data on degree-days for all survey years through 1984. Two evaluations of the effects of using alternative methods were undertaken prior to the 1987 RECS. In a 1982 study by the Energy Resources Group (Blumstein *et al*.), one site was chosen in each of the 103 PSU's included in NIECS and its station data were compared with averages for the NOAA division in which the site was located. The sites were chosen to meet two requirements: high population density and presence of an individual weather station. The data used in this evaluation were 30-year averages.

This comparison showed a median absolute difference in degree-days of five percent between the data for the site averages and the NOAA division averages. Most of the large differences (in excess of 13 percent) were in California, where they averaged 30 percent. Reasons for these large differences included large divisions, with boundaries drawn to coincide with drainage basins rather than areas of homogeneous climate, and climatic patterns that vary substantially over short distances. The study investigators recommended that an alternative method be used to derive degree-day values for housing units in California and in other locations that showed large differences between individual station data and division averages.

The 1986 evaluation (Mooney and Carroll) was undertaken by the main survey contractor, Response Analysis Corporation. It was initially limited to the five States that had shown the largest differences between station and division data in the 1982 evaluation. Instead of selecting one individual station to represent a PSU, a separate selection was made for each SSU. The comparisons were based on data for the 1984 survey reference year, April 1984 through March 1985. The investigators concluded that "... using individual station data on the SSU level, rather than NOAA divisional data, more accurately represents local temperature conditions." (Mooney and Carroll, p.27)

The evaluation also examined the effect of temperature data from alternative sources on the model-based imputation and end-use allocation procedures used in RECS. Based on the data for the five States included in the initial evaluation, the following conclusions were reached:

> ... end use models run with division data are biased in several ways. First, because of the fact that we overestimate degree days to a larger degree for low users of the fuels, the models overestimate the amount of fuel used for space heating. Second, because the degree to which we mis-estimate degree days varies by household, consumption amounts at the household level are mis-estimated. Finally, we underestimate consumption for "imputation" households because the division model allocates too little consumption to non-space heating uses. (Mooney and Carroll, p.40)

Subsequent to the five-State evaluation, all 1984 RECS SSU's were assigned to individual weather stations rather than divisions and the new degree-day values that resulted were assigned to individual households. The models used to impute consumption and to allocate it to end uses were rerun with the new degree-day values, and the results were compared with those derived by using the division averages for degree-days (Response Analysis Corporation 1988). These comparisons showed that:

- As shown in Table 5.8, there was a reduction of 3.6-percent in heating degree-days at the national level, with particularly large reductions in the Mountain and Pacific divisions. Conversely, there was an increase of 12.1 percent in cooling degree-days at the U.S. level, with increases of 10 percent or more in 7 of the 9 Census Divisions.

- The changes in overall consumption were relatively small, because only households lacking supplier data are affected.

- The only fuel with a substantial change in consumption was fuel oil, for which use of the station data led to a reduction of 1.6 percent at the U.S. level.

- End use allocations shifted somewhat. At the national level, the use of station data led to a 1.6 percent decline in space heating consumption which was offset by a 3.6 percent increase in water heating consumption.

As a result of the above findings, RECS degree-day data for the 1987 and subsequent surveys have been based on records provided by NOAA for individual weather stations. The "closest" weather station is identified for each SSU, mainly on the basis of distance, but also taking into account differences in elevation, proximity to large bodies of water, and the extent of missing data for the preferred station. Users should be aware that, because of this change, estimates of degree-days from the 1987 and subsequent survey years are not directly comparable with estimates from earlier surveys.

Table 5.8. Comparison of Heating Degree-Days Using NOAA Division Method Versus Station Method, April 1984 Through March 1985

Census Division	Million Households	Heating Degree-Days			Cooling Degree-Days		
		Division Method	Station Method	Percent Difference	Division Method	Station Method	Percent Difference
United States	86.328	4,686	4,518	-3.6	1,153	1,293	12.1
New England	4.269	6,398	6,331	-1.0	524	621	18.4
Middle Atlantic	14.029	5,663	5,460	-3.6	683	822	20.3
East North Central	15.203	6,524	6,427	-1.5	685	777	13.4
West North Central	6.414	6,619	6,499	-1.8	976	1,076	10.2
South Atlantic	14.777	2,951	2,979	0.9	1,768	1,819	2.8
East South Central	5.784	3,651	3,512	-3.8	1,433	1,583	10.5
West South Central	8.764	2,443	2,444	0.1	2,361	2,431	2.9
Mountain	4.512	5,728	5,158	-10.0	1,102	1,550	40.6
Pacific	12.577	3,508	3,019	-13.9	873	1,148	31.5

Source: Energy Information Administration, *Consumption and Expenditures* (May 1987).

Questionnaire and Interviewer Effects on Measurement Error

Since the inception of RECS, there have been continuing efforts to reduce measurement error by making improvements in questionnaires and in the training and supervision of interviewers. For each survey year, the Household Survey questionnaire and other survey instruments have been pretested and subjected to reviews by EIA and contractor staff and other persons with expertise in questionnaire design. As described in Section 5.1, there has been some use of in-depth interviews in attempts to explain unusual consumption patterns. This section cites some additional examples of relevant activities.

Pretests and Questionnaire Reviews

In preparation for the 1990 RECS, the draft Household Survey questionnaire was pretested by three interviewers, one of them an experienced RECS interviewer, in nine households. Each of the interviewers completed a detailed evaluation form, with comments on each section of the questionnaire, and participated in a debriefing session. In addition to suggestions for clarifying specific questions, some of the points raised in the overall report on the pretest (Miksovic 1989) were (some, but not all, of these suggestions were adopted in the final version of the questionnaire):

- The questionnaire includes some rather abrupt switches from one topic to another. Transition sentences should be provided at these points.

- The interviewers felt that many of the questions were very wordy, especially some that included the phrase "... other apartments, condos, households, businesses, or farm buildings." It was recommended that the phrase "... and farm buildings" be put in parentheses, to be used by interviewers only when it seems appropriate.

- The format of the questionnaire made it difficult for interviewers to refer to the relevant instructions while they were outside making and recording measurements of building dimensions. Several possible improvements were suggested.

- Improvements in format were suggested, such as use of larger print, highlighting skip instructions in various ways, and using different print types.

A user-needs study prior to the 1993 RECS (EIA 1993c) identified a widespread interest in the collection of additional information on lighting, to track use of new lighting equipment technology and to allow estimation of a measure of energy end-use intensity for lighting. Collection of accurate information on lighting facilities and use in the home poses some challenging cognitive problems and could require substantial additional time in the interview. In 1992, contractor staff conducted a series of in-depth interviews, which were recorded on both audio and video tape, to explore various means of asking for the desired data. For the first set of interviews, seven members of the contractor staff served as respondents. Each was interviewed twice, with a week intervening. For the second set of interviews, 5 non-staff respondents were recruited. Two of them were a husband and wife who were interviewed separately and then together, to attempt to reconcile differences in their reports. All respondents were asked to report on use for the day preceding the interview. They were asked to report on all lights (fixtures controlled by one switch, as opposed to individual bulbs) that had been used for at least 15 minutes and to report how long each one had been turned on (Daniels 1992).

There were fairly substantial week-to-week percentage differences in reported use for the respondents who were interviewed twice. Some of these differences could have been real; some could have been caused by response variability. Nevertheless, the relative stability of rankings of the seven respondents in terms of total hours of use suggested that the data could have been used with fair reliability to classify households as high, medium, and low lighting users. The couple who were interviewed separately and then together had significant differences, which could not be completely reconciled in the joint interview. In general, most respondents found it difficult to estimate the time of use for each light, and it was not obvious that allowing them to report time of use in broad categories made it any easier than asking for an answer in hours or fractions thereof. The room-by-room inventory approach used in the pretest was estimated to require an average of at least eight minutes per respondent, even without additional probing that might be necessary to obtain reasonably accurate responses.

On the basis of this test and other considerations, two sets of questions on lighting were included in the 1993 Household Survey questionnaire. A short module, asked for all households, requested them to report the total number of lights and the number of fluorescent lights used on a typical November weekday for: more than 12 hours per day, between 4 and 12 hours per day, and between 1 and 4 hours per day. A supplementary set of questions was asked only for a subsample of 474 households. It called for a more detailed accounting covering each indoor light used in the home, on a typical November weekday, for at least 15 minutes. Respondents were given options on whether to report lights by room, activity, or time-of-day usage and were allowed to report the time used for each light in actual number of hours or in class intervals based on number of hours.

A comparative evaluation of the quality of lighting data obtained from these two modules will be undertaken. For the subsample of households that responded to the supplemental module, it will be possible to analyze any differences in their responses to the two modules.

In 1992, at the request of a member of the American Statistical Association's Energy Statistics Committee, a survey researcher reviewed the cognitive features of the 1990 RECS Household Survey questionnaire, with special emphasis on questions requiring respondent recall (Biemer 1992). A major finding of this review was that many of the questions in this category did not include a reference period as a basis for the response or used a vague, unbounded or ill-defined reference period. In response to this analysis, all recall questions planned for use in the 1993 RECS were carefully reviewed and several changes were made. For example, the 1990 question:

H-10 About how many deliveries [of LPG] does your household usually get in a year?

was changed for 1993 to:

J-14 About how many deliveries did your household get in the past 12 months?

Other Questionnaire Effects: Conservation Improvements

In the 1984 RECS, the Household Survey questionnaire included several questions about conservation improvements that had been made to the housing unit since September 1, 1982, such as storm doors and windows, additional insulation, caulking, weather stripping, and heating system improvements. For all such improvements, respondents were asked to report the month and year in which they were installed, which could have been any month between September 1982 and the month of the Household Survey interview, generally in the Fall of 1984.

Following these questions there was a general question asking whether any improvements of this kind had been added or installed and paid for during calendar year 1983. This question was designed to identify households eligible for the energy tax credit that was permitted on their Federal income tax returns for that year. Households answering "yes" to this question were asked whether or not they had actually taken the energy tax credit on their returns.

A comparison of the general question about improvements in 1983 with responses to the earlier questions about specific improvements that were eligible for the tax credit showed that, of the 1,328 households that answered "yes to the general question, 567 (42.7 percent) had not reported any specific improvements as being added or installed in 1983. This could have been legitimate in some cases; the specific questions allowed for reporting of only a single month and year. If caulking or weather stripping, for example, had been added at two different times during the approximately 2-year reference period, only one of these would have been reported. Also, some improvements might have been installed in 1983 but not paid for until 1984. Nevertheless, the high incidence of apparent inconsistency suggests that responses to the questions about specific improvements or the general question, or perhaps both, were subject to substantial bias or response variability. The general question on improvements in 1983 was complex, with several

subquestions imbedded in it, and interviewers reported difficulties in administering it (EIA 1987a, pp.112-113).

Interviewer Training

Typically, about 300 interviewers have conducted personal interviews for each of the RECS Household Surveys. Partly because of the longer interval between surveys in recent years, interviewer turnover between surveys has increased. In the 1987 RECS, 57 percent of the interviews were conducted by interviewers who had not participated in the 1984 survey. In the 1990 RECS, 60 percent of the interviews were done by interviewers with no experience in the 1987 RECS. This turnover, along with numerous changes in questionnaire content, means that the effectiveness of training and supervision of interviewers can be an important element in determining the quality of the survey results.

For the 1980 RECS, interviewers were trained for two days in small group sessions for 10 to 20 persons each. For the 1981, 1982, and 1984 RECS, new interviewers were trained in the same way as in 1980, but the training of experienced interviewers consisted of completion of self-study materials and practice interviews. For the 1987 RECS, all interviewers were trained in four large group sessions, each lasting two and one-half days.

The cost of training was becoming a substantial element in the total budget for RECS, and means were sought to reduce training costs for the 1990 RECS. The solution adopted was to use home-study materials for all interviewers, including a videotaped presentation in several sections, an interviewer's manual, a quiz and practice interviews, the last two of these to be sent in to the survey contractor for evaluation. Use of these training methods resulted in a significant reduction in training costs, estimated at about 30 percent in constant dollars. Part of the savings were applied to more extensive office reviews of practice and initial interviews, followed by contacts with all interviewers to provide feedback from these reviews (Leach 1991).

Given the rather substantial change in training procedures that was introduced in 1990, it was considered important to try to evaluate the relative effectiveness of the old and new procedures. Two methods were used: administration of an evaluation questionnaire to the interviewers and comparative analyses of the extent of edit changes and imputation in the data processing.

Completed evaluation questionnaires were obtained from 257 of about 290 interviewers who completed the training for the 1990 RECS. Most of those responding had had prior exposure to both large and small-group training sessions for RECS or other surveys. When asked to compare the effectiveness of and their preferences for four kinds of training--small group in-person, large group in-person, self-study only, and self-study plus video--a large proportion, 78 percent, thought small group in-person training was the most effective and 60 percent identified it as their first preference. Self-study plus video was a distant second for both effectiveness (15 percent) and preference (22 percent). When first and second ratings were pooled, self-study plus video received favorable ratings for both effectiveness and preference from 55 percent of the interviewers.

The interviewers' overwhelming preference for in-person training may be influenced in part by factors other than its effectiveness. For most interviewers, these training sessions provide an opportunity to travel away from their home base and to meet fellow interviewers with whom they would otherwise not have much contact.

Interviewers were asked how well they felt they understood each of 11 topics covered in the video presentation. Most were rated "well understood" by at least 80 percent of the interviewers. Exceptions included:

- Fuels and equipment (61 percent understood very well). One written comment suggested that the treatment of combination equipment was inadequate.

- Measurement of total and heated floorspace. This has always been one of the most difficult aspects of the survey for interviewers. Some of the written comments praised this section of the videotape, indicating it was more realistic than what could have been done in a classroom training session.

- Recording of air-conditioner nameplate data. This was a new requirement for the 1990 RECS, so it was difficult to anticipate what kinds of problems might arise and discuss them in the training.

In response to a question about the degree of difficulty of the training exercises and final quiz, nearly all of the interviewers considered them "about right." However, many interviewers did quite badly on the exercises and quiz, especially on topics such as what to measure and what not to measure, who are eligible respondents, and households versus group quarters. These same topics had caused many problems in training and in actual field work in prior survey years.

In addition to finding out how interviewers reacted to the new training procedures and what improvements they had to suggest, it was felt important to seek an objective measure of the effects of the new procedures on actual interviewer performance. The method of analysis adopted was to compare the levels of edit and imputation changes for 14 RECS variables for the 1987 and 1990 RECS in total and for experienced and inexperienced interviewers in each survey year. An experienced interviewer was defined as one who had participated in RECS in the immediately preceding survey year. Inclusion of interviewer identifiers on the RECS file of individual household data for each survey year made it possible to distinguish the work of experienced and inexperienced interviewers. The 14 variables were chosen from among those that were included in the same form in both survey years, had extensive edit checks, and had required the most imputation (Response Analysis Corporation 1991).

The indicator of interviewer performance used in the analysis, admittedly an indirect measure, was the proportion of sample households for which changes had been made in each of the 14 variables following data entry, as the result of editing and imputation procedures. Changes were detected by comparing initial and final values for each variable; intermediate changes were not taken into account. Interviewer errors were only one source of such changes; they could also result from respondent and data entry errors. Moreover, some interviewer errors were detected and corrected in manual reviews prior to data entry.

Table 5.9 shows, for each of the 14 variables selected, the percent of sample households with changes for each survey year for experienced and inexperienced interviewers. Overall, the data do not reveal a substantial difference between the change indicators for the 1987 and 1990 surveys. For a few variables there were fairly large differences in the proportion of changes between the two years: same heating fuel as prior survey (down 5 percent in 1990), year house built (down 6 percent), and presence of a basement (up 4 percent). Except for the possibility of insufficient attention in the 1990 training to the item on basements, more detailed analyses did not reveal any obvious reasons for these changes.

As shown in Table 5.9, the mean proportion of changes for the 14 variables was slightly higher for inexperienced interviewers in both survey years. This finding does not necessarily prove that their performance was not as good as that of experienced interviewers. An alternative explanation would be that interviewer turnover is larger in areas like central cities, where there is likely to be a higher incidence of respondent error and item nonresponse requiring imputation. Table 5.10 provides data relevant to this hypothesis. As shown in the last column of that table, there is a clear association between housing characteristics and the extent of changes subsequent to data entry. Households in center cities, those living in apartment buildings, and those who were not owners had the largest number of changes. These explanatory variables are correlated, and some of the differences for renters of apartments may be explained by changes made to variables related to heating fuel and equipment based on responses to the Rental Agent Survey.

However, the data in Table 5.10 on percent of interviews completed by experienced interviewers, by housing type, provide only moderate support to the supposition that there are higher proportions of inexperienced interviewers conducting interviews with the types of households for which changes subsequent to data entry are most frequent. The proportions of experienced interviewers are nearly the same for owner and non-owner occupied housing units. They were slightly lower for apartments than for single-family units and lower for households living in metropolitan areas.

Taken overall, the results of the interviewer questionnaire and the analysis of processing changes did not demonstrate any clear or substantial differences in effectiveness between the 1987 and 1990 RECS training. However, two features of the 1993 RECS seemed to favor the use of in-person over self-study training for that survey: first, the inclusion of several new items in the Household Survey questionnaire and, second, as a result of the 1993 sample revision, 22 out of 116 primary sampling units had not previously been included in RECS, so the proportion of interviewers lacking previous RECS experience was likely to be higher than usual. Consequently, two and one-half days in-person training sessions were held for all interviewers at four sites, followed by a small make-up session and some telephone training for replacement interviewers.

Table 5.9. Percent of Household Survey Interviews with Imputation or Edit Changes Subsequent to Data Entry, by Interviewer Experience[a]: 1987 vs. 1990

RECS 1990 Question	Total		1987 RECS		1990 RECS	
	1987	1990	Exp.	Not Exp.	Exp.	Not Exp.
B-2 Main Heating Fuel	3	2	3	3	2	2
B-9 Main Heating Equipment	6	5	5	6	4	5
C-3 Water Heating Fuel	5	5	5	4	4	5
K-10 Income	11	14	10	13	16	13
B-3 Same Heating Fuel as 1987[b]	10	5	9	10	6	5
I-1 Budget Plan for Main Fuel	2	4	2	2	3	4
A-6 Year House Built	15	9	14	16	8	9
P-11 Has Basement	1	5	1	1	3	6
L-12 Public Housing	1	3	1	1	4	3
K-7 Race	*	2	*	*	2	2
K-1 Non-Householder Age	1	1	1	1	1	1
P-12 Amount of Basement Heated	3	5	3	3	5	5
K-1 Householder Age	1	1	1	1	1	2
K-6 Marital Status	1	2	1	1	1	2
Mean: 14 Items	4.3	4.5	4.0	4.4	4.3	4.6
Number of Interviews	5,856	4,828	2,530	3,326	1,965	2,873

* = Rounds to less than 0.5 percent.

[a]Interviewers were counted as experienced if they had worked on the immediately preceding RECS.

[b]The 1987 question was "Same Heating Fuel as 1984."

Note: Exp. = Experienced Not Exp. = Not Experienced

Source: Response Analysis Corporation, *Quality Assessment of Videotape Training: Conclusions and Recommendations* (September 1991).

Table 5.10. Interviewer Experience and Extent of Edit and Imputation Changes, by Type of Household: 1990 RECS

Household Category	Interviews		Mean Proportion of Edit and Imputation Changes: 14 Variables[b]
	Number	Percent by Experienced Interviewers[a]	
All households	4,828	40.5	4.5
Metropolitan Status			
Center City	1,543	38.1	5.8
Other Metropolitan	1,994	34.7	4.4
Nonmetropolitan	1,291	52.4	3.8
Housing Type			
Single-Family			
• Detached or Mobile Home	3,346	40.9	3.2
• Attached	289	42.6	5.4
Apartment	1,193	38.7	7.9
Home Ownership			
Owner	3,201	40.7	3.1
Other	1,627	40.1	7.6

[a]Interviewers were counted as experienced if they had worked on the immediately preceding RECS.

[b]Mean, for 14 selected variables, of the proportion of households for which the value was changed by edit or imputation subsequent to data entry.

Source: Response Analysis Corporation, *Quality Assessment of Videotape Training: Conclusions and Recommendations* (September 1991).