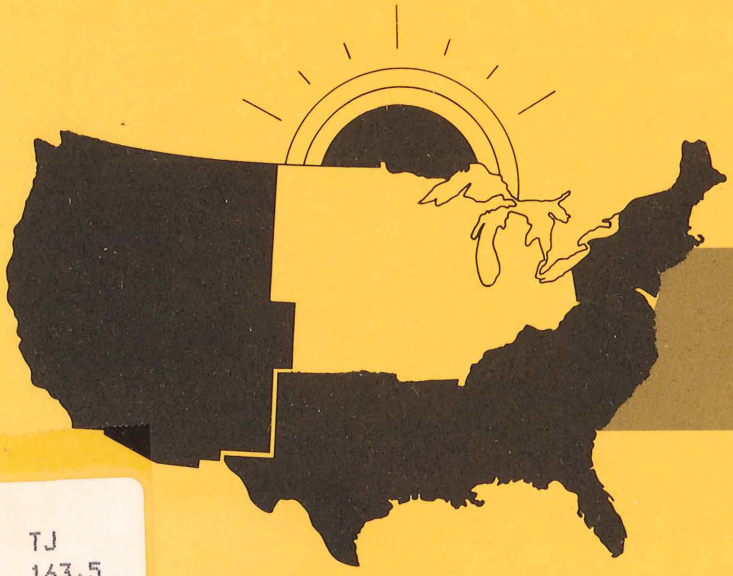
MASEC-R-79-046

EVALUATION OF THE FEDERAL WEATHERIZATION ASSISTANCE PROGRAM IN MINNESOTA

Raj Talwar

December, 1979



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Under Contract Number: 030-979-08133

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ABSTRACT

An evaluation of the Federal Weatherization Assistance Program to determine the fuel savings for participants in Minnesota has been completed. The homes selected in this study were weatherized between April and October 1978. Therefore, a comparison of normalized fuel consumption for the 1976-77 and 1977-78 heating seasons was an appropriate measure of the fuel savings achieved. In addition, a control group was established to reflect fuel consumption changes resulting from the effect of other public energy awareness programs.

The results indicate that the average energy savings was 13.43 percent. This was based on 59 sample group and 37 control group homes representing the population of all weatherized and non-weatherized low-income homes in the state, respectively.

The conclusions of this study are:

- At an average fuel cost of $6 per million BTU, weatherization has been accomplished at a simple payback of 3.5 years.
- 90 percent of the weatherized homeowners have expressed varying degrees of positive satisfaction.
- Behavioral changes (example, raising thermostats) are significant in offsetting potential weatherization savings.
- The Retrotech Job Book, in its present form, has not been used effectively.

ACKNOWLEDGMENTS

Thanks are due to the Minnesota Office of Economic Opportunity and the Minnesota Community Action Agencies for their cooperation through the duration of the project. Ryan George, Sudharman Perera, Patricia Black, and Vickie Ries of the MASEC staff contributed heavily in the implementation of the project. Finally, Eric Hirst of the Minnesota Energy Agency and Al Kaske of MASEC provided valuable advice and support towards the successful completion of this study.

CONTENTS

1.0 INTRODUCTION

The Federal Weatherization Assistance Program was first initiated by the Community Services Administration (CSA) in January, 1975, under the CSA's Emergency Energy Conservation Services (Ref.1). Subsequently, Title IV, Part A of the Energy Conservation and Production Act (PL 94-385, enacted August 14, 1976) directed the Department of Energy (DOE) to establish a federally financed National Weatherization Assistance Program for low-income persons, especially the elderly and handicapped. An excellent documentation of the legislative history and the appropriations for each fiscal year since the enactment of these programs is contained in Ref. 2.

Since FY'77, CSA has phased out of the program with all funding coming from DOE. The table below shows the DOE levels of funding:

	In Millions	
Fiscal Year	Authorized	Appropriated
1977	55.0	27.5
1978	65.0	65.0
1979	200.0	198.9
1980	200.0	200.0

From the start of the program, Minnesota has received both CSA and DOE funds to weatherize low-income homes. Since different laws and regulations were applicable to the CSA and DOE programs and because all current and

future funding is expected to be governed by DOE regulations, for this study it was decided to restrict the scope to only the DOE Weatherization Program.

In Minnesota, the program is implemented through the 26 local Community Action Agencies (CAA). Based on data compiled from 24 CAAs, $3.82 million of DOE monies has been granted to Minnesota for FY'77 and FY'78. The amount of funds allocated to individual CAAs is determined by a formula based on need and population of low-income families. Of these grant monies, $827,000 was spent in the state in FY'77 and FY'78, resulting in a total population of 2,657 homes weatherized.

A need was identified by the Minnesota Energy Agency (MEA) to evaluate this program primarily to determine whether the program has been successful in saving both energy and dollars for low-income families. In March, 1979, in response to MEA's request, the Mid-American Solar Energy Center (MASEC) developed a methodology to evaluate the fuel savings and, if possible, determine cost-effective weatherization strategies. The methodology was designed to have general applicability to other state programs so that the experience could be easily transferable to other states in the MASEC Region and throughout the U.S. The purpose of this report is to describe the Methodology Development as Implemented (Section 2.0), the Sample and Control Group Evaluation (Section 3.0), the Conclusions of the Study in Terms of Fuel Savings[1] (Section 4.0), Recommendations for Future Work (Section 5.0), and the appropriate Appendices as technical back-up of the study.

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[1]Although data at this stage is insufficient to identify cost-effective weatherization strategies, in the proposed continuation of the project to the 1979-80 heating season, it is hoped to establish a large enough data base to determine optimal combinations of different weatherization actions for different levels of expenditures and style and size of homes.

Essential to the development of the methodology was a literature search to identify similar projects in other states. It was determined that although there was voluminous information on the training aspect of the program, there was only one state-wide study and one community-wide study that evaluated the program with respect to fuel savings achieved. These are briefly described below:

- Evaluation by the Office of Economic Opportunity (OEO) of the South Dakota Home Weatherization Program (Ref.3).

  The results are based on 55 homes selected at random from the 6 CAAs in the state. The method involved requesting the CAAs acquire fuel consumption data from the utilities, then supply it to the OEO in terms of heating season consumption. An average of 20.02 percent energy savings was achieved with a range of 0 percent to 69 percent and a standard deviation of 13.0 percent.

  As discussed in Section 2.4 of this report the conclusions are not acceptable since the fuel record analysis (for both the amount consumed and corresponding degree days) was by heating seasons and not delivery schedules. (See Page 10). Also no effort was made to validate the accuracy of fuel records. Furthermore, obvious discrepancies in the results reported by one of the CAAs has not been accounted for, resulting in distortion of the 'average savings per home' figure for the entire sample. Finally, no control group was used for consumption changes resulting from public energy awareness programs.

- Evaluation of the CSA Weatherization Program in the North West Quarter of Wisconsin (Ref. 4).

The study was conducted by the University of Wisconsin, River Falls, in the summer of 1977 for 5 CAA regions of Wisconsin. The results based on 88 reliable fuel records indicate that an energy savings of 24.33 percent was achieved with a range from 5 percent to 75 percent and a standard deviation of 14.5 percent.

The method involved area science teachers and students personally inspecting the sample homes and obtaining fuel release authorization forms which were then mailed directly to the utility suppliers. Although sensitivity to fuel record accuracy was clearly evident in the report and in discussions with the principal investigator, errors were introduced at random since (a) some records reported consumption by heating season and others by delivery breakdowns, (b) there were differing definitions of heating seasons, and (c) no attempt was made to verify accuracy of natural gas records. Finally, in this study also there was no control group evaluation.

The basis of our concerns expressed above are detailed in Section 2.3. However, there are useful data and trends revealed in these reports and the experience gained from discussions with the authors formed the basis of the present evaluation method described in the next section.

2.0 DEVELOPING THE EVALUATION METHOD

2.1 Sample[1] and Control[2] Group Size Selection

In cooperation with the Minnesota Office of Economic Opportunity (OEO) data necessary for selecting the sample size was compiled from the DOE 1 and 2 audit forms[3] and the DOE Labor Questionnaire[4] completed by each CAA in early 1979. Details of the sampling plan are provided in Appendix A and Appendix B shows the final allocation to the 23 CAAs included in the study.

2.2 Interface with the CAAs

Meetings were held with the Minnesota State CAA Association and the CAA Directors' Association to determine the best method of identifying the sample and control groups. The CAA Directors' Association monthly meeting was addressed on April 11, 1979 at which the handout of Appendix B was distributed and discussed. Guidelines for randomly selecting the sample and control groups within each CAA allocation were established. For each sample group a completed Project Retrotech[5] Job Book was requested and

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[1]The sample group was defined as one for which weatherization was completed with DOE funds and using Project Retrotech "Home Weatherization Manual" before the 1978-79 heating season.

[2]The control group was defined as one determined to be eligible for weatherization but as of the end of the 1978-79 heating season the work had not been started. It was held at the same size as the sample group.

[3]DOE 1 and 2 audit forms refer to audited budgetary information on each CAA for FY'77 and FY'78, respectively.

[4]DOE Labor Questionnaire was designed to identify problems each CAA was experiencing in implementing the Weatherization Program. Particular emphasis was on the magnitude and nature of the problem of hiring labor to do the weatherization work.

[5]Project Retrotech is a job book containing energy audit information on each weatherized home. The information is compiled in a site visit by CAA personnel. A step-by-step procedure is used to recommend weatherization measures and estimate the energy savings resulting from each measure.

for the control group a name and an address were considered sufficient. Interest was expressed and cooperation was volunteered by all CAAs represented at the meeting. This is reflected in the high response rate (though somewhat delayed) shown in TABLE 2.1.

TABLE 2.1 RESPONSE RATE OF CAAs TO REQUEST FOR SAMPLE AND CONTROL GROUP INFORMATION

Date of Request: 4/11/79
Total Sample Group Requested: 200
Total Control Group Requested: 200

Date	Cumulative Percent Response for Retrotech Job Books	Cumulative Percent Response for Control Names and Addresses
5/1/79	8.5	8.5
6/1/79	61.5	50.0
7/1/79	80.5	69.0
9/1/79	89.0	84.5

Note 1: 1 CAA requested that the agency itself deal directly with the homeowners. As of a final tabulation we still do not have complete sample or control group details from this agency.

Note 2: 2 CAAs did not respond.

2.3 Data Gathering Instruments

Each of the Sample Group and Control Group was mailed either a "Sample Group Questionnaire" (Appendix C) or a "Control Group Questionnaire" (Appendix D) along with a Fuel Authorization Release form (Appendix E). The response rate from the Sample Group was 65 percent and the Control Group response rate was 44 percent as shown in TABLES 2.2 and 2.3, respectively.

The Sample Group reflects a higher response rate principally because second reminder mailings were made to each non-respondent. The questionnaires were incompletely filled out, in general, and wherever vital information was missing, telephone calls were made to collect the data.

TABLE 2.2 SAMPLE GROUP RESPONSE TO MAIL QUESTIONNAIRE

Mailings		Responses	
Date	Number Mailed	Date	Number Responded
5/31/79	106		
6/31/79	51	6/31/79	82
7/31/79	17	7/31/79	23
8/31/79	4	8/31/79	16
	Total: 178		Total: 116

TABLE 2.3 CONTROL GROUP RESPONSE TO MAIL QUESTIONNAIRE

Mailings		Responses	
Date	Number Mailed	Date	Number Responded
5/31/79	96		
6/31/79	42	6/31/79	47
7/31/79	27	7/31/79	16
8/31/79	4	8/31/79	11
	Total: 169		Total 74

Thus a total of 190 homeowners (both sample and control) returned questionnaires. Forty of these cases could not be used further in the study because either the owner had moved or experienced an unusual change (for example hospitalized, visiting family in another city, etc.) over the winter of 1978-79.

This left a balance of 150 usable questionnaires. In addition, for about 30 homeowners who did not return questionnaires, the Fuel Release Waiver was sent to us directly by the CAA. These 180 Fuel Release Waivers along with a cover letter (Appendix F) were sent to the appropriate utility supplier requesting an itemized breakdown of fuel records for the 1976-77, 1977-78, and 1978-79 heating seasons. An extensive effort was made by the project staff to maximize the number of fuel records acquired.

A response rate of 91 percent for utility bills was achieved as a result of second mailings, telephone calls and personal visits. This is shown below in TABLE 2.4.

Table 2.4 UTILITY RESPONSE TO REQUEST FOR BILLS

Mailings		Responses	
Date	Number Mailed	Date	Number Responded
6/31/79	97	6/31/79	82
7/31/79	37	7/31/79	45
8/31/79	46	8/31/79	36
	Total: 180		Total: 163

Thus a total of 163 fuel records were obtained for further analysis in this study.

2.4 The Nature of Fuel Records

The credibility of the results, conclusions, and recommendations of a project such as this is critically dependent on the accuracy and reliability of the fuel records. This is because the prime measure of success of the weatherization program is the reduction of energy consumption in low income homes. Since annual energy savings are typically expected to be in the 20 percent to 25 percent range it is important that any inaccuracies in fuel records or their method of analysis be reduced to the minimum possible. Therefore, special emphasis has been placed on this aspect of the project and it explains why, out of 163 fuel records received, only 96 were considered reliable and usable.

The areas needing special attention are described below:

2.4.1 The Use of Wood as Primary or Back-up: All fuel records for weatherized homes using wood as primary or backup are not considered reliable and thus are not used in computing percent energy savings. The unit by which wood consumption is reported is a Cord which, depending on the grade of wood, may have a heat content of 5 million to 20 million BTUs. Not only is the range of heating values extremely high but also the possible error per unit of quantity reported is several million BTUs. These uncertainities are probably greater than the expected overall BTU or percent energy savings resulting from weatherization. It was therefore decided not to include fuel records for homes using wood in the reliable fuel record set.

2.4.2 User of Liquid Propane or Fuel Oil: There are two types of instances where Liquid Propane and Fuel Oil records were rejected and not considered reliable.

2.4.2.a. When the customer is not served on a "tank full" basis. This occurs when the supplier does not fill up the tank each time he delivers but only provides the quantity the customer ordered. The error that is introduced in analyzing the fuel record is the result of an inventory problem. There is uncertainty in knowing the amount of fuel in the tank at the beginning and end of the time periods defined for comparing the pre- and post-weatherization fuel consumption. In the worst case the error can be as high as the tank capacity (typically 300-400 gallons) which is of the same order of magnitude as the expected fuel savings for a typical home.

In this project, these cases were clearly identifiable when the fuel deliveries reported were too "round numbered" (for example 200, 150, etc.) and typically followed a pattern (for example 200, 200, 200, 150, 100, 100, etc). In all other cases where doubts existed, a telephone call was made to the supplier expressly to confirm whether or not the customer was served on a tank full basis.

2.4.2.b. When consumption is reported by heating season and delivery breakdowns are not available. Initially this was considered as acceptable. However, when using the analysis method selected (described in 2.4) a serious discrepancy was observed. It is no coincidence that in each case when the consumption was first reported by heating season and the fuel itemized record was subsequently acquired the same error was noted. To illustrate this error an actual fuel oil record of a customer on a tank full basis is shown below after having obtained a breakdown in terms of delivery schedules. The home was weatherized in May, 1978.

Delivery Schedule, 1977-79

Pre-Weatherization			Post-Weatherization		
Date	Gallons		Date	Gallons	
2/15/77	143		11/24/78	119	
11/18/77	177		12/29/78	118	
12/19/77	114		1/23/79	45	593 gals.
1/18/78	124	706 gals.	2/16/79	129	
2/17/78	132		4/02/79	132	
4/12/78	159				

The same record was previously reported in terms of heating seasons as follows:

1977-78 heating season - 706 gals

1978-79 heating season - 592 gals

That is a decrease in consumption of 16.2 percent from 1977-78 to 1978-79.

However, the actual consumption, if measured from a full tank to a full tank, would be obtained on subtracting the first delivery for each period.

1977-78 heating season - 529 gals

1978-79 heating season - 474 gals

That is a decrease in consumption of 10.59 percent.

It is seen that an error of over 5 percent was introduced. This is unacceptable especially when (i) compared to an average expected fuel savings of 20-25 percent and (ii) predicting the error in a subsequent record is not possible and may be much higher or lower.

For the project it was therefore decided that only those cases where delivery breakdowns were available would be considered as usable.

The above two screening processes resulted in approximately 25 records of 50 fuel oil or liquid propane being not considered as usable and rejected.

2.4.3 User of Natural Gas: There is a lower attrition rate in usable fuel records for natural gas users. Several factors account for this:

a. Larger scale operations of gas companies result in centralized well-kept records,

b. Billing is periodic, and

c. There is no inventory problem since the amount billed is normally read off as the difference between two meter readings.

However, for a natural gas record to be acceptable it is essential that we know whether a particular billed amount is an actual reading, an estimated amount, or in some cases represents a two-month period with the one immediately before having been cancelled for some reason. The latter two situations were encountered frequently. An error is introduced by the first type if the months immediately prior to the start of the selected

heating season are estimated consumptions since any errors in their estimation will result in errors in the reported heating season consumption. For the same reasons the selected end of the heating season should be an actual meter reading. In the case of cancellations followed by a multiple period billing, the error will be during addition to determine the total heating season consumption.

For the project, extensive effort was required to personally access and understand gas company microfiche records to locate any of the above errors. For the sample and control groups in the Twin Cities Metro area, these records could be obtained from three separate microfiche cards. However, for the outlying areas, the number of cards required was in excess of eight cards, in some cases. In no case was a fuel record not usable, but certainly the selection of the defined heating season varied considerably, justifying the extra effort expended to maintain maximum accuracy.

There are several other reasons why fuel records were rejected. The more common of these are enumerated below:

- Weatherization was completed in the middle or end of the heating season,
- Weatherization measures were installed over too long a time period,
- Residents were temporarily away during the 1978-79 winter,
- The utility could only supply estimates, but kept no formal record, and
- Weatherization was done on a portion of a duplex.

2.5 Method of Analyzing the Fuel Record

Consider again the fuel record reported in 2.4.2.b[1]. In this case the home was weatherized in May, 1978. Several methods of determining energy savings were considered and the following, although the most time consuming, was considered the most accurate.

Two periods identified as pre-weatherization and post-weatherization were first selected. The closest city for which degree day data was available from National Oceanic and Atmospheric Administration (NOAA) was then identified as Minneapolis/St. Paul. Finally, the following table was completed:

Period	Gallons Consumed	Degree Days	Gal/DD
11/18/77-4/12/78	529	6850	0.07723
11/24/78-4/02/79	474	6561	0.07225

The percent energy savings were then determined to be 100 (.07723 - .07225)/.07723 = 6.5 percent

There are two important aspects to this method:

a. The energy savings are normalized with respect to the severity of the heating seasons used for comparison. If this were not done, the reported percent energy savings would have been (529-474) = 10.4 percent, which is significantly in error.

b. The energy savings is not computed for the entire heating season, but only for that portion of the heating season used in calculating the fuel consumption. The heating season for Minneapolis/St. Paul, if

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[1]In some cases where the fuel consumed included both space and water heating needs, 20 percent of the reported consumption was subtracted for the fuel used for water heating. In the absence of precise determinations, this is the author's estimate.

defined as October 1 to April 30, was 8123 heating degree days in 1977-78 and 8156 heating degree days in 1978-79. If the above caution had not been exercised the percent energy savings computed would have been (529/8123 - 474/8156) x 100/(529/8123) = 10.8 percent, which is again significantly different from the actual 6.5 percent.

The above method was used in analyzing each of the accurate sample and control group fuel records. The results are reported in the next section.

3.0 SAMPLE AND CONTROL GROUP EVALUATION

The sample group results are based on 59 weatherized homes. This represents the total number of homes for which accurate fuel records were acquired and analyzed. In addition to the savings analysis, data was obtained from the Retrotech Job Book for each of the 59 cases and from 45 sample group questionnaires.[1] All data were machine-coded and analyzed using the Statistical Package for the Social Sciences (Ref. 5) at the University of Minnesota Computer Center.

The data was analyzed in four generic categories:

1. Censorial Characteristics
2. Weatherization Actions Performed
3. Participant Attitudes
4. Savings

In addition, cross-tabluations were run between 'Percent BTU Savings'[2] and all variables that could possibly account for the variation in Percent BTU Savings, the purpose being to determine any significant relationships.

The Control Group results are based on 37 homes. The data was again analyzed using SPSS. Because the Control Group questionnaires were incompletely filled out, the only category for which the results are reported considers fuel consumption changes.

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[1]The remaining 14 used for the Savings analysis did not return the sample group questionnaire. Their fuel record was obtained after directly receiving the waiver authorization from the CAA.

[2]"Dollar Savings" and "BTU Savings" were also considered. However, because the pre- and post-weatherization periods for each case were over different lengths of time, these variables are meaningless unless normalized with respect to either degree days or percentages.

3.1 Censorial Characteristics

Table 3.1 shows the Censorial Characteristics of the homes surveyed in the sample group.

Table 3.1 CENSORIAL CHARACTERISTICS

1. Number of Occupants:	
Two or more:	78.0%
Between 3 and 6:	16.0%
More than 6:	6.0%
2. Style of Structure:	
One story:	41.0%
1-1/2 stories:	8.0%
2 stories:	49.0%
2-1/2 stories:	2.0%
3. Age of Structure:	
20 years or less:	9.3%
Between 20 and 60 years:	35.2%
More than 60 years:	54.9%
4. Floor Area:	
500 sq. ft. or less:	6.8%
Between 500 and 1000 sq. ft.:	90.3%
Greater than 1000 sq. ft.:	2.9%
5. Type of Fuel:	
Fuel oil:	32.0%
LP/bottled gas:	13.0%
Natural Gas:	52.0%
Other:	3.0%
6. Geographic:	
Urban:	42.0%
Rural:	58.0%
7. Ownership:	
Own:	98.0%
Rent:	2.0%

Figure 1 shows the geographic distribution of the homes surveyed in the sample group.

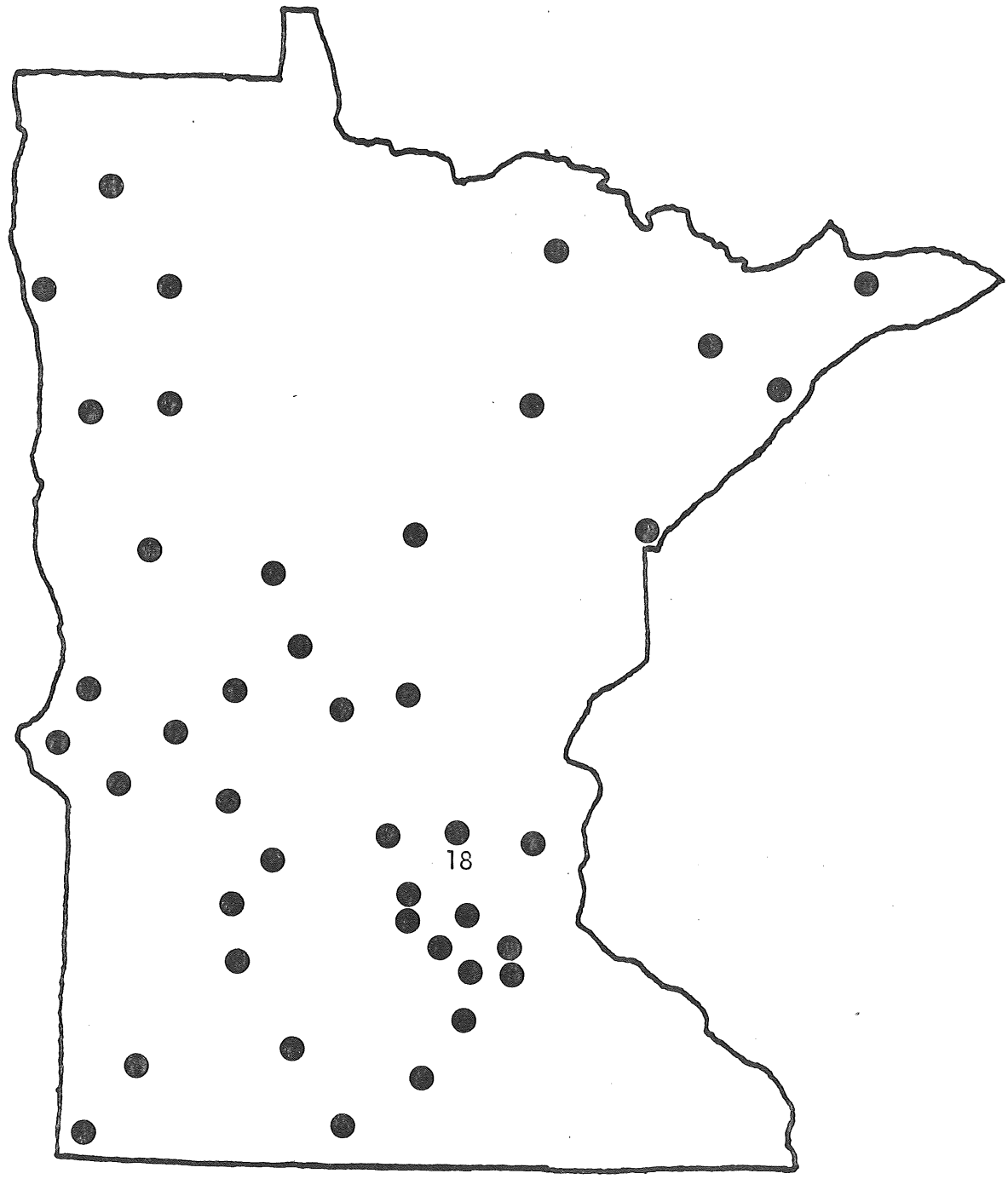

FIGURE 1: DISTRIBUTION OF SAMPLE HOMES

3.2 Weatherization Actions Performed

Table 3.2 lists the weatherization actions performed, the percentage of homes in which each measure was installed, the mean cost of each measure (materials only) and the range of cost of each measure. There were two isolated cases where over $200 was spent in "other repairs". In one case, an electrical space heater was installed by the CAA.

Table 3.2 WEATHERIZATION ACTIONS PERFORMED

	Percent of Homes	Mean Cost($)	Range($)
Ceiling Insulation	85	137	27-378
Caulking & Weatherstripping	82	24	2-82
Other Repairs	66	44	8-244
Storm Doors	47	94	20-248
Glass Replacement	47	22	1-59
Storm Windows	35	172	27-544
Wall Insulation	20	127	48-239

3.3 Participant Attitudes and Expectations

In general, the homeowners surveyed felt the program was needed and well implemented. Although there were a few isolated people who felt they were victims of gross negligence, over 90 percent expressed varying degrees of positive satisfaction with the program. Sixty-eight percent indicated plans for additional weatherization. In response to the fuel savings expectations, it is significant that 55 percent of the homeowners did not know what fuel savings to expect. In addition, 13 percent expected less than $50, 27 percent expected between $50-$100, and 10 percent expected over $100.

"Newspapers", "Direct Contact by the CAA", and "Conversations with Other People" were the three main sources from which the homeowners first heard about the program. The average length of waiting from the time of applying for the program to the start of the weatherization work was 6.5 months. It took an average of 4.5 months for the CAA to tell the

homeowner that he was eligible and another 2 months for starting the work. Exceptional cases are there. For example, in one instance, the CAA did not respond for over 2 years.

3.4 Savings Analysis

The savings achieved as a result of weatherization was measured in terms of:

- Percent BTUs saved,
- BTUs saved per Degree Day per Square Foot of living space,
- Dollars saved per Degree Day.

The data for both the Sample and Control Groups for each of the above three variables is shown in Table 3.4. ALso shown in the table are the baseline numbers for BTU per dd per sq. ft. living space figures before weatherization for both the sample and control groups. Appendix G lists the SPSS printout on these and other pertinent variables.

TABLE 3.4 SAVINGS ANALYSIS

Variable	Sample Group n=59				Control Group n=37			
	Mean	Range	Std. Error	Std. Deviation	Mean	Range	Std. Error	Std. Deviation
Percent BTUs Saved	10.95	-7.4 to 51.7	1.434	11.01	-2.48	-32.85 to 12.01	1.491	9.071
BTUs Saved Per Degree Day Per Sq. Ft. Living Space	1.68	-1.68 to 7.36	.237	1.82	- .295	-2.874 to 1.032	-.194	.971
Dollars Saved Per Degree Day	.006	-.003 to .034	.001	.006	.001	-.016 to .007	.001	.005
BTUs used Per Degree Day Per Sq. Ft. Living Space Before Weatherization	16.55	4.39 to 37.97	.941	7.23	11.67	1.9 to 28.4	1.09	5.44

To determine the net effect of weatherization, the sample group savings analysis is adjusted by the control group fuel consumption changes to conclude the following:

1. Net Percent BTUs Saved = 13.43%

   Standard Error = 2.069

2. Net BTUs saved per Degree Day per Square Foot = 1.98

   Standard Error = 0.306

3. Dollars Saved per Degree Day = 0.007

   Standard Error = 0.0014

The implications of these figures are discussed in the next section.

An attempt to explain the wide variation in percent BTUs saved (-7.4 percent to 51.7 percent) was made by running cross-tabulations between "Percent BTUs Saved" and the following variables:

- Number living in house,
- Number older than 65 years,
- Number younger than 17 years,
- Change in thermostat setting,
- Style of house,
- Satisfaction with work done,
- Age of house,
- Type of fuel,
- Floor area,
- Cost of weatherization, and
- Several combinations of different weatherization actions.

The output showed no relationship of significance. For example, the Raw Chi Square Confidence was consistently less than 0.25 for each cross tabulation. This is partly explained by the lack of a large enough data base.

4.0 CONCLUSIONS

The principal conclusion of this study is that if any sample sub-set be taken from the universe of low-income weatherized homes, there is a 95 percent confidence that the average fuel savings achieved will range from 9.37 percent to 17.49 percent. This is based on an average fuel savings of 13.43 percent with a standard error of 2.069.

In terms of BTUs of energy saved annually, the data implies that for an average low income house in Minnesota of 800 sq. ft. living floor space area, and an average winter of 9000 heating degree days, we have 95 percent confidence that the energy saved will range from 13.8 million BTUs to 14.7 million BTUs.

In terms of dollars saved annually and using the same assumptions as above, we conclude with 95 percent confidence that the dollars saved annually will range from $38.7 to $87.3. This range is much wider as compared to the energy saved range (see above) because the dollar per million BTU cost of the various fuels is significantly different.

Although the data base is not large enough to statistically support any other conclusions, we have noted the following observations:

1. The Retrotech Job Book procedure leads to inherent discrepancies because the heat load requirement of a house calculated by the Retrotech procedure is typically 2 or 3 times greater than the actual heat consumption of the house as measured from utility records. It is suspected that the error is introduced because there is no simple and accurate method of determining infiltration losses. Since infiltration is perhaps the single largest heat loss mechanism in a non-weatherized home, it suggests that it might be a waste of administrative dollars to

devise and implement sophisticated energy audit procedures without properly accounting for this mechanism. There is definite merit to the viewpoint that given a dollar budget per home for weatherization, we should start off with the most simple and cost-effective weatherization actions and continue down the list until the budget is exhausted.

2. It appears that some CAAs hve biased notions of what weatherization actions are effective. Thus one CAA installed storm windows and doors on almost all weatherized homes while another emphasized wall insulation. Such actions imply a lack of confidence in the audit procedure which was confirmed in discussions with some CAAs.

3. A large majority of the participants expressed satisfaction with the program and were sure that they were saving energy even though cross-tabulations between "Percent BTUs Saved" and "Satisfaction" showed very little relationship. In addition, most of the participants did not know how much energy they should be saving.

4. About 35 percent of the participants raised their thermostats after weatherization. Such action will significantly affect any fuel savings.

Conclusions 1 and 2 above are addressed via the Revised Retrotech Procedure enforced by DOE in April, 1979 (Ref. 6). For different styles of structures the states have been directed to prepare lists of weatherization actions prioritized by their cost-effectiveness. This necessary step will ensure that the most cost-effective weatherization action (caulking and weatherstripping) are installed in each case and will also reduce the amount of decision making presently left to the CAAs.

Conclusions 3 and 4 need to be addressed by educating participants to make them energy-aware and also on how behavioral changes can offset the

benefits of weatherization. This can be done by requiring grant recipients to go through a one-day training program which would tell them what to expect in terms of savings, additional savings possible with simple conservation practices, and how seriously the savings could be offset as a result of some common behavioral changes.

5.0 RECOMMENDATIONS FOR FUTURE WORK

It is proposed that the pilot evaluation project be continued into a more comprehensive state-wide evaluation for the 1979-80 heating season. Special emphasis is recommended on the following details:

1. A larger data base. Although the sampling plan was designed to be representative, whether or not the results are actually representative is determined by the number and distribution of accurate fuel records. Since an evaluation team does not have control over the distribution and accuracy of fuel records, a need for a much larger sample size (at least 400 sample homes) at the beginning of the study is required. With a sufficiently large sample, it is possible to determine whether or not the sample group is statistically representative of the universe of weatherized homes. This statistical support is also necessary for the other conclusions of this study.

2. Pre-coded reporting format for fuel records. Great care and accuracy is needed in the format of reporting and analyzing the fuel records. Utility suppliers use a variety of different formats for reporting fuel consumption and excessive time is spent in ensuring consistency. Therefore, it is recommended that pre-coded standardized forms be mailed to utility companies for reporting of fuel consumption data.

3. Precise documentation of weatherization performed. CAAs maintain a separate document (different types kept by individual agencies) which records the work actually performed on the house. Usually there are discrepancies between the recommendations of the Retrotech Job Book and the actual work performed. It is necessary to acquire this documentation so that if

there is a sufficient number of fuel records, it is possible to determine cost-effective weatherization strategies.

4. Consistent selection of the sample group within a CAA. Although not verified by the pilot study results, there may be a bias because the selection of the allocated sample groups by each CAA was not consistent. It is recommended that the evaluating team do the random selection of each CAA's allocated quota from their list of weatherized homes.

5. Field visits. The wide variation in fuel savings seems to reinforce the theoretical hypothesis that resident dependent effects are more critical than structural dependent effects. Field visits to the sample weatherized homes are essential to support this conclusion. These visits are also necessary to inspect the quality of the work done.

6. Consumption changes with time. Since all of the sample group was weatherized in 1978, the fuel savings determined is for the first heating season after weatherization. It is important to know what adjustments take place over time by comparing the first year with fuel savings for the second year. Thus, the entire sample group evaluated for the pilot study should again be evaluated for the 1979-80 heating season.

REFERENCES

1. Economic Opportunity Act, Sec. 222(a) 12 (P.L. 93-644)

2. "Some Major Policy Issues in the Administration of a Federal Weatherization Program", CSA B7D-5547, May 23, 1978. Prepared for Community Services Administration by Urban System Research and Engineering, Inc.

3. "Evaluation of South Dakota's Home Weatherization Program", October 1976. Prepared by University of Wisconsin, River Falls.

4. "Energy Conservation Evaluation", September, 1977. Prepared by University of Wisconsin, River Falls.

5. "Statistical Package for the Social Sciences", McGraw-Hill, 1970.

6. "Weatherization Assistance Program for Low-Income Persons; Proposed Amendments". Federal Register/Vol.44, No. 74/Monday, April 16, 1979.

7. "Evaluation of CSA Emergency Energy Conversion Services Program. Research Design: Sampling. Data Collection, Data Management", Contract #B7B-5547, June 7, 1978. Prepared for Community Services Administration by Urban Systems Research and Engineering, Inc.

APPENDIX A

SELECTING THE SAMPLE GROUP

APPENDIX A: SELECTING THE SAMPLE GROUP

Since the present study was restricted to a single state, it was decided to sample 100 percent of the CAAs and select a random stratified sample of weatherized homes. The approach used for stratifying the sample is similar to the one recommended by Urban Systems Research Corporation for sampling CAAs in a study whose scope would include all states where the weatherization program was in effect (Ref. 7).

The information from DOE I and DOE II audit forms, and the DOE labor questionnaire completed by all CAAs in early 1979 is compiled in TABLE A.1. The Urban/Rural figures were obtained by summing population data over all the individual counties for each CAA district from Reference 2.

TABLE A.1 PROGRAM STRUCTURE OF 23 CAAs

Total DOE Grants FY'77 and FY'78	=	$3.82 million
Total DOE Spent FY'77 and FY'78	=	$827,000
Number of Homes Weatherized	=	2,657
Average DOE Dollar/Weatherized Home	=	$311
Range, DOE Dollars/Weatherized Home	=	$114 to $515
Average Percent Urban	=	42%
Range Percent Urban	=	7% to 100%

Note: 1 CAA did not weatherize any homes. No information was available on 2 CAAs and all the Indian CAAs.

The selection of the stratifying dimensions is based on these choices:

- Those parameters that have the greatest effect on outcomes. It is important that only one select the most significant parameters since as the number of strata increases the sample size must be increased to make conclusions with the same degree of confidence.
- Those that have significant variation in the universe and are not highly correlated with another dimension.

Based on the above, it was decided to select two dimensions:

1) Budget (Dollars spent per weatherized home)
2) Urban/Rural

In the first dimension, three classifications were selected: high budget (over $425 per weatherized home), medium budget (between $205 and $425 per weatherized home), and low budget (below $205 per weatherized home). The second dimension has two classifications: urban and rural. Thus, a total of six possible strata were identified and the CAAs were each grouped in their appropriate strata as shown in TABLE A.2.

The optimal allocation of a given sample size to the different strata which minimizes the standard error in the estimate of the mean energy savings is:

$$n_i/n = \frac{N_i S_i}{\Sigma N_i S_i}$$

where N_i is the number of weatherized homes sampled in the i^{th} stratum, n is the total sample size, N_i is the estimated standard deviation of annual energy savings of homes in the i^{th} stratum. The statistical confidence in the results can only be determined after all the data has been analyzed, but for initial sample selection appropriate S_i values

have to be estimated. In this study it is assumed that the standard deviation of mean annual energy savings depends on the budget dimension and is $75 for a low budget strata, $112.5 for a medium budget strata, and $150 for a high budget strata.[1]

The fractional allocation to different strata of a particular sample size is given in the N_i/n column in TABLE A.2.

The sample size n is related to the level of confidence derived in the estimate of mean annual energy savings. For stratified samples, the standard error of the mean is:

$$S_{\bar{x}} = \sqrt{\sum_i \frac{N_i^2 S_i^2}{n_i} \frac{(1-n_i)}{N_i}} \Bigg/ \sum_i N_i$$

For different values of sample size n, $S_{\bar{x}}$ values may be computed. TABLE 2 shows that the standard error of the mean is $14.17 and $9.91 for a sample size of 50 and 100, respectively.

These standard errors can be translated into confidence regions as shown in TABLE A.3.

TABLE A.3. CONFIDENCE REGION AND SAMPLE SIZE

	Confidence Internal	
Sample Size n	90% Confidence	95% Confidence
50	± $23.24	± $28.34
100	± $16.25	± $19.82

[1]These values are best estimates based on experience and expected weatherization payback periods. Their precise determination is not necessary since validity of the results is more dependent on the distribution of reliable fuel records over the different strata.

TABLE A.2 SAMPLE ALLOCATION TO DIFFERENT STRATA

Stratum	Budget	Urban/ Rural	CAA's	No. of CAA's	No. of Weather-ized Homes	Si	Ni/n	NiSi	N=50		N=100	
									Ni	Sx	Ni	Sx
1	High	Urban	1	1	64	150	.0359	9600	2		4	
2	Medium	Urban	2,5	2	219	112.5	.092	24637.5	5		9	
3	Low	Urban	12	1	438	75	.1227	32,850	6	$14.17	12	$9.91
4	High	Rural	11,21	2	243	150	.1362	36,450	7		14	
5	Medium	Rural	3,6,10, 14,15, 18,19, 22,23, 24,26	11	1012	112.5	.4253	113,050	21		42	
6	Low	Rural	7,8,9,13 17,20	6	671	75	.188	50,325	9		19	

That is, if from a sample of 50 homes, the average annual energy savings is $200, then there is 90 percent confidence that the true average annual energy savings in the 2,647 homes is between $176.76 and $223.24. The other values of TABLE A.3 may be interpreted in a similar fashion.

Given the assumed S_i values, a satisfactory sample size for the study is 50. However, to ensure that at least 50 usable fuel records would be acquired, a starting size of 200 was selected and allocated to the different strata by multiplying 200 by the fractional allocation N_i/n of each strata. Again within each strata, the total sample allocation can be further divided among the different CAAs in that strata in relative proportion to the number of homes weatherized by each CAA. TABLE A.4 shows the final allocation of the sample size to the CAAs as obtained by this method.

TABLE A.4 ALLOCATING THE 200 SAMPLE SIZE TO THE INDIVIDUAL CAAs

Stratum	CAA	N_i	Stratum	CAA	N_i
1	1	7	5 cont.	18	9
2	2	10		19	2
	5	8		22	4
3	12	25		23	9
4	11	15		24	17
	21	12		26	4
5	3	3	6	7	7
	6	10		8	4
	10	9		9	3
	14	6		13	6
	15	12		17	12
				20	6

APPENDIX B

INSTRUCTIONS TO CAAs

LETTER PREPARED FOR MINNESOTA COMMUNITY ACTION AGENCIES (CAA)

DIRECTORS' ASSOCIATION MEETING HELD ON APRIL 11, 1979

MID-AMERICAN
SOLAR ENERGY
COMPLEX

The MASEC Center
1256 Trapp Road
Eagan, Minnesota 55121
(612) 452-5300

April 9, 1979

Prepared for the Minnesota Community Action Agencies (CAA)
Directors' Association meeting held on April 11, 1979

The Mid-American Solar Energy Center (MASEC) and the Minnesota Energy Agency (MEA) have a project to determine the energy savings resulting from weatherization in Minnesota. The project results will be used for formally documenting the cost effectiveness of weatherization and meeting the information needs of appropriate public officials in the state, the MASEC Region and nationally.

The energy savings will be documented by selecting a representative sample of weatherized homes, examining the fuel consumption pre- and post-weatherization, normalizing the fuel savings with respect to climate and a control group of non-weatherized homes, and statistically projecting the savings to the entire population of weatherized homes. Over 13,000 low income homes have been weatherized in the state since the start of the program in late 1974. However, because differing methods of determining weatherizing actions needed were used, our universe of homes is restricted to about 3,000 homes that were weatherized using the Department of Energy (DOE) funds and Project Retrotech - Home Weatherization Manual.

In cooperation with the State of Minnesota Office of Economic Opportunity (OEO), we have compiled the information contained in the DOE I and DOE II reports, and the DOE Labor Questionnaire that have been completed by almost all the CAAs. Based on the data we have selected a statistically representative stratified sample, with the distribution of homes within the CAAs in each strata depending on the relative proportion of the number of homes weatherized. The results of the sample allocation to each of the CAAs is shown in Attachment 1.

Our information needs are described in the next section. The success of this project hinges on the cooperation of the CAAs in providing the information and we urge you to do so at your earliest convenience. We will then separately contact the identified homeowners to invite their participation in the project and sign a waiver providing us access to their fuel records.

If at any time you have questions please call us:

MASEC Contact: Raj Talwar/Ryan George (612) 452-5830

MEA Contact: Eric Hirst (612) 296-0257

Our Information Needs

From each of the CAA districts identified in Attachment 1, we need information in the following 2 categories:

1. Sample Group: We need to know exactly what weatherizing actions (and their cost) were performed on the number of sample homes identified in your CAA district in the Attachment. These homes should meet the following criteria:

   a. Homes must have been weatherized using DOE funds and Project Retrotech - Home Weatherization Manual.

   b. The present homeowners must have lived in them for at least one full year prior to weatherization since we will have to access their fuel records for that time period.

   c. Homes which were weatherized during the period May 1, 1977, to October 1, 1977, and May 1, 1978, to October 1, 1978, are preferable. However, it is not essential that this criteria be met.

   The information we need is available in the Project Retrotech Home Weatherization Job Book that should have been completed on each weatherized home. It would be most desirable to obtain a copy of this job book for each home identified by you in your district.

2. To determine if changes in fuel consumption <u>are</u> the result of weatherization and not behavioral changes arising from other public energy conservation programs, we need to establish a control group. Ideally this control group of homes is statistically identical to the sample group. In this category, we therefore need the names, addresses and telephone numbers of the same number of homeowners in your CAA as the sample group. These homeowners must have applied for weatherization, and determined by you to be eligible, but the weatherization had not been done as yet.

Attachment 1

Name of CAA	Number of weatherized homes (using DOE funds and Project Retrotech) selected for sampling
Anoka Economic Opportunity Agency	7
Arrowhead Economic Opportunity Agency	10
Bi-County Community Action Council	3
Duluth CAP	8
Goodhue-Rice-Wabasha Citizens Action Council	10
Inter-County Community Council	7
Koochiching-Itaska Action Council	4
Lakes and Pines Community Action Council	3
Mahube Community Council	9
Minnesota VAlley Action Council	15
Minneapolis Community Action Agency	25
Northwest Community Action Council	6
Ottertail-Wadena Community Action Council	6
Prairie Five CSA	12
Region 6 - East CAA	12
Scott Carver Economic Council	9
SEMCAC	2
Southwest Minnesota Opportunity Council	6
Tri-County CAP	12
Tri-County Action Programs	4
Tri-Valley Opportunity Council	9
West Central Minnesota Communities Action	17
Wright Community Council	4

Note: 1 CAA district reported as having weatherized no homes with DOE funds and for 2 other districts, no data is available.

APPENDIX C

SAMPLE GROUP QUESTIONNAIRE

QUESTIONNAIRE

Please complete the information below as accurately as possible. All information on individual homeowners will be confidential.

Name _____ Address _____
No. and Street

Telephone ( ) _____ _____
City State Zip

1. Do you own or rent this house? Own ____ Rent____

2. How many people, including yourself, usually live in this household? ____

   How many of these are 17 years old or younger? ____

   How many are 65 years old or older? ____

   How many are handicapped or disabled? ____

3. How did you find out about the weatherization program? Please tell us if you heard about the program from any of the following: (You may check more than one)

   ____a. TV or radio
   ____b. Newspaper
   ____c. Letter from CAA agency
   ____d. Phone call or visit from CAA agency
   ____e. Referral from other agency
   ____f. Conversations with other people
   ____g. Other (specify): _____

4. When did you apply for the weatherization program? ___/___ (mo. yr.)

   About how long after you applied were you told you were eligible? ____mos.

   When did work start on your house? ___/___ (mo. yr.)

5. Do you (or your landlord) plan further weatherization in addition to that done by the agency? Yes____ No____

   If yes, what do you plan to do?

   _____

   _____

   _____

6. Please describe what you feel is the most important result of the weatherization work for your household.

   _____

   _____

   _____

7. Before weatherization by the agency, did you close off any rooms of your house during the heating season? Yes____ No____

8. Do you close off any rooms during the heating season now? Yes____ No____

9. Does your heating system have a thermostat? Yes____ No____

(If yes)
At what temperature do you set your thermostat during the day in winter? ____degrees

At what temperature do you set your thermostat during the night in winter? ____degrees

Before weatherization, at what temperature did you set your thermostat in winter? during day ____degrees
at night ____degrees

10. If your household uses a fuel other than electricity, Gas or Fuel Oil, please specify the name of the fuel and an approximation of the amount consumed below

Name of Fuel _____

Heating Season Consumption _____1976 _____1977 _____1978

11. Is someone usually home most of day? Yes____ No____

12. Before your house was weatherized, was someone usually home most of the day? Yes____ No____

13. Overall, are you saving money as a result of weatherization? Yes____ No____

About how much are you saving compared to what you paid the last year before weatherization?

____a. Under $50
____b. $50-$100
____c. $100-$200
____d. $200-$300
____e. More than $300
____f. Don't Know

14. Do you think the weatherization crew did a good job on your home? Yes____ No____

Please explain your answer. _____

_____

_____

15. Please list any additional comments on the weatherization program:

_____

_____

_____

_____

_____

APPENDIX D

CONTROL GROUP QUESTIONNAIRE

QUESTIONNAIRE

Please complete the information below as accuratley as possible. All information on individual homeowners will be confidential.

Name _____ Address _____
No. and Street

Telephone ( ) _____ _____
City State Zip

1. Do you own or rent this house? Own____ Rent____

2. How many people, including yourself, usually live in this household? ____

   How many of these are 17 years old or younger? ____

   How many are 65 years old or older? ____

   How many are handicapped or disabled? ____

3. How did you find out about the weatherization program? Please tell us if you heard about the program from any of the following:

   ____a. TV or radio
   ____b. Newspaper
   ____c. Letter from CAP Agency
   ____d. Phone call or visit from CAP Agency
   ____e. Referral from other agency
   ____f. Conversations with other people
   ____g. Other (specify): _____

4. When did you apply for the weatherization program? ____/____ (mo. yr.)

   About how long after you applied were you told you were eligible? ____ mos.

   When did the agency say your home would be weatherized? ____/____ (mo. yr.)

5. Please tell us if this house has any of the following:

Caulking	Yes____	No____
Weatherstripping	Yes____	No____
Storm Windows	Yes____	No____
Storm Doors	Yes____	No____
Insulation of:		
Ceilings	Yes____	No____
Walls	Yes____	No____
Floors	Yes____	No____
Hot Water Pipes	Yes____	No____
Hot Water Heater	Yes____	No____
Heating Ducts	Yes____	No____
Foundation Banking	Yes____	No____
Foundation Skirting	Yes____	No____
Foundation Repair	Yes____	No____
Furnace Cleaning & Repair	Yes____	No____
Furnace Installation	Yes____	No____
Window Glass Replacement	Yes____	No____
Roof Repairs	Yes____	No____
Chimney Repairs	Yes____	No____
Siding Repairs	Yes____	No____

6. Please tell us whether any of the following are problems:

Low House Temperature	Yes____	No____
Drafts	Yes____	No____
Cold Spots	Yes____	No____
Cold Walls	Yes____	No____
Cold Floors	Yes____	No____
Sweating/Icing Inside Windows	Yes____	No____
Roof Leaks	Yes____	No____
Basement Cold and/or Wet	Yes____	No____
Moisture in Walls	Yes____	No____
Hot Water Not Hot Enough	Yes____	No____
Other (Specify)	Yes____	No____

_____

7. What is the total number of rooms in this house, not including halls, bathrooms, closets, or porches? ____rooms

8. What is the approximate size of this house? _____ sq. ft.

9. Please place a check mark against the most appropriate description of the style of your house:

____ one-story ____ 2-½ story ____Other (please specify)

____ two-story ____ split level _____

10. Do you close off any rooms during the heating season? Yes____ No____

11. Does your heating system have a thermostat? Yes____ No____

(If yes)
At what temperature do you set your thermostat in the winter? during the day _____degrees

at night _____degrees

12. Is someone usually home most of the day? Yes____ No____

13. Do you know about how much you spent on fuel for your main heating unit during:

June 1, 1978-May 31, 1979 $ _____

June 1, 1977-May 31, 1978 $ _____

14. Do you know about how much you spent on fuel for your backup heating unit during:

June 1, 1978-May 31, 1979 $ _____

June 1, 1977-May 31, 1978 $ _____

15. Do your fuel costs include fuel for your hot water heater? Yes____ No____

(If no)
What was your average hot water bill during the last 12 months?

$_____
per billing period

APPENDIX E

FUEL RELEASE AUTHORIZATION FORM

Mid-American Solar Energy Center Survey
Authorization Form for
Information on Residential Energy Consumption

I hereby give permission to the company (companies) below to provide information to the Mid-American Solar Energy Center for confidential use in connection with their weatherization project.

This authorization covers use of fuels (electricity, natural gas or LPG, or fuel oil) by my household from October 1, 1976, through April 30, 1979, including:

1. The total amount of fuels used by my household.
2. The total price charged for fuels used by my household.

Companies are authorized to provide this information by monthly periods or by delivery date, whichever applies. A photocopy of this authorization may be accepted with the same authority as the original.

Signature: _____

Date: _____

Please Print Below:

Name _____ Address _____

Telephone ( ) _____

_____
City State Zip

Please complete below for each fuel used by your household: (If more than one supplier of a particular fuel, use the other side of this sheet to provide the information)

Electricity

Name of Electric Company

_____
Address

_____
City State Zip

_____
Telephone: ( ) _____

Gas including LPG (Bottled or Tank gas)

Name of Gas Company

_____
Address

_____
City State Zip

_____
Telephone: ( ) _____

Fuel Oil

Name of Oil Company

_____
Address

_____
City State Zip

_____
Telephone: ( ) _____

APPENDIX F

COVER LETTER TO UTILITIES

MID-AMERICAN
SOLAR ENERGY
COMPLEX

The MASEC Center
1256 Trapp Road
Eagan, Minnesota 55121
(612) 452-5300

Dear Sir:

The Mid-American Solar Energy Center and the Minnesota Energy Agency are working on a program to determine the fuel savings from weatherization in homes belonging to low-income families. The weatherization work is funded by the Department of Energy and the Community Services Administration. It has been implemented in Minnesota by local Community Action Agencies and over 3,000 homes in the state have been weatherized in the past two years.

An essential part of this project is the gathering of actual fuel use records of the homes included in our statistically representative sample and control groups. We have contacted the selected homeowners and have obtained their release form authorizing you to provide us this information. Your cooperation in this matter is necessary for the success of this project.

Below are the names and addresses of the homeowners who have purchased their utilities through you during the past three years. The time periods for which their fuel records are necessary are also shown. If possible, we would prefer the data in the form of the amount of fuel supplied for each billing period and an average price. A xerox copy of the bill is acceptable.

Also enclosed are the signed waivers from the homeowners which you may keep as part of your records. We appreciate your time and effort in providing this necessary information. If you have any questions, please call me or Ryan George at 612/452-5830.

Sincerely yours,

Raj Talwar, P.E.
Analysis and Assessment Division

/pb
Enclosures

APPENDIX G

SPSS MACHINE ANALYZED RESULTS

FILE SUBSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE BTUPDDB BTU USED PER DEG DAY- BEFORE

MEAN	12779.896	STD ERR	675.675	STD DEV	5189.942
VARIANCE	.2693E+08	KURTOSIS	-.255	SKEWNESS	.626
MINIMUM	5258.389	MAXIMUM	25437.683	SUM	754013.889
C.V. PCT	40.610	.95 C.I.	11427.390	TO	14132.403

VALID CASES 59 MISSING CASES 2

VARIABLE BTUPDDA BTU USED PER DEG DAY- AFTER

MEAN	11437.942	STD ERR	650.325	STD DEV	4995.241
VARIANCE	.2495E+08	KURTOSIS	-.408	SKEWNESS	.640
MINIMUM	3700.927	MAXIMUM	23817.222	SUM	674838.585
C.V. PCT	43.673	.95 C.I.	10136.175	TO	12739.709

VALID CASES 59 MISSING CASES 2

VARIABLE BTUSDD BTU SAVED PER DEG DAY

MEAN	1341.954	STD ERR	187.755	STD DEV	1442.170
VARIANCE	2079854.843	KURTOSIS	1.960	SKEWNESS	1.245
MINIMUM	-787.781	MAXIMUM	6555.931	SUM	79175.304
C.V. PCT	107.468	.95 C.I.	966.125	TO	1717.786

VALID CASES 59 MISSING CASES 2

VARIABLE CPDDB COST PER DEG DAY- BEFORE

MEAN	.053	STD ERR	.002	STD DEV	.018
VARIANCE	.000	KURTOSIS	1.489	SKEWNESS	.841
MINIMUM	.021	MAXIMUM	.119	SUM	3.110
C.V. PCT	34.978	.95 C.I.	.048	TO	.058

VALID CASES 59 MISSING CASES 2

FILE SUDSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE CPDDA COST PER DEG DAY- AFTER

MEAN	.073	STD ERR	.026	STD DEV	.202
VARIANCE	.041	KURTOSIS	58.070	SKEWNESS	7.592
MINIMUM	.015	MAXIMUM	1.590	SUM	4.310
C.V. PCT	275.955	.95 C.I.	.021	TO	.126

VALID CASES 59 MISSING CASES 2

- -

VARIABLE CSAVDD COST SAVINGS PER DEG DAY

MEAN	-.020	STD ERR	.026	STD DEV	.202
VARIANCE	.041	KURTOSIS	58.874	SKEWNESS	-7.669
MINIMUM	-1.542	MAXIMUM	.034	SUM	-1.200
C.V. PCT	991.064	.95 C.I.	-.073	TO	.032

VALID CASES 59 MISSING CASES 2

- -

VARIABLE BTUSDDSF BTU SAVINGS PER DEG DAY PER SQ FT-ENV

MEAN	.580	STD ERR	.088	STD DEV	.675
VARIANCE	.455	KURTOSIS	4.340	SKEWNESS	1.699
MINIMUM	-.420	MAXIMUM	3.079	SUM	34.245
C.V. PCT	116.246	.95 C.I.	.405	TO	.756

VALID CASES 59 MISSING CASES 2

- -

VARIABLE CSAVDDSF COST SAVINGS-DD-SQ FT- 1000000 ENVLOP

MEAN	-4.289	STD ERR	6.909	STD DEV	53.070
VARIANCE	2816.388	KURTOSIS	56.554	SKEWNESS	-7.638
MINIMUM	-404.294	MAXIMUM	16.357	SUM	-253.036
C.V. PCT	1237.417	.95 C.I.	-16.119	TO	9.541

VALID CASES 59 MISSING CASES 2

- -

FILE SUDSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE BTUSDDFL BTU SAVINGS PER DEG DAY PER SQ FT-FL

MEAN	1.682	STD ERR	.237	STD DEV	1.817
VARIANCE	3.300	KURTOSIS	1.407	SKEWNESS	1.067
MINIMUM	-1.683	MAXIMUM	7.356	SUM	99.250
C.V. PCT	107.992	.95 C.I.	1.209	TO	2.156

VALID CASES 59 MISSING CASES 2

- -

VARIABLE CSAVDDFL COST SAVINGS-DD-SQ FT- 1000000 ENVLOP

MEAN	-21.284	STD ERR	28.740	STD DEV	220.760
VARIANCE	48734.798	KURTOSIS	58.827	SKEWNESS	-7.664
MINIMUM	-1687.065	MAXIMUM	39.075	SUM	-1255.766
C.V. PCT	1037.201	.95 C.I.	-78.814	TO	36.246

VALID CASES 59 MISSING CASES 2

- -

VARIABLE PCNTBTUS PERCENTAGE BTU SAVINGS

MEAN	10.945	STD ERR	1.434	STD DEV	11.013
VARIANCE	121.284	KURTOSIS	2.151	SKEWNESS	1.059
MINIMUM	-7.402	MAXIMUM	51.743	SUM	645.745
C.V. PCT	100.622	.95 C.I.	8.075	TO	13.815

VALID CASES 59 MISSING CASES 2

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VARIABLE BTUDDFLB BTU PER DEG DAY PER SQ FT FL AREA BEFORE

MEAN	16.550	STD ERR	.941	STD DEV	7.230
VARIANCE	52.268	KURTOSIS	1.077	SKEWNESS	1.016
MINIMUM	4.393	MAXIMUM	37.977	SUM	976.422
C.V. PCT	43.685	.95 C.I.	14.665	TO	18.434

VALID CASES 59 MISSING CASES 2

- -

FILE SUDSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE BTUDDFLA BTU PER DEG DAY PER SQ FT FL AREA AFTER

MEAN	14.867	STD ERR	.924	STD DEV	7.100
VARIANCE	50.417	KURTOSIS	.861	SKEWNESS	1.034
MINIMUM	3.092	MAXIMUM	36.370	SUM	877.172
C.V. PCT	47.759	.95 C.I.	13.017	TO	16.718

VALID CASES 59 MISSING CASES 2

- -

VARIABLE BTUDDENB BTU PER DEG DAY PER SQ FT ENVLOP BEFORE

MEAN	5.426	STD ERR	.306	STD DEV	2.350
VARIANCE	5.523	KURTOSIS	-.146	SKEWNESS	.354
MINIMUM	.279	MAXIMUM	11.092	SUM	320.150
C.V. PCT	43.312	.95 C.I.	4.814	TO	6.039

VALID CASES 59 MISSING CASES 2

- -

VARIABLE BTUDDENA BTU PER DEG DAY PER SQ FT ENVLOP AFTER

MEAN	4.846	STD ERR	.291	STD DEV	2.235
VARIANCE	4.996	KURTOSIS	-.019	SKEWNESS	.506
MINIMUM	.245	MAXIMUM	10.886	SUM	285.904
C.V. PCT	46.126	.95 C.I.	4.263	TO	5.428

VALID CASES 59 MISSING CASES 2

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VARIABLE FLAREA FLOOR AREA OF THE HOUSE

MEAN	806.607	STD ERR	27.867	STD DEV	217.651
VARIANCE	47371.876	KURTOSIS	.062	SKEWNESS	.497
MINIMUM	384.000	MAXIMUM	1400.000	SUM	49203.000
C.V. PCT	26.984	.95 C.I.	750.864	TO	862.350

VALID CASES 61 MISSING CASES 0

- -

FILE SUDSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE WLAREA GROSS WALL AREA OF THE HOUSE

MEAN	2710.934	STD ERR	983.321	STD DEV	7679.981
VARIANCE	.5898E+08	KURTOSIS	58.021	SKEWNESS	7.544
MINIMUM	800.000	MAXIMUM	61010.000	SUM	165367.000
C.V. PCT	283.296	.95 C.I.	744.000	TO	4677.869

VALID CASES 61 MISSING CASES 0

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VARIABLE HSEAGE AGE OF THE HOUSE

MEAN	56.661	STD ERR	3.510	STD DEV	26.267
VARIANCE	689.974	KURTOSIS	-.706	SKEWNESS	-.214
MINIMUM	5.000	MAXIMUM	100.000	SUM	3173.000
C.V. PCT	46.359	.95 C.I.	49.626	TO	63.695

VALID CASES 56 MISSING CASES 5

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VARIABLE CALKCOST COST OF CAULKING

MEAN	36.500	STD ERR	13.381	STD DEV	88.761
VARIANCE	7878.442	KURTOSIS	40.224	SKEWNESS	6.225
MINIMUM	2.000	MAXIMUM	600.000	SUM	1606.000
C.V. PCT	243.180	.95 C.I.	9.514	TO	63.486

VALID CASES 44 MISSING CASES 17

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VARIABLE STWNCOST COST OF STORM WINDOWS

MEAN	172.056	STD ERR	33.385	STD DEV	141.632
VARIANCE	20059.703	KURTOSIS	1.170	SKEWNESS	1.235
MINIMUM	27.000	MAXIMUM	544.000	SUM	3097.000
C.V. PCT	82.318	.95 C.I.	101.623	TO	242.488

VALID CASES 18 MISSING CASES 43

- -

FILE SUDSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE STDRCOST COST OF STORM DOORS

MEAN	93.583	STD ERR	10.505	STD DEV	51.464
VARIANCE	2648.514	KURTOSIS	2.898	SKEWNESS	1.653
MINIMUM	20.000	MAXIMUM	248.000	SUM	2246.000
C.V. PCT	54.992	.95 C.I.	71.852	TO	115.315

VALID CASES 24 MISSING CASES 37

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VARIABLE SKRTCOST COST OF BANKING SKIRTING REPAIRS

MEAN	51.000	STD ERR	16.000	STD DEV	22.627
VARIANCE	512.000	KURTOSIS	0	SKEWNESS	0
MINIMUM	35.000	MAXIMUM	67.000	SUM	102.000
C.V. PCT	44.367	.95 C.I.	-152.299	TO	254.299

VALID CASES 2 MISSING CASES 59

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VARIABLE FUNDCOST COST OF FOUNDATION REPAIRS

MEAN	15.500	STD ERR	8.999	STD DEV	22.043
VARIANCE	485.900	KURTOSIS	5.541	SKEWNESS	2.331
MINIMUM	3.000	MAXIMUM	60.000	SUM	93.000
C.V. PCT	142.214	.95 C.I.	-7.633	TO	38.633

VALID CASES 6 MISSING CASES 55

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VARIABLE FURNCOST FURNACE REPAIR AND CLEANING COST

STATISTICS CANNOT BE COMPUTED FOR THIS VARIABLE
IT IS EITHER MISSING IN EVERY CASE OR HAS BAD DATA VALUES.

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FILE SUBSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

VARIABLE GLASCOST COST OF GLASS REPLACEMENTS

MEAN	22.167	STD ERR	3.379	STD DEV	16.552
VARIANCE	273.971	KURTOSIS	.288	SKEWNESS	.992
MINIMUM	1.000	MAXIMUM	59.000	SUM	532.000
C.V. PCT	74.671	.95 C.I.	15.177	TO	29.156

VALID CASES 24 MISSING CASES 37

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VARIABLE OTHRCOST COST OF OTHER REPAIRS

MEAN	44.229	STD ERR	8.141	STD DEV	48.162
VARIANCE	2319.593	KURTOSIS	11.121	SKEWNESS	3.217
MINIMUM	8.000	MAXIMUM	244.000	SUM	1548.000
C.V. PCT	108.894	.95 C.I.	27.684	TO	60.773

VALID CASES 35 MISSING CASES 26

- -

VARIABLE ESTCOST ESTIMATED TOTAL COST

MEAN	301.810	STD ERR	18.803	STD DEV	143.198
VARIANCE	20505.806	KURTOSIS	1.693	SKEWNESS	.874
MINIMUM	45.000	MAXIMUM	785.000	SUM	17505.000
C.V. PCT	47.447	.95 C.I.	264.158	TO	339.462

VALID CASES 58 MISSING CASES 3

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VARIABLE BTUSDFDU BTU SAV PER DD PER SQ FT-FL PER 1000$

MEAN	6.868	STD ERR	1.211	STD DEV	9.059
VARIANCE	82.062	KURTOSIS	4.338	SKEWNESS	1.970
MINIMUM	-4.728	MAXIMUM	39.647	SUM	384.624
C.V. PCT	131.893	.95 C.I.	4.442	TO	9.294

VALID CASES 56 MISSING CASES 5

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ILE SUBSURV (CREATION DATE = 79/10/17.) DATA FOR THE SAMPLE GROUP

ARIABLE WTELGBLE MONTHS WAITED FOR ELIGIBILITY

EAN	4.581	STD ERR	1.717	STD DEV	11.257
ARIANCE	126.725	KURTOSIS	26.724	SKEWNESS	4.910
INIMUM	0	MAXIMUM	69.000	SUM	197.000
.V. PCT	245.716	.95 C.I.	1.117	TO	8.046
ALID CASES	43	MISSING CASES	18		

ARIABLE WTWORK MONTHS WAITED FOR WORK TO START

EAN	2.000	STD ERR	.438	STD DEV	2.590
ARIANCE	6.706	KURTOSIS	1.586	SKEWNESS	1.541
INIMUM	0	MAXIMUM	9.000	SUM	70.000
.V. PCT	129.479	.95 C.I.	1.110	TO	2.890
ALID CASES	35	MISSING CASES	26		

ARIABLE CLNGCOST COST OF CEILING INSULATION

EAN	137.422	STD ERR	10.589	STD DEV	71.032
ARIANCE	5045.613	KURTOSIS	.567	SKEWNESS	.846
INIMUM	27.000	MAXIMUM	338.000	SUM	6184.000
.V. PCT	51.689	.95 C.I.	116.082	TO	158.763
ALID CASES	45	MISSING CASES	16		

ARIABLE WALSCOST COST OF WALL INSULATION

EAN	127.222	STD ERR	19.661	STD DEV	58.983
ARIANCE	3478.944	KURTOSIS	.582	SKEWNESS	.404
INIMUM	48.000	MAXIMUM	239.000	SUM	1145.000
.V. PCT	46.362	.95 C.I.	81.884	TO	172.560
ALID CASES	9	MISSING CASES	52		

FILE SUDCONT (CREATION DATE = 79/10/18.) DATA FOR THE CONTROL GROUP

VARIABLE BTUPDDB

MEAN	10438.905	STD ERR	661.702	STD DEV	4024.976
VARIANCE	.1620E+08	KURTOSIS	3.195	SKEWNESS	1.293
MINIMUM	3965.647	MAXIMUM	24737.673	SUM	386239.493
C.V. PCT	38.557	.95 C.I.	9096.911	TO	11780.899

VALID CASES 37 MISSING CASES 0

VARIABLE BTUPDDA

MEAN	10639.079	STD ERR	667.418	STD DEV	4059.746
VARIANCE	.1648E+08	KURTOSIS	3.512	SKEWNESS	1.346
MINIMUM	4126.081	MAXIMUM	25386.131	SUM	393645.908
C.V. PCT	38.159	.95 C.I.	9285.492	TO	11992.665

VALID CASES 37 MISSING CASES 0

VARIABLE BTUSDD

MEAN	-200.173	STD ERR	148.004	STD DEV	900.270
VARIANCE	810486.545	KURTOSIS	.489	SKEWNESS	-.799
MINIMUM	-2456.853	MAXIMUM	1334.372	SUM	-7406.415
C.V. PCT	449.745	.95 C.I.	-500.338	TO	99.992

VALID CASES 37 MISSING CASES 0

VARIABLE CPDDB

MEAN	.048	STD ERR	.003	STD DEV	.020
VARIANCE	.000	KURTOSIS	2.400	SKEWNESS	1.350
MINIMUM	.019	MAXIMUM	.107	SUM	1.771
C.V. PCT	41.258	.95 C.I.	.041	TO	.054

VALID CASES 37 MISSING CASES 0

FILE SUDCONT (CREATION DATE = 79/10/18.) DATA FOR THE CONTROL GROUP

VARIABLE CPDDA

MEAN	.049	STD ERR	.003	STD DEV	.020
VARIANCE	.000	KURTOSIS	2.860	SKEWNESS	1.430
MINIMUM	.019	MAXIMUM	.116	SUM	1.809
C.V. PCT	41.740	.95 C.I.	.042	TO	.056
VALID CASES	37	MISSING CASES	0		

VARIABLE CSAVDD

MEAN	-.001	STD ERR	.001	STD DEV	.005
VARIANCE	.000	KURTOSIS	2.665	SKEWNESS	-1.292
MINIMUM	-.016	MAXIMUM	.007	SUM	-.038
C.V. PCT	446.393	.95 C.I.	-.003	TO	.001
VALID CASES	37	MISSING CASES	0		

VARIABLE BTUSDDFL

MEAN	-.295	STD ERR	.194	STD DEV	.971
VARIANCE	.943	KURTOSIS	.524	SKEWNESS	-1.066
MINIMUM	-2.874	MAXIMUM	1.032	SUM	-7.371
C.V. PCT	329.327	.95 C.I.	-.696	TO	.106
VALID CASES	25	MISSING CASES	12		

VARIABLE CSAVDDFL

MEAN	-1.613	STD ERR	1.069	STD DEV	5.345
VARIANCE	28.569	KURTOSIS	3.598	SKEWNESS	-1.696
MINIMUM	-19.009	MAXIMUM	5.861	SUM	-40.330
C.V. PCT	331.330	.95 C.I.	-3.820	TO	.593
VALID CASES	25	MISSING CASES	12		

FILE SUDCONT (CREATION DATE = 79/10/18.) DATA FOR THE CONTROL GROUP

VARIABLE PCNTBTUS

MEAN	-2.482	STD ERR	1.491	STD DEV	9.071
VARIANCE	82.280	KURTOSIS	2.148	SKEWNESS	-1.209
MINIMUM	-32.849	MAXIMUM	12.024	SUM	-91.823
C.V. PCT	365.508	.95 C.I.	-5.506	TO	.543
VALID CASES	37	MISSING CASES	0		

VARIABLE BTUDDFLB

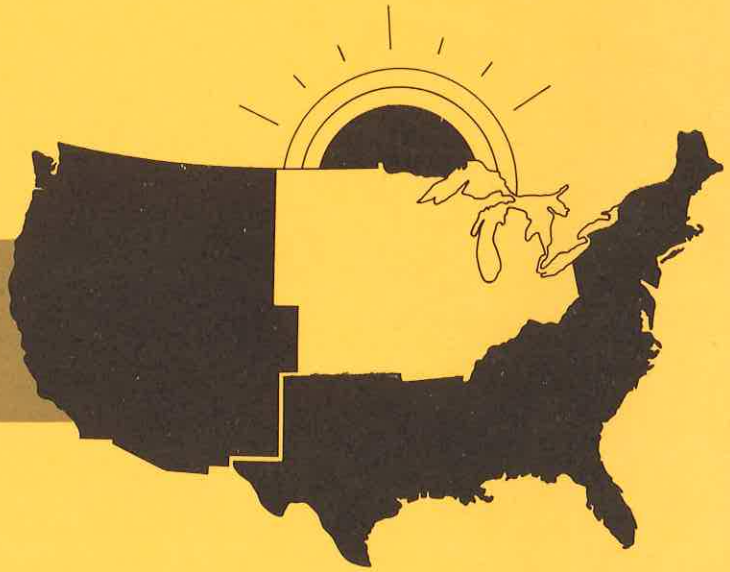
MEAN	11.673	STD ERR	1.088	STD DEV	5.440
VARIANCE	29.594	KURTOSIS	4.077	SKEWNESS	1.616
MINIMUM	1.903	MAXIMUM	28.465	SUM	291.821
C.V. PCT	46.604	.95 C.I.	9.427	TO	13.918
VALID CASES	25	MISSING CASES	12		

VARIABLE BTUDDFLA

MEAN	11.968	STD ERR	1.124	STD DEV	5.619
VARIANCE	31.569	KURTOSIS	3.374	SKEWNESS	1.433
MINIMUM	1.953	MAXIMUM	29.206	SUM	299.191
C.V. PCT	46.948	.95 C.I.	9.648	TO	14.287
VALID CASES	25	MISSING CASES	12		

VARIABLE FLAREA

MEAN	1325.080	STD ERR	488.270	STD DEV	2441.348
VARIANCE	5960179.827	KURTOSIS	24.582	SKEWNESS	4.940
MINIMUM	480.000	MAXIMUM	13000.000	SUM	33127.000
C.V. PCT	184.242	.95 C.I.	317.341	TO	2332.819
VALID CASES	25	MISSING CASES	12		



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