STATE OF MINNESOTA HIGH LEVEL WEATHERIZATION PROJECT

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In 1984 the Minnesota Department of Energy and Economic Development contracted with the University of Minnesota, Underground Space Center to carry out research on weatherization of low income houses. One of the components of this research was the high level weatherization study.

The high level weatherization study was designed in order to assist the Community Action Programs (CAP's) in determining the most cost-effective method of weatherizing low-income housing. The intent of the project was to study the auditing diagnostic procedures, the process for selecting the weatherization interventions given the available resources, and the quality of the resulting weatherization work. The focus of this approach was to evaluate the auditing methodology and to identify diagnostic procedures which would facilitate the auditor and work crews in their selection of weatherization interventions for each individual house.

A process-oriented approach was adopted in response to the reality that optimium weatherization strategies vary from house to house. What may be a high priority intervention for one house may be a lower priority for another. While a priority list of weatherization interventions can be a valuable tool in identifying and selecting the work to be done, how well a house is weatherized relies on the expertise and efficacy of the auditor and work crew. Given the economic constraints of weatherizing a low-income house, it is essential that the weatherization crews are provided with the appropriate diagnostic tools and resources to treat each house most effectively.

In order to study the weatherization process, three sets of approximately 20 houses each were studied. The first set of houses was weatherized according to the current standard procedure while the second set received weatherization following a high level procedure. This procedure was based on the current protocol but was enhanced by the availability of additional time and materials to insure completion of the weatherization, the use of blower door and IR scanner diagnostic equipment, and pre- and post-weatherization inspections by independent consultants. The third set of houses was a control group in which no weatherization interventions were performed. To facilitate statistical comparisons between the groups, the specifications for the houses were that they all be one story with a basement, have natural gas forced air furnaces with no auxiliary space heating from wood stoves, space heaters or fireplaces, and do not change occupants during the two heating season monitoring period. There were only a few exceptions where all of these specifications were not met. All houses that were chosen qualified for low-income weatherization.

The study was performed over a two heating season period from 1984 to 1986 in close cooperation with four weatherization contractors. As a result, the houses included in the study were located in St. Paul, Minneapolis, Winona and Eveleth and were weatherized by the local CAP agencies. The first heating season from 1984 to 1985 represented the pre-weatherization year. During this time no weatherization was performed on the houses and weekly

utility meter readings were performed on the high-level houses. Prior to the second heating season, the standard and high level weatherization houses were treated and weekly meter readings were performed for the post-weatherization heating season, 1985 to 1986. Utility bill data were collected for all the houses over the two year period.

A PRISM analysis was performed on the fuel bill data to assess pre- and post-weatherization NAC values of the three house sets. In addition, interior air temperatures were measured continuously in the high level houses over the two year period. Three thermographs were placed in each house: near the thermostat on the first floor, in the basement, and outside of the house. The temperature measurements were used to gauge possible lifestyle changes produced by weatherization which might affect fuel use. Furthermore, pre- and post-weatherization humidity and NO_2 levels in the high level houses were measured using hygrothermographs and Palmes tubes, respectively. For a select number of high level houses, pre- and post-weatherization air infiltration rates were also measured using a PFT system.

With the help of the participating CAP agencies, independent energy consultants, and advisors from the state agencies, a high level weatherization protocol was developed which focused on the process of achieving more effective weatherization. In addition to prescribing increased diagnostic procedures, the protocol included improvements to the heating distribution and mechanical system, increased air tightening of the house, foundation insulation, and the study of moisture. In order to insure the quality and extent of the retrofit package, state guidelines on total cost of retrofit were relaxed for the high level houses. The protocol was divided into five parts: a protocol for the audit, work crew, mechanical work, evaluation/follow-through, and client education. A sequential air tightening was also performed during the work. This involved performing a blower door test at the end of each weatherization sequence. The sequence of weatherization interventions was recommended to be: 1) most obvious leaks, 2) blow in wall insulation (if the wall has existing but substandard wall insulation, blow if possible), 3) attic bypasses, 4) foundations and rim joists and 5) windows, doors, and all others.

At the time of this writing, analysis of the data is incomplete and only preliminary results can be reported. Collection and analysis of all the data will be completed by the time of the conference. The findings from the available data show that the high level houses have obtained an average total NAC savings of 25% and a heating only NAC savings of 35%. Figure 1 shows the pre- and post-NAC for the high level houses. This compares to 8% savings in total NAC for a group of standard houses from a statewide data base and a 10% savings in heating only NAC. Basement temperatures in the high level houses increased between 5 to 8°F and first floor temperatures decreased by 1.5°F.

Figure 2 shows the air change rates of the high level houses before and after weatherization. The average decrease in air change rate at 50 Pa is 3.9 ACH and the average post-air change rate is 5.0 ACH. Results from the sequential air tightenting tests are shown in figure 3. These findings demonstrate that the reduction in air change rate is not consistent for each measure over the group of houses and that a prioritization of air tightness measures would vary from house to house. A more thorough and complete description of the study will be presented at the summer study.

Figure 1.
Normalized Annual Consumption

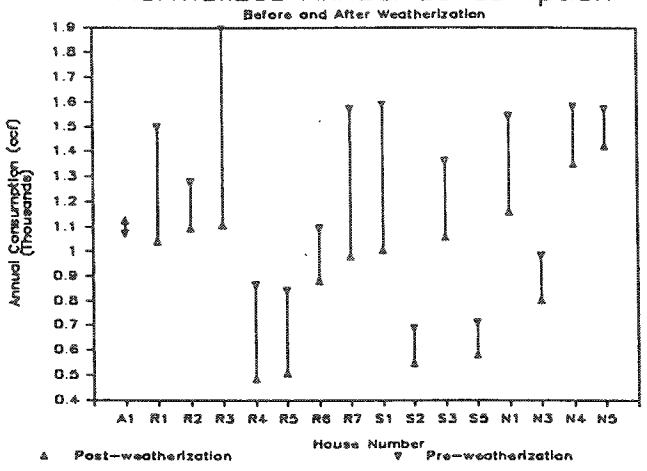


Figure 2.
Air Change Rate as 50 Pa

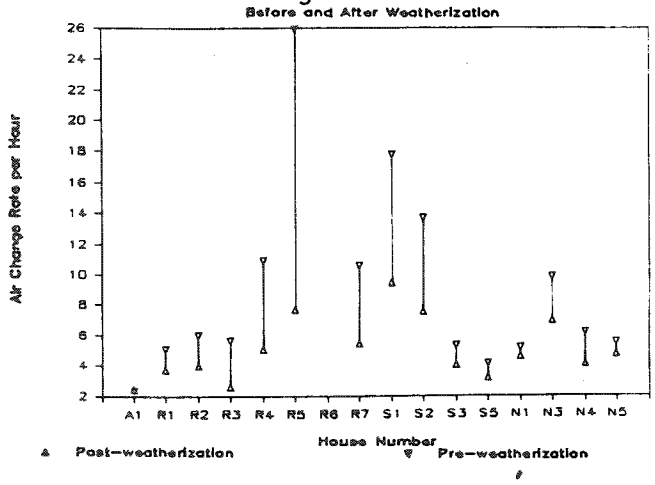
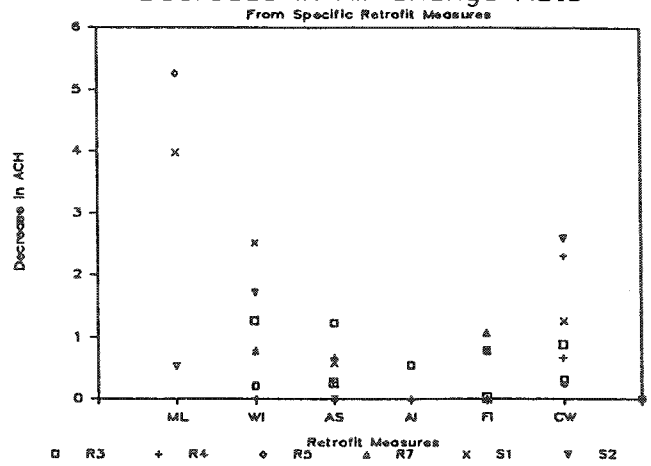


Figure 3.
Decrease in Air Change Rate



RETROFIT MEASURES

ML = MAJOR LEAKS SEALED
WI = WALL INSULATION
AS = ATTIC BY PASSES SEALED
AI = ATTIC INSULATION
FI = FOUNDATION INSULATION
CW = CAULKING AND WEATHERSTRIPPING