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DETERMINATION OF THE IMPACT OF INFILTRATION REDUCTION MEASURES ON HOUSE AIR LEAKAGE

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Abstract

The purpose of this study was to measure the direct impact that caulking and weatherstripping of windows and doors and installation of storm windows and storm doors had on house leakage in two counties in New York State. House leakage was estimated for 60 homes by performing blower door measurements with and without the weatherization measures in place. The overall reduction in house leakage resulting from both weatherization procedures was 17%. Generally, the effect of caulking/weatherstripping was greater than the effect of storm doors/windows. Homes in Onondaga County appeared to show a greater overall effect than homes in Suffolk County. Older homes appeared to show a greater overall effect than new homes.

Over recent years, there has been increased emphasis on energy conservation through weatherization programs that control air leakage in and out of the house. As weatherization becomes more popular and methods for minimizing air leakage become better, the potential for increased indoor air pollution problems becomes greater. An overall goal of the research program was to obtain information for guiding conservation programs and for providing information to homeowners so as to achieve maximum conservation potential while ensuring that the implementation of conservation measures is compatible with the maintenance of acceptable indoor air quality.

The first objective of the study was to determine if various weatherization procedures (storm protection, caulking, and weatherstripping) would decrease house leakage. We also estimated the magnitude of this change. Finally, factors affecting the difference in house leakage were evaluated.

Field monitoring was performed on 60 homes in Suffolk and Onondaga Counties in New York State. In each home, house leakage was estimated by performing blower door measurements during two visits. Measurements with and without storm protection were made at the first visit. Prior to the second visit, caulking and weatherstripping were applied to the house by an experienced craftsman. Measurements with and without storms were then made again.

Homes were selected based on information collected during telephone interviews. A home could be included in the study if 80% or more of its windows and doors were storm protected (use of removable storm windows and doors) and if less than 20% of its openings had been weatherstripped in the past five years or if the status of weatherstripping was unknown. This latter criterion was intended to identify homes that required weatherization. The need for caulking was not used as a criterion for selection.

During the field study, the subcontractor caulked and weatherstripped only those windows and doors that could be weatherized and that needed weatherization. The amount of weatherization actually performed on the 60 test homes is summarized by the distributions shown in Table 1. These distributions indicate that in many homes less than the maximum amount of caulking and weatherstripping was applied.

TABLE 1.

% Opening Receiving Treatment in Each Home	Percent of Study Homes			
	Weatherstripped		Caulked	
	Windows	Doors	Windows	Doors
0-20	35.5	6.6	38.9	42.7
21-40	16.5	23.3	13.6	5.3
41-60	8.4	23.4	5.1	11.9
61-80	10.2	18.4	6.8	12.2
81-100	30.4	28.3	35.6	27.9

Statistical analyses were performed for all homes for which the relevant measurement data were obtained. Analyses were also performed for a subset of about 28 homes. Homes were excluded from the subset homes if

- outside wind velocity >5 m/sec occurred during any of the blower door measurements (18 homes: 6 at ~5 m/sec, 6 at 5-10 m/sec, 6 at >10 m/sec),
- no or limited weatherization could be applied (13 homes), or
- no storms were present (2 homes).

Preliminary analysis of the data was performed using the regression lines from blower door measurements (Ln pressurization versus Ln airflow) generated for each weatherization condition. This analysis was used to determine

- if there was a significant difference in house leakage caused by weatherization, and

- if the difference in house leakage was independent of pressurization.

Since both results were positive, additional data analysis was performed using estimated airflow at a single pressurization (namely, 25 Pascals).

Summary statistics for predicted air flow (25 Pascals) were calculated for each of the weatherization conditions. These statistics included means, standard errors, quartiles, and ranges of predicted airflow. Results of these analyses showed that houses in Onondaga County were tighter than those in Suffolk County. Also, houses built between 1940 and 1976 had a lower leakage than those built before 1940. The houses in Onondaga were tighter before weatherization and storms, on the average, than the weatherized Suffolk County homes with storms.

Summary statistics for percentage difference in air flow at 25 Pascals resulting from the addition of storms, weatherstripping/caulking and both, were calculated. Table 2 shows the mean percent difference in airflow for no storms to storms, no weatherization to weatherization, and no storms without weatherization to storms with weatherization. In all cases the estimated percent difference was significantly greater than zero (0.01 significance level). Generally, the effect of caulking/weatherstripping was greater than the effect of storms. Homes in Onondaga County appeared to show a greater overall effect than homes in Suffolk County. Older homes appeared to show a greater overall effect than new homes. Homes built between 1940 to 1976 appeared to show a greater effect for caulking and weatherstripping than storms. While this pattern was the same for the subset houses, the reduction in house leakage was greater.

Confidence intervals at the 90% level were estimated for the effect of weatherization applied to homes. Table 3 shows these intervals, by age, for all homes and for the subset homes.

An analysis of variance model was applied to the data for all homes to determine if the effect of weatherization varied by county or house age. Results indicate

- the effect of weatherstripping/caulking is significantly different for Suffolk and Onondaga Counties (0.05 level of significance);
- this effect results in an overall change in house leakage (storms plus weatherstripping/caulking) that is different for the two counties (0.10 level of significance); and,
- the effect of using storm windows/doors is different for the two age categories (0.10 level of significance).

Analysis of variances models were not applied to the subset homes because of the limited sample size.

TABLE 2. MEAN PERCENT DIFFERENCE IN AIRFLOW AT 25 PASCALS

Treatment	Mean % Difference				
	Total	Suffolk Homes	Onondaga Homes	Pre-1940 Homes	1940-1976 Homes
All Homes					
Number of Homes	52-53[a]	25-26[a]	27[a]	26[a]	26-27[a]
Storms	5	5	5	6	4
Caulking/ Weatherstripping	9	7	11	10	8
Both	13	11	15	15	11
Subset Homes					
Number of Homes	28[a]	13[a]	15[a]	26[a]	13[a]
Storms	6	6	6	8	4
Caulking/ Weatherstripping	12	9	14	13	10
Both	17	14	19	20	13

[a]Number of homes included in data analysis.

TABLE 3. 90% CONFIDENCE INTERVALS OF MEAN PERCENT DIFFERENCES IN AIRFLOW AT 25 PASCALS BY AGE OF HOME

Treatment	Pre-1940	1940-1976
All Houses		
Overall	11 - 18	8 - 15
Storms	4 - 7	2 - 5
Caulking/Weatherstripping	7 - 13	5 - 12
Subset Homes		
Overall	16 - 24	7 - 19
Storms	6 - 10	3 - 5
Caulking/Weatherstripping	9 - 17	5 - 15

Because the correlations were not strong, no definite conclusions were made concerning the effect of house characteristics (i.e., house volume, number of windows and doors, number of windows and doors weatherized) on differences in house leakage.