A HOUSE HEATING STUDY IN THE DARIEN, CONNECTICUT AREA

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ABSTRACT

Fuel oil delivery and related data were provided by more than 80 home owners for periods ranging from one to seven years. These data were correlated with degree day information from the weather station at the Stamford, Connecticut Museum and Nature Center.

Heating oil usage expressed as a Heating Factor and a Heating Comparison Factor were calculated for each heating season for which delivery information was available.

The Heating Comparison Factors showed a remarkable ratio of almost six to one. Changes in the distribution of this factor are traced over the years and correlated with conservation actions taken by participants in the study.

A new understanding of furnace operation has evolved from the study; explaining the wide variation found in the basic data classification and providing an analytical method for effective and economical achievement of fuel conservation and heating system efficiency.

1. GENERAL

Is the current "oil glut" here to stay? Or will we, as many authorities believe, find ourselves again in a perilous situation when circumstances conspire to repeat that very recent period of our "oil shortage?"

Fuel conservation became a worldwide priority in 1974 when a combination of events created an "oil shortage" and sent related prices to record high levels. Homeowners, who faced a multitude of house-heating problems suddenly needing solution, responded with often unplanned and usually costly actions to reduce their oil use. Unfortunately they had no reliable measure of the effectiveness of those actions, nor of the dollars spent.

During the summer of 1979, several members of the Darien Senior Men's Association (SMA), discussed the possibility of defining their home fuel use more precisely in order to measure, with reasonable accuracy, the results of conservation measures implemented. They also sought some measure which would enable them to compare the fuel efficiency of their homes with others.

Darien has no gas service. Therefore, the only basic data available were the dates and amounts of fuel oil delivered. Many homes had 550 gallon oil tanks and received only three to five deliveries per year, at irregular time intervals. Most homes also heated domestic hot water with oil from the same tank, either by coils in the furnace or separate oil fired water heaters. Daily temperature and other meteorological information were available from the nearby weather station at the Stamford, Connecticut Museum and Nature Center.

Fuel delivery data for several years were obtained for a few houses. The number of degree days between deliveries was determined and for each interval between deliveries, the gallons used per degree day was calculated. This figure showed remarkable stability for intervals during the heavy part of the heating season, November through March. This heating season fuel use, expressed as gallons per degree day, is designated as the HEATING FACTOR (HF).

The next step was to make a house-by-house comparison of fuel use during the heating season, taking into account differences in size and configuration. The most commonly understood denominator for the size of a house is the square feet of living space. Therefore, the heating factors were divided by the thousands of square feet of living space heated. This has been designated as the HEATING COMPARISON FACTOR (HCF).

The first few houses analyzed on this basis were about the same age and quality of construction, although quite different in size and configuration. Their factor, expressed as gallons of fuel consumed per degree day per thousand square feet of living space heated showed a remarkable consistency, ranging from 0.100 to 0.120.

The use of fuel for late spring, summer and early fall non-heating periods was estimated by multiplying the Heating Factor by the degree days between delivery intervals covering these months and subtracting this amount from total fuel delivered. For the first few houses this amount varied from 200 to 600 gallons per year from house to house. Nevertheless, it was remarkably uniform over a period of several years for each house.

A decision was made to begin a detailed study, using these methods of analysis. To build a data base, a presentation was made at the SMA and members were asked to provide fuel oil delivery information for their houses for as many years as practicable. Each was asked to provide information about the age, size and type of his house and a description of the heating system and the methods used to supply domestic hot water. This was followed by an open discussion sponsored by Consumer Alert at the Darien Library.

Response to these and subsequent meetings produced data which have been analyzed for 80 houses. All of the houses are in good residential areas and are well maintained. Because the sampling started at the SMA, most of them are occupied by two people. Their size varies from 900 to 5,000 square feet. There are ranch style, split level and two and three story houses whose age ranges from almost new to 100 years.

This report sets forth the results of this effort, including observations on the operation of house heating systems; explaining the wide variations found in the basic data classification and providing a method for effective and economical achievement and measurement of fuel conservation and heating system efficiency.

2. THE HEATING COMPARISON FACTOR DISTRIBUTION PATTERN

Figure 1 shows the Heating Comparison Factor (HCF) distribution of the 73 homes for which data were available for the 1981-82 heating season (September 1, 1981 to June 30, 1982). Numbers of houses are plotted against HCF. It is immediately apparent that the distribution is not random. The columns rise steeply from the most efficient house to a maximum, and then descend in a more gentle slope to the least efficient.

The values plotted in Figure 1 approximate a reasonably normal distribution (bell-shaped) curve through the range of HCF's represented.

The statistical parameters are:

Mean HCF	0.089	G/DD/MFt.^{2}	(12.3 Btu/Ft.^{2})
Range	0.110	G/DD/MFt.^{2}	(15.2 Btu/Ft.^{2})
Minimum	0.043	G/DD/MFt.^{2}	(5.9 Btu/Ft.^{2})
Maximum	0.153	G/DD/MFt.^{2}	(21.1 Btu/Ft.^{2})
Std. Dev.	0.026		

The curve is slightly skewed toward the higher values. This might be expected because there is no limiting influence at the high end of the curve, such as that which exists at the low end, reflecting an approach to the maximum benefits of better construction, insulation and equipment. Lack of insulation, faulty or old heating equipment or aged construction would tend to leave open-ended the extent to which higher values of HCF might occur.

It is noteworthy that a tenfold spread between maximum and minimum values of HCF was observed for 1972, the earliest year for which we have any delivery data, compared to the fourfold spread shown in Figure 1.

The range of each bar is 0.015 Gal./DD/MFt^2 which was established for grouping houses. This is equivalent to 87 gallons per year per 1,000 square feet of heated living space, or about 195 gallons per year during a standard 5800 degree day season for the average sized house of 2,250 square feet. It is felt that selecting bands of this width would take care of nearly all anticipated uncertainties in the study. For example. temperature differences at specific house locations from those recorded at the Stamford Museum, differences in exposure to wind and sun, errors in measuring the area of the living space heated, variation in average inside temperature from thermostat settings, etc. It is believed that such variations, in the worst case, would not move the rating of a house more than one bar to the right or left. Such errors could never shift it from the relatively poor 0.135-0.150 band down to the more efficient 0.075-0.090 band.

Therefore, the only significant year-to-year shifts in this pattern must come from planned conservation actions. Such actions include: moderate to severe changes in lifestyles; added wall and ceiling insulation; added storm windows and doors; major caulking and weather stripping; new furnaces, new burners and furnace control systems; heating duct and piping insulation; improved window blinds, blind management, etc.

It will be shown that the aggregate effect of such actions has altered the shape of this distribution curve from year-to-year. The effects of individual actions in some houses will be described.

The following examples illustrate the significance of such a wide range of HCF's during a standard 5800 degree day heating season:

(1) A 3,000 square foot house with a HCF of 0.050 would use 5800 x .050 x 3.0 = 870 gallons of oil.

(2) A 1,500 square foot house with HCF of 0.150 would use 5800 x .150 x 1.5 = 1,350 gallons of oil.

The house in the second example uses 50% more oil to heat half the living space of the house in the first example. The examples are very close to the actual situation in two houses included in the bar chart. Both have electric hot water heaters. The difference in heating effectiveness is dramatic.

The HCF analysis also brings a new awareness to many people. They can now compare their heating fuel use efficiency with that of neighbors and friends on a reasonably sound basis and the grounds for aimless and rationalized argument disappear.

3. CHANGES OVER TIME

Data on 68 of these 73 houses is available for four full heating seasons 1978-1979 through 1981-1982. Figure 2 is a series of four bar charts showing the distribution of the HCF's for these 68 houses for each of the four years.

Improvement in many of the least efficient, high HCF, houses over this period of time is readily apparent. The shift to the left, toward lower HCF's is pronounced. The mean HCF, over these years, has dropped from 0.112 to 0.089. The total use of fuel during a standardized 5800 DD heating season has dropped from 99,600 gallons to 78,300 gallons, a decrease of 21.4%.

Table 1 sets forth pertinent statistical data for the HCF's of these sixty-eight houses for each of the four years.

Data on 40 of the 73 houses are available for seven full heating seasons from 1975-1976 through 1981-1982. Table 2 sets forth data on these 40 houses for each of the seven years. The mean HCF has dropped from 0.116 to 0.086 and the heating season fuel use from 59,100 gallons to 43,400 gallons, a reduction of 26.6%.

Figure 3 shows changes in the mean HCF value for both the four and seven year periods. Although the 40 houses show a drop of 26% in seven years, the large drop between the 1975/76 and 1976/77 heating seasons probably reflects actions taken as a result of the 1974 "oil shortage" and the really drastic increase in prices. Thereafter the HCF remained steady for three years, then dropped about 20% during the most recent three years.

The downward trend in oil use since 1978-79 coincides with the start and continuation of this heating study. Thus it is reasonable to assume that the counseling, cajoling and information reports provided the participants, have produced results beyond that which might have been expected from more general pleas for conservation action.

It is possible that the present mean value of HCF can be reduced by at least 10% and perhapes as much as 20% with physical conservation efforts. Almost 15% of the participants in this study have taken no conservation actions of any substance and further improvement is still possible in many of the houses where good results have already been obtained.

The houses were classified into Ranch type and multistory. The multistory houses were again subdivided into "old" (over 40 years) and "new." No sharply defined results were found. It could be generally said that the chances of finding a high HCF were greater in the older houses, least in the new multistory houses, while the Ranch houses were spread across the spectrum, from low to high.

4. SUMMER FUEL USE

Summer Fuel Use (SFU) includes all fuel that is burned during the late spring, summer and early fall (about 150 days in the area) when there is no call for heat in a house. It is especially significant in systems with domestic hot water provided by a coil in the furnace, a "side-arm" water heater or a separate oil-fired water heater.

The amount of such fuel used was estimated for delivery intervals spanning this season by multiplying the number of degree days in the interval by the heating factor and subtracting this from the total fuel used.

Any error in the winter heating factor, or in the number of effective degree days for a specific house, will be reflected in the calculated value of summer fuel use. In most cases these will result in a low SFU, but on the average this should not exceed 75 gallons per year.

These calculated values have ranged over the years of the study from below 50 gallons per year to a high of 750 gallons per year, a ratio of 15 to 1.

Figure 4 shows the 1981 summer oil use of the 52 homes with oil heated hot water of the 73 used in compiling the 1981-1982 heating season data. (The mean HCF for these 52 houses is 0.089; identical with that of all 73 houses.) In all of our data summer oil use is coupled with the year of the start of a heating season. The calculated summer use varies from 10 to 450 gallons. In total it amounts to 6,245 gallons, 7% of the fuel used.

Figure 5 shows the trends in the distribution of summer fuel use for the 48 of the 68 homes for which we have four-year records. Figure 6 shows changes in the summer fuel use for both four and seven year periods. The mean dropped from 203 gallons to 125 gallons over the four year period, a reduction of 38%. (See SFU data in Tables 1 and 2.)

Summer fuel use has two components: fuel used to heat domestic hot water and fuel used to keep the furnace or water heater warm enough to deliver hot water at any hour of the day or night. This second use has been labeled "standby fuel." Elapsed time meters were installed on a few selected burners and a 24 hour recording instrument was borrowed for a few weeks for further investigation of this wide variance in summer fuel.

The results were revealing. Standby fuel use could account for most of the wide variations. Although two domestic hot water systems with major faults were found, they were the exceptions, not the rule. Furnace operation, control management, and insulation of the furnace and its immediately adjacent piping determine the major variances.

Additional and complimentary benefits from reductions in winter standby losses are reflected in lower HCF values.

Motivated by widespread appeals to save energy, many people with hot water coils in the furnace were turning their blending valves down to 120-130 degrees. They were leaving the furnace, at an average of 190° day and night, throughout the summer, just to meet the few hours demand for 120° hot water. This made their summer fuel use much higher than necessary and defeated their fuel saving intentions. It became evident that leaving a furnace, the largest radiator in the house, at a high temperature all summer long can waste from 100 to 500 gallons of oil.

The remedy is obvious: Turn the furnace water temperature control settings down in the spring; turn them up again in the fall. This has resulted in a reduction of summer fuel use of up to 30%. In addition add insulation to the furnace jacket and the immediately adjacent piping. (This includes piping within five to ten feet from the furnace.)

The results of these inexpensive and simple procedures are always immediate and often spectacular. Even houses burning only 200 gallons of summer fuel were able to cut that amount by half or sometimes even more.

As a result of actual measurements, study results demonstrate that in this New England coastal area, a two person household, doing its own laundry, with a dishwasher load, a tub bath and a shower each day; with a well insulated and tuned furnace, can easily and comfortably get by with the use of, at most, 100 gallons of oil for the five month, no-heat-call period, from mid-May to mid-October.

5. TOTAL FUEL USE REDUCTION

Table 3 summarizes the total fuel use by years for the 68 homes over a four year period and for the 40 homes over a seven year period. The total is subdivided into heating season use and summer use.

The total represents the oil actually put in the tanks each year, modified to a standardized 5800 degree day heating season. There can be little or no question as to its validity. There may, however, be some doubt as to the accuracy of the calculated split between heating season and summer use. Results of many actual measurements indicate that the order of magnitude is correct.

For the 68 houses, the reduction of total oil use over a four year period was from 109,300 gallons to 84,300 gallons; a reduction of 25,000 gallons per year of 22.9%.

6. INDIVIDUAL HOUSE PERFORMANCE

Each year, at the end of the heating season, each participant is sent a chart setting forth the various performance factors for his house. This is accompanied by a form letter defining the various factors, how they are derived from the fuel delivery data which was supplied and a copy of the bar chart showing the latest distribution of the HCF's with his position marked on the bar chart. This is generally accompanied by a personal note with pertinent comments relative to his achievements and further opportunities.

Reviewing these summary tables and seeing the progress that has been made in fuel conservation each year is a gratifying experience.

Tables 4, 5 and 6 are replicas of three such summary report charts. Table 4 represents one of the few participants who has made no changes over the years. This house has a good HCF and the homeowner has not elected to take any conservation actions.

Table 5 represents the house of one of the participants who did little or nothing for several years. Conservation actions were taken in 1981 and the resulting 500 gallon drop in fuel use is gratifying.

Table 6 represents the house of a participant who has worked for years at conservation. He has cut his total fuel use almost in half. He is planning actions for 1982 which should lead to a further reduction of at least 20%.

The time and a brief description of the conservation actions taken are marked on the tables.

7. WINTER HOT WATER AND STANDBY FUEL USE

The concept of summer fuel use split between fuel used to heat hot water and fuel used for standby, led us to speculate about winter use. We knew that for these homes on city water, the incoming water reached a high of 70° in the summer and a low of 36° during very cold winters. For those with their own deep wells, the incoming water temperature was steady at about 53°, winter and summer. Hence a reasonable calculation of fuel used to heat hot water in winter could be made from the summer data. Standby fuel use presented another problem. Furnace temperatures were typically higher, heat loss from the basement of furnace room was greater in winter than in summer. Standby fuel use should therefore, be greater in winter than in summer.

During February 1981, the area experienced a few days of warm weather during which there was no heat call at night. This provided opportunity to measure the standby fuel use in two houses with the furnaces in the basement. It was almost 50% higher than in the summer. For those homes with the furnaces in more weather-exposed furnace rooms, the variation should be even greater.

Checking the data from a few houses convinced the study group that this thought had merit. Two were selected for trial. They had both done almost everything else; added attic insulation, repaired insulation by-pass mechanisms, one had foam put in the walls, the other had the crawl space overhead insulated. Both had turned down their furnace temperatures in the summer. Still the Heating Comparison Factors remained higher than they should have.

During the middle and latter part of the summer of 1981 both of these houses added insulation to their furnaces and also insulated all of the piping in the furnace rooms. As far as we know, no other changes were made. One reduced annual fuel use by almost 500 gallons and the other by over 200 gallons, reductions of approximately 30% and 17%.

We are convinced that the reduction of what we call standby losses may provide one of the easiest and least expensive methods of reducing fuel consumption.

8. DISTRIBUTION SYSTEM LOSSES

Distribution system losses are those that occur in hot water and steam systems, beyond the furnace and the piping in its immediate vicinity. In hot air systems, the losses from the furnace shell would be included because there is, in effect, no standby fuel used.

In January, 1980, a house with a high heating comparison factor of 0.145 was chosen for further study. It was a neat, well maintained ranch type with four inches of properly installed insulation in the attic, good storm windows, well caulked and weatherstripped. It also had a new New Yorker furnace with a Beckett flame retention burner and an electric water heater. Half of the house was over a crawl space and half over an unfinished basement. The radiators were of the finned type. The distribution piping was heavy walled iron.

The owner agreed to accept help to insulate the distribution piping. He also agreed to start weekly oil tank gauging. The piping was wrapped with sections of nominal four-inch, R-11 foil covered fiberglass wall insulation. Within a week after completion of the piping insulation, the HCF had dropped from 0.145 to 0.110, where it has held. This resulted in an annual saving of 300 gallons of oil, almost 25% at a material cost of less than $50.00.

In December 1981, another house was chosen for study. It was a small, old bungalow with the original gravity hot air furnace without a return duct. The HCF was 0.177. Ducts in the basement were uninsulated and there was no insulation on the furnace shell. Material was provided and the owner was helped in the insulation of the ducts and the furnace shell, using two-inch fiberglass duct wrap. He also started weekly tank gaugings. The HCF immediately dropped from 0.177 to 0.140, a reduction of 20%. (The owner then replaced the 37-year old burner with a new Beckett for a further reduction of the HCF to 0.110.) These two actions reduced his annual oil consumption by 48%.

During the past year, participants have been urged to wrap distribution piping systems and ducts. To date, we have little information about the results of this effort. As the study progresses, we may be able to define reduction of distribution system losses and consequent savings.

9. PRO-FORMA HOUSES

To clarify the implications of the data developed and processed in this study and the insights it provided, annual heating system operations for five theoretical houses have been postulated. This information is displayed in Table 7 and in the five graphic portrayals, Figures 7 through 11.

House A is taken as the base. With a HCF of 0.070 and a summer fuel use of 80 gallons, it is slightly better than average.

B-1 has a summer fuel use of 80 gallons, B-2, 220 gallons. The graphic display clearly indicates that the first priority in conservation measures should be concerned with the structure in B-1 and with the furnace and hot water system in B-2.

Similarly, Houses C-1 and C-2, each have an HCF of 0.150. This would be considered a very high figure. C-1 has a summer fuel use of 80 gallons, C-2, 435 gallons. The graphic displays emphasize even more clearly where the priorities for conservation measures should lie.

For a "House Doctor," it should certainly be helpful to have an analysis like those made for this study to give guidance about where to look for major trouble, before inspecting a house.

The graphic display for House A has marked on it four break-even lines; two in the fall and two in the spring. The areas between these lines representing fuel use are included as heating in our calculations. For a house with a low break-even temperature, this oil should be shifted to summer fuel use. This readily explains the fact that in some houses with low summer fuel use, the calculations can show an unrealistically low summer use and even at times, a negative value.

Unfortunately, we have been unable to detect any method for estimating distribution system losses from the basic data inputs to this study. The dashed line on Figure 10 (House C-1) shows what it is believed the losses should be like.

10. CONCLUSIONS

The study group believes:

(1) The present apparent oversupply of oil, which has resulted in some price reductions and convinced many that the crisis has passed, is dangerously deceptive if it eases our conservation concerns. World events could change the situation quickly. Thus, any activity which promotes house-heating and other energy conservation activities continues to be a top priority for the individual and the nation.

(2) A method of measuring the actual fuel performance of houses and classifying them as good, average, or poor is a logical starting point for a heating fuel conservation program.

(3) The method should be capable of measuring the results of conservation actions for reporting back to homeowners the results of their conservation investments and efforts.

(4) A successful conservation program in any single house should expect its objectives to be accomplished only after a series of actions, probably covering a span of several years. During such time, repeated contact with, reporting results to and consultation with the homeowner about further actions must be planned and carried out.

(5) When houses achieve fuel efficiency better than average, it becomes increasingly difficult to achieve further reductions in fuel use. The prediction and vertification of savings from any conservation action can become very tenuous.

11. ACKNOWLEDGEMENT

This is a volunteer activity of the Darien YMCA - Senior Men's Association. The Darien Senior Men's Association is a unique group of nearly 200 retired executives representing almost every aspect of American business, professional, scientific, and civic activity. The majority have been leaders in their fields and, where possible, continue to contribute their acquired knowledge and skills to benefit community and national interests.

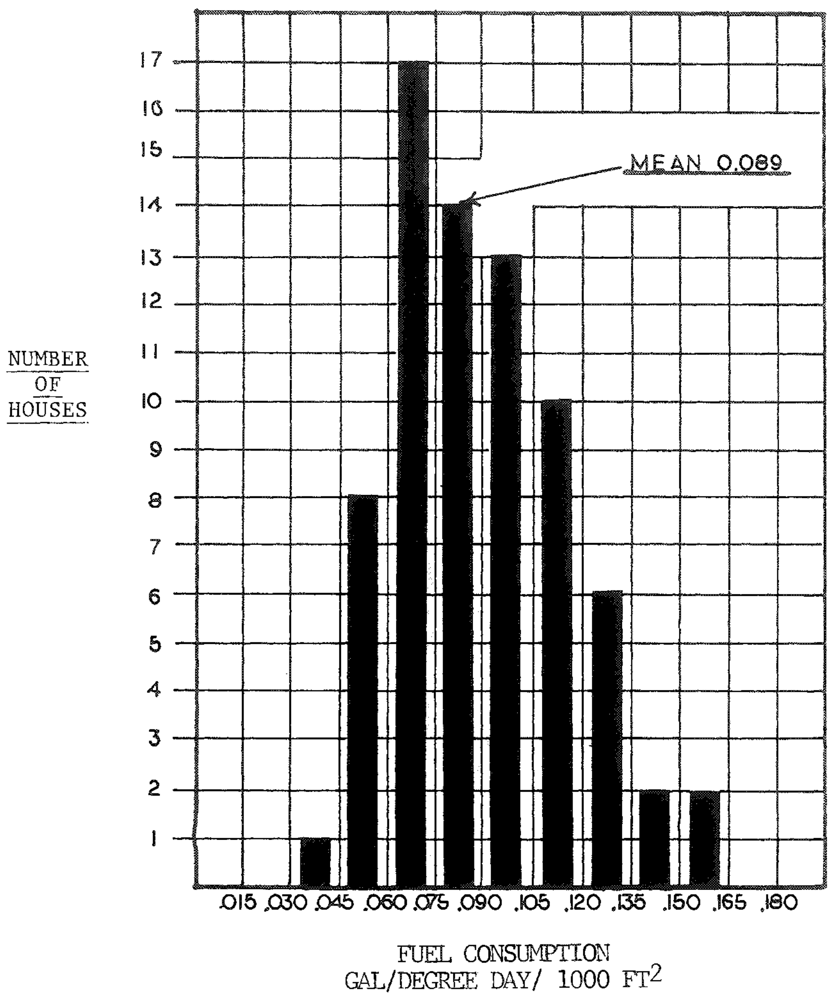

Fig. 1. Heating comparison factor, 73 houses 1981-82 heating season

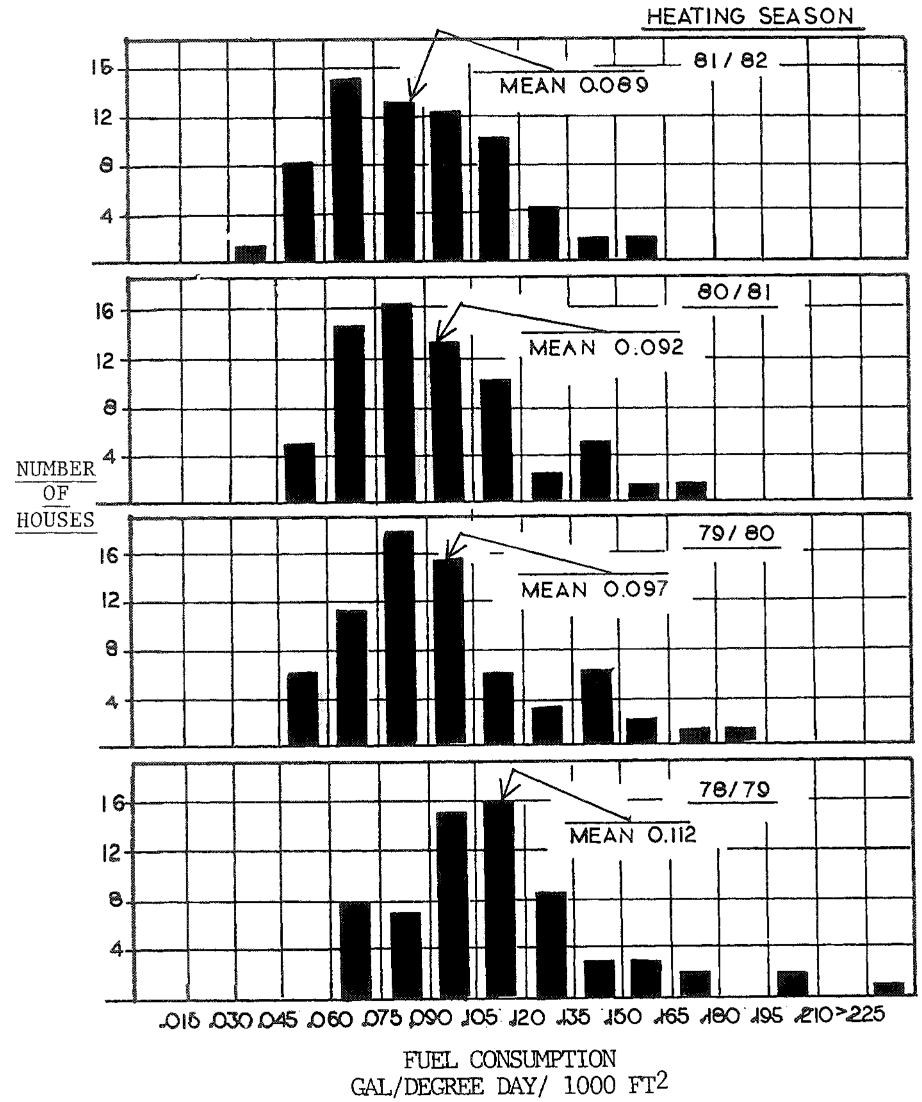

Fig. 2. Heating comparison factor, 68 houses

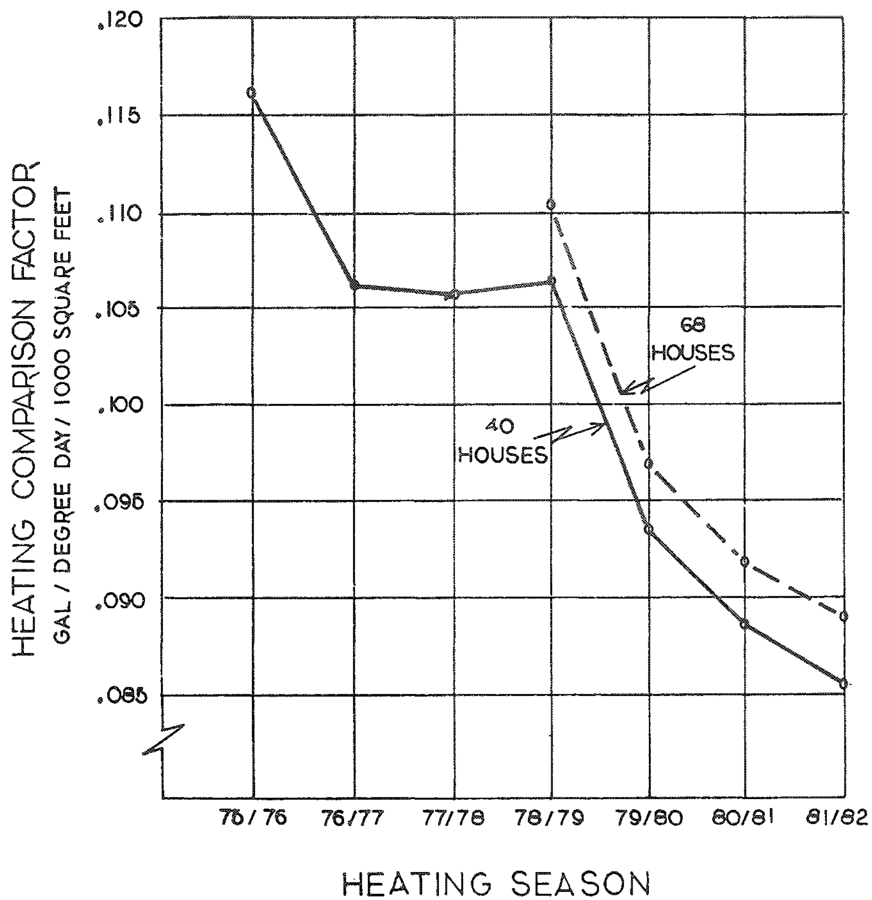

Fig. 3. Heating comparison factor -vs- time

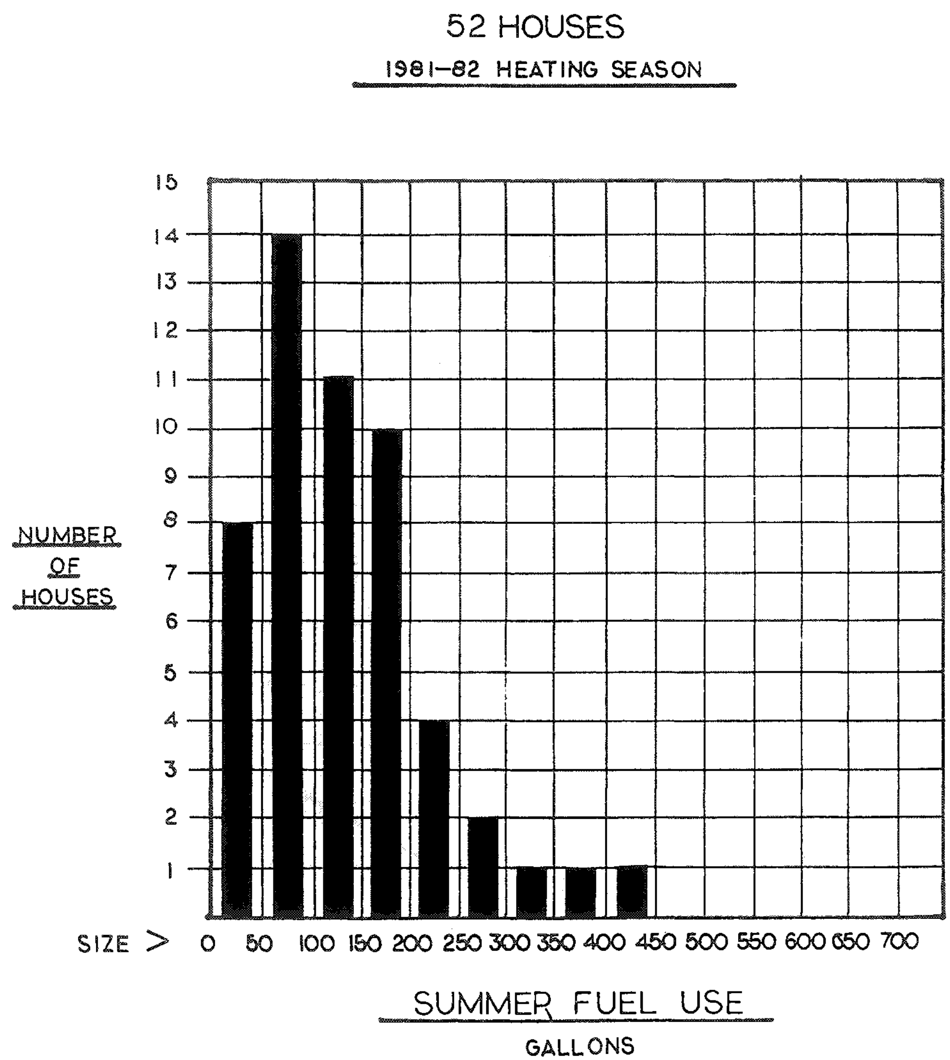

Fig. 4. Summer fuel use

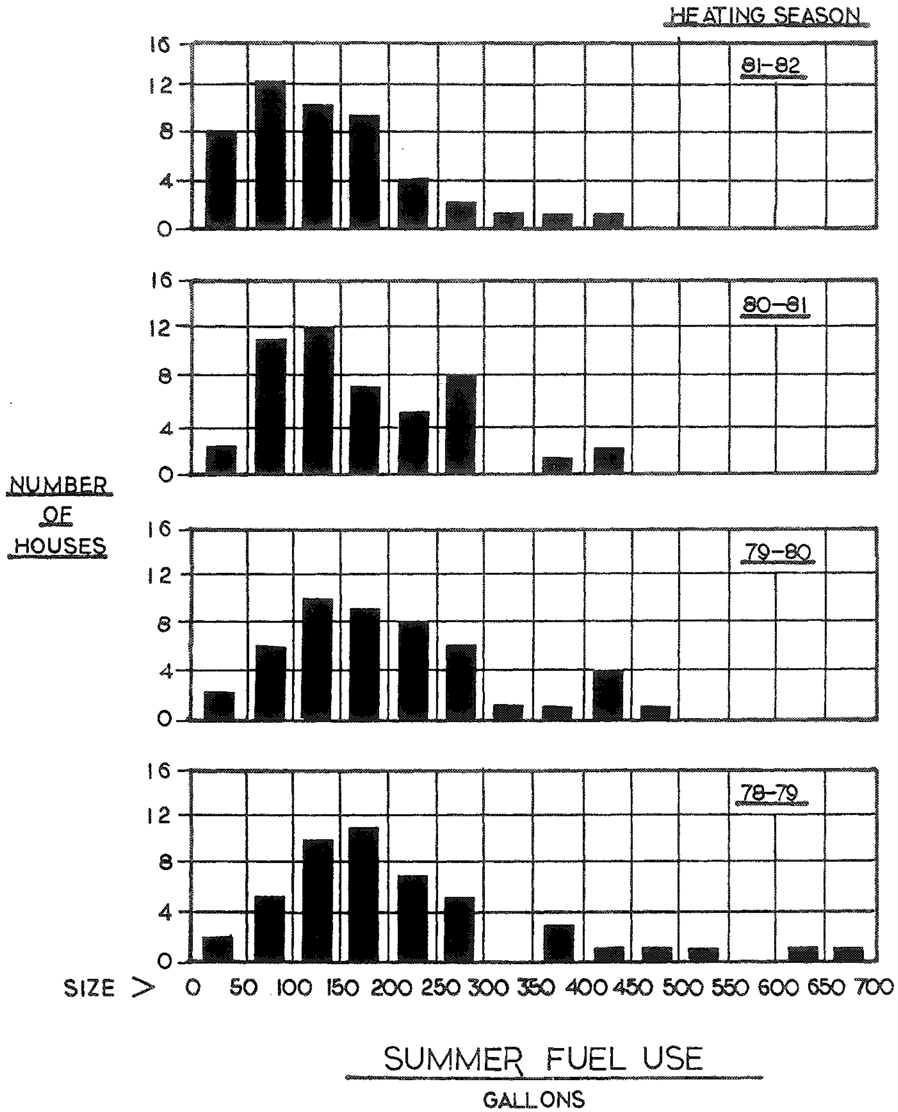

Fig. 5. Summer fuel use, 48 houses

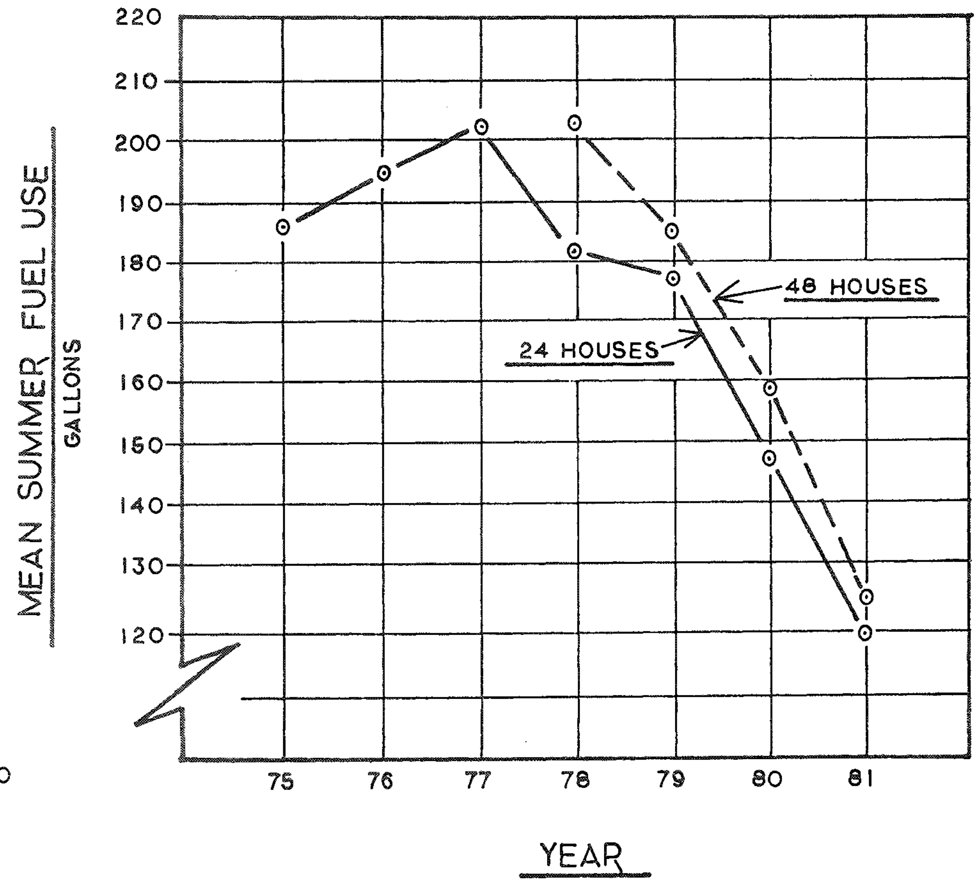

Fig. 6. Summer fuel use -vs- time

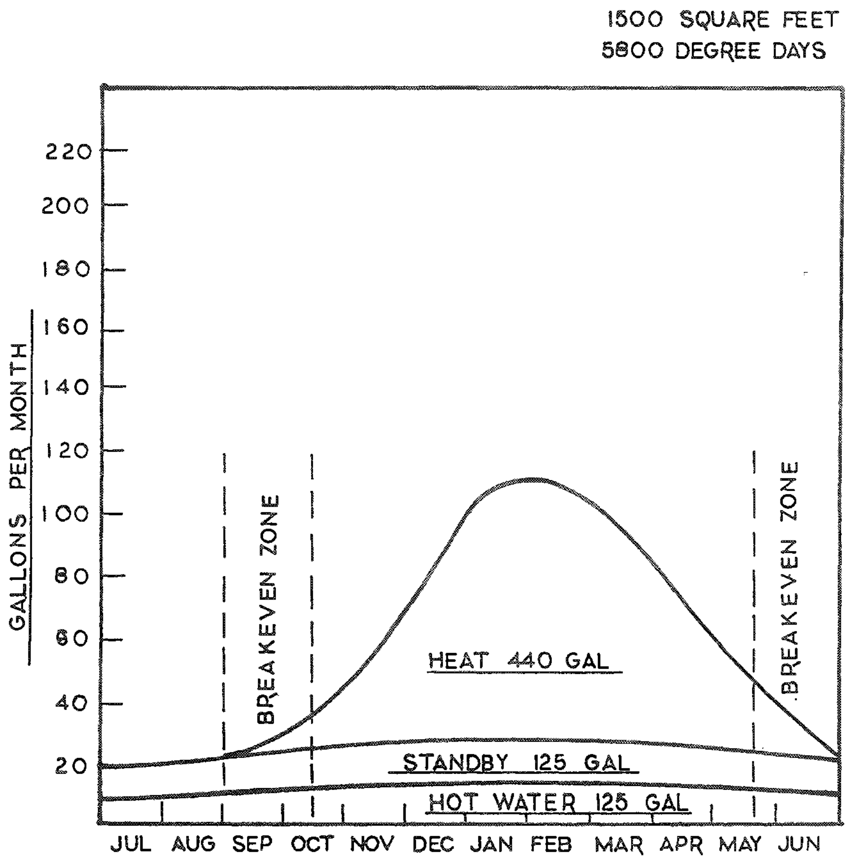

Fig. 7. Pro-forma house A
HCF 0.070
SFU 80 gallons

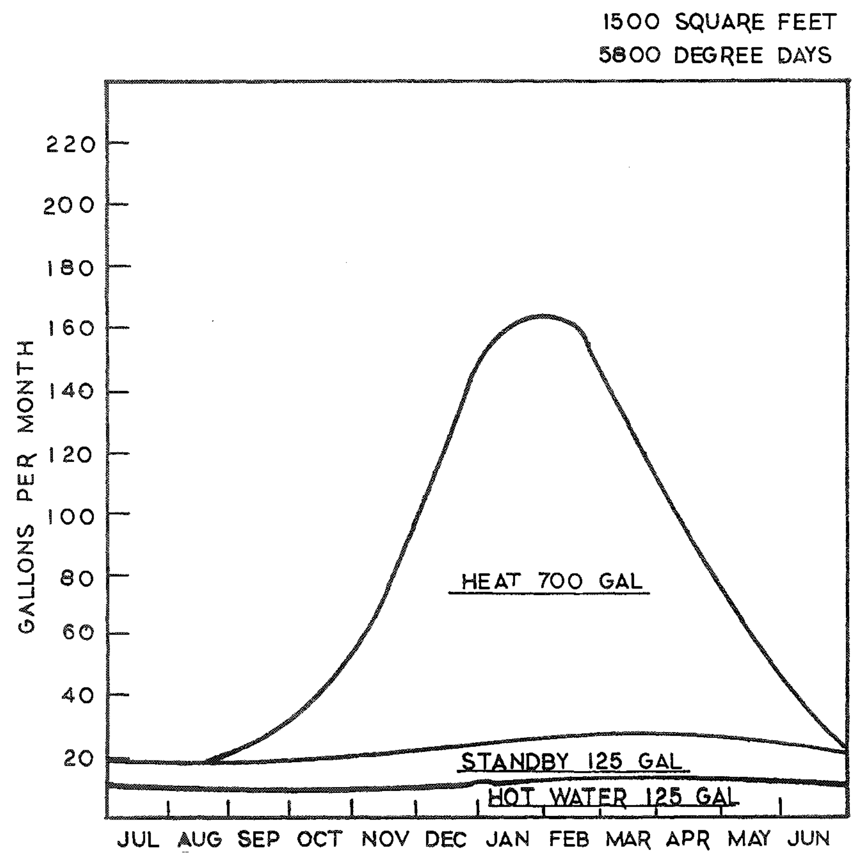

Fig. 8. Pro-forma house B-1
HCF 0.100
SFU 80 gallons

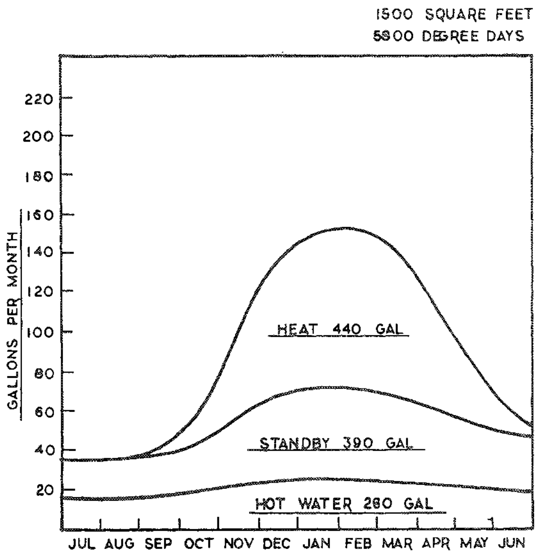

Fig. 9. Pro-forma house B-2
HCF 0.100
SFU 220 gallons

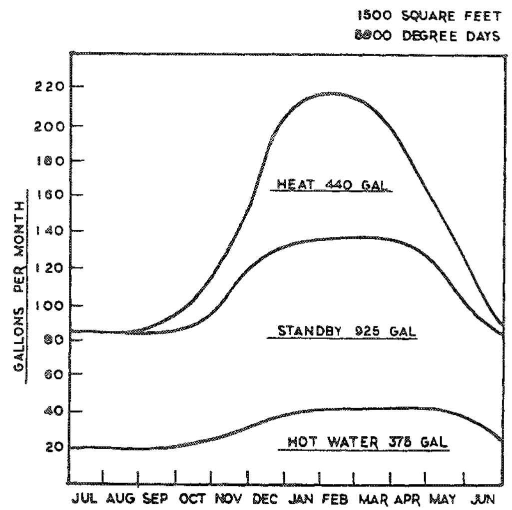

Fig. 11. Pro-forma house C-2
HCF 0.150
SFU 435 gallons

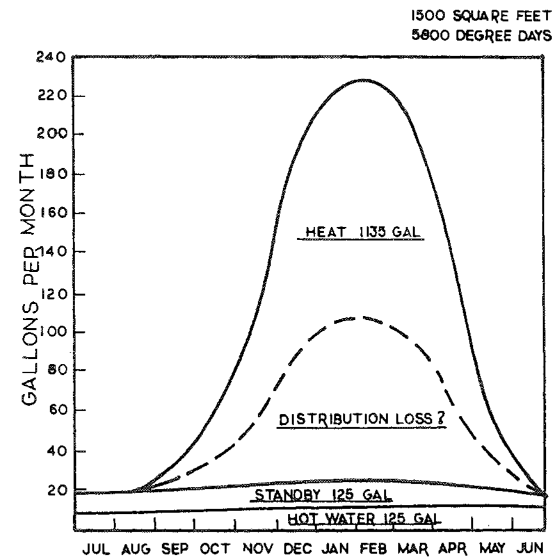

Fig. 10. Pro-forma house C-1
HCF-0.150
SFU 80 gallons

TABLE 1.

HEATING FUEL USE DATA FOR 68 HOUSE GROUPING

Over Four Consecutive Years

Heating Season	No. of Houses	Heating Comparison Factor (HCF) Gal./D.D./1000 Sq. Ft. Heated					
		Mean	Std.Dev.	Range	Min.	Max.	Mean Htd. BTU/Sq.Ft.
1981/82	68	0.089	0.026	0.110	0.043	0.153	12.3
1980/81		0.092	0.027	0.118	0.047	0.165	12.7
1979/80		0.097	0.030	0.130	0.054	0.184	13.4
1978/79		0.112	0.037	0.200	0.059	0.259	15.5

SUMMER FUEL USE DATA FOR 48 HOUSE GROUPING

Over Four Consecutive Years

(Houses included in grouping above)

Summer Season	No. of Houses	Summer Fuel Use (SFU)				
		Mean	Std.Dev.	Range	Min.	Max.
1981	48	125	85	375	25	400
1980		158	93	390	10	400
1979		185	106	440	10	450
1978		203	145	740	10	750

TABLE 2.

HEATING FUEL USE DATA FOR 40 HOUSE GROUPING

Over Seven Consecutive Years

Heating Season	No. of Houses	Heating Comparison Factor (HCF) Gal./D.D./1000 Sq. Ft. Heated					
		Mean	Std.Dev.	Range	Min.	Max.	Mean Htd. BTU/Sq.Ft.
1981/82	40	0.086	0.023	0.090	0.043	0.133	11.9
1980/81		0.089	0.024	0.095	0.050	0.145	12.3
1979/80		0.094	0.029	0.119	0.054	0.173	13.0
1978/79		0.106	0.030	0.131	0.059	0.190	14.6
1977/78		0.105	0.029	0.125	0.062	0.187	14.5
1976/77		0.106	0.028	0.133	0.063	0.196	14.6
1975/76		0.116	0.039	0.212	0.065	0.277	16.0

SUMMER FUEL USE DATA FOR 24 HOUSE GROUPING

Over Seven Consecutive Years

(Houses included in grouping above)

Summer Season	No. of Houses	Summer Fuel Use (SFU)				
		Mean	Std.Dev.	Range	Min.	Max.
1981	24	120	73	295	25	320
1980		147	72	280	10	290
1979		177	91	390	10	400
1978		181	113	590	10	600
1977		202	114	575	25	600
1976		194	113	550	50	600
1975		185	116	575	25	600

TABLE 3. TOTAL FUEL USE

Grouping	Number of Houses: Total	Number of Houses: Using Fuel For Dom.H.W.	Heating Season	Total Heated Sq. Ft.	Gal.of Fuel Used: For Heating	Gal.of Fuel Used: For Summer	Total
All Houses Currently In Study	73	52	1981/82	164679	82,864	6245	89,109
4 Year Trend	68	48	1981/82	155410	78304	6020	84324
			1980/81		79857	7565	87422
			1979/80		83507	8860	92367
			1978/79		99559	9730	109289
7 Year Trend	40	24	1981/82	90924	43351	2870	46221
			1980/81		44871	3535	48406
			1979/80		45633	4255	49888
			1978/79		54223	4350	58573
			1977/78		53886	4850	58736
			1976/77		53456	4655	58111
			1975/76		59135	4440	63575

*Heating Fuel Use normalized to 5800 degree days per year. (65 degree F. basis)

**Summer Fuel Use in houses using common fuel source for domestic hot water supply and house heating.

TABLE 4. STANDARDIZED OIL USAGE BASED ON 5800 DEGREE DAYS/YEAR

HOUSE NUMBER 016

HEATING YEAR	HEATING FACTOR G/DD	HEATING COMPARISON FACTOR G/DD/Mft^2
1975-76	0.121	0.087
1976-77	0.115	0.077
1977-78	0.113	0.075
1978-79	0.112	0.075
1979-80	0.115	0.077
1980-81	0.115	0.077
1981-82	0.114	0.076
1982-83		
1983-84		
1984-85		

OIL USED

HEATING SEASON	SUMMER	TOTAL
705	----	705
670	----	670
653	----	653
653	----	653
670	----	670
670	----	670
661	----	661

TABLE 5. STANDARDIZED OIL USAGE BASED ON 5800 DEGREE DAYS/YEAR

HOUSE NUMBER 057

HEATING YEAR	HEATING FACTOR G/DD	HEATING COMPARISON FACTOR G/DD/Mft^2		OIL USED		
				HEATING SEASON	SUMMER	TOTAL
1975-76	0.311	0.128		1804	230	2034
1976-77	0.266	0.109		1543	240	1783
1977-78	0.284	0.118		1647	330	1977
1978-79	0.311	0.128		1804	180	1984
1979-80	0.251	0.103	(1)	1456	215	1671
1980-81	0.236	0.097		1369	165	1569
1981-82	0.182	0.075	(2)	1056	30	1086
1982-83						
1983-84						
1984-85						

(1) Added wall and attic insulation

(2) Lowered furnace temperature, insulated furnace shell and furnace room piping.

TABLE 6. STANDARDIZED OIL USAGE BASED ON 5800 DEGREE DAYS/YEAR

HOUSE NUMBER 047

HEATING YEAR	HEATING FACTOR G/DD	HEATING COMPARISON FACTOR G/DD/Mft^2		OIL USED: HEATING SEASON	OIL USED: SUMMER	OIL USED: TOTAL
1975-76						
1976-77						
1977-78	0.371	0.147		2150	700	2850
1978-79	0.345	0.137		2004	750	2754
1979-80	0.306	0.121	(1)	1775	450	2225
1980-81	0.246	0.098	(2)	1426	250	1676
1981-82	0.227	0.090	(3)	1316	175	1492
1982-83						
1983-84						
1984-85						

(1) Installed third heating zone. Reduced inside temperature.

(2) Added attic insulation, repaired insulation bypasses, lowered summer furnace temperature.

(3) Insulated furnace shell and furnace room piping.

TABLE 7. PRO-FORMA HOUSES

1500 Sq. Ft. 5800 Degree Days

House	A	B-1	B-2	C-1	C-2
	Fuel Use - Gallons				
WINTER (215 Days)					
Heat	440	700	440	1135	440
Hot Water	85	85	170	85	250
Standby	85	85	260	85	615
Total	610	870	870	1305	1305
SUMMER (150 Days)					
Hot Water	40	40	90	40	125
Standby	40	40	130	40	310
Total	80	80	220	80	435
ANNUAL					
Heat	440	700	440	1135	440
Hot Water	125	125	260	125	375
Standby	125	125	390	125	925
Total	690	950	1090	1385	1740
Calculated Values					
HF G/DD	0.105	0.150	0.150	0.225	0.225
HCF G/DD/MFt^2	0.070	0.100	0.100	0.150	0.150
BTU/Ft.^{2}	9.7	13.8	13.8	20.7	20.7
Heat Only	0.051	0.080	0.051	0.130	0.051
Heat & Standby	0.060	0.090	0.080	0.138	0.121
SFU	80	80	220	80	435