**An Innovative Educational Program
for Residential Energy Efficiency**

Final Report

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An Innovative Educational Program for Residential Energy Efficiency

Introduction

The United States has made much progress in areas related to energy efficiency since the energy crisis of the 1970s. Although improvements have been made in all economic sectors, the fact remains that optimal levels of energy efficiency are rarely implemented. Consequences of continuing inefficiency include environmental problems, national security concerns, and economic losses.

In the United States, the residential sector -- housing -- accounts for about one-third of our nation's total energy consumption however, low rates of adoption of most energy conservation measures characterize the housing stock. For instance, only six percent of single family homes are built or adapted for optimal levels of energy efficiency. Although we can't totally eliminate housing-related energy loss, we can reduce it. There is growing evidence that this can be done with several no-cost or low-cost methods in the design as well as the maintenance of our homes and/or apartments. There are also significant but unrealized potential ways to promote savings in this sector, including the need for energy conservation education programs that are tailored to individual households, and, at the same time, addressing consumer misconceptions about energy conservation and indoor air pollution.

Recognizing the importance of energy conservation, under sponsorship of the U. S. Department of Energy, Cornell University conducted a research and demonstration project entitled *An Innovative Educational Program for Residential Energy Efficiency*. The research project examined the amount of residential energy that can be saved through changes in behavior and practices of household members. To encourage these changes, a workshop was offered to randomly-selected households in New York State. Two surveys were administered to household participants [Survey I

and Survey II, Appendix A] and a control group; and a manual was developed to convey many easy but effective ways to make a house more energy efficient [See Residential Manual, Appendix B].

Implementing methods of energy efficiency will help reduce this country's dependence on foreign energy sources and will also reduce the amount of money that is lost on inefficient energy use. Because Cornell Cooperative Extension operates as a component of the land-grant university system throughout the United States, the results of this research project have been used to develop a program that can be implemented by the Cooperative Extension Service nationwide.

In the following sections, the specific goals and objectives for this project will be outlined, the population and sample for the research will be described, and the instruments utilized for the survey will be explained. A description of the workshop and manual will also be discussed. This report will end with a summary of the results from this project and any observed changes and/or recommendations for future surveys pertaining to energy efficiency.

Research Design

Objectives

Cornell's primary goal for the *Innovative Educational Program for Residential Energy Efficiency* project was to develop more effective educational methods and materials to teach households about energy conservation. The specific objectives of the research and demonstration project were to:

1. Examine the amount of energy that can be saved in the residential sector through changes in the habits and housing management practices of household members.

2. Provide factual, non-biased information on effective ways to make the home more energy efficient; and

3. Correct common misconceptions about relationships between energy conservation and indoor air quality.

Population and Sampling

This project utilized an experimental research design. A two-stage sampling procedure was followed. In the first stage, ten counties within New York State were randomly selected to participate in the project (See Listing of Counties, Appendix C). In the second stage, random digit telephone dialing was employed to identify experimental (also referred to in this report as workshop participants) and control group households in each of the ten counties. Within each county, 25 homeowners were randomly selected and invited to attend a free energy conservation workshop at the county education center of Cornell Cooperative Extension. An additional 25 households were also randomly selected in the same ten counties for a control group -- they were not invited to participate in the Extension-sponsored workshop. Thus, a total of 250 households for the experimental group and 250 households for the control group were selected to participate in this project.

Sample

The sample is representative of the population in those counties that were included in this project. For instance, the white population more than triples non-whites in nine of the ten counties. A similar pattern is also observed for family incomes, since a larger percentage of the families are in middle to upper socioeconomic levels (See Census Summary Tables, Appendix D).

The sample for this research was heterogeneous. It consisted of racially diverse persons whose ages ranged from 39 to above 70 years old, and most of whom had obtained college and above training. The sample also consisted of persons in various

occupational roles. Participants in this project were primarily from middle to upper income households, most of whom were married, and employed full-time. The sample is representative of the population in the counties that were involved in this project, in terms of its demographic and socioeconomic characteristics (See Census Summary Tables, Appendix D).

The sample consisted of an experimental and a control group of household members. The experimental group members were invited to attend a workshop in which they were provided information on energy efficiency. Those who could not attend the workshop were given a manual from which to obtain their information about energy efficiency.

Measures

A two-wave survey was administered to all project participants. The first-wave survey, referred to as Wave I, was administered before the energy educational workshops were conducted [See The Cornell Energy Survey, Appendix A]. This survey collected information regarding basic demographics and socioeconomic characteristics of homeowners, structural and locational characteristics of housing units, energy conservation activities performed prior to the survey, and monthly energy expenditures for the analyses. Results from a radon screening test and humidity measurement test were also included in the baseline data for the analyses. Selected homes in the treatment group received blower door tests.

The baseline data were collected to: 1) determine the existing levels of energy efficiency for all participating households; 2) understand basic profiles of respondents and their housing units; and 3) establish a solid data base to evaluate the potential impact of the educational program on household consumption one year after the workshop.

The second-wave survey, Wave II, was conducted one year after the energy educational program was administered. Information was collected on newly adopted

energy conservation activities, monthly energy expenditures, knowledge of indoor air quality acquired from the workshop, average monthly temperature, and other related issues. The program effect was evaluated in terms of: 1) the number of technical responses that participants adopted after the workshop; 2) the number of behavioral responses that they also adopted after the workshop; and 3) the price adjusted differences in energy consumption between conducting the first and second-wave surveys.

Workshop Description

In each of the ten counties, a workshop on residential energy efficiency with a dual focus was offered to teach participants about indoor air quality and energy conservation. The workshop content corrected common misconceptions about indoor air quality in energy efficient homes and also stressed the amount of money that people lose if they don't implement simple conservation measures, rather than what they would save through conservation. The workshop then focused on simple technical responses available to homeowners, such as 1) caulking and weatherstripping, 2) installing timers on water heaters and set-back thermostats for heating systems, 3) using off-peak wiring for electrical appliances, 4) converting to thermal storage heating for electrically heated homes, and 5) replacing inefficient electrical appliances with efficient models. The workshop also focused on simple behavioral responses, such as 1) manual thermostat set-back, 2) shutting off unused rooms in a house during the winter months, and 3) turning off unnecessary lighting.

The workshops were conducted by Cooperative Extension Personnel in each participating county. Each County Extension Agent or designated representative participated in a training session to gain the necessary understanding for coordinating the workshop (See Attachment: Program Manual). Any household in the treatment group that was unable to attend the workshop was mailed a manual on residential

energy efficiency which contained the same information that was presented in the workshop.

During the workshop, the Extension Agent presented an illustrated lecture that conveyed images of effects of infiltration through cracks in the building thermal envelope, inefficient windows, etc. Then financial losses associated with energy inefficiencies were explained. Local Extension Agents also provided participating households with assistance in obtaining home energy surveys from local utility companies. Results and recommendations from the surveys were supplemented with information about energy efficiency using vivid imagery and personalized approaches.

Selected workshop participants were also offered the opportunity to have a free blower door test. All received a radon screening test and a relative humidity measurement in their homes. The radon screening test was conducted with the use of activated charcoal canisters, with supervision from trained field workers. Trained field workers were also used to conduct the humidity tests using sling psychrometers.

Each workshop participant was encouraged to request a free energy audit from the local utility company. An Extension Agent later contacted each participant to determine if arrangements had been made or if there were plans to make arrangements for the audit. If arrangements had been made for the audit, the Extension Agent made notations based on the response. If there were plans to arrange for an energy audit in the near future, the Extension Agent informed the household participant that another contact would be made; and a follow-up call was made after one month. If the participant responded that there were no plans to arrange for an audit, the Extension Agent concluded the conversation, and there was no follow-up call.

Manual

A Residential Manual was developed and provided to all household participants in

the treatment group who did not attend the workshops [See Residential Manual, Appendix B]. This manual, which now serves as a program resource, presents many easy and effective ways to make a house more energy efficient. For instance, the manual provides information about indoor air quality, including specific pollutants such as radon. Relationships between airtightness and relative humidity are discussed. And common misconceptions about energy efficiency and indoor air quality are dispelled. Methods of prevention that will help make homes and apartments energy efficient are also included in this manual. As in the workshop, the manual stresses that implementation of these methods will help reduce the amount of money that is lost on inefficient energy use instead of what will be saved. The reasoning behind this focus is drawn from research in the field of behavioral decision theory which holds that people are more sensitive to the possibility of incurring financial losses than they are to realizing monetary gains.

Results

Sociodemographic Characteristics

The sample for this project was heterogeneous. Approximately 86 percent of the treatment and 66 percent of the control participants were white; the other 14 percent treatment and 34 percent control participants were non-white, although no specific groups were identified [See Figure I, Appendix E]. Participants in the treatment and control groups were likely to be married (83.7 percent and 78.2 percent, respectively), but the control group had more household participants who were widowed (10.5 percent versus 6.7 percent) [See Figure II, Appendix E].

There appeared to be more of a variance in the household size for participants in the treatment group in that 11.7 percent reported having a one-family member household; 32 percent reported a household of two people; 21.4 percent

consisted of four members, 14 percent with three members; and 20.1 percent consisted of five or more family members. In the control group 14.6 percent had a one-family member household; 28.7 percent reported having two family members; 22 percent consisted of four family members; 16.4 percent reported three household members; and 18 percent consisted of five or more household members [See Figure III, Appendix E].

The control group was more likely than the treatment group to have participants with less than five years of residence in their county (52 percent and 41 percent, respectively), while the treatment group was more likely overall to have participants who had lived in their county between six and twenty years (51 percent versus 28 percent). However, more participants in the control group (19 percent) than the treatment group participants (17 percent) reported having lived in their county twenty or more years [See Figure IV, Appendix E].

The participants in the sample included many persons with a college education (treatment group, 49 percent; control group, 40 percent), with approximately 19 percent of participants in both groups having obtained post-graduate education. Fewer treatment group participants than control group participants had less than a high school education (4.7 percent versus 6 percent), and more had technical or vocational training (8.5 percent and 4.7 percent, respectively) [See Figure V, Appendix E].

There was quite a variance in occupations represented in this research, although the largest group consisted of professionals, 36.9 percent in the treatment and 37 percent in the control group. Those participants in clerical and sales positions were less likely to be represented in the treatment group (8 percent) than in the control group (9 percent). However, the control group was more likely than the treatment group to have participants in the "Others" category for occupations (42.8 percent versus 27 percent). Those participants in labor positions were more likely to be

represented in the treatment (10.8 percent) than in the control group (8 percent), as well as managers in the treatment (17 percent) and the control (15.6 percent) groups [See Figure VI, Appendix E].

Over one-half of the participants in both groups (61 percent treatment and 62 percent control), were employed full-time, although a number of retirees (23 percent treatment and 19 percent control) were also included [See Figure VII, Appendix E]. Approximately 70 percent of all the participants reported a family income of more than \$20,000; and a larger number in the treatment group (20 percent) than the control group (12 percent) reported family incomes of \$60,000 or more [See Figure VIII, Appendix E].

Energy Conservation

Regarding results for the energy conservation activities, differences in workshop and control participants attitudes about an energy survey appeared mixed [See Table I, Appendix F]. For instance, during Wave I, 31.4 percent of workshop participants, and 26.4 percent of those in the control group reported having had an energy survey during the last 5 years. One year after the workshop was offered, 20.2 percent of those who participated and 20.4 percent of those in the control group reported having an energy survey during that last year. Similar results were revealed for participants with programmable thermostats for heating systems. During Wave I, 22.1 percent of workshop participants and 21.9 percent of participants in the control group reported having a programmable thermostat. During Wave II, 18.2 percent of workshop, and 22.7 percent of control participants revealed having a programmable thermostat for their heating systems.

These results suggest a need for improvement in strategies to disseminate information which will more effectively influence homeowners attitudes and behaviors

toward conserving energy. However, it could be that results are a reflection of the time effects between Wave I and Wave II. It could be that a number of participants who were involved in the first-wave survey, and reported having a programmable thermostat for their heating system, were not involved in the second-wave survey.

Workshop participants demonstrated no change in behavior during Wave I and Wave II when asked, "Have you had your home wired for off-peak electrical rates?" In response to both surveys, 9.1 percent reported having the money-saving system. There was, however, some suggested change in control participants behavior since during Wave I, 6.3 percent, and during Wave II, 9.2 percent reported having had their homes wired for off-peak electrical rates.

The data do suggest that workshop participants responded somewhat better than control participants to information presented in the workshop regarding the average amount of attic and wall insulation. For instance, results from the Energy Survey for Wave I and Wave II revealed that levels of insulation in attics and walls increased from 6.9 percent to 8.5 percent and from 3.9 percent to 4.7 percent, respectively, for workshop and control participants. The control group also revealed a slightly smaller increase in attic insulation from Wave I (6.9 percent) to Wave II (7.5 percent) and less of an increase in wall insulation between Wave I (3.6 percent) and Wave II (3.7 percent) [See Table II, Appendix F]. These results suggest that an educational approach for energy conservation which focuses on financial losses from not taking action rather than on monetary savings from taking action has the potential for impressive results.

Finally, on a 5-point scale, with 1 being the value for "Not At All Concerned" and 5 being the value for "Extremely Concerned", during Wave I and Wave II, research participants had the opportunity to respond to questions about indoor air pollutants in their homes. They were asked if their homes had been tested for any

indoor air pollutants and to identify the pollutant(s) for which they had tested. Analyses are currently underway for the data reported in response to this question.

Conclusion & Recommendations

In general, the results of the project suggest that effective educational methods do matter in conserving energy when habits and housing management practices are changed. However, there is evidence that in future research on energy conservation, some methodological changes should be employed to more accurately assess changes in participants knowledge. For instance, it may be useful for a study to use a more personalized approach to deliver the energy conservation information to participants. Such an approach may enhance consistency and encourage those who are involved in Wave I to continue their participation in Wave II.

A study with a focus on low income households and apartment dwellers in particular would be useful, particularly since findings from a study with a sample of participants from higher income households cannot be generalized to other segments of the population. Persons from families with higher incomes tend to volunteer to participate in research studies at a higher rate than person from lower income families. It is likely that persons from low income groups and those who live in apartments need different strategies for the dissemination of energy conservation information. An empirical study on this issue would answer questions about group differences.

Finally, the workshop resource manual that was developed for this project -- *Energy Efficiency: Can You Afford to Lose?* -- has been pilot-tested in counties that did not take part in the research. Initial results indicate that this program can be a useful component of an energy education strategy for local communities.

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**Cornell
Cooperative
Extension**

**Department of Design and
Environmental Analysis**

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607-255-2144

November 15, 1990

TO: John Nettleton
New York City

FROM: Joe Laquatra
Extension Faculty

RE: Innovative Educational Program for Residential Energy Efficiency

I am pleased to inform you that Queens Borough is among the ten counties in New York State which were randomly selected for participation in our research and demonstration project that is funded through the U.S. Department of Energy. Thank you for your willingness to participate in this exciting and important project.

Our preliminary project schedule calls for orientation for local office personnel in the participating counties to be conducted sometime in February, 1991. We may be able to accomplish this through a teleconference. We also hope to conduct an inservice training in the Spring, and will keep you informed regarding the date (tentatively March, 1991).

Our immediate task is to select the sample of 50 households from your county (25 for the experimental group; 25 for the control group). The sample will be randomly selected with assistance from the Cornell Institute for Social and Economic Research (CISER).

If you have any questions, feel free to contact either Jim McCarty or myself (CENET addresses: LAQUATRA; MCCARTY). We will contact you in the next month or so regarding orientation.

Selected counties:	Cattaraugus	Niagara
	Clinton	Queens Borough (New York City)
	Cortland	Saratoga
	Dutchess	Seneca
	Nassau	Steuben

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Cornell Cooperative Extension provides equal program and employment opportunities. NYS College of Agriculture and Life Sciences, NYS College of Human Ecology, and NYS College of Veterinary Medicine at Cornell University, Cooperative Extension associations, county governing bodies, and U.S. Department of Agriculture, cooperating.

Appendix D

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Saratoga County

RACE
Universe: Persons

White (800-869, 971).....	176,866
Black (870-934, 972).....	2,513
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	272
Eskimo (935-940, 974).....	0
Aleut (941-970, 975).....	0
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	153
Filipino (608, 977).....	144
Japanese (611, 981).....	65
Asian Indian (600, 982).....	391
Korean (612, 979).....	280
Vietnamese (619, 980).....	8
Cambodian (604).....	0
Hmong (609).....	0
Laotian (613).....	0
Thai (618).....	35
Other Asian (601-603, 610, 614-617, 620-652, 985).....	78
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	29
Samoan (655, 983).....	0
Tongan (657).....	0
Other Polynesian (656, 658, 659).....	0
Micronesian (660-675, 984):	
Guamanian (660, 984).....	0
Other Micronesian (661-675).....	6
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	0
Other race (700-799, 986-999).....	436

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Saratoga County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	1,774
\$5,000 to \$9,999.....	4,315
\$10,000 to \$12,499.....	2,105
\$12,500 to \$14,999.....	2,304
\$15,000 to \$17,499.....	2,410
\$17,500 to \$19,999.....	2,286
\$20,000 to \$22,499.....	2,754
\$22,500 to \$24,999.....	2,659
\$25,000 to \$27,499.....	2,774
\$27,500 to \$29,999.....	2,656
\$30,000 to \$32,499.....	2,916
\$32,500 to \$34,999.....	2,422
\$35,000 to \$37,499.....	2,855
\$37,500 to \$39,999.....	2,322
\$40,000 to \$42,499.....	2,777
\$42,500 to \$44,999.....	2,173
\$45,000 to \$47,499.....	2,176
\$47,500 to \$49,999.....	1,999
\$50,000 to \$54,999.....	3,894
\$55,000 to \$59,999.....	3,220
\$60,000 to \$74,999.....	6,450
\$75,000 to \$99,999.....	4,545
\$100,000 to \$124,999.....	1,496
\$125,000 to \$149,999.....	512
\$150,000 or more.....	691

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Saratoga County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	13,058
Professional specialty occupations (043-202).....	15,081
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	3,738
Sales occupations (243-302).....	12,149
Administrative support occupations, including clerical (303-402)..	15,188
Service occupations (403-472):	
Private household occupations (403-412).....	195
Protective service occupations (413-432).....	1,283
Service occupations, except protective and household (433-472)....	9,208
Farming, forestry, and fishing occupations (473-502).....	1,100
Precision production, craft, and repair occupations (503-702).....	9,323
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	4,328
Transportation and material moving occupations (803-863).....	3,444
Handlers, equipment cleaners, helpers, and laborers (864-902).....	2,599

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Saratoga County

EDUCATIONAL ATTAINMENT

Universe: Persons 18 years and over

Less than 9th grade.....	6,915
9th to 12th grade, no diploma.....	15,967
High school graduate (includes equivalency).....	43,077
Some college, no degree.....	24,720
Associate degree.....	12,726
Bachelor's degree.....	20,309
Graduate or professional degree.....	10,983

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Seneca County

RACE

Universe: Persons

White (800-869, 971).....	32,676
Black (870-934, 972).....	585
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	90
Eskimo (935-940, 974).....	0
Aleut (941-970, 975).....	2
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	48
Filipino (608, 977).....	12
Japanese (611, 981).....	2
Asian Indian (600, 982).....	54
Korean (612, 979).....	85
Vietnamese (619, 980).....	2
Cambodian (604).....	0
Hmong (609).....	0
Laotian (613).....	11
Thai (618).....	3
Other Asian (601-603, 610, 614-617, 620-652, 985).....	19
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	0
Samoan (655, 983).....	0
Tongan (657).....	0
Other Polynesian (656, 658, 659).....	0
Micronesian (660-675, 984):	
Guamanian (660, 984).....	2
Other Micronesian (661-675).....	0
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	0
Other race (700-799, 986-999).....	92

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Seneca County

HOUSEHOLD INCOME IN 1989
Universe: Households with householder of Hispanic origin

Less than \$5,000.....	9
\$5,000 to \$9,999.....	5
\$10,000 to \$14,999.....	12
\$15,000 to \$24,999.....	14
\$25,000 to \$34,999.....	12
\$35,000 to \$49,999.....	10
\$50,000 to \$74,999.....	2
\$75,000 to \$99,999.....	0
\$100,000 or more.....	0

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Seneca County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	1,559
Professional specialty occupations (043-202).....	2,040
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	523
Sales occupations (243-302).....	1,412
Administrative support occupations, including clerical (303-402)..	2,062
Service occupations (403-472):	
Private household occupations (403-412).....	42
Protective service occupations (413-432).....	303
Service occupations, except protective and household (433-472)....	2,121
Farming, forestry, and fishing occupations (473-502).....	648
Precision production, craft, and repair occupations (503-702).....	2,211
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	962
Transportation and material moving occupations (803-863).....	651
Handlers, equipment cleaners, helpers, and laborers (864-902).....	671

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Seneca County

EDUCATIONAL ATTAINMENT

Universe: Persons 25 years and over

Less than 9th grade.....	1,859
9th to 12th grade, no diploma.....	3,373
High school graduate (includes equivalency).....	8,108
Some college, no degree.....	3,513
Associate degree.....	1,986
Bachelor's degree.....	1,919
Graduate or professional degree.....	1,202

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Steuben County

RACE

Universe: Persons

White (800-869, 971).....	97,150
Black (870-934, 972).....	1,092
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	247
Eskimo (935-940, 974).....	2
Aleut (941-970, 975).....	0
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	48
Filipino (608, 977).....	54
Japanese (611, 981).....	68
Asian Indian (600, 982).....	98
Korean (612, 979).....	76
Vietnamese (619, 980).....	27
Cambodian (604).....	0
Hmong (609).....	0
Laotian (613).....	13
Thai (618).....	1
Other Asian (601-603, 610, 614-617, 620-652, 985).....	73
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	4
Samoan (655, 983).....	0
Tongan (657).....	0
Other Polynesian (656, 658, 659).....	0
Micronesian (660-675, 984):	
Guamanian (660, 984).....	2
Other Micronesian (661-675).....	0
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	0
Other race (700-799, 986-999).....	133

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Steuben County

HOUSEHOLD INCOME IN 1989

Universe: Households with householder of Hispanic origin

Less than \$5,000.....	9
\$5,000 to \$9,999.....	4
\$10,000 to \$14,999.....	16
\$15,000 to \$24,999.....	37
\$25,000 to \$34,999.....	21
\$35,000 to \$49,999.....	22
\$50,000 to \$74,999.....	19
\$75,000 to \$99,999.....	8
\$100,000 or more.....	2

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Steuben County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	3,949
Professional specialty occupations (043-202).....	5,996
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	1,653
Sales occupations (243-302).....	3,962
Administrative support occupations, including clerical (303-402)..	5,570
Service occupations (403-472):	
Private household occupations (403-412).....	161
Protective service occupations (413-432).....	701
Service occupations, except protective and household (433-472)....	5,489
Farming, forestry, and fishing occupations (473-502).....	1,825
Precision production, craft, and repair occupations (503-702).....	5,670
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	4,099
Transportation and material moving occupations (803-863).....	2,013
Handlers, equipment cleaners, helpers, and laborers (864-902).....	1,968

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Steuben County

EDUCATIONAL ATTAINMENT

Universe: Persons 25 years and over

Less than 9th grade.....	5,476
9th to 12th grade, no diploma.....	10,434
High school graduate (includes equivalency).....	23,596
Some college, no degree.....	9,038
Associate degree.....	5,843
Bachelor's degree.....	5,256
Graduate or professional degree.....	3,930

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 New York County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	62,042
\$5,000 to \$9,999.....	76,111
\$10,000 to \$12,499.....	28,790
\$12,500 to \$14,999.....	20,477
\$15,000 to \$17,499.....	25,034
\$17,500 to \$19,999.....	22,626
\$20,000 to \$22,499.....	29,039
\$22,500 to \$24,999.....	20,836
\$25,000 to \$27,499.....	27,889
\$27,500 to \$29,999.....	19,326
\$30,000 to \$32,499.....	28,998
\$32,500 to \$34,999.....	16,426
\$35,000 to \$37,499.....	24,000
\$37,500 to \$39,999.....	15,948
\$40,000 to \$42,499.....	22,097
\$42,500 to \$44,999.....	12,710
\$45,000 to \$47,499.....	16,780
\$47,500 to \$49,999.....	12,010
\$50,000 to \$54,999.....	27,760
\$55,000 to \$59,999.....	19,932
\$60,000 to \$74,999.....	48,931
\$75,000 to \$99,999.....	46,313
\$100,000 to \$124,999.....	28,426
\$125,000 to \$149,999.....	15,515
\$150,000 or more.....	48,795

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 New York County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	147,525
Professional specialty occupations (043-202).....	219,021
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	23,266
Sales occupations (243-302).....	90,178
Administrative support occupations, including clerical (303-402)..	109,722
Service occupations (403-472):	
Private household occupations (403-412).....	5,527
Protective service occupations (413-432).....	9,657
Service occupations, except protective and household (433-472)....	78,352
Farming, forestry, and fishing occupations (473-502).....	1,303
Precision production, craft, and repair occupations (503-702).....	26,503
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	31,023
Transportation and material moving occupations (803-863).....	13,998
Handlers, equipment cleaners, helpers, and laborers (864-902).....	14,009

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 New York County

RACE
Universe: Persons

White (800-869, 971).....	868,120
Black (870-934, 972).....	327,684
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	4,707
Eskimo (935-940, 974).....	164
Aleut (941-970, 975).....	106
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	72,277
Filipino (608, 977).....	8,531
Japanese (611, 981).....	11,364
Asian Indian (600, 982).....	5,689
Korean (612, 979).....	6,200
Vietnamese (619, 980).....	854
Cambodian (604).....	88
Hmong (609).....	0
Laotian (613).....	14
Thai (618).....	700
Other Asian (601-603, 610, 614-617, 620-652, 985).....	3,954
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	162
Samoan (655, 983).....	65
Tongan (657).....	10
Other Polynesian (656, 658, 659).....	18
Micronesian (660-675, 984):	
Guamanian (660, 984).....	184
Other Micronesian (661-675).....	0
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	58
Other race (700-799, 986-999).....	176,587

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 New York County

EDUCATIONAL ATTAINMENT

Universe: Persons 25 years and over

Less than 9th grade.....	136,204
9th to 12th grade, no diploma.....	134,725
High school graduate (includes equivalency).....	174,018
Some college, no degree.....	146,194
Associate degree.....	41,887
Bachelor's degree.....	242,390
Graduate or professional degree.....	219,899

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Niagara County

RACE

Universe: Persons

White (800-869, 971).....	204,812
Black (870-934, 972).....	12,083
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	2,202
Eskimo (935-940, 974).....	0
Aleut (941-970, 975).....	0
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	180
Filipino (608, 977).....	109
Japanese (611, 981).....	42
Asian Indian (600, 982).....	207
Korean (612, 979).....	285
Vietnamese (619, 980).....	21
Cambodian (604).....	0
Hmong (609).....	0
Laotian (613).....	0
Thai (618).....	11
Other Asian (601-603, 610, 614-617, 620-652, 985).....	52
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	0
Samoan (655, 983).....	0
Tongan (657).....	0
Other Polynesian (656, 658, 659).....	0
Micronesian (660-675, 984):	
Guamanian (660, 984).....	0
Other Micronesian (661-675).....	0
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	0
Other race (700-799, 986-999).....	752

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Niagara County

EDUCATIONAL ATTAINMENT

Universe: Persons 18 years and over

Less than 9th grade.....	12,584
9th to 12th grade, no diploma.....	25,833
High school graduate (includes equivalency).....	60,903
Some college, no degree.....	30,749
Associate degree.....	14,641
Bachelor's degree.....	13,737
Graduate or professional degree.....	7,283

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Niagara County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	4,093
\$5,000 to \$9,999.....	9,759
\$10,000 to \$12,499.....	4,467
\$12,500 to \$14,999.....	3,484
\$15,000 to \$17,499.....	4,137
\$17,500 to \$19,999.....	3,711
\$20,000 to \$22,499.....	4,045
\$22,500 to \$24,999.....	3,615
\$25,000 to \$27,499.....	3,784
\$27,500 to \$29,999.....	3,437
\$30,000 to \$32,499.....	4,464
\$32,500 to \$34,999.....	3,152
\$35,000 to \$37,499.....	3,581
\$37,500 to \$39,999.....	2,631
\$40,000 to \$42,499.....	3,311
\$42,500 to \$44,999.....	2,570
\$45,000 to \$47,499.....	2,534
\$47,500 to \$49,999.....	1,920
\$50,000 to \$54,999.....	3,575
\$55,000 to \$59,999.....	2,996
\$60,000 to \$74,999.....	5,061
\$75,000 to \$99,999.....	3,048
\$100,000 to \$124,999.....	686
\$125,000 to \$149,999.....	229
\$150,000 or more.....	398

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Niagara County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	9,508
Professional specialty occupations (043-202).....	11,949
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	3,450
Sales occupations (243-302).....	11,424
Administrative support occupations, including clerical (303-402)..	14,649
Service occupations (403-472):	
Private household occupations (403-412).....	144
Protective service occupations (413-432).....	1,907
Service occupations, except protective and household (433-472)....	13,741
Farming, forestry, and fishing occupations (473-502).....	1,367
Precision production, craft, and repair occupations (503-702).....	13,393
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	10,203
Transportation and material moving occupations (803-863).....	4,024
Handlers, equipment cleaners, helpers, and laborers (864-902).....	4,801

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Dutchess County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	16,318
Professional specialty occupations (043-202).....	25,837
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	7,870
Sales occupations (243-302).....	13,220
Administrative support occupations, including clerical (303-402)..	19,545
Service occupations (403-472):	
Private household occupations (403-412).....	436
Protective service occupations (413-432).....	3,287
Service occupations, except protective and household (433-472)....	13,117
Farming, forestry, and fishing occupations (473-502).....	1,865
Precision production, craft, and repair occupations (503-702).....	13,612
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	5,436
Transportation and material moving occupations (803-863).....	3,929
Handlers, equipment cleaners, helpers, and laborers (864-902).....	3,453

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Dutchess County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	2,133
\$5,000 to \$9,999.....	5,125
\$10,000 to \$12,499.....	2,640
\$12,500 to \$14,999.....	2,368
\$15,000 to \$17,499.....	2,625
\$17,500 to \$19,999.....	2,539
\$20,000 to \$22,499.....	3,057
\$22,500 to \$24,999.....	2,806
\$25,000 to \$27,499.....	3,132
\$27,500 to \$29,999.....	2,411
\$30,000 to \$32,499.....	3,746
\$32,500 to \$34,999.....	2,513
\$35,000 to \$37,499.....	3,661
\$37,500 to \$39,999.....	2,708
\$40,000 to \$42,499.....	3,722
\$42,500 to \$44,999.....	2,563
\$45,000 to \$47,499.....	3,034
\$47,500 to \$49,999.....	2,614
\$50,000 to \$54,999.....	6,108
\$55,000 to \$59,999.....	4,671
\$60,000 to \$74,999.....	11,022
\$75,000 to \$99,999.....	8,954
\$100,000 to \$124,999.....	3,009
\$125,000 to \$149,999.....	1,150
\$150,000 or more.....	1,316

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Dutchess County

EDUCATIONAL ATTAINMENT

Universe: Persons 25 years and over

Less than 9th grade.....	12,265
9th to 12th grade, no diploma.....	21,677
High school graduate (includes equivalency).....	48,960
Some college, no degree.....	29,398
Associate degree.....	14,393
Bachelor's degree.....	24,673
Graduate or professional degree.....	17,080

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Dutchess County

RACE
Universe: Persons

White.....	229,506
Black.....	21,490
American Indian, Eskimo, or Aleut.....	460
Asian or Pacific Islander.....	5,795
Other race.....	2,211

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Nassau County

RACE
Universe: Persons

White (800-869, 971)	1,116,949
Black (870-934, 972)	110,991
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973)	1,500
Eskimo (935-940, 974)	80
Aleut (941-970, 975)	46
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976)	11,095
Filipino (608, 977)	4,210
Japanese (611, 981)	3,202
Asian Indian (600, 982)	12,214
Korean (612, 979)	5,082
Vietnamese (619, 980)	505
Cambodian (604)	18
Hmong (609)	0
Laotian (613)	27
Thai (618)	450
Other Asian (601-603, 610, 614-617, 620-652, 985)	1,927
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978)	33
Samoan (655, 983)	15
Tongan (657)	0
Other Polynesian (656, 658, 659)	0
Micronesian (660-675, 984):	
Guamanian (660, 984)	73
Other Micronesian (661-675)	19
Melanesian (676-680)	0
Pacific Islander, not specified (681-699)	44
Other race (700-799, 986-999)	18,868

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Nassau County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	9,577
\$5,000 to \$9,999.....	17,114
\$10,000 to \$12,499.....	8,667
\$12,500 to \$14,999.....	7,422
\$15,000 to \$17,499.....	9,437
\$17,500 to \$19,999.....	8,608
\$20,000 to \$22,499.....	10,931
\$22,500 to \$24,999.....	8,848
\$25,000 to \$27,499.....	11,537
\$27,500 to \$29,999.....	9,505
\$30,000 to \$32,499.....	13,171
\$32,500 to \$34,999.....	9,958
\$35,000 to \$37,499.....	12,433
\$37,500 to \$39,999.....	9,690
\$40,000 to \$42,499.....	13,714
\$42,500 to \$44,999.....	9,921
\$45,000 to \$47,499.....	12,421
\$47,500 to \$49,999.....	10,392
\$50,000 to \$54,999.....	25,578
\$55,000 to \$59,999.....	21,109
\$60,000 to \$74,999.....	57,749
\$75,000 to \$99,999.....	60,087
\$100,000 to \$124,999.....	31,513
\$125,000 to \$149,999.....	14,390
\$150,000 or more.....	27,376

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Nassau County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	112,278
Professional specialty occupations (043-202).....	115,951
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	20,753
Sales occupations (243-302).....	93,861
Administrative support occupations, including clerical (303-402)..	130,222
Service occupations (403-472):	
Private household occupations (403-412).....	4,033
Protective service occupations (413-432).....	18,932
Service occupations, except protective and household (433-472)....	49,354
Farming, forestry, and fishing occupations (473-502).....	5,202
Precision production, craft, and repair occupations (503-702).....	57,824
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	17,761
Transportation and material moving occupations (803-863).....	19,174
Handlers, equipment cleaners, helpers, and laborers (864-902).....	16,141

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Nassau County

EDUCATIONAL ATTAINMENT

Universe: Persons 18 years and over

Less than 9th grade.....	54,767
9th to 12th grade, no diploma.....	100,686
High school graduate (includes equivalency).....	299,073
Some college, no degree.....	198,809
Associate degree.....	69,165
Bachelor's degree.....	168,892
Graduate or professional degree.....	115,821

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Cortland County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	907
\$5,000 to \$9,999.....	1,857
\$10,000 to \$12,499.....	915
\$12,500 to \$14,999.....	853
\$15,000 to \$17,499.....	983
\$17,500 to \$19,999.....	838
\$20,000 to \$22,499.....	1,005
\$22,500 to \$24,999.....	651
\$25,000 to \$27,499.....	905
\$27,500 to \$29,999.....	655
\$30,000 to \$32,499.....	850
\$32,500 to \$34,999.....	744
\$35,000 to \$37,499.....	652
\$37,500 to \$39,999.....	631
\$40,000 to \$42,499.....	696
\$42,500 to \$44,999.....	532
\$45,000 to \$47,499.....	473
\$47,500 to \$49,999.....	416
\$50,000 to \$54,999.....	696
\$55,000 to \$59,999.....	445
\$60,000 to \$74,999.....	826
\$75,000 to \$99,999.....	487
\$100,000 to \$124,999.....	199
\$125,000 to \$149,999.....	13
\$150,000 or more.....	86

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Cortland County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	2,452
Professional specialty occupations (043-202).....	3,460
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	714
Sales occupations (243-302).....	2,212
Administrative support occupations, including clerical (303-402)..	3,267
Service occupations (403-472):	
Private household occupations (403-412).....	71
Protective service occupations (413-432).....	496
Service occupations, except protective and household (433-472)....	2,784
Farming, forestry, and fishing occupations (473-502).....	946
Precision production, craft, and repair occupations (503-702).....	2,477
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	2,088
Transportation and material moving occupations (803-863).....	911
Handlers, equipment cleaners, helpers, and laborers (864-902).....	1,063

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Cortland County

RACE
Universe: Persons

White (800-869, 971).....	47,968
Black (870-934, 972).....	406
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	176
Eskimo (935-940, 974).....	0
Aleut (941-970, 975).....	0
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	6
Filipino (608, 977).....	47
Japanese (611, 981).....	14
Asian Indian (600, 982).....	85
Korean (612, 979).....	25
Vietnamese (619, 980).....	7
Cambodian (604).....	0
Hmong (609).....	0
Laotian (613).....	0
Thai (618).....	0
Other Asian (601-603, 610, 614-617, 620-652, 985).....	11
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	7
Samoan (655, 983).....	0
Tongan (657).....	0
Other Polynesian (656, 658, 659).....	0
Micronesian (660-675, 984):	
Guamanian (660, 984).....	0
Other Micronesian (661-675).....	0
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	0
Other race (700-799, 986-999).....	211

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Cortland County

EDUCATIONAL ATTAINMENT

Universe: Persons 18 years and over

Less than 9th grade.....	2,192
9th to 12th grade, no diploma.....	5,368
High school graduate (includes equivalency).....	11,890
Some college, no degree.....	8,138
Associate degree.....	3,490
Bachelor's degree.....	3,608
Graduate or professional degree.....	2,123

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Clinton County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	3,403
Professional specialty occupations (043-202).....	4,958
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	1,008
Sales occupations (243-302).....	4,199
Administrative support occupations, including clerical (303-402)..	5,300
Service occupations (403-472):	
Private household occupations (403-412).....	105
Protective service occupations (413-432).....	2,107
Service occupations, except protective and household (433-472)....	4,698
Farming, forestry, and fishing occupations (473-502).....	1,140
Precision production, craft, and repair occupations (503-702).....	3,518
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	2,054
Transportation and material moving occupations (803-863).....	1,459
Handlers, equipment cleaners, helpers, and laborers (864-902).....	1,431

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Clinton County

HOUSEHOLD INCOME IN 1989
Universe: Households

Less than \$5,000.....	1,825
\$5,000 to \$9,999.....	2,933
\$10,000 to \$12,499.....	1,460
\$12,500 to \$14,999.....	1,446
\$15,000 to \$17,499.....	1,591
\$17,500 to \$19,999.....	1,410
\$20,000 to \$22,499.....	1,617
\$22,500 to \$24,999.....	1,283
\$25,000 to \$27,499.....	1,361
\$27,500 to \$29,999.....	1,235
\$30,000 to \$32,499.....	1,534
\$32,500 to \$34,999.....	1,000
\$35,000 to \$37,499.....	1,218
\$37,500 to \$39,999.....	873
\$40,000 to \$42,499.....	1,186
\$42,500 to \$44,999.....	664
\$45,000 to \$47,499.....	851
\$47,500 to \$49,999.....	523
\$50,000 to \$54,999.....	1,083
\$55,000 to \$59,999.....	888
\$60,000 to \$74,999.....	1,726
\$75,000 to \$99,999.....	943
\$100,000 to \$124,999.....	311
\$125,000 to \$149,999.....	113
\$150,000 or more.....	128

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Clinton County

HOUSEHOLD INCOME IN 1989

Universe: Households with householder of Hispanic origin

Less than \$5,000.....	11
\$5,000 to \$9,999.....	39
\$10,000 to \$14,999.....	22
\$15,000 to \$24,999.....	42
\$25,000 to \$34,999.....	47
\$35,000 to \$49,999.....	42
\$50,000 to \$74,999.....	12
\$75,000 to \$99,999.....	0
\$100,000 or more.....	4

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Clinton County

EDUCATIONAL ATTAINMENT

Universe: Persons 18 years and over

Less than 9th grade.....	5,563
9th to 12th grade, no diploma.....	9,814
High school graduate (includes equivalency).....	21,328
Some college, no degree.....	13,993
Associate degree.....	4,706
Bachelor's degree.....	5,507
Graduate or professional degree.....	3,636

1990 Census Of Population And Housing Summary Tape File 1C

040 New York
050 Broome County

RACE	
Universe: Persons	
White.....	202,949
Black.....	4,333
American Indian, Eskimo, or Aleut.....	355
Asian or Pacific Islander.....	3,677
Other race.....	846

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Broome County

EDUCATIONAL ATTAINMENT

Universe: Persons 25 years and over

Less than 9th grade.....	10,705
9th to 12th grade, no diploma.....	18,563
High school graduate (includes equivalency).....	45,549
Some college, no degree.....	21,642
Associate degree.....	13,466
Bachelor's degree.....	17,113
Graduate or professional degree.....	11,511

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Broome County

OCCUPATION

Universe: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)...	11,701
Professional specialty occupations (043-202).....	17,323
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242).....	5,428
Sales occupations (243-302).....	10,917
Administrative support occupations, including clerical (303-402)..	15,006
Service occupations (403-472):	
Private household occupations (403-412).....	281
Protective service occupations (413-432).....	1,415
Service occupations, except protective and household (433-472)....	12,783
Farming, forestry, and fishing occupations (473-502).....	932
Precision production, craft, and repair occupations (503-702).....	9,963
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802).....	6,426
Transportation and material moving occupations (803-863).....	3,485
Handlers, equipment cleaners, helpers, and laborers (864-902).....	3,123

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Broome County

HOUSEHOLD INCOME IN 1989
Universe: Households with householder of Hispanic origin

Less than \$5,000.....	63
\$5,000 to \$9,999.....	71
\$10,000 to \$14,999.....	41
\$15,000 to \$24,999.....	156
\$25,000 to \$34,999.....	47
\$35,000 to \$49,999.....	112
\$50,000 to \$74,999.....	94
\$75,000 to \$99,999.....	19
\$100,000 or more.....	27

1990 Census Of Population And Housing Summary Tape File 3C

040 New York
050 Chautauqua County

RACE
Universe: Persons

White (800-869, 971).....	136,256
Black (870-934, 972).....	2,298
American Indian, Eskimo, or Aleut (000-599, 935-970, 973-975):	
American Indian (000-599, 973).....	435
Eskimo (935-940, 974).....	0
Aleut (941-970, 975).....	0
Asian or Pacific Islander (600-699, 976-985):	
Asian (600-652, 976, 977, 979-982, 985):	
Chinese (605-607, 976).....	118
Filipino (608, 977).....	53
Japanese (611, 981).....	19
Asian Indian (600, 982).....	244
Korean (612, 979).....	190
Vietnamese (619, 980).....	14
Cambodian (604).....	78
Hmong (609).....	0
Laotian (613).....	2
Thai (618).....	0
Other Asian (601-603, 610, 614-617, 620-652, 985).....	79
Pacific Islander (653-699, 978, 983, 984):	
Polynesian (653-659, 978, 983):	
Hawaiian (653, 654, 978).....	0
Samoan (655, 983).....	8
Tongan (657).....	0
Other Polynesian (656, 658, 659).....	0
Micronesian (660-675, 984):	
Guamanian (660, 984).....	20
Other Micronesian (661-675).....	0
Melanesian (676-680).....	0
Pacific Islander, not specified (681-699).....	0
Other race (700-799, 986-999).....	2,081

Appendix E

Figure I. Characteristics - Race

Figure II. Characteristics - Marital Status

Figure III. Characteristics - Household Size

Figure IV. Characteristics - Residence

Figure V. Characteristics - Education

Figure VI. Characteristics - Occupation

Figure VII. Characteristics - Employment Status

Figure VIII. Characteristics - Family Income

Appendix F

Table I. Changes of Energy Conservation Activities for Workshop Participants and Control groups Between Wave I (1991) and Wave II (1992)

Energy Conservation Activities	Workshop Participants	Control Group	Total
1. Energy Audit Survey the last 5 years [Wave I]			
No	68.6	73.6	71.4
Yes	31.4	26.4	28.6
N	102	125	227
	X-square =.68	C=.06	
Energy Audit Survey last year [Wave II]			
No	79.8	79.6	79.7
Yes	20.2	20.4	20.3
N	89	152	241
	X-square=.001	C=.002	
2. Do you have a programmable thermostat for your heating system?			
[Wave I]			
No	77.9	98.1	78.0
Yes	22.1	21.9	22.0
N	104	123	227
	X-square=.001	C=.002	
[Wave II]			
No	81.8	97.3	78.8
Yes	18.2	22.7	21.2
N	33	66	99
	X-square=.27	C=.052	

3. Do you have your home wired for off-peak electrical rates?

[Wave I]

No	90.8	93.7	92.4
Yes	9.1	6.3	7.6
N	103	119	222

X-square=.69

C=.056

[Wave II]

No	90.9	90.8	90.8
Yes	9.1	9.2	9.2
N	33	65	98

X-square=.001

C=.002

4. Average insulation in attic or ceiling (inches)

[Wave I]	6.9	6.9	F=0
[Wave II]	8.5	7.49	F=3.34

5. Average wall insulation (inches)

[Wave I]	3.95	3.64	F=0.94
[Wave II]	4.38	3.72	F=4.97

*

Significant at the 5% level

Table II. Whether or not tested the indoor air pollutants in the home for Workshop participants and control group between Wave I (1991) and Wave II (1992).

Whether tested Indoor Air Pollutants	Workshop Participants	Control Group	Total
[Wave I]			
No	93.0	94.3	93.8
Yes*	7.0	5.7	6.2
N	86	106	192
	X-square=.14	C=.027	
[Wave II]			
No	80.2	86.0	83.4
Yes	19.8	14.0	16.6
N	86	107	193
	X-square=1.4	C=.077	

* A majority of respondents were testing for radon, followed by inadequate or excessive humidity, asbestos and combustion gas.

Energy Efficiency:

Can you
afford
to lose?

Department of Design & Environmental Analysis, Cornell University
and the United States Department of Energy

ENERGY EFFICIENCY: CAN YOU AFFORD TO LOSE?

Inservice

Agenda

Joseph Laquatra, James A. McCarty

April 24, 1991, MVR 114

- 8:30-9:00** refreshments and sign-in
- 9:00-9:15** Program Organization
- 9:15-9:30** Logistics of Survey (1st wave)
 - 1.** Must be completed before workshop
 - 2.** Agent response if participant asks for help
- 9:30-10:00** Sling Psychrometer demonstration and practice
- 10:00-10:15** Logistics for reimbursement
 - 1.** Field Workers and Extension Agents
 - 2.** forms provided
- 10:15-10:30** break
- 10:30-10:45** Utility contacts by Agents
 - 1.** Distribution of materials from utility companies
 - 2.** Utility funding for blower-door testing (coordinate with Joe, Jim)
- 10:45-11:00** Follow-Up activities
 - 1.** Agents/Utility Representative available for assistance
 - 2.** Three months after workshop (forms provided)
- 11:00-11:45** Questions and Answers
- 11:45-12:30** lunch in 114
- 12:30-1:15** Indoor Air Quality Slides – Joe Laquatra
- 1:15-1:30** Break
- 1:30-2:15** Energy Efficiency Slides – Jim McCarty
- 2:15-2:45** Questions and Answers; Adjourn at 2:45

ENERGY EFFICIENCY: CAN YOU AFFORD TO LOSE?

Introduction

Under sponsorship of the U.S. Department of Energy, Cornell Cooperative Extension is conducting a research and demonstration project to examine the amount of residential energy that can be saved through changes in behaviors and practices of household members. The basis for this project is an experimental research design that focuses on the delivery of energy conservation information.

In ten randomly selected counties, two groups of 25 households (50 households per county) have been identified for participation in this project by the Survey Research Facility of the Cornell Institute for Social and Economic Research. In each county, 25 households have been assigned to a treatment group and 25 to a control group. Neither group knows about the existence of the other. Those households in the treatment group have agreed to attend a free energy conservation workshop, and to complete questionnaires they will receive in 1991 and 1992. Those in the control group have agreed only to complete the questionnaires in both years.

During the Spring of 1991, both treatment and control groups of households will receive the baseline questionnaire on energy conservation attitudes and practices. Sometime after they receive these questionnaires, and before the energy conservation workshop is held, households in the treatment group must complete their surveys. In some counties, households in the treatment groups will have blower door tests conducted on their homes. In all ten counties, both groups of households will receive a single-point measurement of indoor relative humidity in 1991; in 1992, they will receive a free radon detector.

The workshop to be conducted will differ from typical energy conservation programs in the way that information regarding residential energy efficiency will be conveyed. Recommendations for increasing efficiency will focus on simple behavioral and technical responses; benefits will be conveyed as financial losses from not taking appropriate actions; for households receiving the blower door tests, personalized approaches using vivid imagery will be used. In addition, workshop attendees will be encouraged to have energy audits performed on their homes, if they have not yet done so, and will be contacted after the workshop to determine if the audit has been conducted and if assistance in interpreting recommendations is needed.

In early 1992, a second wave survey will be sent to all households to identify changes in attitudes and behaviors that may be attributed to this program. Knowledge gained from this project will be used to implement similar programs across New York State. Results of the project and program materials will be made available to the Cooperative Extension Service nationwide.

Helping You Put Knowledge to Work

Significance

Although the importance of energy conservation in the residential sector of the U.S. economy is highlighted by issues related to environmental protection, the affordability of housing, and economic development, barriers to an efficient use of energy resources prevent the realization of a large potential for energy savings. As the residential sector accounts for about one-third of total energy consumption in the United States, overcoming these barriers to the achievement of higher levels of energy efficiency in housing is necessary in light of the growing dependence of this country on imported oil to meet energy demand. Oil imports are now at levels higher than those during the 1973-74 Arab oil embargo, and could amount to between 50 and 60 percent of total consumption by 1995.

Despite the existence of a wide range of readily available information and technologies, low rates of adoption of most energy conservation measures characterize residential housing in the United States, with only 6% of single family homes built or adapted for optimal levels of energy efficiency. Potential savings in this sector are significant but unrealized because of numerous factors that have been observed, including the need for energy conservation education programs that are tailored to individual households and present information in more meaningful ways, and at the same time, address consumer misconceptions about energy conservation and indoor air pollution.

The Program

Energy Efficiency: Can You Afford to Lose? is a unique educational program because of its application of social-psychological principles to convey the financial implications of household energy conservation; the use of credible sources of information and personalized approaches; and the correction of misconceptions about adverse health effects from making housing more energy efficient.

The social-psychological principles that will be applied to the county workshop are based in behavioral decision theory. Some researchers in this area have observed that when information on investments is presented in the context of money that will be lost by not investing, instead of saved by investing, people are more likely to take action, because of a greater sensitivity to financial losses than to financial gains. In addition, when credible sources present the information and use personalized approaches, people are more likely to take action. In Energy Efficiency: Can You Afford to Lose? these principles will be applied to energy conservation, by stressing how much money people lose if they don't make their homes and heating systems more energy efficient.

Regarding a credible source of information, Cornell Cooperative Extension is a highly regarded for its educational efforts. Our programs are based in research and presented in an unbiased manner through the efforts of County Extension Agents and their paid and volunteer staff members. In Energy

Efficiency: Can You Afford to Lose?, we will be taking an additional step of contacting workshop attendees, to determine if energy audits were conducted in their homes, and if they need assistance in understanding findings from the audits. For those participants who will have blower door tests conducted on their homes, personalized information from the results of the tests will be prepared in the Department of Design and Environmental Analysis at Cornell. This information will be turned over to County Extension Agents for distribution through the mail to those households.

An important component of Energy Efficiency: Can You Afford to Lose? is a focus on indoor air quality. In this segment of the workshop, principles of indoor air management will be conveyed to workshop participants, to dispel misconceptions about relationships between energy conservation and indoor air quality and to teach principles about various indoor air pollutants, so that households will have a factual basis for managing this aspect of their environments.

This research and demonstration phase of Energy Efficiency: Can You Afford to Lose? is an important first step in the development of the statewide program that will be available to Local Associations in the near future. Based on what is learned from this phase, the program will be adapted as necessary, with useful components retained, and others fine tuned. Because of local sponsorship of the workshop and direct contact with project participants, Extension staff in the ten Local Associations participating in this research and demonstration project are playing a very important role in the eventual direction of the program. Insights, comments, and criticisms about program organization and materials are welcome at any time. We appreciate your willingness to be involved with this effort.

Joseph Laquatra
Project Director

James A. McCarty
Field Coordinator

County: _____

Agent: _____

Workshop Date: _____

Today's Date: _____

Name of Workshop Participant: _____

Instructions to Agent: Call the home of the workshop participant, and ask to speak to the participant. If he/she is not home, ask to speak to any adult household member. Suggested script:

"Hello, Mr./Ms./Mrs. _____. This is _____ from Cornell Cooperative Extension of _____ County. You (or someone from your household) recently attended a workshop on energy conservation. One of the points covered in the workshop was the importance of having a free energy audit conducted on your home. I'm calling to see if you have contacted _____ (name of utility company) to arrange for this energy audit."

Check one and respond, depending on answer:

_____ yes-----> "I'm glad to hear that. Do you need any assistance in interpreting the results of the audit, or would you like any more information to help you decide what steps to implement? For example, we have fact sheets that you may find useful on insulation weather-stripping, caulking, and heating system efficiency."

To Agent: write notes based on response here:

Conclude conversation and hang up.

_____ no-----> "Do you plan to arrange for an energy audit in the near future?" (Check one and respond, depending on answer.)

_____ yes-----

↓

Agent: "Thank you, Mr./Ms./Mrs. _____. If it's alright with you, I'll contact you in about a month to see if you've had any luck in getting any energy audit scheduled. Thank you for your time." Follow-up call in one month.

_____ no -----

↓

Agent: "I understand, Mr./Ms./Mrs. _____. Thank you for your time. Conclude conversation and hang up. No follow-up call."

Send this completed form to:

Joseph Laquatra
Department of Design and Environmental Analysis
MVR Hall
Cornell University
Ithaca, NY 14853

County: _____

Agent: _____

Workshop Date: _____

Today's Date: _____

Name of Workshop Participant: _____

Instructions to Agent: Call the home of the workshop participant, and ask to speak to the participant. If he/she is not home, ask to speak to any adult household member. Suggested script:

"Hello, Mr./Ms./Mrs. _____ This is _____ from Cornell Cooperative Extension of _____ County. You (or someone from your household) recently attended a workshop on energy conservation. One of the points covered in the workshop was the importance of having a free energy audit conducted on your home. I'm calling to see if you have contacted _____ (name of utility company) _____ to arrange for this energy audit."

Check one and respond, depending on answer:

_____ yes-----> "I'm glad to hear that. Do you need any assistance in interpreting the results of the audit, or would you like any more information to help you decide what steps to implement? For example, we have fact sheets that you may find useful on insulation weather-stripping, caulking, and heating system efficiency."

To Agent: write notes based on response here:

Conclude conversation and hang up.

_____ no-----> "Do you plan to arrange for an energy audit in the near future?" (Check one and respond, depending on answer.)

_____ yes-----
↓

Agent: "Thank you, Mr./Ms./Mrs. _____ Good luck with your energy audit, and feel free to contact us if you need any assistance with scheduling it or with interpreting the results. We have a number of free fact sheets on different aspects of energy conservation that you may find useful. Thank you for your time."

_____ no-----
↓

Agent: "I understand, Mr./Ms./Mrs. _____ Thank you for your time. **Conclude conversation and hang up.**"

Send this form in. Don't contact a third time. Send completed form to:

Joseph Laquatra
Department of Design and Environmental Analysis
MVR Hall
Cornell University
Ithaca, NY 14853

INVOICE FOR SERVICES RENDERED

For survey collection and/or humidity testing in connection with the DEA/DOE project.

County in which surveys were collected: _____

Period during which services were rendered (mo/da/yr - mo/da/yr): _____

Hours worked for the period: _____

Miles driven (to be reimbursed at \$0.21/mile): _____

Worker name and address:

Social Security # _____

I certify that this invoice accurately reflects the hours worked and the mileage driven to complete these services during the period indicated above.

Signature of worker: _____

Date submitted: _____

NOTE TO COUNTY:

These forms should be collected weekly and mailed to:

Diane Prignon, Accounts Assistant
DEA Department, MVR Hall
College of Human Ecology, Cornell University
Ithaca, NY 14853-4401

In recent years, a growing body of scientific evidence has indicated the air people breathe inside their homes can be more seriously polluted with dangerous toxins than outdoor air in even the largest and most industrialized cities. The growing awareness of this issue is causing indoor air pollution to become a national health concern. The issue is important because of the amount of time people spend indoors, with people in urban and other areas spending about 90 percent of their time indoors. Other people, such as the elderly and infirm, may spend all of their time indoors. The issue is serious when one considers that toxin levels in indoor air can be 10 to 100 times higher than what is permitted by federal regulations in outdoor air.

INDOOR AIR POLLUTION

A NATIONAL HEALTH CONCERN

- Urban residents: 90% of their time indoors**
- Toxin levels indoors: 10 - 100 times higher than permitted outdoors**

The growing awareness of indoor air pollution is giving rise to indoor air management as a new consumer skill. Three separate aspects of indoor air management are pollutant identification, source control, and mitigation. Let's consider each of these points.

Pollutant identification. Unfortunately, there is no single test that can be used to identify all possible pollutants in the air of your home. Separate tests are conducted for each pollutant. If you think something in the air of your home is making you sick, you should see your doctor, who can tell you if your symptoms are related to a pollutant. Then you can go about testing for that pollutant. But this does not work for pollutants for which there are no immediate adverse health symptoms. For these, it is best to follow guidelines that have been established by the U.S. Environmental Protection Agency.

Source Control. Source control refers to the prevention of indoor air pollution by not allowing the sources of pollutants in your home in the first place. This is the most effective air quality control measure.

Mitigation. Even in homes where great care has been exercised to prevent indoor air pollution, a pollutant may be found. In that case, it can be removed by what are called mitigation measures.

INDOOR AIR MANAGEMENT: A NEW CONSUMER SKILL

- **Pollutant identification**
- **Source control**
- **Mitigation**

Many people incorrectly assume that energy conserving or "energy tight" homes are more susceptible to indoor air pollution than are homes that are kept deliberately leaky. These people may be surprised to learn that properly designed and maintained energy efficient homes can have a better quality of indoor air than leaky, drafty homes. This is because in new homes that are built to be energy conserving and in older homes that have had energy conservation features correctly installed, many pollutants are less likely to enter the homes, and those that do can be removed with controlled ventilation.

Remember, in a home that is left intentionally leaky, there is no way to control the air that enters through cracks and other openings. That air flow is affected by wind speed, topography, and vegetation. In energy efficient homes, on the other hand, exhaust fans remove excessive moisture and cooking odors; and a tight building shell makes sure that toxins in soil gas do not enter the home.

AIR POLLUTION IN THE "ENERGY TIGHT" HOME

What are the pollutants that can be found in the air of a home? This slide shows that they can be radon, asbestos, combustion products, biological contaminants, organic gases, and lead. The following slides will show us what these pollutants are, where they come from, and what can be done to control them.

INDOOR AIR POLLUTANTS

Many of us have heard the phrase, "tight houses sweat," which refers to the fact that moisture, if not controlled properly, can build up in energy conserving homes to levels which can cause condensation problems. We may see this condensation directly, such as when it builds up on windows, or indirectly, such as its effects including mold and mildew on exterior walls and in closets. Uncontrolled moisture levels in homes can lead to structural problems from rotting studs and joists. In addition to affecting the health of our homes, uncontrolled moisture levels can affect human health.

This chart summarizes research that has been conducted on what happens at different levels of relative humidity. Note that humidity levels from 0 to 100 percent are shown on the horizontal axis. If we go down the list on the vertical axis, we can see that bacteria populations are high at low levels of relative humidity and then drop off at 30 percent relative humidity; then begin to increase again at 60 percent relative humidity. Levels of viruses are high at low levels of relative humidity till about 50 percent relative humidity; then begin to increase again at 70 percent relative humidity. Fungi and house dust mites need moisture to survive. We begin to see fungal growth at 60 percent relative humidity and mites at 50 percent relative humidity. Research on respiratory infections and relative humidity is limited, but suggests that more infections occur at low levels of relative humidity. Allergy problems and asthma occur at both low and high levels of relative humidity. Chemical interactions – and here the main interaction is formaldehyde emission -- begin at about 30 percent relative humidity and increase as relative humidity increases. Ozone is a respiratory irritant that is produced by some appliances. Its levels are highest at low levels of relative humidity.

The main feature of this chart is that there is an optimum zone of relative humidity of between 40 and 60 percent, where the presence of these pollutants is minimized.

Here is a picture of a house dust mite as seen through an electron microscope. Millions of these tiny creatures can be in our houses. Body parts of dead dust mites, and fecal pellets from live mites can be present in the air. People with allergies can be adversely affected by these materials in the air. Dust mites can live in carpeting and bedding. Remember, controlling humidity can control dust mites.

This slide shows mold growing on a wall where moisture has condensed. As mold spores are released, they accumulate in the air. Many people, especially those with allergies, can be affected by mold spores. In addition, mold that grows in closets can damage clothing and leather goods.

The presence of biological pollutants that are associated with excess moisture levels in a home can be minimized by controlling relative humidity. Two things about a home affect indoor relative humidity levels: 1) how it was built, and 2) how it is used. In the next few slides, principles of relative humidity will be covered.

Warm air is capable of holding more moisture than cold air. In this slide, the cube on the left represents air at 75 degrees Fahrenheit and a level of relative humidity of 30 percent. That means that the air is holding 30 percent of the moisture it is capable of holding. When this same cube of air, with the same amount of moisture, is cooled to 40 degrees Fahrenheit, it is capable of holding less moisture, and is now at 100 percent relative humidity.

WARM AIR HOLDS MORE WATER VAPOR THAN COLD AIR

75°F — 30% relative humidity

40°F — 100% relative humidity

When air is at 100 percent relative humidity, it is said to be saturated. This is the dew point temperature, at which water vapor condenses to liquid. We see this occurring in many ways. For example, on a hot, muggy afternoon in the summer, moisture forms on the outside of a glass of iced tea. This is because the air near the glass cools, and moisture from the air condenses on the glass. In the wintertime in a home, moisture-laden air cools as it approaches a window, and condenses on the window.

MOISTURE CONDENSES AT 100% RELATIVE HUMIDITY OR SATURATION
THIS IS THE DEW POINT TEMPERATURE

Water in its vapor form is a gas, and like a gas, it moves from areas where it is highly concentrated to areas of low concentration. The force behind this movement is called vapor pressure, or vapor drive. This slide shows that on a cold winter night, relative humidity inside a home is higher than relative humidity outside. Vapor pressure can cause moisture movement from inside the home to the outside.

What are sources of moisture in a home? Moisture is produced by common household activities such as cooking, cleaning, and taking showers. People, plants and pets also produce moisture.

SOURCES OF MOISTURE

The average family of four generates between three and six gallons of water in a day. A person gives off three pints of moisture by breathing. Cooking and dishwashing produces about one pint of water per meal. And about one half pint of moisture is released into the air from taking a shower.

**THE AVERAGE FAMILY OF FOUR GENERATES
FROM 3 TO 6 GALLONS OF WATER PER DAY.**

breathing — 3 pints/day

cooking and dishwashing — 1 pint/meal

shower — ½ pint

Moisture also gets into a house from exterior sources. A broken downspout, for example, can allow rain water to run along the side of a house and down its foundation wall, so that it can leak into a basement. Once water is in a basement, it can raise the relative humidity levels inside the house.

Crawl spaces and basements are also sources of moisture in a home, especially if they have dirt floors that are not covered by a moisture barrier. Moisture migration can occur through the soil into the home. And any water that leaks into crawl spaces or basements can raise moisture levels throughout the house.

**CRAWL SPACE and BASEMENT
ARE SOURCES of INDOOR MOISTURE**

The key to controlling relative humidity levels in a home is to maintain a moisture balance. Remember, some moisture in the air is necessary for human health and comfort; but too much moisture can cause problems. A moisture balance is maintained by making sure a home has vapor diffusion protection, through the installation of vapor retarders, as well as adequate ventilation, especially at points where moisture is produced.

MOISTURE BALANCE

CONTROL MOISTURE AT ITS SOURCE

Vapor Diffusion Protection

Adequate Ventilation

Relative humidity in a home can be maintained at healthy levels by controlling moisture at its source. This means preventing it from entering a space as well as giving it an escape route where it is produced.

The walls in a home are typically provided with adequate vapor diffusion protection when they are constructed, by installing a vapor retarder over the insulation. In this slide, a layer of polyethylene is stapled to the studs of a wall that has been insulated. This polyethylene prevents moisture from passing through the insulation and possibly condensing inside the wall.

As has been pointed out with broken downspouts, exterior sources of moisture should also be controlled at their source, to prevent water entry into a home. An ice dam can also cause water entry. Ice dams are usually caused by inadequate attic ventilation. Without ventilation, heat can build up in an attic. This causes snow to melt on a roof in the wintertime. The melted snow runs down the roof until it reaches the overhang, which is colder. At this point, the water freezes and begins an ice build-up. As this ice dam grows, it can push water under the roof shingles. Then water can leak into an attic or wall.

Inside the home, moisture should be exhausted to the outside from the point that it is produced. This means that a kitchen stove needs an exhaust fan over it, which should be ducted to the outside. A circulating fan may remove some cooking odors from the air, but it will not remove moisture. A bathroom also needs an exhaust fan that leads to the outside. This fan should be used when anyone is taking a shower and for a short time afterwards, until moisture levels have decreased to the point that condensation is not occurring on windows and mirrors. In the laundry, a clothes dryer should be vented to the outdoors.

EXHAUSTING AIR AND MOISTURE FROM KITCHEN, BATHROOM, AND LAUNDRY

Despite our best efforts at controlling moisture at its source, we may still see condensation on windows and other cooler surfaces. This condensation that occurs where we can see it is referred to as surface condensation.

Sometimes surface condensation is merely a nuisance, because it covers up a window, and prevents us from seeing outside. Excessive surface condensation can lead to mold and mildew growth on windows, and can damage window sills.

This chart shows when surface condensation occurs on windows. You can see that depending on the type of windows you have in your home, condensation will occur at different levels of relative humidity. For example, when the temperature outside is 0 degrees Fahrenheit and it is 70 degrees Fahrenheit inside, condensation will occur on the interior surface of a single-pane window when the indoor relative humidity level is 15 percent; on a double-pane window, condensation will occur at 42 percent relative humidity; and on a low-emissivity window at 65 percent. You can see that by increasing the energy efficiency of your windows, you can lessen the occurrence of condensation.

WINDOW TYPE	CONDENSING HUMIDITY LEVEL
Single-pane	15%
Double-pane	42%
Low-emissivity	65%

INDOOR TEMPERATURE - 70°F

OUTDOOR TEMPERATURE - 0°F

Appendix A

THE CORNELL ENERGY SURVEY

SECTION A: CHARACTERISTICS OF YOUR HOME AND NEIGHBORHOOD

- 1) In what size community is your home located? *(Please circle ONE response.)*
- 1 rural farm, less than 2,500
 - 2 small town, less than 2,500
 - 3 Rural farm, 2,500 to 9,999
 - 4 Town, 2,500 to 9,999
 - 5 City or Town over 10,000
- 2) Which of the following best describes the ages of people in your neighborhood? *(Please circle ONE response.)*
- 1 predominantly elderly people
 - 2 predominantly middle-aged and elderly people
 - 3 predominantly middle-aged and young families
 - 4 mixed ages
 - 5 I don't know
 - 6 Other *(Please specify.)* _____
- 3) Which of the following best describes the race/ethnicity of people in your neighborhood? *(Please circle ONE response.)*
1 African-American	5 Native American Indian
2 Asian	6 I don't know
3 Caucasian	7 Other <i>(Please specify.)</i> _____
4 Hispanic	
- 4) Which of the following best describes the education levels of people in your neighborhood? *(Please circle ONE response.)*
1 Grade school	5 Technical or vocational training
2 Some high school	6 College graduate
3 High school graduate	7 Post graduate
4 Some college	8 I don't know
- 5) Is there anything about the neighborhood that bothers you?
- 0 no
1 yes
- 6) What? *(Please circle ALL THAT APPLY.)*
1 No Problem	6 Poor city/county services
2 Crime	7 Undesirable commercial, institutional, or industrial property
3 Noise	8 People
4 Traffic	9 Other
5 Litter or housing deterioration	

7) How would you rate the neighborhood on a scale of 1 to 10? 10 is best, 1 is worst.

8) Which best describes your house?

- 1 single family, detached house
- 2 duplex or triplex
- 3 row house
- 4 apartment building
- 5 mobile home
- 6 town house or condominium
- 7 other, specify: _____

9) On a scale of 1 to 10, how would you rate the house/apartment as a place to live? 10 is best, 1 is worst.

10) Do you own or rent this house?

- 1 1 own
- 2 2 rent
- 3 3 live here free

11) Suppose that for some reason you had to move out of your present home and you were given a chance to live in each of the places listed below during the next 5 years:

- 1. Buy a mobile home located on rented space in a mobile home park
- 2. Buy a mobile home located on a lot that you also buy
- 3. Buy a single family house
- 4. Buy a townhouse (shares side wall with houses next door)
- 5. Rent a single family house
- 6. Rent an apartment in a building containing 5 or more other apartments
- 7. Rent a unit in a duplex

Which of the above would you most prefer to live in? *(Give the number of your choice.)*

_____ first preference
_____ second preference

Which of the above would you most dislike? *(Give the number of your choice.)*

_____ most dislike
_____ second most dislike

12) OWNERS ONLY: Is there a mortgage or other loan on this house/apartment?

- 0 no-----> GO TO QUESTION 16
- 1 yes

13) What is the current monthly payment?

\$_____

14) Besides principal and interest, does this payment include --

a) property taxes?	0 no
1 yes
b) homeowner's insurance?	0 no
1 yes
c) anything else?	0 no
1 yes
d) how much were the other charges last year?	\$_____

15) RENTERS ONLY:

- a) How often is the rent due? 1 monthly
2 _____ times per year
- b) How much is the rent? \$ _____
- c) Do you pay separate rent for the land? 0 no----->GO TO e
1 yes
- d) How many times a year is the land/site rent due? 1 monthly
2 _____ times per year
- e) What is cost each billing period? \$ _____
- f) Are there any other required fees for utility hookups, mobile home association fees, and so forth? 0 no
1 yes
- g) How many times a year are the fees due? 1 monthly
2 _____ times per year
- h) What is the average cost each billing period for those fees? \$ _____
- i) Is the building owned by a public housing authority? 0 no
1 yes

- j) Does the Federal Government pay some of the cost of the unit? 0 no
1 yes
- k) Does the State or local government pay some of the cost of the unit? 0 no
1 yes
- l) Is there rent control on the unit? 0 no
1 yes
- m) Is the rent adjusted because someone in the household works for or is related to the owner? 0 no
1 yes

16) About when was this building originally built?

1	1985 or later---->year: _____	5	1960-69
2	1980-84	6	1950-59
3	1975-79	7	1940-49
4	1970-74	8	1939 or earlier

17) What year did you move into your present house? _____

18) Please indicate how many rooms you have of the different types in this dwelling. Exclude all outbuildings.

	<u>number</u>
a) bedrooms	_____
b) living-dining combination	_____
c) living room	_____
d) separate dining room	_____
e) kitchen with no eating area	_____
f) kitchen with small eating area	_____
g) kitchen-dining combination	_____
h) full baths	_____
i) half baths	_____
j) family room or recreation room	_____
k) den, library, or office	_____
l) utility room or laundry room	_____
m) sewing room or workshop	_____
n) other room, specify: _____	_____

19) Do you have any plans to move to another house? (Please check only one answer from the following.)

1 I plan to live in my present house forever.

2 I don't have any plans to move for now.

3 I would like to move if I find a better place.-----|

4 I would like to move as soon as possible.-----|

----->Please explain why:

5 I am planning to move out very soon.-----|

6 I don't know.

20) In the last year, how much was spent on routine maintenance, such as painting, repairs, etc?

\$-----

21) Has water leaked into your home from outdoors in the last 12 months?

0 no

1 yes

22) Have there been water leaks in this house/apartment from INSIDE the building in the last 12 months?

0 no

1 yes

23) In the last 3 months, was there any time when all the toilets in the home were not working?

0 no

1 yes

24) How many of these breakdowns lasted 6 hours or more? -----

25) Does every room have an electric outlet or wall plug that works?

0 no

1 yes

26) Have any fuses blown or circuit breakers tripped in the last 3 months?

0 no

1 yes

27) How many times in the last 3 months? -----

SECTION B: ENERGY-RELATED INFORMATION

- 1) During the last 5 years, have you had an energy audit performed on your home?

0 no
1 yes

- 2) At what temperature do you usually keep your home during the winter? *(Please write on the lines below.)*

Daytime

Evening while awake

Evening while asleep

_____ °F

_____ °F

_____ °F

- 3) Listed below are certain energy-saving features that might be added to your home. Please indicate if each one (1) existed in your home before you moved in, (2) was added since you moved in, (3) you plan to add it within three years, (4) you would like to add it some day, or (5) you probably never will add it. **CIRCLE ALL THAT APPLY**

Existed Added Plan to Add Like to Add No Plans

(Please circle ONE response per feature)

a. Exterior storm windows on most windows	1	2	3	4	5
b. Exterior storm door (s)	1	2	3	4	5
c. Interior window coverings such as styrofoam boards, plexiglass, quilted shades, plastic for insulation	1	2	3	4	5
d. Ceiling or attic insulation	1	2	3	4	5
e. Wall insulation	1	2	3	4	5
f. Basement/foundation insulation	1	2	3	4	5
g. Caulking/weatherstripping	1	2	3	4	5
h. A large amount of glass to the south	1	2	3	4	5

	<u>Existed</u>	<u>Added</u>	<u>Plan to Add</u>	<u>Like to Add</u>	<u>No Plans</u>
i. Large shade trees around the house	1	2	3	4	5
j. A windbreak	1	2	3	4	5
k. Awnings on some windows	1	2	3	4	5
l. An attic vent/fan	1	2	3	4	5
m. Ceiling fan(s)	1	2	3	4	5
n. Cross ventilation	1	2	3	4	5
o. A solar unit	1	2	3	4	5
p. Insulation on water heater	1	2	3	4	5

- 4) What is the main type of heating fuel used in your home? *(Please circle ONE response)*

1 natural gas	5 wood
2 electricity	6 coal
3 LP gas	7 kerosene
4 oil	8 other <i>(Please specify.)</i> _____

- 5) What is the main type of cooking fuel used in your home? *(Please circle ONE response)*

1 natural gas	5 wood
2 electricity	6 coal
3 LP gas	7 kerosene
4 oil	8 other <i>(Please specify.)</i> _____

- 6) What is the main type of fuel you use to heat your water? *(Please circle ONE response)*

1 natural gas	5 wood
2 electricity	6 coal
3 LP gas	7 kerosene
4 oil	8 other <i>(Please specify.)</i> _____

7) What is the main type of fuel you use to operate your clothes dryer? (Please circle ONE response)

- 1 none
- 2 natural gas
- 3 electricity
- 4 LP gas
- 5 Other(Please specify.) _____

8) How do you cool your home? Do you use...: CHECK ALL THAT APPLY

- 1 central air conditioning
- 2 window air conditioning units
- 3 portable floor fans
- 4 open windows for cross ventilation
- 5 ceiling fans
- 6 Other(Please specify.) _____

9) Have you had or do you have any moisture-related problems in your home?

- 0 yes
- 1 no -----> GO TO QUESTION 11

10) If yes, please check all those that apply:

- 1 leaking roof
- 2 water in crawl space
- 3 mold or mildew in closets
- 4 mold or mildew on walls or ceilings
- 5 excessive condensation on windows
- 6 rotting window sills
- 7 rotting wood joists or rafters
- 8 frost in attic during winter
- 9 Other(Please specify.) _____

11) During the winter, do you shut off any unused rooms?

- 0 no
- 1 yes

12) During the winter, do you turn down the thermostat in any unused rooms?

- 0 no
- 1 yes

13) Do you have a programmable thermostat for your heating system?

- 0 no
- 1 yes

14) Do you have your home wired for off-peak electrical rates?

- 0 no
- 1 yes

15) How many inches of insulation are in your attic or ceiling? _____ inches, or check below:

_____ Don't Know

16) What type of insulation is in your attic or ceiling?

- 0 None
- 1 fiberglass
- 2 cellulose
- 3 rigid board insulation
- 4 Other (*Please specify.*) _____
- 5 Don't know

17) How many inches of insulation are in your walls? _____ inches, or check below:

_____ Don't Know

18) What type of insulation is in your walls?

- 0 None
- 1 fiberglass
- 2 cellulose
- 3 rigid board insulation
- 4 Other (*Please specify.*) _____
- 5 Don't know

19) During the past 12 months, did you replace your:

a) furnace or boiler?

0 no

1 yes-----

>Was this rated as an energy-efficient model?

0 no

1 yes

b) water heater?

0 no

1 yes-----

>Was this rated as an energy-efficient model?

0 no

1 yes

c) refrigerator?

0 no

1 yes-----

>Was this rated as an energy-efficient model?

0 no

1 yes

d) dish washer?

0 no

1 yes

Was this rated as an energy-efficient model?

0 no

1 yes

SECTION C: BACKGROUND INFORMATION

- 1) Which of the following best describes your current occupation or the occupation you had prior to retirement? (Circle the number which best describes your occupation and also your spouse's or partner's occupation.)

Your Occupation

Occupation of Spouse/Partner

No Spouse/Partner _____ (check here)

- 1 Clerical/Secretarial
- 2 Professional (teacher, lawyer, etc.)
- 3 Managerial
- 4 Technician
- 5 Labor (construction, factory)
- 6 Sales
- 7 Medical/health related field
- 8 Police or other protective service
- 9 Own my own business
- 10 Farmer
- 11 Homemaker
- 12 Military
- 13 Unemployed
- 14 Student
- 15 Other (Please specify.) _____

- 1 Clerical/Secretarial
- 2 Professional (teacher, lawyer, etc.)
- 3 Managerial
- 4 Technician
- 5 Labor (construction, factory)
- 6 Sales
- 7 Medical/health related field
- 8 Police or other protective service
- 9 Own my own business
- 10 Farmer
- 11 Homemaker
- 12 Military
- 13 Unemployed
- 14 Student
- 15 Other (Please specify.) _____

- 2) During the past year, were you:

- 1 working full-time
- 2 working part-time
- 3 retired
- 4 unemployed
- 5 Other (Please specify.) _____

- 3) What is the highest grade you completed in school? (Please circle ONE response.)

1 Grade school	5 Technical or vocational training
2 Some high school	6 College graduate
3 High school graduate	7 Post graduate
4 Some college	

4) What do you consider to be your ethnic background? *(Please circle ONE response.)*

1 African-American	5 Native American Indian
2 Asian	6 I don't know
3 Caucasian	7 Other <i>(Please specify.)</i> _____
4 Hispanic	

5) What is your current marital status? *(Please circle ONE response.)*

- 1 Single, never married
- 2 Married/Living with partner
- 3 Separated/Divorced
- 4 Widowed

6) INCLUDING YOURSELF, How many people live in this house?

7) Using the blanks below, please list your relationship to each person living with you, their age and their sex. Please start with yourself. *(Please write on the lines below.)*

RELATIONSHIP TO YOURSELF	AGE	SEX (M/F)
MYSELF	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

8) In 1990, what was your family's gross income (including tax and bonus)? Please circle one answer from the following:

1 less than \$5,000	11 \$50,001 - \$55,000
2 \$5,001 - \$10,000	12 \$55,001 - \$60,000
3 \$10,001 - \$15,000	13 \$60,001 - \$65,000
4 \$15,001 - \$20,000	14 \$65,001 - \$70,000
5 \$20,001 - \$25,000	15 \$70,001 - \$75,000
6 \$25,001 - \$30,000	16 \$75,001 - \$80,000
7 \$30,001 - \$35,000	17 \$80,001 - \$95,000
8 \$35,001 - \$40,000	18 \$95,001 - \$100,000
9 \$40,001 - \$45,000	19 over \$100,001
10 \$45,001 - \$50,000	

SECTION D: INDOOR AIR QUALITY

- 1) By circling the appropriate numbers below, please indicate how concerned you are about the following indoor air pollutants in your home:

	Not at all Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Am not familiar with this
a) Radon	1	2	3	4	5	0
b) Formaldehyde	1	2	3	4	5	0
c) Volatile organic compounds	1	2	3	4	5	0
d) Inadequate or excessive humidity	1	2	3	4	5	0
e) Asbestos	1	2	3	4	5	0
f) Lead	1	2	3	4	5	0
g) Combustion gases	1	2	3	4	5	0
h) Respirable particles	1	2	3	4	5	0

- 2) Have you tested your home for any of the indoor air pollutants listed above? *(Please circle one response.)*

0 no-----> Go to QUESTION 6 below
1 yes

- 3) Which pollutant did you test for? *(Please circle all that are appropriate.)*

1 Radon
2 Formaldehyde
3 Volatile organic compounds
4 Inadequate or excessive humidity
5 Asbestos
6 Lead
7 Combustion gases
8 Respirable particles

- 4) Were corrective measures necessary or recommended to you? *(Please circle one response.)*

0 no-----> Go to QUESTION 6 below
1 yes

5) Did you implement corrective measures? *(Please circle one response.)*

0 no

1 yes-----> Please describe briefly: _____

6) For the following statements, please circle the number that best indicates your level of agreement or disagreement. *(Please circle ONE response per statement.)*

	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
a) Implementing energy-conserving measures in a home causes indoor air pollution.	1	2	3	4	5
b) I can easily improve the quality of the air in my home.	1	2	3	4	5
c) A radon problem can be solved by opening windows.	1	2	3	4	5
d) I am actually losing money by not conserving energy in my home.	1	2	3	4	5

- 7) As part of this study, we need to review your energy-related expenses. Please assist us with this by completing the following:

I understand it is necessary to review my energy usage for the Cornell Energy Study and I hereby grant permission for my utility company/fuel oil dealer/bottled gas supplier to release this information to an authorized representative of Cornell University.

Signature_____

Name:_____

Address:_____

City:_____ Zip Code:_____

Gas/Electric Company:_____ Account No:_____

Fuel Oil Dealer:_____ Account No:_____

LP Gas Supplier:_____ Account No:_____

THANK YOU FOR YOUR TIME AND ASSISTANCE WITH THIS SURVEY

For Cooperative Extension Use:

RELATIVE HUMIDITY MEASUREMENT

Final reading of:

Wet Bulb_____

Dry Bulb_____

Relative Humidity_____%

The Energy Conservation Survey

Sponsored by:

Cornell University's
Department of Design and Environmental Analysis and
The Department of Consumer and Economic Housing

SECTION A: ENERGY-RELATED INFORMATION

- 1) Do you have any plans to move to another residence?

(Please circle ONE statement below that BEST describes your plans.)

1 I plan to live in my present house permanently.

2 I don't have any plans to move for now.

3 I would like to move if I find a better place.

4 I would like to move as soon as possible.

5 I am planning to move out very soon.

6 I don't know.

Please explain why.

- 2) During the past year, did you have an energy audit performed on your home?

1 NO

2 YES

- 3) At what temperature did you keep your home during the past winter?

(Please write the temperature on the lines below the time period.)

Daytime

Evening while awake

Evening while asleep

_____°F

_____°F

_____°F

- 4) Did you close off any unused rooms during the past winter?

1 NO

2 YES

4b.) If yes, which rooms?

1 _____

2 _____

3 _____

4 _____

5 _____

- 5) Below is a list of energy saving features. For each feature, please indicate one of the following: (1) it existed in your home before you moved in, (2) it was added last year, (3) you plan to add it within three years, (4) you would like to add it some day, or (5) you probably will never add it.

(Please circle ONE response per feature)					
	EXISTED	ADDED LAST YEAR	PLAN TO ADD	LIKE TO ADD	NO PLANS
a. Exterior storm windows on most windows	1	2	3	4	5
b. Exterior storm door (s)	1	2	3	4	5
c. Interior window coverings such as styrofoam boards, plexiglass, quilted shades, plastic for insulation	1	2	3	4	5
d. Ceiling or attic insulation	1	2	3	4	5
e. Wall insulation	1	2	3	4	5
f. Basement/foundation insulation	1	2	3	4	5
g. Caulking/weatherstripping ...	1	2	3	4	5
h. A large amount of glass to the south	1	2	3	4	5
i. Large shade trees around the house	1	2	3	4	5
j. A windbreak	1	2	3	4	5
k. Awnings on some windows ...	1	2	3	4	5
l. An attic vent/fan	1	2	3	4	5
m. Ceiling fan(s)	1	2	3	4	5
n. Cross ventilation	1	2	3	4	5
o. A solar unit	1	2	3	4	5

- 6) What is the *main type* of heating fuel used in your home?
(Please circle ONE response)

1	natural gas	5	wood
2	electricity	6	coal
3	LP gas	7	kerosene
4	oil	8	other (Please specify.) _____

- 7) What is the *main type* of cooking fuel used in your home?
(Please circle ONE response)

1	natural gas	5	wood
2	electricity	6	coal
3	LP gas	7	kerosene
4	oil	8	other (Please specify.) _____

- 8) What is the *main type* of fuel you use to heat your water?
(Please circle ONE response)

1	natural gas	5	wood
2	electricity	6	coal
3	LP gas	7	kerosene
4	oil	8	other (Please specify.) _____

- 9) What is the *main type* of fuel you use to operate your clothes dryer?
(Please circle ONE response)

1	none/no dryer	4	LP gas
2	natural gas	5	Other (Please specify.) _____
3	electricity		

- 10) How do you cool your home? (Circle ALL that apply.)

1	central air conditioning
2	window air conditioning units
3	portable floor fans
4	open windows for cross ventilation
5	ceiling fans
6	Other (Please specify.) _____

11) Have you had or do you have any moisture-related problems in your home?

1 YES

2 NO —————> GO TO QUESTION 14

11a) If yes, please circle ALL those that apply:

1 leaking roof

2 water in crawl space

3 mold or mildew in closets

4 mold or mildew on walls or ceilings

5 excessive condensation on windows

6 rotting window sills

7 rotting wood joists or rafters

8 frost in attic during winter

9 Other (Please specify.) _____

12) Do you have a programmable thermostat for your heating system?

1 NO

2 YES

13) Do you have your home wired for off-peak electrical rates?

1 NO

2 YES

14) How many inches of insulation are in your attic or ceiling?

1 NUMBER OF INCHES _____

2 DON'T KNOW

15) What type of insulation is in your attic or ceiling? (Please circle ONE response.)

1 None

2 fiberglass

3 cellulose

4 rigid board insulation

5 Other (Please specify.) _____

6 Don't know

16) How many inches of insulation are in your walls?

- 1 NUMBER OF INCHES _____
2 DON'T KNOW

17) What type of insulation is in your walls? (Please circle ONE response.)

- 1 None 4 rigid board insulation
2 fiberglass 5 Other (Please specify.) _____
3 cellulose 6 Don't know

18) During the past year, did you replace the following items with a model that was rated energy-efficient? (Please circle ONE response for replaced and IF YES, ONE response for whether it was rated energy efficient.)

		REPLACED?		RATED ENERGY EFFICIENT?	
		NO	YES	NO	YES
1	furnace or boiler	NO	YES	NO	YES
2	water heater	NO	YES	NO	YES
3	refrigerator	NO	YES	NO	YES
4	dish washer	NO	YES	NO	YES

SECTION B: INDOOR AIR QUALITY

1) Please indicate how concerned you are about the following indoor air pollutants in your home by circling one number per item on the following scale.

	NOT AT ALL CONCERNED	SOMEWHAT CONCERNED	CONCERNED	VERY CONCERNED	EXTREMELY CONCERNED	DON'T KNOW
a. Radon	1	2	3	4	5	6
b. Formaldehyde	1	2	3	4	5	6
c. Volatile organic compounds	1	2	3	4	5	6
d. Inadequate or excessive humidity	1	2	3	4	5	6
e. Asbestos	1	2	3	4	5	6
f. Lead	1	2	3	4	5	6
g. Combustion gases	1	2	3	4	5	6
h) Respirable particles	1	2	3	4	5	6

2) Have you tested your home for any of the indoor air pollutants listed in Question 1?

- 1 NO _____ > Go to QUESTION 6 below
2 YES

3) Which pollutant did you test for? (Please circle ALL that apply.)

- a. Radon
- b. Formaldehyde
- c. Volatile organic compounds
- d. Inadequate or excessive humidity
- e. Asbestos
- f. Lead
- g. Combustion gases
- h. Respirable particles

4) Were corrective measures necessary or recommended to you?

- 1 NO _____ > Go to QUESTION 6 below
2 YES

5) Did you implement corrective measures?

- 1 NO
2 YES (Please describe briefly:) _____

6) For the following statements, please circle the number that best indicates your level of agreement or disagreement.

(Please circle ONE response per statement.)

	STRONGLY DISAGREE	DISAGREE	NOT SURE/ NO OPINION	AGREE	STRONGLY AGREE
a. Implementing energy-conserving measures in a home causes indoor air pollution.	1	2	3	4	5
b. I can easily improve the quality of the air in my home.	1	2	3	4	5
c. A radon problem can be solved by opening windows.	1	2	3	4	5
d. I am actually losing money by not conserving energy in my home.	1	2	3	4	5

SECTION C: BACKGROUND INFORMATION

- 1) Which of the following *best describes your current occupation* or your occupation prior to retirement?

(Circle the number which best describes your occupation and also your spouse's or partner's occupation currently or prior to retirement.)

No Spouse/Partner ☐ (check here)
Occupation of Spouse/Partner

Your Occupation		Occupation of Spouse/Partner
1 Clerical/Secretarial		1 Clerical/Secretarial
2 Professional (teacher, lawyer, etc.)		2 Professional (teacher, lawyer, etc.)
3 Managerial		3 Managerial
4 Technician		4 Technician
5 Labor (construction, factory)		5 Labor (construction, factory)
6 Sales		6 Sales
7 Medical/health related field		7 Medical/health related field
8 Police or other protective service		8 Police or other protective service
9 Own my own business		9 Own's own business
10 Farmer		10 Farmer
11 Homemaker		11 Homemaker
12 Military		12 Military
13 Unemployed		13 Unemployed
14 Student		14 Student
15 Other (Please specify.) _____		15 Other (Please specify.) _____

- 2) During the past year, were you:

- 1 working full-time
- 2 working part-time
- 3 retired
- 4 unemployed
- 5 other (Please specify.) _____

3) What is the highest grade you completed in school?

(Please circle ONE response.)

1	Grade school	5	Technical or vocational training
2	Some high school	6	College graduate
3	High school graduate	7	Post graduate
4	Some college		

4) What do you consider to be your ethnic background?

(Please circle ONE response.)

1	African-American	5	Native American Indian
2	Asian	6	I don't know
3	Caucasian	7	Other (Please specify.) _____
4	Hispanic		

5) What is your current marital status? (Please circle ONE response.)

1	Single, never married	3	Separated/Divorced
2	Married/Living with partner	4	Widowed

6) Including yourself, how many people live in ~~this~~ ^{your} house?

7) Please indicate your age: _____.

8) Are you:

1	Male	2	Female

9) In 1991, what was your family's gross income (including tax and bonus)?

(Please circle ONE of the following.)

1	less than \$5,000	11	\$50,001 - \$55,000
2	\$5,001 - \$10,000	12	\$55,001 - \$60,000
3	\$10,001 - \$15,000	13	\$60,001 - \$65,000
4	\$15,001 - \$20,000	14	\$65,001 - \$70,000
5	\$20,001 - \$25,000	15	\$70,001 - \$75,000
6	\$25,001 - \$30,000	16	\$75,001 - \$80,000
7	\$30,001 - \$35,000	17	\$80,001 - \$95,000
8	\$35,001 - \$40,000	18	\$95,001 - \$100,000
9	\$40,001 - \$45,000	19	over \$100,001
10	\$45,001 - \$50,000		

SECTION D: ENERGY EFFICIENCY QUESTIONS

This section is an energy efficiency "quiz". We hope that this section will provide some indication of how accessible information regarding energy efficiency has been in your area.

- 1) Which of the following actions would minimize energy and dollar losses associated with home lighting? *(Please circle ONE response.)*
 - 1 Using incandescent lighting
 - 2 Using fluorescent lighting

- 2) One way to minimize financial losses from home heating is to:
(Please circle ONE response.)
 - 1 Use the heating system only at night
 - 2 Use space heaters
 - 3 Have the heating system serviced by a technician every year

- 3) The component of a building which is intended to stop heat transfer is called: *(Please circle ONE response.)*
 - 1 The furnace
 - 2 The thermostat
 - 3 The thermal envelope

- 4) When a warm object is in contact with a cooler object, heat loss occurs through: *(Please circle ONE response.)*
 - 1 Conduction
 - 2 Convection
 - 3 Radiation

- 5) True or false: A clothes dryer should always be vented to the outdoors.
(Please circle ONE response.)
 - 1 True
 - 2 False

- 6) True or false: If a furnace does not get its combustion air from outside, it can draw radon gas into a house. *(Please circle ONE response.)*
- 1 True
 - 2 False
- 7) Which of the following is capable of holding more moisture?
(Please circle ONE response.)
- 1 Cold air
 - 2 Warm air
- 8) Which radon detector gives you a better indication of average annual radon levels in your home? *(Please circle ONE response.)*
- 1 Activated charcoal canister
 - 2 Alpha track detector
- 9) The most effective way to prevent indoor air pollution is to
(Please circle ONE response.)
- 1 Open a window
 - 2 Use air cleaners
 - 3 Control pollutants at their source
- 10) An effective way to evaluate the efficiency of new heating equipment is to
(Please circle ONE response.)
- 1 Compare initial purchase costs
 - 2 Compare life cycle costs

THANK YOU VERY MUCH FOR HELPING US WITH OUR STUDY! PLEASE PLACE YOUR COMPLETED QUESTIONNAIRE IN THE POST PAID ENVELOPE AND DROP IT IN THE MAIL TO US.

*Sponsored by Cornell University
June 1992*

**The Energy Conservation
Survey**

Appendix B

Cornell Cooperative Extension

Energy Efficiency: Can you afford to lose?

Residential Manual

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ENERGY EFFICIENCY: CAN YOU AFFORD TO LOSE?

Residential Manual

Thank you for your participation in **Energy Efficiency: Can you Afford to Lose?**, an innovative educational program sponsored by the U.S. Department of Energy and administered by Cornell Cooperative Extension.

Although the importance of energy conservation in the residential sector of the U.S. economy is highlighted by issues related to environmental protection, the affordability of housing, and economic development, barriers to an efficient use of energy resources prevent the realization of a large potential for energy savings.

Despite the existence of a wide range of readily available information and technologies, low rates of adoption of most energy conservation measures characterize residential housing in the United States, with only 6% of single family homes built or adapted for optimal levels of energy efficiency. Potential savings in this sector are significant but unrealized because of numerous factors that have been observed, including the need for energy conservation education programs that are tailored to individual households and present information in more meaningful ways, and at the same time, address consumer misconceptions about energy conservation and indoor air pollution.

This manual presents many easy, but effective ways to make your house more energy efficient. While implementing these methods will help reduce this country's dependence on foreign energy sources, it will also reduce the amount of money you lose on wasteful or inefficient energy use.

INDOOR AIR QUALITY

In recent years, a growing body of scientific evidence has indicated the air people breathe inside their homes can be more seriously polluted with dangerous toxins than outdoor air in even the largest and most industrialized cities. The growing awareness of this issue is causing indoor air pollution to become a national health concern. The issue is important because:

- People spend 90% of their time indoors.
- Toxin levels indoors can be 10 - 100 times higher than permitted outdoors.

The growing awareness of indoor air pollution is giving rise to indoor air management as a new consumer skill. Three separate aspects of indoor air management are pollutant identification, source control, and mitigation. Let's consider each of these points.

Pollutant identification. Unfortunately, there is no single test that can be used to identify all possible pollutants in the air of your home. Separate tests are conducted for each pollutant. If you think something in the air of your home is making you sick, you should see your doctor who can tell you if your symptoms are related to a pollutant. Then you can go about testing for that pollutant. But this does not work for pollutants for which there are no immediate adverse health symptoms. For these, it is best to follow guidelines that have been established by the U.S. Environmental Protection Agency.

Source Control. Source control refers to the prevention of indoor air pollution by not allowing the sources of pollutants in your home in the first place. This is the most effective air quality control measure.

Mitigation. Even in homes where great care has been exercised to prevent indoor air pollution, a pollutant may be found. In that case, it can be removed by what are called mitigation measures.

Many people incorrectly assume that energy conserving or "energy tight" homes are more susceptible to indoor air pollution than are homes that are kept deliberately leaky. These people may be surprised to learn that properly designed and maintained energy efficient homes can have a better quality of indoor air than leaky, drafty homes. This is because in new homes that are built to be energy conserving and in older homes that have had energy conservation features correctly installed, many pollutants are less likely to enter the homes, and those that do can be removed with controlled ventilation. Remember, in a home that is left intentionally leaky, there is no way to control the air that enters through cracks and other openings. That air flow is affected by wind speed, topography, and vegetation. In energy efficient homes, on the other hand, exhaust fans remove excessive moisture and cooking odors; and a tight building shell makes sure that toxins in soil gas do not enter the home.

AIR POLLUTION

IN
THE
"ENERGY TIGHT"
HOME

What are the pollutants that can be found in the air of a home? This diagram shows that they can be radon, asbestos, combustion products, biological contaminants, organic gases, and lead. It is important to know what these pollutants are, where they come from, and what can be done to control them.

Many of us have heard the phrase, "tight houses sweat," which refers to the fact that moisture, if not controlled properly, can build up in energy conserving homes to levels which can cause condensation problems. We may see this condensation directly, such as when it builds up on windows, or indirectly, such as its effects including mold and mildew on exterior walls and in closets. Uncontrolled moisture levels in homes can lead to structural problems from rotting studs and joists. In addition to affecting the health of our homes, uncontrolled moisture levels can affect human health.

The chart on the right summarizes research that has been conducted on what happens at different levels of relative humidity. Note that humidity levels from 0 to 100 percent are shown on the horizontal axis. The effects of relative humidity on the support of various pollutants are illustrated in this chart. For example, we can see that bacteria populations are high at low levels of relative humidity and then drop off at 30 percent relative humidity; then begin to increase again at 60 percent relative humidity.

The main feature of this chart is that there is an optimum zone of relative humidity of between 40 and 60 percent, where the presence of these pollutants is minimized.

The presence of biological pollutants that are associated with excess moisture levels in a home can be minimized by controlling relative humidity. Two things about a home affect indoor relative humidity levels: 1) how it was built, and 2) how it is used. The principles that govern relative humidity are illustrated below.

Warm air is capable of holding more moisture than cold air. In the illustration on the right, the cube on the left represents air at 75 degrees Fahrenheit and a level of relative humidity of 30 percent. That means that the air is holding 30 percent of the moisture it is capable of holding. When this same cube of air, with the same amount of moisture, is cooled to 40 degrees Fahrenheit, it is capable of holding less moisture, and is now at 100 percent relative humidity.

When air is at 100 percent relative humidity, it is said to be saturated. This is the dew point temperature, at which water vapor condenses to liquid. We see this occurring in many ways. For example, on a hot, muggy afternoon in the summer, moisture forms on the outside of a glass of iced tea. This is because the air near the glass cools, and moisture from the air condenses on the glass. In the wintertime in a home, moisture-laden air cools as it approaches a window, and condenses on the window.

What are sources of moisture in a home? Moisture is produced by common household activities such as cooking, cleaning, and taking showers. People, plants and pets also produce moisture.

The average family of four generates between three and six gallons of water in a day. A person gives off three pints of moisture by breathing. Cooking and dishwashing produce about one pint of water per meal. And about one half pint of moisture is released into the air from taking a shower.

Crawl spaces and basements are also sources of moisture in a home, especially if they have dirt floors that are not covered by a moisture barrier. Moisture migration can occur through the soil into the home. And any water that leaks into crawl spaces or basements can raise moisture levels throughout the house.

SOURCES OF MOISTURE

CRAWL SPACE and BASEMENT
ARE SOURCES of INDOOR MOISTURE

The key to controlling relative humidity levels in a home is to maintain a moisture balance. Remember, some moisture in the air is necessary for human health and comfort; but too much moisture can cause problems. A moisture balance is maintained by making sure a home has vapor diffusion protection, through the installation of vapor retarders, as well as adequate ventilation, especially at points where moisture is produced.

The walls in a home are typically provided with adequate vapor diffusion protection when they are constructed, by installing a vapor retarder over the insulation. As illustrated here, a layer of polyethylene is stapled to the studs of a wall that has been insulated. This polyethylene prevents moisture from passing through the insulation and possibly condensing inside the wall.

Exterior sources of moisture should also be controlled at their source to prevent water entry into a home. An ice dam can also cause water entry. Ice dams are usually caused by inadequate attic ventilation. Without ventilation, heat can build up in an attic. This causes snow to melt on a roof in the wintertime. The melted snow runs down the roof until it reaches the overhang, which is colder. At this point, the water freezes and begins an ice build-up. As this ice dam grows, it can push water under the roof shingles. Then water can leak into an attic or wall.

Inside the home, moisture should be exhausted to the outside from the point that it is produced. This means that a kitchen stove needs an exhaust fan over it, which should be ducted to the outside. A circulating fan may remove some cooking odors from the air, but it will not remove moisture. A bathroom also needs an exhaust fan that leads to the outside. This fan should be used when anyone is taking a shower and for a short time afterwards, until moisture levels have decreased to the point that condensation is not occurring on windows and mirrors. In the laundry, a clothes dryer should be vented to the outdoors.

EXHAUSTING AIR AND MOISTURE FROM
KITCHEN, BATHROOM, AND LAUNDRY

Despite our best efforts at controlling moisture at its source, we may still see condensation on windows and other cooler surfaces. This condensation that occurs where we can see it is referred to as surface condensation.

Sometimes surface condensation is merely a nuisance, because it covers up a window, and prevents us from seeing outside. Excessive surface condensation can lead to mold and mildew growth on windows, and can damage window sills.

The chart on the right shows when surface condensation occurs on windows. You can see that depending on the type of windows you have in your home, condensation will occur at different levels of relative humidity. For example, when the temperature outside is 0 degrees Fahrenheit and it is 70 degrees Fahrenheit inside, condensation will occur on the interior surface of a single-pane window when the indoor relative humidity level is 15 percent; on a double-pane window, condensation will occur at 42 percent relative humidity; and on a low-emissivity window at 65 percent. You can see that by increasing the energy efficiency of your windows, you can lessen the occurrence of condensation.

WINDOW TYPE	CONDENSING HUMIDITY LEVEL
Single-pane	15%
Double-pane	42%
Low-emissivity	65%

INDOOR TEMPERATURE - 70°F

OUTDOOR TEMPERATURE - 0°F

Radon gas in the home environment is now recognized as a significant health hazard. While the presence of elevated levels of the gas in a home is a serious issue, proven methods, which are in many cases simple to implement, can successfully reduce dangerous concentrations of the gas.

Radon is a colorless, odorless, radioactive gas that results naturally from the decay of uranium and radium, and is found in low amounts in soils all over the world.

Once radon comes in contact with a house, it can be drawn inside through cracks or other openings in foundation walls and concrete floors. Some of these other openings include sump holes, French drains, and utility pipes or wires that penetrate a foundation wall. Radon has also been found to contaminate some private water supplies. Once in water, radon is released into the air of a house when the water is aerated at dish and clothes washers, faucets, and showers.

After it enters a house, radon continues to decay, and solid particles are formed. These particles are also radioactive. They can easily become attached to other solid objects --such as dust or smoke -- which are then inhaled into peoples' lungs. Radiation released from these particles can then damage lung tissue and eventually cause lung cancer.

How can we test for radon? One way of detecting its presence is by using a canister of activated charcoal -- which costs about 15 dollars. Once opened and set in place for a specified period -- anywhere from two to seven days -- radon in the air is adsorbed, or collected onto the surface of the charcoal granules. The first measurement taken in a house is known as the screening measurement -- to help decide whether more measurements should be made. When the test period is completed, the canister is sealed and sent back to the testing company. After it has been examined, you'll receive a report on the radon level.

Because radon concentrations vary with time, the screening measurement from a charcoal canister should only be used as an indicator of a potential problem. A year-long measurement can give a better idea of average radon levels in a house.

Another radon testing method uses an alpha track detector, which costs about 25 dollars. Instead of measuring radon gas, this device records radiation damage from radon decay products on a plastic film inside the canister. This type of detector is kept in place for a period of three months to a year. As with the charcoal canister, it is sent to a laboratory for analysis.

To better understand how radon enters a house, and how the gas and its decay products move about once inside, consider the air movement principles which are illustrated on the left.

A house comes under positive pressure when air is blown into it, by using a window fan directed inside, for example. The house comes under negative pressure when air is drawn out of it. This can happen when exhaust fans or combustion appliances are used. A house is under neutral pressure when it is at equilibrium with outdoor pressure. This can happen when windows on all sides of a house are open.

Imbalances can be created when combustion air, for appliances like furnaces or boilers, is drawn from inside the house. When this happens the house comes under negative pressure, which causes air to be pulled inside through cracks and other openings in the building shell, as well as from soil beneath the house.

AIR PRESSURE

NEGATIVE

POSITIVE

NEUTRAL

COMBUSTION AIR CONCEPTS

Heat radiates in all directions, but warm air rises. In a house that is not energy efficient, some of the warm air escapes through cracks and other openings in the upper levels of the structure, and is then replaced by cooler air which enters the house at lower levels, as well as from soil beneath the house. Chimneys for combustion appliances can also create a stack effect, as air is pulled up and out of a chimney, even when the appliance is not operating.

The diagram on the right shows a section view of a basement. The basement wall has been finished by installing studs against the wall and insulating between them with fiberglass. Notice that radon can enter this basement through openings in the finished wall, such as the electric receptacle. There is also a crack in the concrete floor that serves as another radon entry route. Once inside the basement, radon can be drawn into unsealed furnace ducts, and be distributed throughout the house through the ductwork and registers. It can also be drawn into the living space through openings around pipes in floors.

Preventing the entry of radon gas into a home involves sealing all openings to the soil, such as this settling crack in a foundation wall. Settling cracks occur in foundation walls and in concrete floors. These can be filled with cement grout if they are large enough, or high quality caulking compounds if they are small cracks. Simply sealing cracks in basement walls and floors is usually not an effective radon remedy, especially in a finished basement, where many cracks will probably be overlooked.

A very effective radon mitigation method diverts radon from a house at its source, through soil gas suction. Here a plastic pipe is installed in a concrete floor. The pipe extends to the gravel beneath the slab and is sealed where it enters the slab with caulking compound.

The pipe extends to the attic of the house where a special fan -- called an in-line fan -- draws radon gas out of the soil from beneath the house and pulls it upward through the pipe. The radon gas is then exhausted to the exterior where it is diluted with outside air. This method of radon removal is effective because it addresses the pollutant at its source, the soil beneath the basement floor. Radon is removed from the soil and sent outside, before it has a chance to enter the house.

At this time, there is no reliable method for testing a building site to determine if radon is going to be a problem in a house to be built there. The best way to avoid a potential radon problem is to take preventive steps during construction. Many of these steps are similar to those implemented for waterproofing a house, such as treating a foundation wall and installing traps in floor drains. Others, such as soil suction, are new, but cost very little when a house is first being built. Some builders will install part of a soil gas suction system, such as the pipe without the fan. If radon is present in the new house, the fan will be installed later.

Wood stoves, kerosene heaters, fireplaces, furnaces, boilers, water heaters and other fuel-burning appliances, as well as tobacco smoke, are all potential sources of combustion products in a home. Some of these harmful products are carbon monoxide, which can be lethal at high concentrations; nitrogen dioxide, which can cause respiratory irritation and chronic bronchitis; and respirable particles -- the solid particles in smoke from tobacco, wood, gas, and oil. If released into household air, these particles become suspended in the air and can then be inhaled and cause respiratory problems. Furnaces, water heaters, wood stoves, and ranges typically do not cause indoor air problems if they are properly installed and maintained. When they are not maintained, however, problems such as a cracked heat exchanger in a furnace or boiler can allow combustion products into a home.

EXPOSURE TO COMBUSTION PRODUCTS CAN BE REDUCED BY:

- not using any unvented fuel-fired space heaters indoors
- properly maintaining your heating system
- not smoking in the home
- using exhaust fans over gas stoves

Formaldehyde is a colorless gas with a strong odor. It is emitted from various construction materials, including plywood wall paneling, particleboard, fiberboard, furniture and cabinetry made from these products, and urea formaldehyde foam insulation (UFFI). It is also used as a component of glues and adhesives, and as a preservative in some paints and coating products. Formaldehyde is also used to add permanent-press qualities to clothing and draperies. Because this pollutant is also a product of combustion, other sources include unvented, fuel-burning appliances and environmental tobacco smoke.

Exposure to formaldehyde can cause watery eyes; nose, throat, and eye irritation, and difficulty in breathing for some people. High concentrations may trigger asthma attacks in asthmatics and chemical sensitivity in some people. Formaldehyde has also been shown to induce cancer in animals and may have this same effect on people.

TO REDUCE EXPOSURE TO FORMALDEHYDE:

- use exterior grade wood products
- control humidity levels
- avoid products that contain formaldehyde

Volatile organic compounds -- or VOCs -- are present in many household products; many are known or suspected carcinogens. Benzene, for example, is a carcinogen; xylene may injure the heart, liver, kidney, and nervous system at high concentrations.

Common sources of VOCs include paints, paint strippers, and other solvents, aerosol sprays, cleansers and disinfectants, moth repellents, air fresheners, stored fuels, automotive products, hobby supplies, and dry cleaned clothing. To reduce exposure to VOCs, use household products according to manufacturers' directions; use them outdoors or in well-ventilated places; throw away unused or little-used containers safely; and buy in quantities that you will use soon.

For all of the pollutants mentioned, controlling them at their source is the most effective way to improve indoor air quality. Another approach to lowering concentrations of indoor air pollutants in your home is to increase the amount of outside air coming indoors. Opening windows and doors, when the weather permits, increases the natural ventilation rate. Turning on bathroom or kitchen exhaust fans, if they are vented to the outdoors, can lower pollution levels by removing contaminants from the room where the fan is located. Where radon may be a problem, a window should be opened while bathroom or kitchen exhaust fans are in use. This keeps the amount of radon entering the house from increasing. It is particularly important to take as many of these steps as possible while you are involved in short-term activities that can generate high levels of pollutants -- for example, painting, paint stripping, heating with kerosene heaters, engaging in hobby activities such as welding, sanding, or soldering. You might also choose to do some of these activities outside, if you can and if the weather permits.

In some cases, air cleaning may be desirable, if neither source control nor ventilation can reduce indoor air pollution. And, as we saw earlier, controlling humidity in a home can minimize exposure to indoor air pollutants.

ENERGY EFFICIENCY

As a nation, we've become more energy efficient since the energy crisis of the 1970's. We've made progress in our use of energy. But the simple fact remains that we still use more energy than is necessary, and not only is that costing us real, after-tax dollars, but much of the energy we use contributes to environmental problems. We're losing on both counts.

This section of the manual is designed to show you how simple but important it can be to avoid energy losses in your home or apartment, and to give you a better idea of what it will cost if you do nothing about reducing energy losses.

In the United States, the residential sector -- housing -- accounts for about one-third of our nation's total energy consumption. The other major users of energy are transportation and industry. While we can't totally eliminate housing-related energy, we can reduce it.

Let's begin to understand the challenge with a quick look at heat transfer -- the way heat moves in our universe. Once we recognize how heat transfer works, we can cut our energy costs by anticipating it.

There are many well-known ways heat is lost from homes in winter, but there are actually just three different types of heat transfer: conduction, convection, and radiation.

CONDUCTION occurs when a warm object is in physical contact with a cooler object. The warmer object releases its heat to the cooler object. In the diagram below, the heat in the room is being conducted through the building materials to cooler areas. Another example is the heat you feel when you place your hand on a warm object. The warmth of the object is transferred to your hand by physical contact -- conduction.

CONVECTION is the transfer of heat by the movement of a liquid or gas. In the diagram, convection currents of air move the heated air to cooler spots, warming that air. Fans, blowers, and natural currents are convection forces.

RADIATION does not require physical contact or convection forces. It is electromagnetic. We receive warmth from the sun through radiation. When you walk near the south side of a masonry building on a cold day, you may feel the radiant heat of the masonry being released to your face. In this diagram, heat is being radiated from the warm exterior surfaces of the building into the cold air surrounding the building.

- The principles of heat transfer explain why we heat buildings during cold weather. The heat in our buildings is continually lost to the outdoors through many places: windows, chimneys, and through our walls. And to make up for the heat loss, furnaces, boilers, wood stoves, electric heaters and other equipment is used to replace the lost heat with newly heated air.

- In winter, especially in New York and other northern states, heat losses are a significant problem. It's not hard to visualize money leaking out our houses like the arrows in this diagram. This cycle continues all day and all night during the winter, and costs you money.

In the summer, the same phenomenon occurs, but in a different direction. In summer, heat is gained by the house. But in this case it's not a good gain. Equipment such as fans and air conditioners help move hot air back out, or remove the heat from the air. This process to stop heat from being transferred can cost you large amounts of money.

The component of a building which is intended to stop heat transfer is called the thermal envelope. Just as a paper letter envelope completely encloses a letter, the thermal envelope encloses living space where the thermal conditions, or temperature, need to be maintained. Insulation, which we will talk about later, is the primary component of the thermal envelope. Other components of the thermal envelope are the interior and exterior finishes and a vapor retarder.

This diagram shows a section, or vertical cut, through a two-story house with a basement and attic. The thick black line represents the thermal envelope. It's easy to see where there is insulation and where there is none. For example, the walls and the thermal envelope are the same. However, the basement floor is not insulated, so there is a defect in the thermal envelope there.

As illustrated in the diagram on the right, any spot where materials are joined is a potential thermal defect which might permit heat transfer, especially by convection currents.

A conventional house has a minimal thermal envelope as well as a number of thermal defects. Significant heat loss will occur because there is little or no resistance to heat losses. Heat losses are dollar losses because the heating system must make up heat to replace that which is lost.

When a conventional house is compared to an energy-efficient house, the conventional house has a greater heat loss, and the heating system will have to provide more heat than for an energy-efficient house.

This diagram compares these two types of houses. A conventional house is represented by the top bar, and an energy-efficient house by the bottom bar. Each house has some internal or "free" heat gains due to appliances, lighting, trapped solar energy, and the heat given off by people. The energy-efficient house may have slightly higher solar energy gains because of its design.

The heat to be supplied by the heating system in the conventional house is significantly greater than the heat needs of the energy-efficient house. The space on the bar showing heat supplied by the heating system represents the cost to the owner to heat the house.

It's clear that the costs to heat are much greater in the conventional house.

ENERGY COST REDUCTION: Low-cost methods

There are several no-cost or low-cost ways to cut energy losses. One way, remembering to turn lights off when their not in use, is a good habit that can reduce losses. Also remember that dirty light bulbs are less efficient than clean ones. Minimize your energy losses by cleaning light bulbs and lighting fixtures three or four times a year.

The use of daylighting is becoming a widespread practice in the business sector where energy costs for lighting are a significant part of total energy expenses. The residential sector can take advantage of the variety of window treatments which admit and control light. The daylight admitted to the room by opening these blinds can replace some electric light, thereby reducing losses. As a bonus, it provides a view outdoors. Of course, the use of daylighting depends on the time of year, time of day, and cloud cover. Remember to close draperies and other window treatments at night to minimize heat losses through windows.

In summer, slightly different guidelines apply. Close window treatments on the east during summer mornings and on the west during summer afternoons to keep out the heat.

If you use a forced-air heating system, you may be able to turn off ducts supplying rooms which are seldom or never used. You may have an extra bedroom or even an entire second floor being heated but which could be closed off. When you shut off a duct to a room, remember also to place a towel or other fabric along the bottom edge of all of its doors to keep air currents from moving heated air into the room. Also remember to protect any plumbing and fixtures in the room from freezing temperatures.

Forced air system vents such as the one shown in the center, as well as radiators used with a hydronic system should be kept clear of furniture, draperies, or other obstructions, and should be kept clean. Forced air systems and radiators rely on strong convective currents to move heat throughout a room. If the vent is restricted, the room won't stay as warm as planned and members of the household may raise the thermostat for more heat. This only wastes energy and costs more.

Follow these temperature recommendations for setting the thermostat:

- for winter days the high setting should be 68 degrees;
- for winter nights, the setting can be lowered (set back) to 55 degrees
- in summer, 78 degrees or higher

Exceptions to these recommendations:

- infants or elderly persons may be affected by too-cool or too-warm temperatures
- heat pumps should be set only 5 degrees below the normal daytime setting.

Sometimes wasteful habits are incorrectly developed by young and old. These habits can cause energy losses, and in the case of children, can lead to successive generations of energy-wasters. Proper operation of appliances includes minimal energy expenditures. Be familiar with the appliances and how the energy demand is influenced by the use of the appliance. It may be difficult to change the habits of adults, but children and others can learn by example. Learn how to use your appliances efficiently, and then share that information with others in the household.

Residential water heaters are asked to do a lot. They are expected to provide hot water any time, day or night. To do this, they are almost always using energy to heat water, or to keep water hot. This "stand-by" service results in energy costs for water heaters that are usually second only to space heating.

Water heaters should be set at 140 degrees (F) if a conventional automatic dishwasher is being used. Otherwise, the 120 degree setting will provide water hot enough for manual dishwashing and bathing. The higher setting uses more energy and will cause energy bills to be higher. In addition, when away from home for more than a few days, turn the setting down to the lowest point.

Sediment collects at the bottom of most water heaters, and in time the sediment makes the water heater less efficient. The tank should be drained twice a year to keep sediment to a minimum, and thus reduce excessive energy costs.

Always wait until the dishwasher is full before operating it, and use cold water to rinse food before loading dishes. Newer models dry the load by circulating air over the dishes, and provide an "energy-miser" switch or cycle. If this feature is not used, operating costs increase because air is electrically heated during the drying cycle. In most older models, you can open the door after washing is complete to bypass the electric heating; otherwise, the heater will require more energy.

ENERGY COST REDUCTION: Changes in equipment or to the house.

Other ways to cut energy losses require some changes in equipment or changes to the house. These might include buying more efficient appliances when it's time to replace existing ones, or this might mean purchasing and installing insulation materials to reduce energy costs.

Using a solid-state dimmer switch can reduce energy losses because you can adjust the light level to the need. You won't need to have full brightness on all the time, and sometimes a lower light level is more comfortable visually. Dimmer switches are easily installed and are available in a variety of types. A three-way lamp switch performs a similar function. The higher the light level, the more energy you are paying for.

A simple, hand-size timer can be used to turn off lights and other energy users when not needed. When you're away from home, a timer can operate one or more lights to maintain the appearance of someone being there without leaving interior or exterior lights on all the time.

Other controls such as photocells and detectors can help cut lighting costs. Photocells are light-sensitive, turning the power on during darkness and turning them off when it's light. Detectors sense movement or body heat, turning lights on when triggered, and then off again after a set period of time.

Any of these components will help you minimize your use of lighting, and therefore reduce your energy costs.

Whenever possible, use fluorescent lighting (shown on the right) instead of incandescent lighting (shown on the left). The arguments against fluorescent lighting used to be valid: the ballasts were noisy, and the color of the light produced was unpleasant. Lighting technology has improved the situation. Fluorescent bulbs are available to fit almost any application now serviced by incandescent lighting in a color to match that of incandescent, and with no noise. Special types are available for dimming, for recessed fixtures, and for outdoors.

These two bulbs produce approximately the same amount of light. The incandescent, on the left, requires over four times the energy needed by the fluorescent. So, for every incandescent bulb in your household that hasn't been replaced by a fluorescent bulb, you're wasting approximately 75% of the energy needed for lighting. Or, to put it another way, in one year it costs you three year's worth of electricity to energize existing incandescent lighting.

You may not find a wide selection of fluorescent bulbs in your grocery store or even at your favorite hardware store. Often, a lighting fixture store will have the best selection to fit your needs.

The importance of efficiency is suggested by the illustration on the right. For every energy dollar spent on heating, you will receive some useful heat output along with some heat losses. A portion of the losses can be avoided with appropriate measures.

Because energy used for home heating represents such a large portion of a household's energy cost, it's especially appropriate to be sure losses here are minimized. One way is to have your heating system regularly maintained by a trained professional. Your heating system may even be due for replacement or modification.

A qualified service technician should check your heating system on a regular basis. Oil-fired and wood-burning systems should be serviced every year, gas-fired systems every two years, and heat pumps every two or three years. On average, failure to have a complete service check adds 3%-10% in energy costs. In addition, such a visit enables the technician to spot and correct any problems which have the potential for increased energy and maintenance costs.

The technician will check the combustion efficiency of your system, clean critical parts, remove any sediment or debris, adjust air and fuel flow, and inspect blowers or pumps. The combustion efficiency is a measure of the system's efficiency while it is running.

- You can make simple modifications to avoid annual energy losses. Insulate ducts which pass through unheated spaces, and tape joints of ducts where you can feel air leaks. Insulate any hot water and steam pipes which run through unheated spaces. Installing an insulation blanket on the water heater to prevent energy losses during the water heater's "stand-by" period is another good way to reduce energy costs.

If your heating system uses radiators in each room, purchase or fabricate reflectors which stand between the radiator and the wall. The reflectors, which need to be kept clean, will help reflect heat toward the room.

A modification that can be made to most heating systems is replacing the manual thermostat with an automatic setback thermostat. If you're not using such a thermostat, you could be overspending on energy by as much as 12%.

Most automatic setback thermostats are pre-programmed, but can easily be modified to fit the needs of your household. Automatic setback thermostats are now required by the New York State Energy Efficiency and Construction Code for dwelling units built, planned, or significantly renovated after March 1, 1991.

To reduce energy costs, there are several options for modifying or replacing your heating system. Now, high-efficiency furnaces are available with an 80-95% AFUE rating. AFUE stands for annual fuel utilization efficiency. It measures the heating system's efficiency over time, and includes losses due to starting up and cooling down.

An energy auditor, who is not in the business of selling heating systems, can tell you whether you should upgrade or replace your system. However, depending on the type of heating system you have, you may be able to avoid energy losses by having the system modified. These modifications include reducing the system size, replacing the oil or gas burner, and adding a flue damper.

An option for replacing a heating system or adding supplementary heating is electric thermal storage (ETS). ETS systems use electric rates which are lower at night, during what are called "off-peak" rates. These rates are usually half the daytime rates.

ETS systems use electricity to store heat in special ceramic blocks. During the day when heat is needed, the blocks release heat to the room. ETS units are placed according to room size; several are needed to heat an average house. Units can be turned off in rooms not in use, and individual rooms can be set at different temperatures.

In addition, a separate off-peak meter and wiring can be installed for electric water heaters. Working on the same principle as ETS, such water heaters operate at night when electric rates are lower, and then stop heating during the day when rates are high.

Summer weather often presents a challenge for residents of New York State, since even in the same region, temperatures may fluctuate widely within a 24-hour period. Some areas of the state rarely need mechanical cooling, while for others air conditioning may often be desirable.

If window fans, ceiling fans, and whole-house fans are used to cool a house, the use of mechanical air conditioning and its energy costs can be avoided.

Even the movement of warm air produces a significant cooling effect. Guidelines for summer cooling without air conditioning include opening windows and ventilating during cool parts of the day; keeping windows and doors closed during the hottest part of the day; and keeping windows covered when the sun is shining on them.

If air conditioning is a requirement, the choice is usually between central systems and individual window- or wall-mounted units. Efficiency is rated differently for each type. Central systems use a seasonal energy efficiency ratio (SEER) which takes climate into account. For room air conditioners, the energy efficiency ratio (EER) is used. In both cases, the higher the number, the more efficient the unit, thereby minimizing money spent on cooling costs.

A room air-conditioner can be controlled by a timer, so that it is turned on a half hour or so before household members are expected to return. This eliminates coming home to a hot, stuffy house, while avoiding the high energy cost of leaving the unit operating when no one is home.

Room Air-Conditioner
Capacity 4,000 Btu/hr

JAC Corporation
Model BAC-0540

ENERGYGUIDE

Learn how the energy guide shows the efficiency of this and other room air conditioners.

1. Look at the energy guide number: **8.8**

2. Look at the energy guide number on the other models you are considering.

The higher the number, the more efficient the unit.

How much will this model cost you to run yearly?

Number of hours of use	330	550	1000	2000	3000
Cooling cost	\$11	\$17	\$33	\$66	\$99
Electricity cost	\$4	\$7	\$13	\$26	\$40
Annual cost	\$15	\$24	\$46	\$92	\$139
100% efficient	\$11	\$17	\$33	\$66	\$99
10% efficient	\$12	\$19	\$37	\$74	\$111
5% efficient	\$13	\$21	\$41	\$82	\$123

Also look for the energy guide number on the energy guide label on the unit. It will show you the energy guide number for your model and the energy guide number for the unit you are considering.

Important: Read the label on the unit before you buy. It will show you the energy guide number for the unit you are considering.

Energy Guide

Insulation is a material that slows or prevents heat loss, or resists convective heat transfer. The insulating value of a material's resistance to heat loss. The insulating value of a material is indicated by the material's resistance to heat loss. This resistance is expressed in a number, called a R-value. A material with a high R-value is a good insulator; a material with a low R-value is a poor insulator.

Wall insulation is important because it is an integral part of the thermal envelope, and the wall makes up one of the largest exposed areas of a house. Your local utility or an energy auditor will help you determine how much insulation you need, and the type of insulation most appropriate for your situation.

This diagram shows how additional insulation can be added to a finished house with 6" batts between the wall framing. An additional 2" layer of rigid foam insulation, which has an R-value of 10, is applied over the exterior sheathing. Then, exterior siding is applied over the insulation. The batt insulation's R-value, 19, is added to the rigid insulation's R-value, 10, for a total wall value of R-29.

As an alternative to adding insulation to the exterior of a building, fibrous or foam insulation can be blown in by an insulation contractor. This process may involve removing siding or drilling temporary holes, but eliminates disrupting the interior or adding new siding.

Often, ceiling insulation is easier to add than wall insulation because in most homes there is access to the attic. Batt insulation or blown insulation (as shown in this picture) are effective, especially when the insulation is deep enough to cover the ceiling joists or ceiling chords of roof trusses. Many homeowners have taken on this project themselves on a weekend.

In order to maintain adequate attic ventilation, insulation should not extend into the eaves or cover the soffits.

A way to stop losing 30% or more of your total heat loss is to insulate the foundation crawl space or basement walls. This diagram shows a framed wall has been built inside the basement wall to hold the insulation and its drywall cover.

Advantages to this interior approach include these:

- the work can be done in any weather
- no digging is required
- a vapor barrier and moisture barrier can be installed

Disadvantages to this approach include:

- interior finishing may already be completed
- poor for basements with severe moisture problems
- existing pipes, ducts, and wires on the wall complicate the framing

The alternative to interior placement of insulation is exterior placement.

Advantages include these:

- disturbance of any previous interior finishing is avoided
- interior living space is not lost
- interior water lines are protected
- insulating materials can act as a moisture barrier

Disadvantages are:

- extensive digging is required
- it's difficult to continue the insulation around patios, steps, and decks
- existing landscaping is disturbed or can be damaged
- the insulation can be damaged as the ground shifts or settles

Heat losses through windows are significant. These losses account for 1/3rd of the total heat loss of the building. Such losses are both conductive (direct transfer through glass) and convective (air leaks). Conduction losses are high because glass, by itself, is a very poor insulator. The R-value of a single pane of glass is only 0.91. Compare this R-value to the surrounding wall which may be anywhere from R-11 to R-30! The introduction of a second pane of glass increases the R-value by trapping air between the panes. This trapped air is a very good insulator and is the general idea behind insulated glass. As illustrated below, the wider the airspace between the glass and the more glass panes used the higher the R-value of the glass.

A recent introduction to window technology is low-emissivity glazing, or Low-E. This glazing consists of a microscopically thin metallic coating applied to the glass or to an intermediate plastic film. The low-E film reflects heat back towards the room, thereby reducing the heat loss of the window. The diagram below illustrates how heat, that is attempting to escape to the exterior by conduction, is reflected back into the room by the low-E film. This window has twice the R-value of a conventional double-paned unit without a low-E film.

The use of insulated window coverings and storm windows can also reduce heat losses and are good alternatives to insulating glass or windows with low-E films. Without storm windows, in one year the average house loses the equivalent of about a gallon oil per square foot of window, or about a 100 therms of gas per square foot of window. Window coverings which not only provide privacy but also insulation, can be effective at cutting nighttime heating loss. To be most effective, such coverings need to have tracks or seals around the edges so that they fit tightly.

Convective losses through windows can be reduced by retrofitting or sealing openings around the window frame. If your windows are drafty due to leaks around the edges of the sash, it's possible to replace the original channels on double-hung windows. Replacement channels are spring loaded, and maintain slight pressure on the sash edges, cutting leaks to a minimum. This is an attractive option if window sashes are in good condition but loose fitting. Another product available for tightening widows is a pulley seal. In older windows, heated room air escapes around the small holes where window pulleys are located. Pulley seals close off this small opening and prevent heat loss.

Because weatherstripping materials meet a variety of needs, there are several different types: felt, adhesive foam, vinyl or tubular gaskets, plastic and metal trim, nylon brush-seals, and others. Your local hardware store or building materials center will have a wide selection. Most of these materials are easy to install, requiring only basic skills and tools.

Caulking performs a similar function, but is packaged as a semi-solid material which can be placed where needed, and in the thickness needed. There are a variety of caulking products to meet the needs of the situation where caulking is required.

The material is applied with a special gun which forces the material through a nozzle. The placement of the nozzle and the size of its opening, as well as the skill of the applicator determine the appearance and effectiveness of the caulking job.

Caulking is not limited only to outdoor use. There are many joints and holes inside the building which permit heated air to escape.

These are reproductions of ENERGYGUIDE labels for two comparable water heaters. Labels like these are required on all major appliances sold in the United States. The labels list the projected annual operating cost for the appliance to enable shoppers to compare appliances objectively.

In these examples, the water heater on the left is expected to cost \$135 per year to operate; the one on the right is expected to cost \$112. However, the purchase price of the water heater on the left is \$160, while the purchase price of the one on the right is \$198.

Lower operating costs are often associated with higher purchase prices. There is a method for determining whether the higher purchase price is compensated for by the lower operating costs.

WATER HEATER-NATURAL GAS
FIRST HOUR RATING
66 GALLONS

MODEL
R7400-7
2204

ENERGYGUIDE

ESTIMATES ON THE SCALE
ARE BASED ON A NATIONAL
AVERAGE NATURAL GAS
RATE OF \$3.367 PER
THERM

ONLY MODELS WITH
FIRST HOUR RATING
OF 60 TO 75
GALLONS ARE LISTED
IN THE SCALE

Model with
lowest
energy cost
\$110

\$135

Model with
highest
energy cost
\$151

THIS MODEL

Your cost will vary depending on your local energy rate and how you use the product. The energy cost is based on a 60-gallon operating rate.

How much will this model cost you to run yearly?

Yearly Cost	
COST PER THERM	10 \$122
12	\$135
14	\$148
16	\$161
18	\$174
20	\$187
22	\$200
24	\$213

Ask your salesperson or local utility for the energy rate in your area.

IMPORTANT: Check out this label before purchasing a water heater. Federal law (42 U.S.C. 6205).

Purchase Price \$160.

WATER HEATER-NATURAL GAS
FIRST HOUR RATING
66 GALLONS

MODEL
R7400-7
2104

ENERGYGUIDE

ESTIMATES ON THE SCALE
ARE BASED ON A NATIONAL
AVERAGE NATURAL GAS
RATE OF \$3.367 PER
THERM

ONLY MODELS WITH
FIRST HOUR RATING
OF 60 TO 75
GALLONS ARE LISTED
IN THE SCALE

Model with
lowest
energy cost
\$110

\$112

Model with
highest
energy cost
\$151

THIS MODEL

Your cost will vary depending on your local energy rate and how you use the product. The energy cost is based on a 60-gallon operating rate.

How much will this model cost you to run yearly?

Yearly Cost	
COST PER THERM	10 \$102
12	\$112
14	\$122
16	\$132
18	\$142
20	\$152
22	\$162
24	\$172

Ask your salesperson or local utility for the energy rate in your area.

IMPORTANT: Check out this label before purchasing a water heater. Federal law (42 U.S.C. 6205).

Purchase Price \$198.

The life-cycle cost is a quick formula to determine the total cost of the appliance over its useful life. If you have life-cycle costs for comparable appliances, a comparison will tell you which is the most cost-efficient. The life-cycle cost is determined by adding the original purchase price to the projected cost of energy needed to operate the appliance over a period of time.

$$\begin{array}{r} \text{original purchase price} \\ + \text{cost of energy to operate} \\ \hline = \text{life-cycle cost} \end{array}$$

In this example of a life-cycle cost comparison, two similar water heaters are available. The standard model will cost \$160, and is estimated to cost \$135 per year in operating energy. The energy-efficient model will cost \$198, and is estimated to cost \$112 per year in operating energy. If the expected life is 12 years, we can easily compare the life-cycle costs.

Add the purchase price of the standard model, \$160, to twelve years' worth of operating costs (\$135 X 12 years). The life-cycle cost for the standard model is \$1,780.

Add the purchase price of the energy-efficient model, \$198, to twelve years' worth of operating costs (\$112 X 12 years). The life-cycle cost for the energy-efficient model is \$1,542.

In this case, the energy-efficient model is more economical to operate. If you had chosen to purchase the standard model because of its lower price, you would have overpaid by \$238 (\$1,780 - 1,542).

life-cycle cost comparison of two similar water heaters:

	standard	energy-efficient
purchase price	\$160.00	\$198.00
operating costs (for 12 years)	<u>1,620.00</u>	<u>1,344.00</u>
	\$1,780.00	\$1,542.00

Fireplaces are great for setting an atmosphere, but waste most of the energy from the wood they burn as well as a significant amount of the air in the rooms around them.

An open fire requires a supply of air to burn the fuel. In a house, the fireplace will take supply air from the inside the house and use that air to burn fuel. Not only does most of the heat energy from the wood fuel go up the chimney, but so does the air from inside the house. Even after the fire is out, heated room air will continue to travel up the chimney to the outside.

To minimize energy losses due to fireplace operation, close the damper as soon as the fire has cooled. Use glass doors to minimize room heat losses during and after the fireplace is used. Lower the thermostat to prevent the heating system from operating while there is a fire.

In New York State, a separate fresh-air supply must be provided for fireplaces in new homes to insure heated indoor air is not wasted.

Avoiding energy losses is not limited only to things to be done to the dwelling. Outdoors, some techniques can help minimize heating and cooling bills.

Windbreaks are usually placed between the dwelling and the direction of prevailing winds to block and divert away from or up and over the dwelling. Evergreen trees -- those that keep their foliage during cold weather -- serve well as windbreaks.

With properly placed trees, it's possible to reduce winter wind speeds by 50 per cent or more. This will reduce heating costs.

Leaf-bearing trees should be placed on the south, east, and west sides of the dwelling for maximum summer shade. This strategy will make it easier to keep the dwelling cool during warm weather. In the winter, these trees will lose their leaves and let the sun help warm the dwelling.

We hope this manual has given you some practical ideas for improving the energy efficiency of your home. Whether you implement some of the no-cost measures like turning down your thermostat, low-cost measures like caulking and weather stripping, or higher-cost like installing new insulation or heating equipment, you will stop losing money from inefficient use of energy.

We also hope that you have gained a better understanding of issues related to indoor air quality. Remember, an energy efficient home can have a higher level of indoor air quality than an inefficient home. And all indoor air pollutants can be controlled effectively at their source.

If you would like to receive any more information on energy efficiency and indoor air quality for your home, just call your county's office of Cornell Cooperative Extension. Cornell Cooperative Extension is your link to the research and knowledge base of Cornell University and is ready to help you put knowledge to work.

Appendix C

Radon gas in the home environment is now recognized as a significant health hazard. While the presence of elevated levels of the gas in a home is a serious issue, proven methods, which are in many cases simple to implement, can successfully reduce dangerous concentrations of the gas. The next group of slides describes what radon is, where it comes from, and what can be done to test for its presence and, if necessary, lower its levels in a home.

Area radon gas levels exceed U.S. limit

By Michael E. Kline
Staff Writer

JOHNSTOWN—Homes in Western and Central counties that have been tested for radon gas show levels slightly above federal Environmental Protection Agency

County towns and villages and not provide radon gas levels. Radon gas levels are higher in homes in the western part of the county, but west of the Johnstown-Cortland line, and in homes in the north.

"One house can test very high, and the house next door or across the street can test very low."

John E. Kline
Home improvement specialist

Radon gas, a colorless, odorless, tasteless gas, is found in some homes. It is a natural byproduct of the decay of uranium and thorium, which are found in rocks and soil. Radon gas can enter a home through the ground, through cracks in the foundation, or through the air. Radon gas is a health hazard because it can cause lung cancer. The EPA has set a limit of 4 picocuries per liter (pCi/L) for radon gas in homes. If the radon level is higher than this, it is recommended that the radon be tested and, if necessary, reduced.

test testing, results from these tests should be available, he said.

Radon gas levels in homes in the western part of the county are higher than the EPA limit. In some homes, the radon level is as high as 10 pCi/L. In other homes, the radon level is as low as 1 pCi/L. The radon level in a home can vary from day to day, so it is important to test the radon level in a home regularly.

Homeowners should take steps to reduce radon gas levels in their homes. One way to do this is to seal cracks in the foundation. Another way is to install a radon gas mitigation system. These systems use a fan to draw radon gas out of the home and vent it to the outside.

Homeowners should also take steps to reduce radon gas levels in their homes. One way to do this is to seal cracks in the foundation. Another way is to install a radon gas mitigation system. These systems use a fan to draw radon gas out of the home and vent it to the outside.

GOVERNMENT

Concern over Radon in Homes Triggers Plan for National Survey

Recent studies show high levels of radioactive gas in many homes; aim of EPA's planned two-year survey is to determine average levels

One of the most extensive studies in being performed by the U.S. Environmental Protection Agency (EPA) is a two-year survey of radon gas in homes. The survey is being conducted in homes in the western part of the country, where radon gas levels are higher than in other parts of the country.

Radon gas is a health hazard because it can cause lung cancer. The EPA has set a limit of 4 pCi/L for radon gas in homes. If the radon level is higher than this, it is recommended that the radon be tested and, if necessary, reduced.

Danish teacher returns to area

• 1986 Home Appliance Guide • Great Home Plans p.76

The possibility of widespread health exposure to radon gas was slow to drive on the U.S. public. It is now, however, a fact of life. High levels of the gas in people's homes. The resulting concern is prompting both the government and researchers to learn more about the problem. A comprehensive report by the Division of Nuclear Chemistry & Technology with a wide program of research.

NEW SHELTER

THE RADON REPORT

Radon is a colorless, odorless, radioactive gas that results naturally from the decay of uranium and radium, and is found in low amounts in soils all over the world.

RADIOACTIVE DECAY

- Uranium
- Radium
- Radon

Once radon comes in contact with a house, it can be drawn inside through cracks or other openings in foundation walls and concrete floors. Some of these other openings include sump holes, French drains, and utility pipes or wires that penetrate a foundation wall. Radon has also been found to contaminate some private water supplies. Once in water, radon is released into the air of a house when the water is aerated at dish and clothes washers, faucets, and showers. There have also been isolated instances of radon emanating from contaminated construction materials.

RADON ENTRY POINTS

- Foundations
- Utility Entry
- Water Supply
- Construction Materials

After it enters a house, radon continues to decay, and solid particles are formed. These particles are also radioactive. They can easily become attached to other solid objects --such as dust or smoke -- which are then inhaled into peoples' lungs. Radiation released from these particles can then damage lung tissue and eventually cause lung cancer.

How can we test for radon? One way of detecting its presence is by using a canister of activated charcoal – which costs about 15 dollars. Once opened and set in place for a specified period – anywhere from two to seven days --radon in the air is adsorbed, or collected onto the surface of the charcoal granules. The first measurement taken in a house is known as the screening measurement -- to help decide whether more measurements should be made. When the test period is completed, the canister is sealed and sent back to the testing company. After it has been examined, you'll receive a report on the radon level.

Because radon concentrations vary with time, the screening measurement from a charcoal canister should only be used as an indicator of a potential problem. A year-long measurement can give a better idea of average radon levels in a house.

Another radon testing method uses an alpha track detector, which costs about 25 dollars. Instead of measuring radon gas, this device records radiation damage from radon decay products on a plastic film inside the canister. This type of detector is kept in place for a period of three months to a year. As with the charcoal canister, it is sent to a laboratory for analysis.

To better understand how radon enters a house, and how the gas and its decay products move about once inside, consider these next few slides, which illustrate air movement principles.

AIR FLOW PRINCIPLES

A house comes under positive pressure when air is blown into it, by using a window fan directed inside, for example. The house comes under negative pressure when air is drawn out of it. This can happen when exhaust fans or combustion appliances are used. A house is under neutral pressure when it is at equilibrium with outdoor pressure. This can happen when windows on all sides of a house are open.

AIR PRESSURE

NEGATIVE

POSITIVE

NEUTRAL

Combustion appliances, such as furnaces, boilers, wood stoves, gas driers, and water heaters, need oxygen to support their flames. When this combustion air is drawn from inside the house, the house comes under negative pressure, which causes air to be pulled inside through cracks and other openings in the building shell, as well as from soil beneath the house.

COMBUSTION AIR CONCEPTS

Heat radiates in all directions, but warm air rises. In a house that is not energy efficient, some of the warm air escapes through cracks and other openings in the upper levels of the structure, and is then replaced by cooler air which enters the house at lower levels, as well as from soil beneath the house. Chimneys for combustion appliances can also create a stack effect, as air is pulled up and out of a chimney, even when the appliance is not operating.

This slide shows a section view of a basement. The basement wall has been finished by installing studs against the wall and insulating between them with fiberglass. Notice that radon can enter this basement through openings in the finished wall, such as the electric receptacle. There is also a crack in the concrete floor that serves as another radon entry route. Once inside the basement, radon can be drawn into unsealed furnace ducts, and be distributed throughout the house through the ductwork and registers. It can also be drawn into the living space through openings around pipes in floors.

Preventing the entry of radon gas into a home involves sealing all openings to the soil, such as this settling crack in a foundation wall. Settling cracks occur in foundation walls and in concrete floors. These can be filled with cement grout if they are large enough, or high quality caulking compounds if they are small cracks. Simply sealing cracks in basement walls and floors is usually not an effective radon remedy, especially in a finished basement, where many cracks will probably be overlooked.

A very effective radon mitigation method diverts radon from a house at its source, through soil gas suction. Here a plastic pipe is installed in a concrete floor. The pipe extends to the gravel beneath the slab and is sealed where it enters the slab with caulking compound.

The pipe extends to the attic of the house. Here, a special fan -- called an in-line fan -- draws radon gas out of the soil from beneath the house and pulls it upward through the pipe.

The pipe, which extends through the roof of the house, then exhausts the radon gas to the outside, where it is diluted with outdoor air. This method of radon removal is effective because it addresses the pollutant at its source, the soil beneath the basement floor. Radon is removed from the soil and sent outside, before it has a chance to enter the house.

At this time, there is no reliable method for testing a building site to determine if radon is going to be a problem in a house to be built there. The best way to avoid a potential radon problem is to take preventive steps during construction. Many of these steps are similar to those implemented for waterproofing a house, such as treating a foundation wall and installing traps in floor drains. Others, such as soil suction, are new, but cost very little when a house is first being built. Some builders will install part of a soil gas suction system, such as the pipe without the fan. If radon is present in the new house, the fan will be installed later.

Wood stoves, kerosene heaters, fireplaces, furnaces, boilers, water heaters and other fuel-burning appliances, as well as tobacco smoke, are all potential sources of combustion products in a home. Some of these harmful products are carbon monoxide, which can be lethal at high concentrations; nitrogen dioxide, which can cause respiratory irritation and chronic bronchitis; and respirable particles -- the solid particles in smoke from tobacco, wood, gas, and oil. If released into household air, these particles become suspended in the air and can then be inhaled and cause respiratory problems. Furnaces, water heaters, wood stoves, and ranges typically do not cause indoor air problems if they are properly installed and maintained. When they are not maintained, however, problems such as a cracked heat exchanger in a furnace or boiler can allow combustion products into a home.

Exposure to combustion products in a home can be reduced by not using any unvented fuel-fired space heaters indoors; by properly maintaining your heating system; by not smoking in the home; and by using exhaust fans over gas stoves. The importance of exhaust fans over kitchen stoves has already been mentioned for moisture control. You can see that with a gas stove it is also important for removing combustion products of the gas flames.

REDUCE EXPOSURE TO COMBUSTION PRODUCTS

- no unvented fuel-fired space heaters
- heating system maintenance
- no smoking in the home
- exhaust fan over gas stoves

This slide shows a heating system technician performing an annual check on a furnace. This annual maintenance is important for preventing any combustion products from entering the home. Necessary adjustments to the fuel burner will be made during this time, to make sure that the air-fuel mixture is just right; soot will be cleaned away from the heat exchanger surface, and the heat exchanger will be inspected for any possible cracks. In the second half of this workshop you will see how annual furnace maintenance also prevents you from losing money unnecessarily.

Because carbon monoxide is a colorless, odorless gas, you cannot detect its presence until it causes problems. Carbon monoxide detectors are now available in several forms. You can purchase small, button-shaped detectors that change color if carbon monoxide is present in the air, and you can also purchase detectors that are part of smoke detectors. Also, if you suspect that your home has a problem with carbon monoxide, call your utility company and ask that a technician come to your home to perform a test. If carbon monoxide is found in your home and is the result of a defective appliance, that appliance will then be shut off.

Formaldehyde is a colorless gas with a strong odor. It is emitted from various construction materials, including plywood wall paneling, particleboard, fiberboard, furniture and cabinetry made from these products, and urea formaldehyde foam insulation. It is also used as a component of glues and adhesives, and as a preservative in some paints and coating products. Formaldehyde is also used to add permanent-press qualities to clothing and draperies. Because this pollutant is also a product of combustion, other sources include unvented, fuel-burning appliances and environmental tobacco smoke.

Exposure to formaldehyde can cause watery eyes; nose, throat, and eye irritation, and difficulty in breathing for some people. High concentrations may trigger asthma attacks in asthmatics and chemical sensitivity in some people. Formaldehyde has also been shown to induce cancer in animals and may have this same effect on people.

To reduce exposure to formaldehyde, use exterior grade plywood instead of interior grade plywood, because it is formulated differently and emits the gas at lower rates. Some research has indicated that coating pressed wood products with polyurethane -- including all surfaces and edges -- may reduce formaldehyde emissions. As we saw earlier in this presentation, controlling humidity levels will minimize formaldehyde emissions. Of course, the best strategy to reduce exposure to formaldehyde is to avoid the use of products that contain it.

REDUCE EXPOSURE TO FORMALDEHYDE

- exterior grade wood products
- control humidity levels
- avoid products with formaldehyde

Volatile organic compounds -- or VOCs -- are present in many household products; many are known or suspected carcinogens. Benzene, for example, is a carcinogen; xylene may injure the heart, liver, kidney, and nervous system at high concentrations.

Common sources of VOCs include paints, paint strippers, and other solvents, aerosol sprays, cleansers and disinfectants, moth repellents, air fresheners, stored fuels, automotive products, hobby supplies, and dry cleaned clothing. To reduce exposure to VOCs, use household products according to manufacturers' directions; use them outdoors or in well-ventilated places; throw away unused or little-used containers safely; and buy in quantities that you will use soon.

VOLATILE ORGANIC COMPOUNDS

- **Common sources of VOCs:**

- paints**
 - strippers and other solvents**
 - aerosol sprays**
 - cleansers & disinfectants**
 - moth repellants**
 - air fresheners**
 - stored fuels**
 - automotive products**
 - hobby supplies**
 - dry cleaned clothing**

For all of the pollutants mentioned, controlling them at their source is the most effective way to improve indoor air quality. Another approach to lowering concentrations of indoor air pollutants in your home is to increase the amount of outside air coming indoors. Opening windows and doors, when the weather permits, increases the natural ventilation rate. Turning on bathroom or kitchen exhaust fans, if they are vented to the outdoors, can lower pollution levels by removing contaminants from the room where the fan is located. Where radon may be a problem, a window should be opened while bathroom or kitchen exhaust fans are in use. This keeps the amount of radon entering the house from increasing. It is particularly important to take as many of these steps as possible while you are involved in short-term activities that can generate high levels of pollutants -- for example, painting, paint stripping, heating with kerosene heaters, engaging in hobby activities such as welding, sanding, or soldering. You might also choose to do some of these activities outside, if you can and if the weather permits.

In some cases, air cleaning may be desirable, if neither source control nor ventilation can reduce indoor air pollution. And, as we saw earlier, controlling humidity in a home can minimize exposure to indoor air pollutants.

As a nation, we've become more energy efficient since the energy crisis of the 1970's. We've made progress in our use of energy. But the simple fact remains that we still use more energy than is necessary, and not only is that costing us real, after-tax dollars, but much of the energy we use contributes to environmental problems. We're losing on both counts.

This presentation is designed to show you how simple but important it can be to avoid energy losses in your home or apartment, and to give you a better idea of what it will cost if you do nothing about reducing energy losses.

In the United States, the residential sector -- housing -- accounts for about one-third of our nation's total energy consumption. The other major users of energy are transportation and industry. While we can't totally eliminate housing-related energy, we can reduce it.

Let's begin to understand the challenge with a quick look at heat transfer -- the way heat moves in our universe. Once we recognize how heat transfer works, we can cut our energy costs by anticipating it.

There are many well-known ways heat is lost from homes in winter:

- through the glass in windows
- through cracks around windows and doors
- through seams and joints where building materials meet
- up and out the chimney, and
- even through walls.

But there are actually just three different types of heat transfer:

- conduction
- convection, and
- radiation

Heat transfer is a natural phenomenon. It is the nature of heat to equalize temperatures, or reach equilibrium with its surroundings. If you place a cup of hot coffee in a room whose temperature is cool, the coffee temperature will begin to drop as it loses heat to the surrounding air. Or, if you place a cup of ice-cold water in a room whose temperature is 70 degrees (F), the heat in the room air will seek to equalize the water temperature by warming the water .

methods of heat transfer:

- conduction
- convection
- radiation

CONDUCTION, represented here in green, is easy to understand. Heat conduction occurs when a warm object is in physical contact with a cooler object. The warmer object releases its heat to the cooler object. In this diagram, the heat in the room is being conducted through the building materials to cooler areas. Another example is the heat you feel when you place your hand on a warm object. The warmth of the object is transferred to your hand by physical contact -- conduction.

CONVECTION, here in blue, is the transfer of heat by the movement of a liquid or gas. In the diagram, convection currents of air move the heated air to cooler spots, warming that air. Fans, blowers, and natural currents are convection forces.

RADIATION, shown here in red, does not require physical contact or convection forces. It is electromagnetic. We receive warmth from the sun through radiation. When you walk near the south side of a masonry building on a cold day, you may feel the radiant heat of the masonry being released to your face. In this diagram, heat is being radiated from the warm exterior surfaces of the building into the cold air surrounding the building.

The principles of heat transfer explain why we heat buildings during cold weather. The heat in our buildings is continually lost to the outdoors. And to make up for the heat loss, furnaces, boilers, wood stoves, electric heaters and other equipment is used to replace the lost heat.

In winter, especially in New York and other northern states, heat losses are a significant problem. It's not hard to visualize money leaking out our houses like the arrows in this diagram.

The heated air finds its way out through many places: windows, chimneys, and through our walls. As it leaves, the heating system must replace the lost air with newly heated air. This cycle continues all day and all night during the winter, and costs you money.

In the summer, the same phenomenon occurs, but in a different direction. In summer, heat is gained by the house. But in this case it's not a good gain. Equipment such as fans and air conditioners help move hot air back out, or remove the heat from the air.

Just as in the previous diagram, the arrows in this diagram can represent large amounts of money being spent to stop heat from being transferred.

The component of a building which is intended to stop heat transfer is called the thermal envelope. Just as a paper letter envelope completely encloses a letter, the thermal envelope encloses living space where the thermal conditions, or temperature, need to be maintained. In a building, the thermal envelope is the layer or layers of materials which stop heat transfer conducted between the living space and the outdoors.

Some buildings have better thermal envelopes than do others. Insulation, which we will talk about later, is the primary component of the thermal envelope. Other components of the thermal envelope are the interior and exterior finishes and a vapor retarder.

This diagram shows a section, or vertical cut, through a two-story house with basement and attic. The red line represents the thermal envelope. It's easy to see where there is insulation and where there is none. For example, the walls and the thermal envelope are the same. However, the basement floor is not insulated, so there is a defect in the thermal envelope there. Note also that the thermal envelope is not always the same as the roof. The area between the roof and the living space is not enclosed in the thermal envelope.

Thermal defects can occur in many parts of a building.

This diagram shows some of them:

- joints between sill and floor
- around electrical boxes
- vapor barrier tears
- joints at windows
- joints between wall and ceiling
- ceiling light fixtures
- joints at attic hatch

Any spot where materials are joined is a potential thermal defect which might permit heat transfer, especially by convection currents. With thermal defects such as these, heat loss will occur.

A conventional house has a minimal thermal envelope as well as a number of thermal defects. Significant heat loss will occur because there is little or no resistance to heat losses. Heat losses are dollar losses because the heating system must make up heat to replace that which is lost.

When a conventional house is compared to an energy-efficient house, the conventional house has a greater heat loss, and the heating system will have to provide more heat than for an energy-efficient house.

This diagram compares these two types of houses. A conventional house is represented by the top bar, and an energy-efficient house by the bottom bar. Each house has some internal, or "free" heat gains due to appliances, lighting, trapped solar energy, and the heat given off by people. The energy-efficient house may have slightly higher solar energy gains because of its design.

The heat to be supplied by the heating system in the conventional house is significantly greater than the heat needs of the energy-efficient house. The space on the bar showing heat supplied by the heating system represents the cost to the owner to heat the house.

It's clear that the costs to heat are much greater in the conventional house.

It may be helpful to know how energy is used in homes in this country.

Although the actual numbers vary slightly from year to year and by geographic region, this chart shows the breakdown by category of use:

- heating, the largest single category, represents over half, or about 54%
- water heating is about 18%
- appliances use about 23%
- air conditioning represents about 5%.

U.S. RESIDENTIAL ENERGY CONSUMPTION
source: Energy Information Administration

Maybe you would like to take a closer look at how and where you're using energy. If so, a good first step is an energy audit. An energy audit is a procedure which lets you know where your heat losses are occurring, how to correct the conditions causing the losses, and which ones should be corrected first.

An energy auditor will use some specialized equipment, and will inspect insulation amount and condition of your insulation, inspect the tightness of your doors and windows, inspect your heating system, and many other elements that can influence heat losses.

An energy audit will help you cut your energy losses and reduce the amount of money you lose each year. In New York State, if your house was built before 1980, and if the utility which supplies you is an investor-owned utility, you may be eligible for a free energy audit.

At the end of this presentation, we'll have information on how you can get an energy audit.

There are several no-cost or low-cost ways to cut energy losses. Many don't even require an energy audit. We'll show you some here.

**There are several no-cost
or low-cost ways
to cut energy losses.**

It seems so simple, but it's a good habit that can prevent losses. Remember to turn off lights when they're not in use.

Also remember that dirty light bulbs are less efficient than clean ones. Minimize your energy losses by cleaning light bulbs and lighting fixtures three or four times a year.

The use of daylighting is becoming a widespread practice in the business sector where energy costs for lighting are a significant part of total energy expenses. The residential sector can take advantage of the variety of window treatments which admit and control light.

Care should be taken to close window treatments at night to minimize energy losses during cold weather.

The daylight admitted to the room by opening these blinds can replace some electric light, thereby reducing losses. As a bonus, it provides a view outdoors. Of course, the use of daylighting depends on the time of year, time of day, and cloud cover.

Light-colored blinds and light-reflecting walls and ceiling help maximize and control daylight. Usable light can be directed up to the ceiling where it is spread over the whole room.

Remember to close draperies and other window treatments at night to minimize heat losses through windows.

In summer, slightly different guidelines apply. Close window treatments on the east during summer mornings and on the west during summer afternoons to keep out the heat.

If you use a forced-air heating system, you may be able to turn off ducts supplying rooms which are seldom or never used. You may have an extra bedroom or even an entire second floor being heated but which could be closed off.

When you shut off a duct to a room, remember also to place a towel or other fabric along the bottom edge of all of its doors to keep air currents from moving heated air into the room.

Be sure to check for plumbing in or near any rooms you shut off. Protect plumbing and fixtures from freezing temperatures.

Forced air system vents such as this one, as well as radiators used with a hydronic system should be kept clear of furniture, draperies, or other obstructions, and should be kept clean.

Forced air systems rely on strong convective currents to move heat throughout a room. If the vent is restricted, the room won't stay as warm as planned. The same is true for radiators, which transfer heat by a combination of radiation and mild convective currents.

If the heat source is restricted, members of the household may raise the thermostat for more heat. This only wastes energy and costs more, and results in overheating the rest of the household.

Other heating system maintenance you can perform includes replacing the filter in a forced-air furnace monthly during the heating season. Dirty filters make the furnace motor work harder, thus costing more to operate.

Follow these temperature recommendations for setting the thermostat:

- for winter days the high setting should be 68 degrees;
- for winter nights, the setting can be lowered (set back) to 55 degrees
- In summer, 78 degrees or higher

Exceptions to these recommendations:

- infants or elderly persons may be affected by too-cool or too-warm temperatures
- heat pumps should be set only 5 degrees below the normal daytime setting.

It may help you to know how typical New York State households use energy.

60%	heating
15%	water heater
7%	lighting
4.5%	refrigerator
4%	food freezer
3.5%	clothes drying
2.5%	cooking
2%	television
1.5%	air conditioning

TYPICAL HOUSEHOLD ENERGY USE

source: New York State Electric & Gas Corporation

Sometimes wasteful habits are innocently developed by young and old. These habits can cause energy losses, and in the case of children, can lead to successive generations of energy-wasters.

Proper operation of appliances includes minimal energy expenditures. Be familiar with the appliances and how the energy demand is influenced by the use of the appliance.

It may be difficult to change the habits of adults, but children and others can learn by example. Learn how to use your appliances efficiently, and then share that information with others in the household.

Residential water heaters are asked to do a lot. They are expected to provide hot water any time, day or night. To do this, they must stay on "stand-by" all the time. This means they are almost always using energy to heat water, or using energy to keep water hot in case someone wants some hot water. For this kind of service, a heavy penalty is charged. Energy costs for water heaters are usually second only to energy costs related to space heating.

Water heaters should be set at 140 degrees (F) if a conventional automatic dishwasher is being used. Otherwise, the 120 degree setting will provide water hot enough for manual dishwashing and bathing. The higher setting uses more energy and will cause energy bills to be higher.

When away from home for more than a few days, turn the setting down to the lowest point.

Sediment collects at the bottom of most water heaters, and in time the sediment makes the water heater less efficient. The tank should be drained twice a year to keep sediment to a minimum.

Always wait until the dishwasher is full before operating it, and use cold water to rinse food before loading dishes. Newer models dry the load by circulating air over the dishes, and provide an "energy-miser" switch or cycle. If this feature is not used, operating costs increase because air is electrically heated during the drying cycle. In most older models, you can open the door after washing is complete to bypass the electric heating; otherwise, the heater will require more energy.

Other ways to cut energy losses require some changes in equipment or changes to the house. These might include buying more efficient appliances when it's time to replace existing ones, or this might mean purchasing and installing insulation materials to reduce energy costs.

**Other ways to cut energy
losses require some
changes in equipment or
changes to the house.**

Using a solid-state dimmer switch can reduce energy losses because you can adjust the light level to the need. You won't need to have full brightness on all the time, and sometimes a lower light level is more comfortable visually. Dimmer switches are easily installed and are available in a variety of types.

A three-way lamp switch performs a similar function. With low, medium, and high settings, you have the choice of selecting the appropriate lighting (and expense) level. The higher the light level, the more energy you are paying for.

A simple, hand-size timer can be used to turn off lights and other energy users when not needed. When you're away from home, a timer can operate one or more lights to maintain the appearance of someone being there without leaving interior or exterior lights on all the time.

Other controls such as photocells and detectors can help cut lighting costs. Photocells are light-sensitive, turning the power on during darkness and turning them off when it's light. Detectors sense movement or body heat; turning lights on when triggered, and then off again after a set period of time.

Any of these components will help you minimize your use of lighting, and therefore reduce your energy costs.

Whenever possible, use fluorescent lighting (shown on the right) instead of incandescent lighting (shown on the left). The arguments against fluorescent lighting used to be valid: the ballasts were noisy, and the color of the light produced was unpleasant. Lighting technology has improved the situation. Fluorescent bulbs are available to fit almost any application now serviced by incandescent lighting in a color to match that of incandescent, and with no noise. Special types are available for dimming, for recessed fixtures, and for outdoors.

These two bulbs produce approximately the same amount of light. The incandescent, on the left, requires over four times the energy needed by the fluorescent. So, for every incandescent bulb in your household that hasn't been replaced by a fluorescent bulb, you're wasting approximately 75% of the energy needed for lighting. Or, to put it another way, in one year it costs you three year's worth of electricity to energize existing incandescent lighting.

You may not find a wide selection of fluorescent bulbs in your grocery store or even at your favorite hardware store. Often, a lighting fixture store will have the best selection to fit your needs.

The importance of efficiency is suggested by this diagram. For every energy dollar spent on heating, you will receive some useful heat output along with some heat losses. A portion of the losses can be avoided with appropriate measures.

Because energy used for home heating represents such a large portion of a household's energy cost, it's especially appropriate to be sure losses here are minimized. One way is to have your heating system regularly maintained by a trained professional. Your heating system may even be due for replacement or modification.

A qualified service technician should check your heating system on a regular basis. Oil-fired and wood-burning systems should be serviced every year, gas-fired systems every two years, and heat pumps every two or three years. On average, failure to have a complete service check adds 3%-10% in energy costs. In addition, such a visit enables the technician to spot and correct any problems which have the potential for increased energy and maintenance costs.

The technician will check the combustion efficiency of your system, clean critical parts, remove any sediment or debris, adjust air and fuel flow, and inspect blowers or pumps. The combustion efficiency is a measure of the system's efficiency while it is running.

You can make simple modifications to avoid annual energy losses.

Insulate ducts which pass through unheated spaces, and tape joints of ducts where you can feel air leaks. Insulate any hot water and steam pipes which run through unheated spaces.

If your heating system uses radiators in each room, purchase or fabricate reflectors which stand between the radiator and the wall. The reflectors, which need to be kept clean, will help reflect heat toward the room.

A modification that can be made to most heating systems is replacing the manual thermostat with an automatic setback thermostat. If you're not using such a thermostat, you could be overspending on energy by as much as 12%.

Most automatic setback thermostats are pre-programmed, but can easily be modified to fit the needs of your household. You go to sleep each night knowing that the thermostat will automatically be set back during the night and will automatically re-set in the morning before you awake. Weekends can usually be programmed separately, and a manual override is available if needed. Most are simple to install.

Automatic setback thermostats are now required by the New York State Energy Efficiency and Construction Code for dwelling units built, planned, or significantly renovated after March 1, 1991.

Since the energy crisis of the 1970's, heating system technology has come a long way. If the determination has been made that your old system is due modification or replacement, you have several options.

High-efficiency furnaces are available with an 80-95% AFUE rating. AFUE stands for annual fuel utilization efficiency. It measures the heating system's efficiency over time, and includes losses due to starting up and cooling down.

An energy auditor, who is not in the business of selling heating systems, can tell you whether you should upgrade or replace your system. However, depending on the type of heating system you have, you may be able to avoid energy losses by having the system modified. These modifications include reducing the system size, replacing the oil or gas burner, and adding a flue damper.

HIGH EFFICIENCY SYSTEMS

80 - 95 percent AFUE

An option for replacing a heating system or adding supplementary heating is electric thermal storage (ETS). ETS systems use electric rates which are lower at night, during what are called "off-peak" rates. These rates are usually half the daytime rates.

ETS systems use electricity to store heat in special ceramic blocks. During the day when heat is needed, the blocks release heat to the room. ETS units are placed according to room size; several are needed to heat an average house. Units can be turned off in rooms not in use, and individual rooms can be set at different temperatures.

In addition to off-peak rates for electric thermal storage systems, a separate off-peak meter and wiring can be installed for electric water heaters. Working on the same principle as ETS, such water heaters operate at night when electric rates are lower, and then stop heating during the day when rates are high.

Summer weather often presents a challenge for residents of New York State, since the geography varies widely. Even in the same region, temperatures may also fluctuate widely within a 24-hour period. Some areas of the state rarely need mechanical cooling, while for others air conditioning may often be desirable.

If window fans, ceiling fans, and whole-house fans are used to cool a house, the use of mechanical air conditioning and its energy costs can be avoided.

Even the movement of warm air produces a significant cooling effect; cooling the air may be unnecessary. Guidelines for summer cooling without air conditioning include opening windows and ventilating during cool parts of the day; keeping windows and doors closed during the hottest part of the day; and keeping windows covered when the sun is shining on them.

If air conditioning is a requirement, the choice is usually between central systems and individual window- or wall-mounted units. Efficiency is rated differently for each type. Central systems use a seasonal energy efficiency ratio (SEER) which takes climate into account. For room air conditioners, the energy efficiency ratio (EER) is used. In both cases, the higher the number, the more efficient the unit. A higher SEER or EER number means minimizing money spent on cooling costs.

A room air-conditioner can be controlled by a timer, so that it is turned on a half hour or so before household members are expected to return. This eliminates coming home to a hot, stuffy house, while avoiding the high energy cost of leaving the unit operating the time when no one is home.

Insulation is a material that slows or prevents heat loss, or resists conductive heat transfer. Placing your hand on a hot surface would result in the heat from the surface warming your hand. If there is insulation between your hand and the surface, the insulation will slow down the heat transfer, and you might not feel any heat at all.

The insulating value of a material is indicated by the material's resistance to heat loss. This resistance is expressed in a number, called an R-value.

A material with a high R-value is a good insulator. A material with a low R-value is a poor insulator.

insulation

material that slows or prevents
heat loss

Wall insulation is important because it is an integral part of the thermal envelope, and because such a large area is exposed. Your local utility or an energy auditor will help you determine how much insulation you need, and the type of insulation most appropriate for your situation.

This diagram shows how additional insulation can be added to a finished house with 6" batts between the wall framing. An additional 2" layer of rigid foam insulation, which has an R-value of 10, is applied over the exterior sheathing. Then, exterior siding is applied over the insulation. The batt insulation's R-value, 19, is added to the rigid insulation's R-value, 10, for a total wall value of R-29.

As an alternative to adding insulation to the exterior of a building, fibrous or foam insulation can be blown in by an insulation contractor. This process may involve removing siding or drilling temporary holes, but eliminates disrupting the interior or adding new siding.

Often, ceiling insulation is easier to add than wall insulation because in most homes there is access to the attic. Batt insulation or blown insulation (as shown in this picture) are effective, especially when the insulation is deep enough to cover the ceiling joists or ceiling chords of roof trusses. Many homeowners have taken on this project themselves on a weekend.

In order to maintain adequate attic ventilation, insulation should not extend into the eaves or cover the soffits.

A way to stop losing 30% or more of your total heat loss is to insulate the foundation crawl space or basement walls. This diagram shows a framed wall has been built inside the basement wall to hold the insulation and its drywall cover.

Advantages to this interior approach include these:

- the work can be done in any weather
- no digging is required
- a vapor barrier and moisture barrier can be installed

Disadvantages to this approach include:

- interior finishing may already be completed
- existing pipes, ducts, and wires on the wall complicate the framing
- poor for basements with severe moisture problems

The alternative to interior placement of insulation is exterior placement.

Advantages include these:

- disturbance of any previous interior finishing is avoided
- interior living space is not lost
- interior water lines are protected
- insulating materials can act as a moisture barrier

Disadvantages are:

- extensive digging is required
- it's difficult to continue the insulation around patios, steps, and decks
- existing landscaping is disturbed or can be damaged
- the insulation can be damaged as the ground shifts or settles

Heat losses through windows are significant. These account for 1/3rd of the total heat loss of the building. Such losses are both conductive (air leaks) and convective (direct transfer through glass).

There are strategies for reducing heat loss at windows. Window coverings, which not only provide privacy but also insulate, can be effective at cutting nighttime heat loss. To be most effective, such coverings need to have tracks or seals around the edges so they fit tightly.

The reason why windows lose so much energy by conduction is that glass, by itself, is a very poor insulator. The R-value of a single pane of glass is 0.91. Actually, it is only because of air films on both side of the glass that the R-value is even that high -- the glass by itself is only R-0.06!

Compare that R-value of less than 1 to the surrounding wall which may be anywhere from R-11 to R-30!

The addition of a second pane of glass in a window permits a higher R-value. In such cases, the trapped air between the panes is a good insulator. This is the general idea behind insulated glass.

For example, in the upper left, the diagram shows a double-pane window with a 3/16 inch air space between the two panes of glass. The R-value of this configuration is 1.69.

In the lower left drawing, the air space is wider -- 1/2 inch. The R-value has increased to 2.0.

In the upper right diagram, a third pane has been added, creating an additional air space with even higher R-values: 2.5 to 3.2.

And the bottom right diagram uses four panes of glass to create three air spaces: R-values range from 3.5 to 4.0.

A recent introduction to window technology is low-emissivity glazing, or low-E. This technology is rapidly becoming the standard for insulated windows.

Low-E glazing consists of a microscopically thin metallic coating applied to the glass or to an intermediate plastic film. The low-E film reflects room heat back toward the room, thereby reducing the heat losses we expect with windows.

In the diagram below, heat radiated from the room travels toward the window. It passes through the inside pane first, by conduction. Then, the heat is reflected by the low-E film back through the glass to the room. Very little heat passes through the low-E film. This window has twice the R-value of a conventional double-paned unit without a low-E film.

As an alternative to multiple layers of glass or windows with low-E films, storm windows are effective at stopping energy waste and losses.

Without storm windows, in one year the average house loses the equivalent of about a gallon of oil per square foot of window, or about 100 therms of gas per square foot of window.

If your windows are drafty due to leaks around the edges of the sashes, it's possible to replace the original channels on double-hung windows. Replacement channels are spring-loaded, and maintain slight pressure on the sash edges, cutting leaks to a minimum. Many handy homeowners have been able to do the work themselves. This is an attractive option if window sashes are in good shape but loose-fitting.

Another commercial product available for tightening windows is a pulley seal. In older windows, heated interior air escapes around the small holes where window pulleys are located.

Pulley seals close off this small opening and prevent heat loss.

Because weatherstripping materials meet a variety of needs, there are several different types: felt, adhesive foam, vinyl or tubular gaskets, plastic and metal trim, nylon brush-seals, and others. Your local hardware store or building materials center will have a wide selection. Most of these materials are easy to install, requiring only basic skills and tools.

Caulking performs a similar function, but is packaged as a semi-solid material which can be placed where needed, and in the thickness needed. There are a variety of caulking products to meet the needs of the situation where caulking is required.

The material is applied with a special gun which forces the material through a nozzle. The placement of the nozzle and the size of its opening, as well as the skill of the applicator determine the appearance and effectiveness of the caulking job.

Caulking is not limited only to outdoor use. There are many joints and holes inside the building which permit heated air to escape.

This homeowner is adjusting the thermostat on the water heater to the "warm" position. He has already installed an insulation blanket on the water heater to prevent energy losses during the water heater's "stand-by" period.

Water heater insulation blankets are available for both gas and electric units and supplement the manufacturer's built-in insulation.

. Dripping hot water faucets waste energy. Homeowners can easily learn to replace washers or seals on plumbing fixtures to minimize energy losses due to leaks.

These are reproductions of ENERGYGUIDE labels for two comparable water heaters. Labels like these are required on all major appliances sold in the United States. The labels list the projected annual operating cost for the appliance to enable shoppers to compare appliances objectively.

In these examples, the water heater on the left is expected to cost \$135 per year to operate; the one on the right is expected to cost \$112. However, the purchase price of the water heater on the left is \$160, while the purchase price of the one on the right is \$198.

Lower operating costs are often associated with higher purchase prices. There is a method for determining whether the higher purchase price is compensated for by the lower operating costs.

WATER HEATER-NATURAL GAS
FIRST HOUR RATING
66 GALLONS

MODEL
RP408-34
22386

ENERGYGUIDE

ESTIMATES ON THE SCALE
ARE BASED ON A NATIONAL
AVERAGE NATURAL GAS
RATE OF \$3.367 PER
THERM

ONLY MODELS WITH
FIRST HOUR RATING
OF 66 TO 74
GALLONS ARE USED
IN THE SCALE

Model with
lowest
energy cost
\$110

\$135

Model with
highest
energy cost
\$151

THIS MODEL

Estimated yearly energy cost

Your cost will vary depending on your local energy rate and how you use the product. The energy cost is based on a U.S. Government energy rate.

How much will this model cost you to run yearly?

Yearly Cost	
COST PER THERM	10 1027
	20 1074
	30 1111
	40 1148
	50 1185
	60 1222

Ask your salesperson or local utility for the energy rate in your area.

IMPORTANT Read each of this label before consumer purchase is a violation of Federal law (42 U.S.C. 6292)

Purchase Price \$160.

WATER HEATER-NATURAL GAS
FIRST HOUR RATING
66 GALLONS

MODEL
RPC108-28-7
24639

ENERGYGUIDE

ESTIMATES ON THE SCALE
ARE BASED ON A NATIONAL
AVERAGE NATURAL GAS
RATE OF \$3.367 PER
THERM

ONLY MODELS WITH
FIRST HOUR RATING
OF 66 TO 74
GALLONS ARE USED
IN THE SCALE

Model with
lowest
energy cost
\$110

\$112

Model with
highest
energy cost
\$151

THIS MODEL

Estimated yearly energy cost

Your cost will vary depending on your local energy rate and how you use the product. The energy cost is based on a U.S. Government energy rate.

How much will this model cost you to run yearly?

Yearly Cost	
COST PER THERM	10 1021
	20 1061
	30 1092
	40 1122
	50 1152
	60 1184

Ask your salesperson or local utility for the energy rate in your area.

IMPORTANT Read each of this label before consumer purchase is a violation of Federal law (42 U.S.C. 6292)

Purchase Price \$198.

The life-cycle cost is a quick formula to determine the total cost of the appliance over its useful life. If you have life-cycle costs for comparable appliances, a comparison will tell you which is the most cost-efficient.

The life-cycle cost is determined by adding the original purchase price to the projected cost of energy needed to operate the appliance over a period of time.

$$\begin{aligned} &\text{original purchase price} \\ &+ \text{cost of energy to operate} \\ &= \text{life-cycle cost} \end{aligned}$$

In this example of a life-cycle cost comparison, two similar water heaters are available. The standard model will cost \$160, and is estimated to cost \$135 per year in operating energy. The energy-efficient model will cost \$198, and is estimated to cost \$112 per year in operating energy. If the expected life is 12 years, we can easily compare the life-cycle costs.

Add the purchase price of the standard model, \$160, to twelve years' worth of operating costs (\$135 X 12 years). The life-cycle cost for the standard model is \$1,780.

Add the purchase price of the energy-efficient model, \$198, to twelve years' worth of operating costs (\$112 X 12 years). The life-cycle cost for the energy-efficient model is \$1,542.

In this case, the energy-efficient model is more economical to operate. If you had chosen to purchase the standard model because of its lower price, you would have overpaid by \$238 (\$1,780 - 1,542).

life-cycle cost comparison of two similar water heaters:

	standard	energy-efficient
purchase price	\$160.00	\$198.00
operating costs (for 12 years)	<u>1,620.00</u>	<u>1,344.00</u>
	\$1,780.00	\$1,542.00

Fireplaces are great for setting an atmosphere, but waste most of the energy from the wood they burn as well as a significant amount of the air in the rooms around them.

An open fire requires a supply of air to burn the fuel. In a house, the fireplace will take supply air from the inside the house and use that air to burn fuel. Not only does most of the heat energy from the wood fuel go up the chimney, but so does the air from inside the house. Even after the fire is out, heated room air will continue to travel up the chimney to the outside.

To minimize energy losses due to fireplace operation, close the damper as soon as the fire has cooled. Use glass doors to minimize room heat losses during and after the fireplace is used. Lower the thermostat to prevent the heating system from operating while there is a fire.

In New York State, a separate fresh-air supply must be provided for fireplaces in new homes to insure heated indoor air is not wasted.

Avoiding energy losses is not limited only to things to be done to the dwelling. Outdoors, some techniques can help minimize heating and cooling bills.

Windbreaks are usually placed between the dwelling and the direction of prevailing winds to block and divert away from or up and over the dwelling. Evergreen trees -- those that keep their foliage during cold weather -- serve well as windbreaks.

With properly placed trees, it's possible to reduce winter wind speeds by 50 per cent or more. This will reduce heating costs.

Leaf-bearing trees should be placed on the south, east, and west sides of the dwelling for maximum summer shade. This strategy will make it easier to keep the dwelling cool during warm weather. In the winter, these trees will lose their leaves and let the sun help warm the dwelling.

Housing and Home Environment

NOTES

Cornell Cooperative Extension, New York State College of Human Ecology

Radon Information Update

Joseph Laquatra and James McCarty

Radon, a colorless, odorless, radioactive gas that occurs naturally from the decay of uranium and radium, is found in low amounts all over the world. Within the past few years, high levels of this gas have been found in homes around the United States. This is a serious matter because radon breaks down relatively quickly to form very small radioactive particles that can be inhaled into people's lungs. Cell damage from this radiation exposure is considered to be a leading cause of lung cancer among non-smokers.

Radon enters a building through contact with the soil, seeping in through cracks in a foundation wall or basement floor, and by other sources of contamination such as private water supplies, natural gas, and building materials. Once radon gas gets into a building, air movement caused by heating systems, appliances, and exhaust fans can distribute the gas and its decay products throughout the living space. In many homes, radon mitigation (steps taken to lessen the problem) consists of simple measures, such as sealing cracks in basement floors and foundation walls. In other homes, techniques that involve special ventilation systems are used.

A homeowner's decision to treat a radon problem should be based on a measurement taken in that home. Radon levels vary greatly, even within neighborhoods. A high reading in one house does not necessarily indicate high levels in nearby homes. The only way to know whether an individual building is contaminated with radon gas is to test it, using tools manufactured for this purpose. The most widely used of these are activated charcoal canisters, which provide a measurement for a period of three

to seven days, or alpha track detectors, which can be kept in place for up to a year. Results from such devices which measure amounts of radon gas are reported as "picocuries per liter" of air (pCi/l). Although experts disagree over what should be accepted as a dangerous level of radon gas in a home, the U.S. Environmental Protection Agency (EPA) recommends that radon mitigation actions be taken when levels exceed four picocuries per liter (4 pCi/l) of air.

The first radon test conducted in a building is often done with an activated charcoal canister and is referred to as a screening measurement. This screening measurement is made in the area of the house closest to the soil (usually the basement), to help decide whether more measurements should be made.

Because the amount of radon gas concentrated in a house changes throughout the year, a screening measurement does not provide a reliable estimate of average radon levels to which a household is exposed. There can also be differences in radon levels among the different parts of a building. Results of a screening measurement should only be used as a sign of a potential radon problem. Depending on the results of the screening measurement, follow-up tests may be needed. These follow-up tests estimate the long-term average concentrations of radon in living areas of the building. They should be made after a screening measurement has determined that a radon concentration may be high enough to cause long-term health effects, or whenever concentrations in the living area are to be measured.

The New York State Health Department is currently conducting a radon screening program for homes throughout the state. Through this program, activated charcoal canisters are available to state residents for eight dollars, or for free if the home or dwelling unit to be tested has been surveyed through a utility energy analysis program. The toll-free number to receive information about this program is 1-800-458-1158. The New York State Energy Office also operates a toll-free radon hotline: 1-800-342-3722. For information regarding a utility energy analysis, call toll-free: 1-800-852-3733.

Some controversies have been created by the gradually increasing level of awareness of radon gas. Real estate agents, builders, and mortgage lending institutions are all affected by this in different ways and are developing policies to protect their interests. Purchase offers with contingency clauses that require a screening test are becoming common in some areas as part of the home-buying process. Plans are under way for the implementation of a state-sponsored program that will offer homeowners and contractors assistance with radon mitigation.

For more information regarding the problem and its treatment, consult some of the numerous publications that exist, including the following:

"How to Rid Your Home of Radon Gas," Consumers' Research, October 1986.

New York State Health Department. Radon. Albany: 1986.

"Radon Detectors: How to Find Out if Your House Has a Problem," Consumer Reports, July 1987.

United States Environmental Protection Agency. A Citizen's Guide to Radon: What It Is and What to Do About It. Washington: 1986.

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DEA fact sheet 1

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Indoor Relative Humidity and Human Health

Joseph Laquatra

Importance of indoor relative humidity

Human health can be adversely affected by conditions that arise from activities within buildings, materials and techniques used in their construction, and their connections to the external environment. The relationships among these factors and indoor air quality are of concern because of the time people spend indoors at home, estimated to range from 58 to 78 percent of their time, with some groups such as the elderly and infirm spending all of their time indoors.

Indoor air quality is important in all homes, and has become prominent in recent years because of low air exchange rates in newly constructed, energy-efficient homes, and the lowered exchange rates in existing homes retrofitted for energy efficiency. Where ventilation is inadequate, resulting concentrations of air pollutants can pose serious health risks. One pollutant in particular, *excess moisture*, examined for its impacts on human health alone and in conjunction with other airborne contaminants, has been linked with negative health effects.

Moisture sources and effects

Water vapor is always present in household air. Interior sources include people, pets, and daily household activities such as cooking, cleaning, bathing and showering, and simply breathing and perspiring. Moisture can also enter a house from the outside; rain, snow, and groundwater may cause wet and damp conditions in basements and crawl spaces, resulting in conditions associated with high relative humidity throughout the house (as well as structural damage).

Moisture travels through a house chiefly by air movement, diffusion, and capillary action. The effects of these forces vary from house to house because of such site-specific conditions as topography, geology, wind speed, and the characteristics of the structures themselves. The balance among moisture gain, loss, and storage is responsible for the level of indoor relative humidity, a significant component of a building's thermal climate.

Moisture-related problems occur at both low and high levels of relative humidity, and affect a structure, its contents, and the occupants. In homes with high air change rates, dry winter air entering the building envelope through cracks and holes around windows and doors can result in excessively dry air inside a home. Symptoms of *excessive dryness* include frequent shocks from static electric charges, as well as dimensional changes in house wooden structural members and wooden furnishings. In airtight, highly weatherized homes, problems associated with high humidity are more common, including condensation on windows and walls, and in attics and wall cavities. Persistently high levels of condensation can lead to rotting wood by making conditions favorable for the growth of decay fungi.

In addition to its effects on the structural conditions and furnishings in a home, relative humidity has been linked to the control of airborne infections. In reviewing relevant health literature, researchers on this topic have concluded that optimal conditions to minimize risks to human health occur in the range of 40 to 60 percent relative humidity. Below this range, skin and mucous membrane dryness can result in irritations to the throat

Optimum Relative Humidity Ranges for Human Health*

*From: Arundel, et al., 1986.

and other areas. At high levels of relative humidity the process of evaporative cooling is interrupted, increasing the likelihood of heat exhaustion and heat stroke.

Humidity levels can affect health indirectly through interactions with biological pathogens and chemical substances often present in household air. Bacteria populations thrive at both low and high humidity levels, but are minimized within the 30–60 percent relative humidity range. Viruses, including vaccinia (cowpox), measles, influenza, and those responsible for acute respiratory infections have been found at low and high humidities, but their populations are minimized in a 50–70 percent humidity range. The growth of fungus decreases at humidity levels below 80 percent. Within seasonal variations, the population levels of the house dust mite, which has been linked to asthma and allergic rhinitis, appear to be sensitive to relative humidity, with increases noted above 60 percent humidity.

Higher rates of respiratory infections and an increasing severity of asthmatic reactions have been observed at humidity levels below 40 percent, and an increased incidence of allergic rhinitis from exposure to allergens occurs at humidity levels above 60 percent.

Interactions of water vapor with chemicals found indoors produce compounds known to be respiratory and skin irritants. These include salts and acids, as well as formaldehyde from building materials and furnishings. Some of these interactions begin at 30 percent humidity; most occur at levels exceeding 50 percent. In

one study, excessive concentrations of formaldehyde in house air were linked to building products exposed to high humidity levels.

An optimum zone of relative humidity

Determination of an optimum zone for indoor relative humidity conducive to human health is problematic since people are at varying risks for undesirable effects at either high or low humidity levels. Asthmatics, infants, and the elderly have more health problems at low levels; those with allergies have difficulty tolerating high levels. Additionally, the combination of high humidity and high temperature has been shown to increase the risk of adverse health effects for certain groups of people. Given these considerations, researchers have concluded that an optimum zone for human health exists in the range of 40 to 60 percent relative humidity (see chart).

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DEA fact sheet 3

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INDOOR AIR POLLUTANTS, HEALTH EFFECTS AND POLLUTION SOURCES

	<u>Pollutant</u>	<u>Health Effects</u>	<u>Sources</u>
GASES	Benzene	Respiratory irritation; carcinogen	Plastics and rubber solvents, cigarette smoking; paints, varnishes, stains, finishes, putty, filler, liquid spot removers
	Chlorobenzene	Strong narcotic; possible lung, liver, and kidney damage	In production of paint, varnish, pesticides, and various organic solvents
	Ethylbenzene	Severe irritation to eyes and respiratory system	Solvents; in styrene-related products
	Formaldehyde	Eye and skin irritation, nausea, respiratory problems, thirst, headaches, tiredness, nosebleeds, vomiting, possible carcinogen	Building materials such as particleboard, plywood, ureaformaldehyde foam insulation; generated by cooking and smoking
	Pesticides	Suspected carcinogens	Insect control
	Polychlorinated biphenyls (PCB's)	Suspected carcinogens	In various electrical components; in waste oil supplies and in plastic and paper products in which PCB's are used as plasticizers
	Styrene	Narcotic; can cause headaches, fatigue, stupor, depression, uncoordination, and possible eye injury	Used in manufacture of plastics, synthetic rubber and resins
	Toluene	Narcotic; may cause anemia	Solvents, paints, hobby and craft supplies, indoor track floor, by-product of organic compounds used in household products
	Trichloroethane	Subject of OSHA carcinogenesis inquiry	Aerosol propellant pesticide, cleaning solvents, liquid spot removers
	Trichloroethylene	Animal carcinogen; subject of OSHA carcinogenesis inquiry	Oil and wax solvents, cleaning compounds, vapor degreasing products, dry- cleaning operations; also used as an anesthetic

<u>Pollutant</u>	<u>Health Effects</u>	<u>Sources</u>
GASES		
Xylene	Narcotic; irritating; in high concentrations, possibly injurious to heart, liver, kidney, and nervous system	Solvent for resins, enamels, etc.; in non-lead automobile fuels and in manufacture of pesticides, dyes, pharmaceuticals
BIOLOGICAL AGENTS		
Bacteria Fungi Molds Pollen Dust Mites Viruses	Sneezing, allergies, rashes, watery eyes, hoarseness, coughing, dizziness, breathing problems, lethargy, digestive problems Legionnaire's Disease, Humidifier Fever	Ventilation ducts, humidifiers, dehumidifiers, air conditioners, dust, carpets, air-cleaning filters
COMBUSTION POLLUTANTS		
Carbon monoxide (CO)	Headaches, dizziness, nausea, fatigue, excessive yawning, decreased hearing, heart palpitations, loss of appetite, vomiting, flu symptoms, unconsciousness; in extreme cases death	Unvented oil or gas hot water heaters and furnaces, gas clothes dryers, gas stoves, wood burning stoves, faulty heating systems, kerosene heaters, tobacco smoke
Carbon dioxide (CO ₂)	Headaches, dizziness, shortness of breath, drowsiness	Human metabolism, combustion of fossil fuels
Nitrogen dioxide (NO ₂)	Respiratory irritation, chronic bronchitis	Unvented oil or gas hot water heaters and furnaces, gas clothes dryers, gas stoves, wood burning stoves, tobacco smoke
Sulfur dioxide (SO ₂)	Breathing difficulties, irritation of skin, eyes, and mucous membranes	Heating appliances
PARTICULATES		
Asbestos	Asbestosis (scarring of lung tissue), breathing problems, heart failure, skin irritation, cancer of lungs, mesothelioma; may be linked to cancer of the stomach, intestines, and rectum	Acoustic, thermal, and electric insulation, fire retardant, ceiling panels, carpet underlayment, artificial fireplaces, patching compounds, roofing and siding materials, brake linings, pot holders, ironing board pads, hairdryers, electrical wires, textured paints, cements, floor tiles

<u>Pollutant</u>	<u>Health Effects</u>	<u>Sources</u>
PARTICULATES		
Radon decay products	Lung tissue damage, lung cancer	Soil with radon gas, water and natural gas with radon, solar-heating systems using radon-emitting rock to store heat, uranium mining, granite rock, stone
Tobacco smoke	Lung cancer, emphysema, heart disease, eye and throat irritation; headaches, nasal discomfort, coughing, bronchitis and pneumonia in babies; irritation of lung airways in children	Buildings and homes with smokers

from Cathy Reiko Kawasaki, Perceptions of Indoor Air Quality in the Home and Workplace: A Comparison Between Occupants in a Naturally Ventilated Building and an Air Conditioned Building, M.S. Thesis, Cornell University, 1991.

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UNDERSTANDING OIL AND GAS HEATING SYSTEMS

8:D

Recent advances in gas and oil central heating technology have resulted in highly efficient systems. But in conventional furnaces and boilers, efficiency losses can be substantial, and typically amount to 30 to 45 cents of every heating dollar. These losses result from leaky or uninsulated ducts, clogged registers and filters, and - most substantially - from using heated air to maintain chimney draft and combustion.

Conventional furnaces and boilers must sacrifice some efficiency in order to vent unwanted combustion products from the house (Figure 1). By allowing flue gases to retain high temperatures, the natural force of rising hot air creates chimney draft, which exhausts water vapor, carbon dioxide, and nitrogen: all products of combustion. At the same time, air from around the heating unit is drawn into the burner to maintain combustion. In most cases, this is heated air.

FIGURE 1

HEATING SYSTEM EFFICIENCY

Most likely, the efficiency of your present furnace or boiler can be improved. Have an efficiency inspection conducted on your system by a knowledgeable and reputable contractor. The following areas should be examined.

System Sizing

The correct match between a home and its heating equipment is like a balanced equation. A home's heating need is determined through heat loss calculations, which are based on local climatic conditions and thermal characteristics of the house (how much and what type of insulation, etc.). The results of heat loss equations are expressed in BTUs per hour, and refer to the rate at which heat must be supplied to a house during the coldest time of the year. Because furnaces and boilers are categorized according to their heat producing capacity in BTUs per hour, a close match between heat loss and heat production is possible (Figure 2). Competent heating technicians can calculate a home's heating need either by hand or with the assistance of a computer.

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Many houses are heated by systems with much larger heating capabilities than are required to maintain a comfortable temperature. These systems are said to be oversized. The "size" of a furnace refers to how many BTUs it can generate in an hour. What's wrong with oversizing? Two things: 1) It increases the operating cycle losses already mentioned, and 2) It results in high off-cycle losses. When the thermostat sends the proper signal to the burner, the combustion process stops -- essentially turning the system off. Hence the term, "off-cycle." But even though the system is off, the heated combustion chamber continues to send hot gases up the chimney. As this chamber loses air to the chimney, it replaces it with air from around the furnace or boiler. This in turn causes enough negative pressure in the house to result in cold outside air being drawn in through cracks and holes around windows, doors, and other openings.

FIGURE 2

The problems of an oversized heating system can be partially corrected by derating. This refers to adjustments that reduce the rate at which fuel is burned. In an oil system, a smaller nozzle is installed in the burner. A gas system is derated by reducing the burner orifice size or by decreasing the pressure in the manifold, the pipe that distributes gas to the burners. Derating a gas system also involves installing a fixed flue damper to modify the flue opening.

Combustion Efficiency

The amount of heat extracted from fuel depends on the efficiency of the combustion process. A combustion efficiency test should be part of a heating system's annual tune-up. This diagnosis is performed by a heating system technician with special tools that analyze the composition of flue gas and measure its temperature, draft level, and smoke concentration. The efficiency of the combustion process is then calculated from these measurements. Standard tune-up procedures can usually result in a combustion efficiency rating of between 75 and 85 percent for oil and gas systems.

Seasonal Efficiency

A combustion efficiency test provides a measure of how completely the burner converts fuel to useful heat. Another indicator, known as seasonal efficiency, is a gauge of how well the entire heating system extracts heat from fuel and warms the living space with it. This measure takes off-cycle

- losses and the integrity of the distribution system into consideration. Unfortunately, seasonal efficiency is extremely complicated to determine for an existing system, but it can be estimated. The typical seasonal efficiency for an existing system is between 10 and 15 percent less than its combustion efficiency rating. Manufacturers of new systems are required to present information on the efficiency of their furnaces and boilers, and to compare this efficiency with other units of the same size and type. The basis for comparison among units is a laboratory-tested seasonal efficiency known as the Annualized Fuel Use Efficiency (AFUE) rating, and is provided on the required Energyguide fact sheet for each unit.

UPGRADE OR REPLACE?

Improvements to space heating efficiency can often be achieved by upgrading an existing system. A yearly tune-up will insure that the maximum level of combustion efficiency is attained. Seasonal efficiency can be increased through a number of measures. A 5 to 15 percent increase, for example, can result from derating. Boiler pipes or furnace ducts that are leaky and uninsulated can waste over 10% of the heat produced by a system, especially if the pipes or ducts pass through unheated areas, such as a garage or crawl space. Furnace fan switches, automatic vent dampers, flue heat reclaimers, and set-back thermostats also result in increased seasonal efficiency. But if your present system is over 20 years old and cannot be tuned to a high level of combustion efficiency, potential improvements to seasonal efficiency may be limited, and system replacement should be considered.

High Efficiency Heating

There are now a number of new gas and oil central heating systems with AFUE ratings of between 80 and 95 percent. Primarily, these high levels of efficiency are obtained through designs that minimize on-cycle losses. Some of the features that make these furnaces and boilers different from conventional units are forced draft systems, pulse combustion, secondary heat exchangers, and heat transfer modules. Probably the most striking difference is that most of these furnaces don't require chimneys. Combustion products are vented through a wall, much like a dryer, with many furnaces using plastic pipe for this purpose. And because the water vapor resulting from combustion is condensed inside these furnaces, it must be drained away. This is achieved with a connection to a floor drain.

To select among several furnaces or boilers, obtain gas prices from your utility or supplier, or oil prices from your dealer; and use these prices to estimate annual heating costs from the Energyguide fact sheet for each unit. Obtain heating contractor estimates for installed prices of each unit. Compare purchase costs and operating costs of the different units.

You can calculate a simple payback by dividing initial cost differences by annual savings, but remember that the payback only tells part of the story. Savings continue to occur beyond the payback time and a high efficiency system is likely to increase the value of your home.

Written 1985; reviewed and revised 1988; retitled 1990; Joseph Laquatra, Assistant Professor

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EVALUATING OPTIONS IN HEATING SYSTEM EFFICIENCY 8:E

Upgrading the efficiency of your existing heating system or choosing a replacement among the many models of new systems involves an evaluation of alternatives. The first step in this evaluation is to calculate your home's heating requirements, ideally by computing heat loss calculations (see Housing Fact Sheet 8:F). Or you can roughly approximate this from last year's fuel bills. If your water heating and/or cooking fuels are the same as your space heating, the amount used for non-space heating needs must be identified. You can estimate this by subtracting the energy costs for a month with no heating or cooling requirements (May or September) from each month's fuel bill.

From your fuel supplier, or from your own records, you can identify the total fuel units (gallons of oil, therms of gas, KWH of electricity, cords of wood) used for heating your house last year. Convert fuel units to heat content in millions of BTUs (MBTU) with the following chart :

HEAT CONTENT OF FUELS

- .138 MBTU/gallon of #2 Fuel Oil
- .100 MBTU/therm of Natural Gas
- .003412 MBTU/Kwh of Electricity
- .093 MBTU/gallon of LP Gas
- .0125 MBTU/pound of Coal
- 24 MBTU/cord of Mixed Hardwoods (approximate)
- 15 MBTU/cord of Mixed Softwoods (approximate)

Your home's heating requirements for last year can be computed as:

$$\text{TOTAL HEAT (MBTU)} = \left[\frac{\text{total fuel units used}}{\text{fuel unit}} \times \frac{\text{MBTU}}{\text{fuel unit}} \times \text{AFUE} \right] - \left[12 \times \text{Monthly non-heat energy use} \right] \quad (1)$$

AFUE refers to Annual Fuel Utilization Efficiency (sometimes called "seasonal efficiency") -- a gauge of how well a heating system extracts heat and delivers it to the living space. Manufacturers of new furnaces and boilers provide AFUE ratings for their equipment on EnergyGuide fact sheets. But for an existing system, this measure would be very difficult to calculate. You can, however, make an educated guess with the help of a heating contractor or service person. As part of annual servicing, arrange for a combustion efficiency test to be performed. This indicates how completely the burner converts fuel to useful heat. Depending on a number of factors, the AFUE for an existing system is about 10-15% less than its combustion efficiency.

The next step in this evaluation is to adjust your calculated heat requirements from Equation 1 to a typical year. Obtain the number of last year's heating degree days (HDD)* from your local fuel supplier. Then calculate your normalized heat requirement :

$$\text{Normalized Heat Requirement} = \frac{\text{MBTU Required Last Year} \times \text{HDD Typical Year}}{\text{HDD Last Year}} \quad (2)$$

Now operating costs of systems with different fuels and/or AFUE ratings can be compared with the following calculation :

$$\$/\text{MBTU} = (\$/\text{Fuel Unit}) \times (\text{Fuel Unit}/\text{MBTU}) \times 1/\text{AFUE} \quad (3)$$

Example : Oil Heat @ 60% AFUE (average furnace or boiler):

$$\$13.28/\text{MBTU} = (\$1.10/\text{gal}) \times (1 \text{ gal}/0.138 \text{ MBTU}) \times 1/.60$$

Multiply your answer from Equation 2 by your answer from Equation 3, and you can estimate the total heating bill for your house for any fuel, at any price, burned at any efficiency.

HEATING DEGREE DAYS - N. Y. STATE

County	HDD	County	HDD	County	HDD
Albany	7000	Allegany	7000	Bronx	5000
Broome	7000	Cattaraugus	7000	Cayuga	7000
Chautauqua	7000	Chemung	7000	Chenango	8000
Clinton	8000	Columbia	7000	Cortland	8000
Delaware	7000	Dutchess	7000	Erie	7000
Essex	9000	Franklin	8000	Fulton	8000
Genesee	7000	Greene	7000	Hamilton	9000
Herkimer (N.)	9000	Herkimer (S.)	8000	Jefferson	7000
Kings	5000	Lewis	8000	Livingston	7000
Madison	8000	Monroe	7000	Montgomery	7000
Nassau	5000	New York	5000	Niagara	7000
Oneida	8000	Ortndega	7000	Ontario	7000
Orange	6000	Orlean's	7000	Oswego	7000
Otsego	8000	Putham	6000	Queens	5000
Rensselaer	7000	Richmond	5000	Rockland	8000
St. Lawrence	8000	Saratoga	7000	Schenectady	7000
Schoharie	7000	Schuyler	7000	Seneca	7000
Steuben	7000	Suffolk	6000	Sullivan	7000
Tioga	7000	Tompkins	7000	Ulster	7000
Warren	9000	Washington	9000	Wayne	7000
Westchester	6000	Wyoming	7000	Yates	6000

*Heating Degree Days are a measure of the difference between the indoor heated temperature and the outdoor temperature during the heating season.

Written 9/89 by Joe Laquatra, Assistant Professor.

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HEAT LOSS CALCULATIONS 8:F

The amount of energy required to heat a building is determined by how much heat the building loses to the outside environment. Heat flows from warm to cold areas. In a heated house it flows to exterior walls, floors, and ceilings by convection; through the building shell (or thermal envelope) by conduction (and sometimes convection); and away from the house by convection and radiation. Heat is also lost from a house through infiltration: the exchange of warmed indoor air with cold outdoor air.

The first step in computing heat loss calculations for a building is to determine the overall resistance of the thermal envelope to heat conduction. R-values for construction materials express their resistance to this heat flow. For each surface of the thermal envelope, R-values are totaled, as in this example of a wall with 2" x 4" construction.

A = Inside still air film	R = 0.680
B = 1/2" drywall	R = 0.450
C = 6-mil polyethylene	R = 0.00
D = 3 1/2" fiberglass batt insulation	R = 11.000
E = 1/2" plywood sheathing	R = 0.625
F = Building paper	R = 0.060
G = 1" x 10" wood siding	R = 1.050
H = Outside air film	R = 0.170
TOTAL	R = 14.040

Note that both the interior and exterior surfaces of the wall are covered with an air film, a layer of still air that contributes to the overall R-value.

$$U = 1/R \quad (1)$$

The U factor indicates the number of BTUs that flow through one square foot of the building section when there is a difference in temperature between the inside and outside air of 1°F. Using the U factor, a given time period, and design temperatures, conductive heat losses through the section are determined as follows:

$$\text{Conductive Losses} = A \times t (T_{in} - T_{out}) \times U \quad (2)$$

where

- A = Surface area of building component,
- t = Specified time in hours,
- T_{out} = Outside design temperature,
- T_{in} = Inside design temperature,
- U = Transmission coefficient.

The amount of heat transmitted through 300 square feet of the wall shown in Figure 1 over a 24-hour period in Rochester, New York is calculated as follows:

$$\begin{aligned} \text{Conductive Losses} &= 300 \times 24 (65 - 0) \times 1/14.04 \\ &= 33,333 \text{ BTU.} \end{aligned} \quad (3)$$

To obtain total heat transmission through a building's shell, this calculation is made for each external surface. Correction factors are applied to walls and roofs for stud and rafter areas. For a concrete slab, the conductive loss is calculated for exposed perimeter area, not total surface area.

Infiltration losses are calculated separately. These result from the leakage of cold outside air into a building and the resulting need to heat that air. Basically, cold air blows in through cracks, door and window sashes and other small openings in the house on the side facing the wind. At the same time, warm air is pulled out by negative pressure, or suction, on the far (leeward) side.

Infiltration occurs in all buildings, but varies according to many factors, such as quality of construction and the extent of caulking and weatherstripping.

A common method of computing infiltration for houses is the "Air Change" method. Typically, a home will have between 0.5 and 5 air changes per hour (ACH), depending on the number of openings, quality of construction, and level of weatherization, as in the following table:

AIR CHANGE RATINGS

Tight construction, energy conservation specifications, weatherstripping, storm windows, wood sash, entrance vestibule.	0.5 ACH
Conventionally built house, fairly tight, storm windows, some weatherstripping.	2.0 ACH
Old construction or poorly built new, some cracks, loose storm sash and windows, some broken windows, no caulking or weatherstripping.	3-5 ACH

As an example, infiltration losses for a 20-foot x 30-foot, 1-story house with an estimated ACH of 3, are calculated as follows:

$$\text{Infiltration losses} = \text{ACH} \times \text{Volume} \times .018 \text{ BTU} \times (T_{\text{in}} - T_{\text{out}}), \quad (4)$$

where Volume = 20 feet x 30 feet x 8 feet = 4800 cu. ft.
.018 BTU = Heat need to raise 1 lb. of air 1° F.

Carrying out the calculation,

$$\text{Infiltration losses} = 3 \times 4800 \times .018 \text{ BTU} (65^{\circ}\text{F} - 0^{\circ}\text{F}). \quad (5)$$

Thus, 16,848 BTU/hour is added to the total conduction losses to obtain total heat losses for the structure. An alternative to estimating infiltration losses is to measure them precisely with instruments designed for this purpose.

The preceding discussion is intended to provide a general overview of heat loss calculations. This topic is covered in much greater detail in many engineering text books and reference works. Heat loss calculations comprise the first step in determining how to heat a building. Programmable calculators and computer software packages allow heating contractors to determine a structure's annual heating needs with relative ease and precision. This determination facilitates the proper selection of heating equipment.

Written by 9/89 Joseph Laquatra, Assistant Professor.

HOUSING Fact Sheets

HYDRONIC HEATING SYSTEMS 8:G

A hydronic heating system generates heat in a boiler, circulates it through pipes, and emits it from radiators or convectors. A hydronic heating system differs from a warm air system in that the heat transfer medium is steam or hot water instead of air. Boilers are made of cast iron or steel and are designed for burning coal, gas, or oil. Cast iron boilers are more resistant to corrosion than those made of steel; but the life of steel boilers can be prolonged through chemical treatment of corrosive water. Boiler certification indicates that accepted standards of construction have been applied. Cast iron boilers are stamped I=B=R (Institute of Boiler and Radiator Manufacturers); steel boilers are stamped SBI (Steel Boiler Institute).

I. STEAM

In a steam heating system, water is heated to the boiling point and converted to steam under pressure. Steam circulates from the boiler through pipes to heat radiators in the living spaces. As steam cools inside the radiators, it condenses to water and returns to the boiler to be reheated. Steam systems are classified as the gravity circulation type, or the mechanical circulation type, which uses a pump for this purpose. Many types of steam heating systems have been developed and fall into 2 general categories:

1. **One-pipe System:** In this arrangement, a single pipe supplies steam to the heat emitters and returns condensate to the boiler.
2. **Two-pipe System:** A supply pipe delivers steam to the heat emitters and a second pipe returns condensate to the boiler.

In either system, boiler operation can be initiated by a thermostat. Steam is delivered to radiators by the piping distribution system. At each radiator, an air vent valve permits contained air to be eliminated while steam enters. As steam cools in the radiators, condensate forms and flows out, and more steam enters. During cool down the air vent valves allow air to enter the radiators while remaining condensate returns to the boiler. Some systems do not require radiator air valves and may include traps, condensate receivers, and pumps to return water to the boiler.

II. HOT WATER

Another type of hydronic heating system is one which uses the heat from circulating hot water to warm an interior space. Gravity flow and forced circulation are the two basic types of hot water heating systems. A gravity flow system makes use of the principle that hot water rises, and this forces it through pipes and radiators. Although such a system is relatively simple, it has disadvantages (large pipes must be used; future adaptations are difficult), which make forced circulation preferable. A forced flow system uses a circulator, a mechanical device that induces water flow through the distribution system.

Three types of piping layouts generally used for forced hot water circulation systems are:

1. **One Pipe System:** This strategy has many disadvantages and is not recommended. The first radiator in the distribution system takes hot water from the supply main and dumps cold water back into the line. This causes supply-water temperatures for other radiators to be lower, requiring a corresponding increase in radiator size.
2. **Two-Pipe Direct-Return System:** All radiators get the same supply-water temperature, but the last radiator has more pipe resistance than the first. This can be balanced out by sizing the pump for the longest run and installing orifices in the other radiators to add an equivalent resistance for balancing.
3. **Two-Pipe Reversed Return System:** Total pipe resistance is about the same for all radiators. The first radiator in the supply line has the shortest supply pipe and the longest return pipe, while the last radiator has the longest supply pipe and shortest return.

The controls of a hot water heating system are usually arranged as follows : an immersion thermostat in the heater controls the heat source, such as an oil burner. This thermostat is set to maintain the design heater water temperature (usually around 180° F). When the room thermostat calls for heat, it starts the circulator, which forces the supply of hot water to flow to the radiators or convectors. A low-limit switch, usually placed in the boiler and wired in series with the room thermostat and pump, is arranged to shut off the circulator in the event that the water temperature drops below 70°F. This prevents circulation of cool water in the event of flame failure.

A critical component of a hot water heating system is the expansion tank, a chamber mounted above the boiler that provides room for heated water to expand. The tank also serves to eliminate air that may enter the system during the water fill. Older systems may have "open" type expansion tanks that are vented to the atmosphere, with the tank located at the highest point in the system. Most expansion tanks are located near the boiler and are usually air-tight, "closed" tanks containing a column of air. The air is compressed by the rising water volume, allowing for the expansion without a great increase in system pressure.

SYSTEM COMPONENTS

A number of control devices are mounted or connected to the boiler in a steam or hot water heating system, including:

Pressure-Relief Valve: When boiler pressure rises above a safe predetermined level, a limit control shuts off the burner. If that does not function, the safety valve opens and relieves the pressure.

Stop Valves: Valves placed in pipe lines to allow the passage of steam or water or to block it completely.

Check Valves: Valves that allow steam or water to flow through a pipe in one direction only.

Air-Vent Valves: Allows trapped air to escape from a system so that water or steam can circulate.

Draw-off Valve or Drain Cock: A valve connected to the lowest part of the boiler which is used to drain sediment, scale, and other impurities that settle out of water as it is heated.

Low-Water Cut-Off: A mechanical device located either on or in a boiler which consists of a float and a switch. If the boiler water level falls below the float level, the switch shuts off power to the burner.

Try Cocks: Small valves installed on steam boilers at the safe high water level and safe low-water level.

Water Gauge: A glass tube that covers the safe range of the boiler's water level. It is connected by fittings at both ends to the boiler interior, and is used to check water level.

Water Column: A special fitting to which try cocks and water gauges may be connected. This device activates a whistle when boiler water level drops below a safe level.

Trialticator Gauge: Measures height, temperature, and pressure of water in the boiler.

An important precaution in a hydronic system is to avoid air pockets or loops. Pipe should be pitched so that air will collect at points that can be readily vented either automatically or manually. Pipe traps should contain drains for complete drainage in case of shutdown. Zones should be valved so that the complete system need not be shut down for repair of a zone. Multiple circulators may be used to supply the various zones at different times, for different temperature settings and different exposures. All supply and return pipes should be insulated.

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HOUSING Fact Sheets

COMBUSTION EFFICIENCY OF AN OIL-FIRED FURNACE OR BOILER 8:H

Efficiency is a measure of how completely heat is transferred from a fuel source to a heat distribution medium, such as water, air, or steam. Combustion efficiency refers to how completely the burner of a furnace or boiler converts fuel to useful heat. Common efficiency losses occur as follows:

1. In conventional heating systems a certain minimum flue gas temperature is required to prevent the water vapor in combustion gases from condensing and damaging the vent, flue or heat exchanger. If the unit has natural draft, the flue gases must also be warm enough to rise naturally. The heat required to maintain this temperature is lost.

2. Since fuel and air don't mix perfectly, some excess air is needed in the fuel-air mixture to insure complete combustion. This excess air is heated as it passes through the furnace or boiler, and the energy used to heat it is also lost.

3. Water is a product of combustion. In a conventional heating system, this water is carried away from the unit as vapor, along with other combustion products through the flue. Because water absorbs a considerable amount of energy as it is converted from a liquid to a vapor, this energy, the latent heat of vaporization, is lost.

Combustion efficiency can be improved by reducing the stack temperature and excess air to the safe minimums. A combustion efficiency test is conducted for this purpose. The temperature of flue gases is measured directly with a stack thermometer. The intensity of draft is measured with a draft gauge. The composition of flue gas is indicated by a carbon dioxide tester. The degree of smoke content in flue gas is measured with a smoke tester. An alternative method for testing combustion efficiency involves a measurement of the oxygen content of flue gas.

A combustion efficiency test is the only reliable method for properly adjusting oil burners, and is a valuable tool for diagnosing combustion problems. Causes of poor efficiency can be identified in the process.

Temperature of Flue Gases

High temperatures indicate inefficient operation. Typical temperature ranges are:

350 - 500°F	: Good
501 - 650°F	: Fair
Above 650°	: Poor

If the carbon dioxide percentage is high (see below), excessive flue gas temperature can result from soot deposits on heating surfaces, inefficient design, a firing rate that is too high, or

the need for turbulators (baffles) to be installed in boiler tubes. If the carbon dioxide percentage is low, too much combustion air is being supplied to the burner.

Composition of Flue Gases

A high percentage of carbon dioxide in the flue gases indicates efficient combustion. Typical ranges are:

10 - 13%	: Good
8 - 10%	: Fair
Below 8%	: Poor

Causes of a low percentage of carbon dioxide include too much combustion air being supplied to the burner, a broken damper (or one that is open too wide), too much chimney draft, air leaks into the boiler or furnace, or improper setting of the barometric damper.

Smoke Content of Flue Gas

Smoke formation by oil burners is unnecessary and reduces heating system efficiency. Modern oil-fired burners produce almost no smoke in the combustion exhaust gas. Although older burners are not as effective, their performance can be improved by careful adjustment. Typical ranges on the smoke tester are:

0 - 1	: Good
1 - 2	: Fair
3 or above	: Poor

Chimney Draft

Adequate chimney draft is required for efficient burner operation, but excessive draft lowers efficiency. The draft gauge indicates the effectiveness of the chimney in venting combustion products and permits adjustment of the barometric damper. A good draft reading from the flue pipe is between 0.04 and 0.06 inches of water column. Insufficient draft can be caused by a leaking or blocked chimney, an incorrectly sized chimney, or a missing or defective draft regulator.

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Written 9/89 by Joe Laquatra, Assistant Professor.

HOUSING Fact Sheets

TYPES OF INSULATION MATERIALS

11:A

INSULATION

Heat is lost from a house through the natural forces of conduction, convection, and radiation. Insulation is the term used for a number of different materials used primarily to reduce conductive losses. The ability of a material to offer resistance to heat flow is indicated by its R-value. The higher the R-value, the more effective is the material in resisting the flow of heat from inside a house to the outside. Insulation is also useful for air-conditioned houses, where the strategy is to reduce the flow of heat from outside a house to the cooled interior. R-values and U-values are two ways of expressing the same thing. When using an R-value, materials with larger numbers are better insulators; when using U-values, smaller numbers represent better insulators ($R=1/U$; $U=1/R$).

Figure 1

When deciding whether or not to insulate, first check the levels and types of existing insulation. For walls, this task may be accomplished by (1) turning off the electricity, and then (2) probing behind the face plates of electrical boxes on exterior walls (see Figure 1). To check attic, basement, and crawl space areas, physical access to these spaces may be required. In some cases, floorboards or paneling may need to be carefully removed to determine existing insulation levels.

HOW MUCH INSULATION IS NEEDED?

The *New York State Energy Conservation Construction Code* prescribes minimum R-values for new homes and for homes being substantially renovated. However, by exceeding these minimum levels, greater energy savings and comfort can be achieved. Homeowners wanting to insulate existing homes can contact their local utility companies for R-value recommendations, or they can call the New York State Energy Hotline (800-342-3722) for assistance. Investor-owned utility companies provide free energy surveys for New York homes built before 1980.

HEATING DEGREE DAYS

Recommended levels of insulation are indicated by R-values and are usually related to local heating degree days. Heating degree days (HDD) refer to the difference (in degrees F°) between the daily average outdoor temperature and a base temperature (usually 65°F). For example, on a winter day with a low of 5°, a high of 35°, and fluctuations throughout the day, an average of 22° might be calculated. The difference between 22° and 65° (the typical HDD base) is 43°; thus, for that 24-hour period there were 43 HDD. Because local daily temperatures are routinely recorded, annual HDD totals for most locations are available. In New York State, the range of annual HDD is 5,000 (New York City) to 9,000 (Hamilton County). By comparison, the city of Fairbanks, Alaska has 14,407 annual HDD; Houston, Texas has 1267 annual HDD.

HOW MUCH WILL IT COST?

Comparing insulation materials by cost per square foot of R-value will give a rough estimate of material costs. Consider additional costs of labor, equipment, or special needs of different insulation materials when deciding. Manufacturer's stated R-values for blown insulation products can be related to installed density and should be verified by standards and independent tests.

The decision to hire a contractor or attempt to do the job yourself depends on the installation type, cost, and the homeowner's expertise and time available. Certain applications such as sprayed, foamed, and blown types require skills and equipment that may be unfamiliar and unavailable to the average do-it-yourselfer. Refer to Housing Fact Sheet 16:A (*Contractors and Contract Specifications*) which gives further details on the subject of hiring a contractor.

typical attic ventilation systems

Figure 2

If chosen and applied correctly with adequate, controlled ventilation (Figure 2) and a warm-side vapor retarder, (Figure 3) insulation can be part of a home weatherization project. An energy analysis can help point out other building envelope deficiencies such as inadequate caulking and weatherstripping or poor mechanical system efficiencies.

Figure 3

OTHER CONSIDERATIONS

Categories of insulation materials, their R-values, and recommended applications are listed on the following page (see Figure 4). There is no single perfect insulation product, and a selection will probably involve some compromise. Choice of the best material for the job depends on where it is needed, the amount of space available, the cost of the material, labor to install it, and the installation method to be used. Environmental properties of insulation materials may also need to be considered. For example, some insulation materials contain substances which may affect chemically sensitive persons; in these cases, other insulation materials could be substituted. And in some localities, insulation which uses ozone-damaging chlorofluorocarbons has been banned; homeowners in these areas would be required to use alternative materials.

APPLICATIONS FOR INSULATION TYPES
(R-Value per inch listed at far left)

LOCATION (see key below)	1	2	3	4	5	6	7	8
(Rating System: A = most practical; D = least practical)								
batts, blankets								
2.5-3.6 fiber glass	A	A	A	D	A	A	D	D
3.0-3.7 rock wool	A	A	A	D	A	A	D	D
loose fill								
(for poured or blown-in applications)								
2.2-4.0 fiber glass	B	A	B	D	B	D	D	D
2.8-3.7 rock wool	B	A	B	D	B	D	D	D
2.8-3.7 cellulose	B	A	B	D	B	D	D	D
3.3-3.7 perlite	D	B	D	D	D	D	D	D
2.1 vermiculite	D	B	D	D	D	D	D	D
3.85 expanded polystyrene .	D	B	D	D	D	D	D	D
rigid board								
3.85 expanded polystyrene .	B	C	C	B	B	A	A	D
4.0-5.0 extruded polystyrene .	B	C	C	A	B	A	A	A
6.25 urethane	B	C	C	A	B	A	A	C
5.4-7.2 isocyanurate	B	C	C	A	B	A	A	C
5.8-8.8 phenolic	A	C	C	A	C	A	A	C
2.88-4.0 high-density fiber glass	B	C	C	A	A	A	C	A
sprayed-in-place								
3.57-3.9 cellulose	B	A	A	D	D	A	D	D
4.0 fiber glass	B	A	A	D	D	A	D	D
foamed-in-place								
5.26-8.25 urethane	A	A	A	D	A	A	D	D
6.5-7.0 isocyanurate	A	A	A	D	A	A	D	D

Location Description Key

1 roof, cathedral ceiling, interior	5 floors: over unheated spaces
2 attic floor, flat ceiling	6 masonry walls: interior surface, at grade
3 walls: between framing members	7 masonry walls: exterior, above grade
4 walls: as sheathing	8 masonry walls: exterior, below grade

sources: ASHRAE Fundamentals, New York State Energy Office,
Energy Design Update, Solar Age, Rodale's New Shelter.

Figure 4

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RESOURCES

Fact Sheets (by title):

- *Contractors and Contract Specifications* (327REN20FS 16:A) Cornell Cooperative Extension
Available from: Media Services Distribution Center (phone: 607/255-2080)
7 Research Park, Cornell University
Ithaca, NY 14853
(cost: \$1.00 per copy)
- *Insulating Materials* (Circular F6.0) Small Homes Council - Building Research Council
Available from: Small Homes Council - Building Research Council (phone: 217/333-1801)
University of Illinois at Urbana-Champaign
One East Saint Mary's Road
Champaign, IL 61820
(cost: \$1.00 per copy)
- *Insulation Fact Sheet* (DOE/CE-0180) (FS142) U.S. Department of Energy
Available from CAREIRS (see below), or:
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
(no charge)

State and Federal Agency Hotlines:

NEW YORK STATE ENERGY HOTLINE: 800/342-3722
New York State Energy Office
Two Rockefeller Plaza
Albany, NY 12223

CAREIRS (Conservation and Renewable Energy Inquiry and Referral Service): 800/523-2929
P.O. Box 8900
Silver Spring, MD 20907

NATAS (National Appropriate Technology Assistance Service): 800/428-2525
P.O. Box 2525
Butte, MT 59702

11:C

WEATHERSTRIPPING

Heat loss in a home can be attributed to radiation, conduction and convection. One type of convective heat loss is infiltration, where air leakage is due to cracks and openings in a structure's thermal envelope. In a typical home, infiltration through air leaks can amount to 50 percent of total heat loss.

As a building settles over time, and as materials expand and contract from temperature and humidity changes, cracks develop in the shell of a structure. These cracks usually occur around window and door frames, at corners, and wherever two dissimilar building materials meet. These sources of cold air infiltration can be treated with some simple home repairs and easy-to-work-with materials such as caulking and weatherstripping. It is generally installed around openings to unheated areas, including unheated basement entrances, garage doors, and attic access openings.

While caulking should be used between two non-movable materials, weatherstripping is needed at operable openings such as windows and doors.

Weatherstripping or caulking is needed when:

- An operable window moves and rattles when it is in a closed position.
- A length of thread or bathroom tissue indicates air movement through a crack.
- Indoor light can be seen through a crack from outside the house.
- A piece of paper slides easily through a closed opening.

Weatherstripping is made from narrow strips of metal or plastic, and is held in place with nails, staples, or adhesives. Characteristics of the various types available at home centers and department stores are listed in the following chart. Most packages include installation instructions.

WEATHERSTRIPPING MATERIALS

<u>Type</u>	<u>Service Life</u>	<u>Characteristics</u>
Self-adhesive foam	1-2 years	Easy to install; limited durability.
Felt	2 years	Inexpensive and easy to apply; limited durability.
Rolled vinyl or tubular gasket (May have metal backing)	5 years +	Visible when applied; must make contact for proper seal.
Tension spring plastic ("V" strips)	5 years +	Easy to apply; has adhesive backing.
Tension spring metal ("V" strips)	5-10 years +	Good for uniform openings. Flexible along its length for larger openings.
Door Sweep (metal backing, vinyl edge)	5 years +	Easy to apply; vinyl is flexible over adjacent flooring materials.
Vinyl bulb door threshold	5 years +	Flexible vinyl adjusts to lower door openings. Bulbs are available for the lower edges of doors.
Nylon brush-type (fin seal)	5 years +	Used to replace worn weatherstripping on aluminum windows and doors and triple-track storm windows.

Written by Trudy Wythe, Graduate Student Intern, and Joe Laquatra, Extension Associate, Department of Design and Environmental Analysis.

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CAULKING COMPOUNDS**11:D**

As a house settles over time, and as building materials expand and contract from temperature and humidity changes, cracks develop in the building shell, or thermal envelope. These cracks are typically located at seams, edges, and corners -- including those around windows and doors -- as well as wherever 2 dissimilar building materials meet. Other leaks in the thermal envelope may occur at cable or pipe entrances. Wherever they are located, these openings result in an uncontrolled rate of air infiltration between the inside and outside, and can account for up to 55 percent of a home's annual heating requirements.

Caulking compound is an easy-to-use building material that effectively seals cracks and holes in the building shell. Temperature guidelines listed on the cartridge need to be followed for optimum adherence to materials. A variety of caulks for different surfaces is available in disposable tubes. A gun-type mechanism holds the tube as it dispenses a bead of caulk through a tapered plastic nozzle (Figure 1).

Caulking should be applied wherever two building materials come together and form a crack less than 1/2-inch wide. Caulk adheres best when the depth of a crack is half its width or less. Possible locations include:

FIGURE 1

- around doors and window frames (inside and out)
- between foundation and sidewalls (sill plate)
- around utility service entrances and outdoor water faucets
- cracks in brick, stucco and foundation walls
- around vents and fans.
- places where brick and siding meet
- joints between chimney and siding, around flashing
- around mailchutes
- corners and joints between siding pieces
- around clothes dryer vents as they pass through outside walls
- around an air conditioner.

TYPES OF CAULKS

Tubes of caulking are available in seven basic chemical compounds. The following chart lists properties of these materials and differences among the various types. Like many other products on the market, caulks can vary somewhat within chemical classes. Always read instructions on the product before purchase to make sure the product is appropriate for its intended use.

<u>Caulking Compound (Cost)</u>	<u>Service Life*</u>	<u>Flexibility/ Elasticity</u>	<u>Comments</u>
Cord caulk (low)	1-2 years	high	<ul style="list-style-type: none"> . applied by hand to cracks that will be sealed for a length of time. . works well if refrigerated first. . dries out over time, can be re-used.
Oil-based (low)	1-5 years	very low	<ul style="list-style-type: none"> . used in easy to reach places. . can be painted after cured. . oil can stain. . loss of oil eventually causes loss of adhesive. . low resistance to sunlight.
Butyl rubber (moderate)	4-10 years	low	<ul style="list-style-type: none"> . adheres to a wide variety of surfaces. . low resistance to sunlight. . check tube to see if it can be painted. . possible high shrinkage. . cleans up with mineral spirits or naphtha. . high moisture resistance.

Acrylic latex (low to moderate)	3-10 years	very low	<ul style="list-style-type: none"> . cleans up with water. . paintable. . easy to apply. . not good on metals. . 1/4" to 3/8" joints. . limited to indoor uses in low-moisture areas.
Acrylic latex w/silicone (moderate)	20-30 years	high	<ul style="list-style-type: none"> . adheres well. . does not need a primer usually. . good outdoors for joining similar build-material. . paintable. . cleans up with water. . good general purpose caulk.
Polyurethane (moderate to high)	20-30 years	high	<ul style="list-style-type: none"> . very little shrinkage. . abrasion resistant. . forms strong bond - good on plastics and masonry. . primary use is in flexible joints. . not for use with polyethylene vapor barriers. . good surface preparation necessary for strong bond. . low resistance to moisture and sunlight.
Silicone (high)	20-30 years	high	<ul style="list-style-type: none"> . flexible (even at low temperatures) . stands up well to moisture and sunlight.

- . sticks well to most materials except concrete.
- . paintable silicones available.
- . can be applied at low temperatures to dry surfaces.
- . not recommended for pressure treated wood or some vinyls.
- . some are mildew resistant.

Ethylene
copolymer
(moderate)

10-20 years high

- . similar properties as silicones except: somewhat less flexible, not good with plastics, somewhat lower resistance to moisture and sunlight.
- . paintable.
- . can be applied in cold temperature.
- . mildew resistant.
- . paint thinner or cream-type hand cleaner used for clean-up.

* Assumes proper application and maintenance

Urethane foam is available in pressurized cans, and is suitable for sealing cracks or openings wider than 1/2-inch. Foundation sillplates and window and door frames are examples of locations where it can be used.

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ENERGY-SAVING WINDOW TREATMENTS

Windows are a major source of heat loss but, of course, they are necessary for light, ventilation, and view. In a typical single family home, 25% to 35% of the heat is lost through windows.

A single pane window loses 20 times as much heat as the same area in an adjacent well insulated wall, and a double-glazed window loses ten times as much. However, windows can be a source of solar heat gain if they are strategically placed and properly installed and if energy efficient interior window treatments are used.

The addition of insulating treatments to windows is very cost-effective and should be the next step after the following measures have been taken: turning back the thermostat at night from 68° to 60°; adding insulation to uninsulated ceiling (to R-19) and walls (to R-11); adding storm windows to single glazing; and caulking and weatherstripping all crevices. Also, the heating system should be properly maintained for peak efficiency.

Some of the heat loss through a window is due to infiltration of cold air around the window. This can be reduced by caulking and weatherstripping. These measures are very cost-effective and will help ensure the success of insulating interior treatments.

Window heat loss also occurs through radiation, convection, and conduction. Radiation is heat passed from a warm object to a cooler object. Heat always moves from warm to cool. If you are near a bare cold window, your body heat will radiate to the cooler window, making you feel cold.

Convection is heat transfer through a fluid such as air or water. Air infiltration through cracks around the window increases convective air movement and heat loss. This explains why caulking and weatherstripping to reduce air movement also reduce heat loss.

Conduction is heat transfer through solids. Glass is a good conductor of heat and therefore a poor insulator. Heat readily passes through glass. All types of heat loss can be reduced by using insulating treatments on windows. In cold climates such as New York State, heat loss in winter is the major concern, although energy also may be saved by reducing solar heat gain in the summer.

Methods of Reducing Window Heat Loss

After caulking and weatherstripping have been completed, the use of double-glazed or storm windows should be considered. A double-glazed window loses only half the heat of a single-glazed window and is cost effective. Triple glazing reduces the heat loss another 30 percent but usually is not cost-effective. Each additional layer of glass reduces the solar heat gain. For cold climates, the most energy-efficient window is double-glazed with an R-5 interior movable treatment. (R-value represents resistance to heat loss. The higher the R-value, the better the insulating value of the material.) On south-facing windows the treatment should be opened during the day for solar heat gain and properly closed at night. Treatments on north windows may be left closed 24 hours a day for increased efficiency.

A variety of interior window treatments, if properly installed and used, can be effective in reducing window heat loss. Included are roller shades, draperies, insulating Roman shades, venetian blinds, and insulating panels or shutters. Some are more energy efficient than others. The choice depends of the location of the window, the use of the room, the aesthetics, the effectiveness and cost, and thus the payback period.

To be effective, all window treatments must trap and hold air between the treatment and the window. To accomplish this the treatment must be tightly fitted at all edges and about one inch from the glass.

A. Roller Shades

The common roller shade that has been in use for many years is a very effective energy saver, when properly installed. The effectiveness is due to the shade's ability to block air flow and to form an insulating layer of air.

A conventional roller shade mounted inside the frame with no more than 1/4 inch gap at the sides and touching the sill will reduce heat loss by about 27 percent. By adding side tracks the efficiency may be increased to 45 percent, but the cost of adding the track may not be cost-effective. An inside-mounted shade with a reflective coating also may be 45 percent effective.*

To be most efficient, a window shade must be 1) installed with side tracks for a tight fit, 2) place one inch from the glass (inside mount), and 3) covered with a reflective material facing the glass. A shade meeting these conditions will be approximately 55 percent effective.

The reflective material made of uncoated aluminum such as Foylon, is more effective than aluminized polyester film or fabric that has a plastic coating over the aluminum.

*The percent effectiveness indicates the heat loss reduction achieved when the window treatment is installed over a single-glazed window (R-1).

The opaqueness or translucency of the shade can contribute to its efficiency. An opaque shade will be slightly more efficient than a translucent shade.

Shades on a sunny window should be raised in winter to permit solar heat gain in daytime, then lowered at night to prevent heat loss. Just the opposite is true in summer.

B. Draperies

Conventionally hung or unsealed draperies are not efficient energy savers. They will reduce window heat loss no more than 10 percent. This is due primarily to the movement of air by convection through the "tunnel" between the drapery and the glass. Warm air enters at the top of the drapery, moves toward the floor as it is cooled by the glass, enters the room and is warmed,

then rises and repeats the cycle. To be more efficient, draperies should be sealed at all four edges.

This may be accomplished by closing the top to reduce heat loss by the "tunnel" effect, sealing both sides, permitting the drapery to touch the sill or floor and having a four inch overlap at the center. This type of installation will reduce heat loss by convection. Experiments have shown that lined draperies installed in this manner will be up to 25 percent effective. This method of installation is more important in reducing heat loss than the type of fabric, although the fabric must have low air permeability, meaning that little or no air could pass through the fabric. A separate lining is recommended because the incorporated layer of air has some insulating value.

A closed top cornice installed over the top of the drapery is one way to reduce heat loss by the tunnel effect. The cornice may be covered with the drapery fabric, with wallpaper, or it may be stained or painted.

To take advantage of solar heat gain, the drapery should be opened during the day and closed at night to prevent heat loss.

An inside-mounted roller shade, installed as previously described, in combination with sealed draperies, would yield an R-value of 1.6, including a single pane window. This translates to about 40% effective. Because of their high cost and low R-value, draperies are not as cost-effective in energy savings as other treatments.

If a warm air register is below the window, the warm air should be prevented from entering between the drapery and the glass. A metal or plastic deflector can be placed over the register to direct the air out into the room. A deflector may also be used over a radiator, although this heat is not moving as fast as forced air heat.

C. Insulating Roman Shades

Insulating Roman shades offer another choice for energy efficient interior treatments. These consist of flat pieces of fabric with rings sewn on the back and operated with a pull cord causing the fabric to stack in horizontal folds at the top of the window when the shade is open. They consist of a center layer of insulating material, a vapor barrier on the room side, a decorating fabric on the room side and a lining on the back. The shade should be sealed at the sides, top, and bottom. For greatest efficiency the seals must be continuous - not just sealed at intervals. A hinged 1" x 2" wood clamp at the sides makes an effective seal. This shade can be as high as 60-75 percent effective, with an R-value of approximately 4.

D. Venetian Blinds

Standard venetian blinds are not effective in preventing heat loss. They do, however, allow excellent control of daylight and ventilation. Some manufacturers are making blinds with insulated interlocking slats that are more energy efficient, but very expensive.

E. Insulating Panels and Shutters

Insulating panels and shutters are another window treatment option. Panels are removed from the window and stored elsewhere or left in place over the window continuously for the heating season. They can be used where daylight, view, and ventilation are not as essential as reducing heating loss. Shutters are attached to each window frame and remain in place whether opened or closed. The hardware and design are variable: hinged with center opening, hinged with side opening, hinged with top or bottom opening; bifold; or sliding. The choice of hardware and design is determined by the window size, shape, and location in the house.

Insulating shutter and panel materials vary tremendously. Unlike other insulating options described previously, they are usually rigid and are

often made of common building materials. Do-it-yourselfers will find that simple carpentry skills and hand tools are necessary to build this type of window treatment.

A typical insulating shutter or panel might consist of a center insulating core made of rigid foam boards; a bag of cellulose or other loose-fill insulation; or even a series of insulating materials and air spaces.

This insulating core may be covered on both or one side by a sheathing material that gives the shutter or panel rigidity and strength. Sheathing materials include plywood, hardboard, and other thin rigid materials. Next, on the side of the panel/shutter that faces the room, a vapor barrier is added. Finally a decorative material is applied.

The insulating panel or shutter materials are usually encased in a framework made of wood or extruded plastic. This provides strength, rigidity, and a means for attaching hardware and weatherstripping.

REMOVABLE

CLIP-ON

The R-value of this type of insulating window treatment varies tremendously and may be as high as R-10, or about 90% effective. A typical R-value is 4.0 which provides 75% effectiveness. The total R-value of the shutter/panel is found by adding the separate R-values of materials and incorporated air spaces.

F. Commercially Available Window Treatments

A variety of energy-saving window treatments is available commercially. In general they fall into three categories; glazing treatments, operable products, and nonoperable panels.

Glazing treatments resemble a second layer of glass and have similar R-value. The Insider is one example.

Operable products are those that can be opened and closed daily. The Insulating Curtain Wall, R-10, and Window quilt, R-4, are examples of roll-down treatments. Shutters are another type of operable treatment, with R-values from 9 to 14.

Nonoperable panels are those that stay in place during the heating season. One example is Nightwall, with R-3.7 value.

Before choosing a window treatment consider the type of window, its location, the aesthetics of the treatment, the initial cost and the payback period.

The chart on page 6 shows a comparison of the efficiency of the different types of window treatments. Remember this:

TO BE EFFECTIVE A WINDOW TREATMENT MUST TRAP AND HOLD AIR BETWEEN ITSELF AND THE WINDOW

*The following instructions for making window treatments may be obtained from your county Cooperative Extension office:

*Fact Sheet 11:F	"Modifying Draperies to Conserve Energy" 15¢ each
*Fact Sheet 11:G	"Installing an Energy Efficient Roller Shade" 20¢ each
*Fact Sheet 11:H	"Making an Insulated Roman Shade" 20¢ each
*Fact Sheet 11:I	"Constructing and Installing Thermal Shutters and Panels" 20¢ each

**EFFECTIVENESS OF WINDOW TREATMENT
IN REDUCING HEAT LOSS**

(All treatments include a single pane window.)

	<u>Approx. Percentage of Reduction</u>	<u>Approx. R-Value</u>
Roller shade, inside mount, no more than 1/4" gap at sides.....	24-31 %	1.32-1.40
Roller shade, reflective coating, inside mount.....	45 %	1.8
Roller shade, side track, and/or 1" from glass (inside mount).....	40-45 %	1.67-1.8
Roller shade, side track, reflective coating, and 1" from glass (inside mount).....	55 %	2.22
Woven wood shade, inside mount.....	34 %	1.52
Drapery, conventionally hung on traverse rod.....	5-10 %	1.05-1.10
Drapery, tightly woven fabric, separate lining, sealed at all four edges.....	25 %	1.33
Venetian Blind.....	6-7 %	1.07
Roman Shade, 2 layers fabric, plastic vapor barrier and insulating material.....	65-75 %	3.0-4.0
Do-it-Yourself Shutter, insulating core, sheathing material, vapor barrier and decorative covering.....	75-90 %	4.0-10.0
Clip-on insulation board, 1/2" board, fiberglass batt insulation between board and window.....	75-90 %	4.0-10.0
<u>As a comparison:</u>		
Double glazing, bare.....	50 %	2.0
Wall, 3 1/2" fiberglass.....	94 %	16.6
Wall, 6" fiberglass.....	98 %	25.0

*To simplify information, trade names of products have been used.
No endorsement is intended, nor is criticism implied of similar products not named.*

*Thanks to Gwen Cukierski and Regina Rector, former Extension Associates,
for their assistance in preparing this fact sheet.*

Reviewed and revised, 1985 - Department of Design and Environmental Analysis

HOUSING Fact Sheets

HOUSEHOLD MOISTURE PROBLEMS DURING COLD WEATHER

14:A

Although human preferences and tolerances for desired humidity levels differ, some moisture in household air is necessary for comfort as well as for protection against problems caused by dryness, such as cracking and checking of wood floors and furniture; dry and itchy skin and mucous membranes; or static electricity in clothing and carpeting. At the same time, excessive humidity should be avoided as it can lead to problems such as:

- Moisture condensation on interior walls and in closets
- Mildew
- Musty odors
- Warping of windows and doors
- Peeling and blistering paint
- Rusted metal
- Rotted wood

CAUSES

Moisture problems in the wintertime are created by:

- The movement of moisture vapor from the warm inner surface of an exterior wall to its cold outer surface, causing moisture condensation within the wall cavity (Figure 1).
- Poor site drainage which creates damp or wet crawl spaces and basements.
- Lack of gutters and downspouts.
- Lack of exterior foundation drainage and waterproofing systems.
- Everyday household activities such as cooking, cleaning, bathing, and drying clothes.

Figure 1

RECOMMENDATIONS

Following are recommendations for controlling the amount of moisture which enters or is generated inside a house:

Vapor Retarders

These retarders (or barriers) usually consist of 6-mil polyethylene sheets, which are installed during construction or remodeling, between the finished wall and insulated wall cavity, or between the finished ceiling and attic insulation, and generally on the "winter warm" side of insulation installed anywhere in the building shell, (Figure 2). If a vapor barrier must be installed in a wall or ceiling with a finished interior surface, special vapor barrier paints or vinyl wallpaper can be used. Vapor barriers should also be installed over a crawl space floor and over a dirt basement floor. For more information, see *Housing Fact Sheet 14:F, Vapor Retarders In Residential Buildings*.

Figure 2

Passive Ventilation

Carefully sized openings in attics and crawl spaces allow for ventilation and circulation with outdoor air. Attics should have one square foot of vent opening for every 150 square feet of attic floor space, assuming a ceiling vapor retarder is used. A number of attic ventilation strategies exist, including soffit and ridge vents (Figure 3), gable vents (Figure 4), and roof ventilators (Figure 5). Crawl spaces should have one square foot of vent opening for every 1,500 square feet of floor area, with a vapor retarder installed over the floor.

Figure 3
Soffit and Ridge Vents

Figure 4
Gable Vent

Figure 5
Roof Ventilator

Source Control

As much as possible, control the production of moisture at its source. A bathroom should have an exhaust fan with a capacity of 50 cubic feet per minute (cfm); a kitchen range should have an exhaust fan, vented to the outside, rated at 100 cfm; and clothes dryers should be vented to the outside. Don't dry wet clothes inside the house, and store wood for a wood stove or furnace outside.

Basement leakage or seepage can be corrected by one or more of the following procedures:

Gutters and Downspouts; Lot Grading

Roof gutters and downspouts should direct water away from the house, so that rain water does not run along the basement wall. Downspouts can terminate at splash blocks, if the lot is properly graded, or they can be connected to a dry well. The house lot should be graded so that water runs away from it on all sides. Where this is impractical, swales (drainage ditches filled with gravel) may be necessary.

Drain Tile

Below grade, at the foundation exterior, a drain tile should be installed along the base of the footing and connected to a suitable outlet such as a storm sewer or dry well. This is done as a matter of routine in new construction; and although it is effective, it is an expensive treatment for an existing house. Interior drainage systems consist of a pipe installed along the perimeter of the basement floor and connected to a sump pit and pump. This system is less preferable than exterior treatment, because water is allowed to travel through the concrete or masonry wall to get to the pipe.

Waterproofing

Foundation walls should be waterproofed from the outside. When this is not practical, interior treatment is necessary. Key to successful application of a basement wall waterproofer is preparation of the wall, which usually involves brushing with a metal brush, and applying a coat of muriatic acid. Follow manufacturers' instructions carefully.

A CAPILLARY TEST FOR BASEMENT MOISTURE PROBLEMS

This section is adapted from *Moisture and Home Energy Conservation*, by the U.S. Department of Energy, 1983.

Basement moisture problems are not always the result of water leakage or seepage from the exterior. High indoor relative humidity or capillary rise of soil moisture (the upward movement of water through the soil), can also cause the problem. To determine whether excessive basement moisture is coming through the foundation walls or floor to the inside or whether moisture is coming from inside the dwelling itself, do the following:

1. Identify the damp interior surface. Note that testing of multiple locations on the floor or walls may be necessary to locate external sources of moisture.
2. Dry a portion of the damp area approximately 18 inches square. (A hair dryer can quickly dry this surface.) Note that lower areas below grade may be more prone to high moisture content.
3. Cover the dried area with a vapor retarder material, preferably polyethylene, firmly attached and sealed with tape around the edges (see Figure 6).

4. Check the underside of the vapor retarder after a couple of days. If there are beads of moisture under the vapor retarder, there is water seeping or wicking through the surface into the dwelling. However, if the vapor retarder is wet on the room side and dry underneath, the dampness is from another source of moisture, such as plumbing leaks, high relative humidity, or poor ventilation. The condensation is forming due to warm moist air cooled to its dew point by the cold masonry surface. It is possible for both sides to be damp indicating both external seepage and internal condensation problems.

NOTE: Sometimes the results of this test are difficult to interpret. Seasonal variations in surface water flow patterns and the ground water table can cause confusion. You may need to seek further professional advice.

Reviewed and revised, 3/90 - Department of Design and Environmental Analysis (JM/JL)

HOUSING Fact Sheets

VAPOR RETARDERS IN RESIDENTIAL BUILDINGS

14:F

This fact sheet discusses the function, selection, and placement of vapor retarders (also called vapor barriers) in both new and existing residential buildings.

FUNCTION

The function of vapor retarders is to reduce the diffusion of water vapor into walls, ceilings, and floors where it might condense into water droplets and cause damage (Figure 1). They help keep wall, ceiling, and floor insulation dry, and therefore help maintain insulating quality, prevent structural damage by rot or corrosion, and reduce exterior paint problems. Vapor retarders should be used in conjunction with proper house ventilation and source control of moisture (See *Housing Fact Sheet 14:A*).

Although vapor retarders are effective at reducing the diffusion of moisture through building materials, they do not prevent moisture transfer that results from *air movement*, which is controlled through careful sealing of cracks and other openings in the building shell.

Cold air holds less water vapor than warm air. In northern climates winter outdoor temperatures create a water vapor pressure imbalance between inside and outside. Because of this difference, water vapor will seek to migrate by diffusion through building materials. Air infiltration through cracks in the building shell also carries water vapor, which will condense if the air temperature drops below the *dew point*. The exact dew point temperature varies with the actual and potential amount of water vapor in the air, or *relative humidity* (Figure 2).

Figure 2

These drawings represent the same block of air at different temperatures. At 75°F the amount of water vapor in the air is only 30% of the amount that it can hold. When the same air is cooled to 42°F, that same amount of water vapor is all it can hold. The vapor begins to condense into water droplets.

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Surface condensation is visible, and often seen on windows. *Concealed condensation* can occur inside a wall, ceiling or floor cavity. Vapor retarders prevent or reduce concealed condensation, and sometimes change what would have been this type of moisture problem into visible surface condensation. This condensation can be remedied by proper ventilation and reduction of relative humidity in the house.

VAPOR RETARDER MATERIALS

The effectiveness of a material used as a vapor retarder is rated according to its *permeance*, or ability to allow water to pass through it. Commonly referred to as a *perm rating*, the lower this number, the better the material is at slowing moisture transfer. One perm equals one grain (or drop) of water per square foot per hour per unit of vapor pressure difference. While the *best* perm rating for a vapor retarder would be 0.0, allowing no moisture transfer, polyethylene films, which have extremely low perm ratings in the .02 to .08 range, are generally the material of choice.

Knowing the perm rating of a material is critical when choosing materials for walls. To allow the escape of any moisture that might pass through defects in the vapor retarder into the wall cavity, the outer skin of the wall should be at least *five times more permeable* than the vapor retarder. This 1:5 ratio should be applied when choosing a vapor retarder and also when choosing sheathing materials and finishes for the outer skin of the house.

Table 1 lists perm ratings for selected building materials. For a more complete listing of permeance of materials to water vapor, and for more information regarding permeance, permeability, and conversion to the International System of Units (S.I.), see the *ASHRAE Handbook of Fundamentals* (1985 edition), by the American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.

SELECTION

Although the selection of a vapor retarder material depends on whether it is being applied in new construction or remodeling, alternatives exist for either situation. Generally, 6-mil polyethylene is installed on the *winter-warm side* of an exterior wall, between the insulation and interior surface material. However, because the major moisture transport mechanism is thought to be *air movement*, not diffusion, a construction method known as the *Airtight Drywall Approach (ADA)* does not rely on the polyethylene layer. Instead, gypsum board is installed with carefully placed gaskets, resulting in no air leaks into the wall cavity. This approach may be advantageous for several reasons. It's difficult to install large sheets of polyethylene or other materials as vapor retarders without some minor punctures during conventional construction, which often results in air leaks into wall cavities. Even when such materials are successfully installed, house occupants may unknowingly rupture an installed vapor retarder with nails or screws used for hanging pictures or installing shelves. The effectiveness of a vapor retarder is greatly reduced if openings, even small ones, exist in the material. Effective retarders for existing construction include special paints (see Table 1).

Table 1
PERMEANCE OF SELECTED MATERIALS

<i>material</i>	<i>perm rating*</i>
Structural Materials	
brick masonry (4 inches thick)	0.8
gypsum wall board (3/8", plain)	50.0
plaster on wood lath (3/4")	11.0
plaster on plain gypsum lath with studs (3/4")	20.0
plywood (1/4", douglas fir, exterior glue)	0.7
plywood (1/4", douglas fir, interior glue)	1.9
Foils, Films and Papers	
aluminum foil (1 mil)	0.0
aluminum foil (0.35 mil)	0.05
polyethylene (4 mil)	0.08
polyethylene (6 mil)	0.06
polyethylene (8 mil)	0.04
polyethylene (10 mil)	0.03
saturated and coated rolled roofing	0.05
15 - pound asphalt felt	1.0
15 - pound tar felt	4.0
blanket thermal insulation backup paper, asphalt coated	0.4
Paints	
<i>commercial latex paints:</i>	
vapor-retarder paint	0.45
primer-sealer paint	6.28
vinyl acetate/acrylic primer	7.42
vinyl-acrylic primer	8.62
semi-gloss vinyl-acrylic enamel	6.61
exterior acrylic house & trim	5.47
<i>other paints</i>	
two coats enamel on smooth plaster	0.5 - 1.5
various primers plus 1 coat flal oil on plaster	1.6 - 3.0
three coats exterior paint (white lead and oil on wood siding)	0.3 - 1.0
three coats exterior paint (white lead zinc oxide and oil on wood)	0.9

Sources: ASHRAE Handbook, 1985 Fundamentals.

Moisture and Home Energy Conservation: How to Detect, Solve and Avoid Related Problems, U.S. Dept. of Energy, 1983.

*see page 2 for definition

Some wall systems in new construction include a vapor barrier retarder as an integral part of the insulator material. In such systems, a continuous vapor retarder is formed by the a foil, plastic, or other surface on the insulation itself, and the perm rating of the system will be established by the combined perm ratings of the insulation (if rated) and the material used as a vapor retarder.

PLACEMENT

Walls: A vapor retarder should always be provided on the winter-warm side of exterior walls of residential construction, including basement walls.

Crawl Spaces and Basements: A vapor retarder over the floor of an existing crawl space or basement (both concrete and earth floor) is also essential, because of moisture migration upward through the floor, which can result in dampness in the immediate area and throughout the house. A *heated crawl space* should have a vapor retarder on the winter-warm side of the insulation on the walls (Figure 3), as well as a layer of 6-mil polyethylene on the floor. An *unheated crawl space or unheated basement* should have the vapor retarder on the floor insulation facing toward the heated space above (Figure 4). If the insulation has no integral vapor retarder, install a separate, continuous one first. This can be installed between the floor insulation and subfloor or between the subfloor and floor. *This retarder does not preclude the use of one on the basement or crawlspace floor.*

Ceiling: A vapor retarder between a ceiling finish material and attic or ceiling insulation is essential for avoiding condensation problems. In addition, ventilation of these spaces is commonly relied upon as part of a moisture-control strategy. Recent research, however, suggests that ventilation of highly insulated spaces, such as attics or cathedral ceilings in superinsulated houses, may be unnecessary.

**Figure 3
HEATED CRAWL SPACE**

**Figure 4
UNHEATED BASEMENT**

Face vapor barrier toward heated space above.

Revised 3/89 by Joseph Laquatra, Assistant Professor, and James McCarty, Extension Associate.

HOUSING Fact Sheets

CONTRACTORS AND CONTRACT SPECIFICATIONS

Contracting for Home Improvements or Repairs

16:A

If you decide to undertake a home improvement or build a new house, or if circumstances require that you make a major home repair, you will likely need to hire a contractor. It is to your advantage to be informed about the economic and legal aspects of contracting for home improvements or repairs.

Why Hire a Contractor?

- Building contractors probably have more contacts in the building industry and are familiar with the sources of materials, supplies, and sub-contractors. In addition, they will be able to buy materials at a lower cost--sometimes 40 percent less as compared to the 15 to 20 percent discount which you might get.
- Contractors have a thorough knowledge of the building process, especially the sequence of building.
- They have managerial skills and knows how to pair people and materials on the job site at the proper time.
- In instances where work is subcontracted, they may have better working relations with subcontractors who prefer working for a contractor rather than an individual, since the subcontractors know the work will be on continuous basis.

If you do decide to undertake the project on your own, you will save on the contractor's commission. On the other hand, being your own contractor is a time-consuming process and actually may cost you more in the long run. Banks may be less responsive to your financial needs; they know from prior experience that when a home owner undertakes complete responsibility for the project, completion of the project takes longer and costs are higher than expected. Be sure that you have contacts readily available in the building industry and that you have both the time and the expertise required for the project.

Choosing a Contractor

It is important to know that what you want done before you begin contacting potential contractors; otherwise, you may end up with less than you need, or more than you can afford. Once you know what is to be done, there are several sources of information to help you--talk to friends and relatives, check the newspaper or the yellow pages, call your local public utility company or lender, check with your local

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material suppliers, or call the Chamber of Commerce or Better Business Bureau. In any event, contact more than one firm (at least three is recommended).

If your community requires that home improvement/repair contractors be licensed, make sure their license is current. Ask for credit references, as well as names of past customers. Did the contractors do quality work and stay within cost estimates? Are there excessive complaints on file at the licensing bureau, the local Consumer Affairs office, or the Better Business Bureau? Determine whether any of the contractors are members of professional organizations.

The Cost

After receiving initial cost estimates, get a precise estimate, or bid, for both costs and completion time from several contractors. Floor plans and specifications (specs) are the basis for bidding. Specifications describe:

- the work to be done.
- the materials to be used.
- the standards of workmanship.

The specifications should cover everything that the homeowner does not do himself.

Bids can be either a **firm price bid** or a **cost plus bid**. Each has its advantages and disadvantages.

If the cost is quoted as a **firm amount** of money for the entire project, the homeowner will know the total cost of the completed project. A disadvantage, however, is that inflation can lead to lower quality workmanship since the contractor might delete extras to avoid exceeding the allotted budget—or to broaden his profit margin.

The **cost plus bid** is preferred by most contractors since the buyer pays for all materials and labor, plus a 10 to 15 percent commission to the contractor. This arrangement gives the contractor no incentive to cut corners. A disadvantage, however, is that the contractor has no incentive to keep costs down either; the buyer should be sure that he does not receive more quality than he wants to pay for!

One way to reduce the cost of a contract is to employ "sweat equity," i.e., the buyer does some of the work, such as interior painting or installation of insulation. If you decide to utilize "sweat equity," you must complete your tasks before the contractor's deadline, or else you might cause delays in completion or create higher costs.

Be cost-conscious, but remember quality is worth something, too! The lowest bid is not necessarily the best bid. This may be a good time to consider the personality of the contractor. On large projects, you will be spending a lot of time with this individual and his/her subcontractors. The job will run more smoothly if you and the contractor share attitudes about punctuality, attention to detail, and how to deal with other people.

Door-to-Door Sales

Special caution should be taken with respect to door-to-door sales. Avoid "I was in the neighborhood." sales pitches, special deals such as discounts for each additional customer you obtain for the contractor, or prices suspiciously low.

Because of numerous abuses, the Federal Trade Commission (FTC) has established a three-day "cooling-off" period with respect to such sales. New York laws include similar provisions. Salespeople must provide the buyer with a "Notice of Cancellation" that can be mailed back to the contractor. There are some restrictions; for example, if you visit a permanent showroom, and then have a follow-up visit by a salesperson in your home, the rule does not apply.

Fees/Permits/Inspections

A contractor is not necessarily responsible for obtaining the required permits, variances, or inspections. It is a good idea to have the contract make him (or someone) so responsible. Call the Building Department of the city or county to find out what is needed. For many projects, an architect's fee might be an excellent investment; the architect knows what requirements must be met, is qualified to evaluate the quality of the work in progress, and can insure code requirements are satisfied.

Make sure that permits and inspections are gotten, even if this is the contractor's responsibility. According to a representative of the New York Attorney General's Office, people have been defrauded or at least disappointed by contractors starting unauthorized work.

The Contract

The written, signed contract is both your main source of protection and at the same time the main source of problems with home improvement or home repair. A lawyer should be consulted if you have any doubts, and should look over the contract before you sign. A lawyer's fee of a few hundred (or even thousand) dollars is not that much to pay if you stand to lose a great deal more than that.

Read the contract--all the contract--carefully. That contract will become legally binding on both parties. Avoid vague wording. The more specific the contract, the better.

Pre-printed contracts can be altered or amended. If you alter such a contract, have both your initials and the contractor's initials by any changes. Pre-printed forms will probably not favor the buyer.

If the household is Spanish-speaking, the contract should be in Spanish, or in both Spanish and English (with a clause to state which language should be binding in cases of misinterpretation). Make sure you receive and keep a complete copy of the contract.

New York has few laws that specifically require certain consumer safeguards to be in a contract, so be careful. Specific items to watch for in a contract include:

- Complete job specifications: they should be detailed and specific.
- Any extras or promises made verbally should be written into the contract.
- Time schedule for work should be included—some flexibility is required, but avoid excessively broad reasons for delay. A good idea is to tie payments to stages of the work process, and include the work-payment schedule in the contract.
- Cost of the job should be spelled out in the contract.
- Arrangement for certain types of insurance must be included in the terms of the contract. Make sure that liability, comprehensive, fire, property damage, and workmen's compensation insurance is provided by either you or the contractor. The contractor must provide workmen's compensation, but expenses for liability insurance against property damage and injury is often paid jointly. If the homeowner is about to undertake only minor improvements, he or she notifies his/her insurance agent to increase the value of his/her homeowner's policy to cover these improvements. If he/she is about to undertake a major remodeling project or build a new house, he/she obtains a "builder's risk completed value form" for insurance which is increased in value as the project is completed. Require the contractor to provide a certificate of insurance protection for all insurance for which he/she is responsible.
- Warranties and Notices of Cancellation should be explicitly stated.

Recommended contract items to protect the consumer include:

- Complete description of work to be done and materials to be used.
- Specific starting and completion dates. Penalties for late completion. As an example, require the contractor to post a performance or completion bond; if the contractor does not complete the project satisfactorily, the bonding company would obtain another contractor under the same contract terms to complete the job.
- "Hold-back Clause"—allows final payment to be delayed until 30 days or so after work is completed; this allows the buyer to check out the quality of the work, give the contractor an incentive to correct bad work, and protects the consumer from problems caused by the contractor not paying his bills.
- Recognition that the contractor is responsible for obtaining permits, variances, and inspections.
- Protection against liens. If the contractor fails to pay a subcontractor or a materials supplier, a lien can be filed by these other parties to take back the buyer's property as payment (called a mechanic's lien). The contract should at least warn the buyer about these liens; preferably, the contract should require the contractor to either provide the homeowner proof he has paid all

suppliers and subcontractors, or else post a bond to cover any claims by suppliers and subcontractors.

- Protection against unreasonable charges if the buyer cancels the contract after the cooling-off period has passed.

New Law for Home Improvement Contracts

Effective March 1, 1988, home improvement contracts will be regulated under a new state law (Chapter 421, NYS Laws of 1987). The new law requires that home improvement contracts over \$500 be in writing and contain various specified provisions. It also requires down payments and progress payments be placed in escrow, unless a bond is posted or indemnity contract is signed.

Home improvement is broadly defined as repairing, remodeling, altering, converting, modernizing, or adding to residential property. It specifically includes the construction, erection, replacement or improvement of the following things:

driveways	windows	porches
swimming pools	terraces	garages
siding	patios	heating and air conditioning fixtures
insulation	landscaping	solar energy systems
roofing	fences	flooring and basements

The improvement may be made to residential property itself or to the structures or land adjacent to it. Certain goods and services purchased in connection with home improvement are also covered under the new law. These include:

- burglar alarms
- texture coating
- fencing
- air conditioning
- heating

Specifically excluded from the definition of home improvement under this law are each of the following:

- the construction of a new home;
- goods purchased from a seller who does not install or arrange and install them for the buyer;
- the sale or installation of removable appliances that do not alter the premises; and
- the sale or installation of decorative goods and services, such as carpeting or draperies.

The New York State Builders Association sells a booklet which includes a copy of the law, a more detailed description of it, and a sample home improvement contract. Contact the NYSBA at: 112 State Street/ Suite 1318, Albany, New York 12207.

Credit/Financing

Home improvements or major home repairs often require large sums of money. Hence, credit is often needed to finance the job. Sources of credit include commercial banks, savings bonds, Savings and Loans, Credit Unions, finance companies, or the contractor him or herself. The federal government will insure some home improvement loans through their Title I HUD-FHA program. State programs exist to finance home improvements, particularly for energy conservation. Other programs are available for large multi-family units.

Contractors can often arrange financing, or will finance improvements themselves. Be sure that credit through the contractor is at competitive rates and terms. Any credit extended for home improvements or repairs--including credit provided by the contractor--is subject to the Truth-in-Lending laws.

Home improvement or remodeling loans often require a lien be placed on the structure. In other words, you may be required to pledge your home as security for the loan. (Similar to a second mortgage on a house). The Truth-in-Lending law requires you be given a three business-day right of rescision on the contract for the loan if a lien is to be placed on your home. This right of rescision is independent of and different from the right to cancel a contract arising from a door-to-door sale.

Specifics of the Right of Rescission include:

- The creditor is required to inform you of this right, and must provide you with a name and address to which your rescission (cancellation) can be mailed. You must be given a form that you merely sign and mail in order to rescind.
- The contractor cannot start work until the rescission period has expired (to include reasonable time for the mail to be delivered). Nor can the contractor or creditor spend any money advanced to him before the rescission period has passed.
- If a customer rescinds, any down payment or earnest money paid must be returned to him within 10 days of receipt of the rescission notice by the creditor.
- The Right of Rescission can be waived, but only if the following conditions are met:
 - a. The credit is needed to meet an immediate financial emergency of the customer.
 - b. The customer has determined that a delay of three business days will jeopardize the welfare, health, or safety of persons, or endanger the property of the customer.
 - c. The customer gives the creditor a handwritten dated and signed statement of the situation and his or her waiver of the right to rescind the contract. [Section 226.15, Regulation 2, Federal Trade Commission]

Payments during the work process should be tied to performance standards (e.g., passing an inspection, or completion of a given stage of the work). This should be part of the contract. Final payment should not be made until all work is completed.

Follow Up and Redress

It is important to obtain written warranties or guarantees for both materials and workmanship. If something goes wrong, or if the work is defective, contact the contractor first. Give the contractor a chance to correct the problem. If no satisfaction can be obtained, try the local Consumer Affairs office, the bureau which licensed the contractor, the Attorney General's office, or if necessary, get private legal help. Disputes can be settled with the help of the local Better Business Bureau, a community dispute resolution center or with the small claims court. The important thing is to deal with problems early. Follow up as soon as you can.

References and Resources

Federal Reserve System, Board of Governors. Truth In Lending: Regulation Z (amended to April 1, 1981).

Federal Trade Commission, "Trade Regulation Rule Concerning a Cooling-Off Period for Door-to-Door Sales," effective June 7, 1974.

"Home-Improvement Contracts: How to Protect Yourself," Consumer Reports (February, 1978), pp. 74-77.

New York State Consumer Protection Board, "Home Improvements Without Headaches." (including a model contract), revised to 1984.

"Working With General Contractors," Consumers' Research (September, 1985) pp. 35-37.

New York State Department of Law, Attorney General's Office, "Consumer Guide to Home Improvements," January, 1982.

Chapter 421, Laws of 1987, NYS, effective March 1, 1988.

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