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RESEARCH PROJECTS IN RESIDENTIAL TECHNOLOGY

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RESEARCH PROJECTS IN RESIDENTIAL TECHNOLOGY

ABBREVIATIONS

EPA The Environmental Protection Agency

DOE The U.S. Department of Energy

MCS The Model Conservation Standards. These standards were developed by the Northwest Power Planning Council to reduce electric energy use in new buildings.

NWPPC The Northwest Power Planning Council. It was created by Congress to coordinate and plan for the region's electric energy needs.

RCDP The Residential Construction Demonstration Project. This project was developed to test new methods of meeting the Model Conservation Standards for new residences.

RSDP The Residential Standards Demonstration Program. This program, now completed, was designed to demonstrate that the Model Conservation Standards could be used in new residential construction and determine the energy savings and additional costs.

INTRODUCTION

This booklet provides a brief description of both completed and ongoing research and development projects assigned to the Residential Technology Section. It describes the objective and results of each completed project along with a report title and contact person for each project for more information. For ongoing projects, the objective, the anticipated results and completion date, and a contact person are provided.

The Residential Technology Section is one of three sections under Bonneville Power Administration's (BPA) Residential Programs Branch (RMR). The section performs research and technical analysis for RMR's other two sections--New Residences Section and Existing Residential Section. These two sections oversee programs for energy-efficient new home construction and weatherizing existing homes.

Residential Technology Section projects are presented here in three groups:

- completed studies in the RSDP,
- ongoing projects in the RCDP, and
- assorted research and development projects.

Reports with a DOE document number can be obtained by calling the Residential Technology Section's secretary at 230-5488. Reports lacking a DOE document number are available from the contact person listed after the report summary.

RESIDENTIAL STANDARDS DEMONSTRATION PROGRAM

The RSDP was initiated in 1983 to demonstrate that electrically heated homes could be built to new energy-efficient standards--Model Conservation Standards--developed by the Northwest Power Planning Council. For comparison, the program also included control homes built to current construction practices. It tracked building costs, energy use, and other characteristics of both groups. Home construction for this program ended in 1986.

Data collected in the program underwent a series of analyses. The following reports contain these analyses.

Preliminary Air-to-Air Heat Exchanger Testing Results (DOE/BP-584)

Objective: To assess the performance of air-to-air heat exchangers in MCS homes.

Results: Air-to-air heat exchangers ventilate buildings by exchanging stale, indoor air for fresh outdoor air while transfering heat from the warm exhaust air to the cooler fresh air. The study found that the 227 air-to-air heat exchangers tested in the RSDP exchanged only half as much air, on average, as claimed in their design specifications. After results were published, though, it was found that this deficiency may have been exaggerated by the measurement method used in the study.

Homeowners were generally well satisfied with the units, though some complained of cold air drafts. The median installed cost of the units was $1,350.

BPA contacts: Philip Thor, (503) 230-3098 or Jeffrey Harris, (503) 230-3307

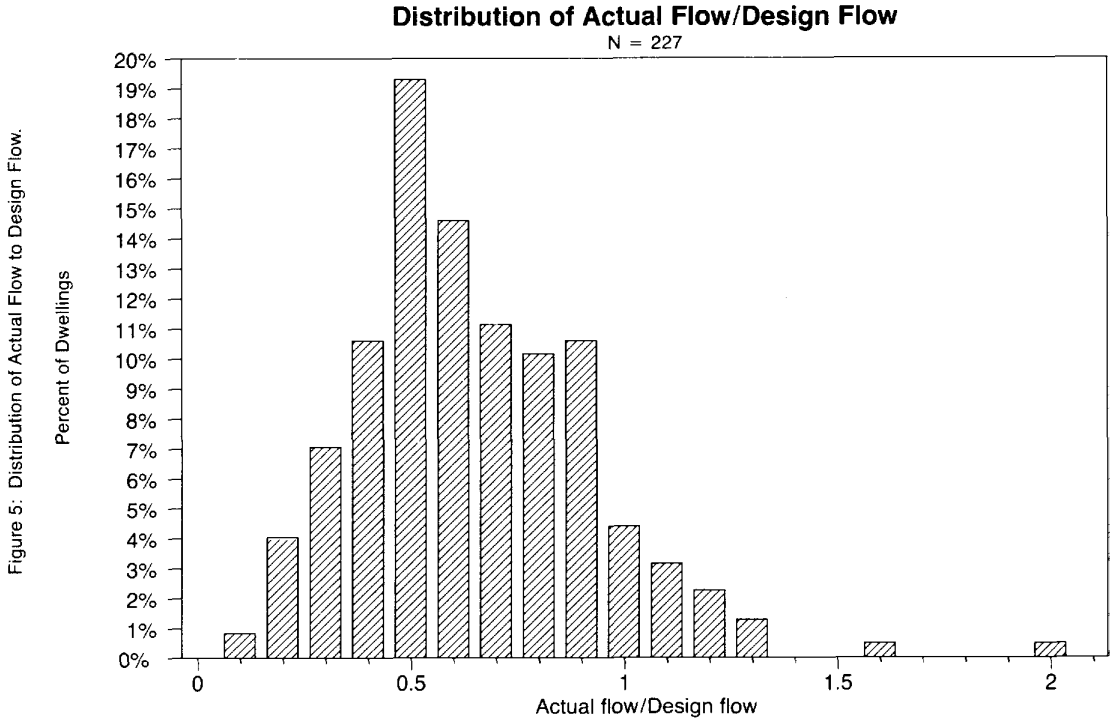

Figure 5: Distribution of Actual Flow to Design Flow.

Builder Cost Analysis (DOE/BP-20521-1)

Objective: To measure the added costs of building energy-efficient homes.

Results: Using data submitted by builders of MCS homes, this study determined the median added costs for energy-efficient homes in four states and three climate zones. Total added costs ranged from $2.15 per square foot of floor area in Idaho, to $3.35 per square foot in Oregon. However, since the energy-efficient design of these homes usually exceeded the MCS, costs were higher than for homes achieving but not exceeding the MCS.

The study also determined added median costs for specific building components in MCS homes. These ranged from no added costs for basement walls, to $2.64 per square foot for windows. Added per square foot costs for doors were $0.92; walls, $0.60; ceilings, $0.34; floors, $0.25; and air infiltration barriers, $0.12.

Also of interest, the report lists per square foot costs of altering current practice to MCS practice for specific building components and situations.

For example, the average cost difference between a standard-truss attic with loosefill R-30 insulation and the same type of attic with R-38 insulation is $0.11 per square foot of ceiling.

BPA contacts: Philip Thor, (503) 230-3098 or Jeffrey Harris, (503) 230-3307

Builder Exit Survey (DOE/BP-676)

Objective: To characterize the attitudes, problems, and practices of builders of MCS homes.

Results: Though medium and large-sized builders were 23 percent of those surveyed, they accounted for 71 percent of the homes built by the survey group in the last 5 years. Large builders, however, tended to be somewhat negative about the program, while small and medium-sized builders were generally positive. This was consistent with the small-to-medium sized builder's greater willingness to continue building better insulated and more energy-efficient homes.

Before the RSDP, 39 percent of the builders surveyed had used insulation levels equal to or greater than those required by the MCS. However, few builders had previous experience with air-to-air heat exchangers.

In general, builders felt their experience in the program would help them reduce future costs of building energy-efficient homes. Large builders were not as sure they could reduce costs. The results are not typical of builders in general because those with previous experience building energy-efficient homes were probably over-represented in the program.

BPA contact: Mark Johnson, (503) 230-7669

Thermal Analysis (DOE/BP-13795-18)

Objective: To compare the energy needed to heat MCS homes with that needed for control homes built to current practice.

Results: Information was gathered from more than 500 RSDP homes. The study's major conclusion was that MCS homes used 45 percent less space heat than control homes.

This report also contains a valuable spreadsheet summarizing information on all RSDP homes--their location, floor area, number of occupants, indoor and outdoor temperature, and other characteristics.

BPA contacts: Philip Thor, (503) 230-3098 or Jeffrey Harris, (503) 3230-3307

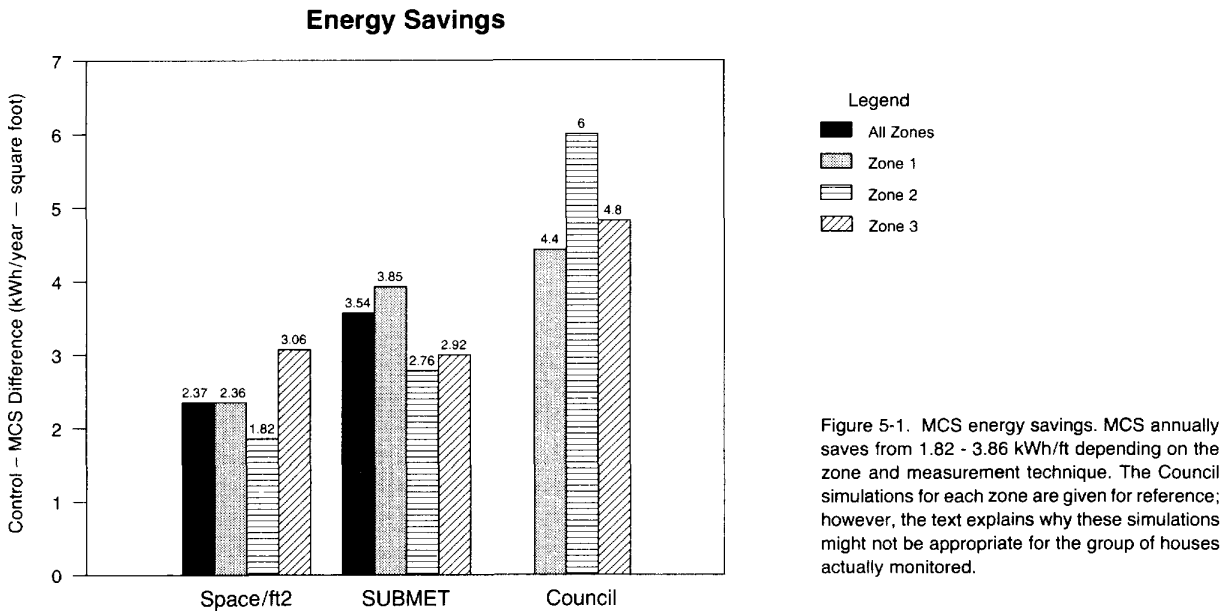

Figure 5-1. MCS energy savings. MCS annually saves from 1.82 - 3.86 kWh/ft depending on the zone and measurement technique. The Council simulations for each zone are given for reference; however, the text explains why these simulations might not be appropriate for the group of houses actually monitored.

Thermal Performance (DOE/BP-13795-16)

Objective: To compare energy consumption in a group of homes built to the MCS, with a group of closely matched control homes built to current practice.

Results: The study presents a detailed analysis of a small subset of MCS and control homes. Under the End-Use Load and Conservation Assessment Project (ELCAP), homes were monitored far more extensively than other RSDP homes. Several techniques were used to measure thermal performance, that is, the relationship between kilowatt hours consumed and interior temperature achieved in the home.

For the group of homes studied, MCS homes required less energy to heat than control homes. However, because of the small number of homes in the study and drawbacks in the sampling technique, results are not conclusive regarding MCS and control homes in general.

BPA contacts: Philip Thor, (503) 230-3098 or Jeffrey Harris, (503) 230-3307

Solar Access Report (DOE/BP-1098)

Objectives: To compare solar access of MCS homes with that of control homes built to current practice; to compare solar access of RSDP homes in different states and climates; and to determine whether exposure to the sun affected the amount of energy used to heat RSDP homes.

Results: The study found that MCS homes as a group had slightly better solar access than control homes. For all RSDP homes, solar access improved in the colder climate zones.

Overall, RSDP homes with good solar access used 10 percent less electricity for space heating than homes with poor solar access when the shading effect of various building features was accounted for in defining solar access. However, when the definition of solar access accounted only for site characteristics, homes with "good" and "poor" solar access differed minimally in the amount of energy used for heating. This suggests that building characteristics are as important as site characteristics in reducing heating costs through solar access.

BPA contact: Mark Johnson, (503) 230-7669

Final Formaldehyde Testing Results (DOE/BP-993)

Objective: To test and compare formaldehyde levels in MCS homes and control homes built to current practice, and compare overall formaldehyde levels in different states and climate zones.

Results: Final testing in this project confirmed earlier observations that formaldehyde levels vary in different climatic zones and between states. Homes in colder zones generally have higher formaldehyde levels; differences in building codes and construction techniques and using materials containing formaldehyde may also be contributing factors. Results confirmed the highest formaldehyde levels in indoor air in new homes. These levels decrease over time as gas is released from materials. By the second year there was no statistically significant difference between new MCS homes and older control homes.

Formaldehyde is commonly found in the glues and plastic foam used for home construction materials and furniture. Formaldehyde gas can be given off by materials in new homes, affecting indoor air quality. For the 876 RSDP homes tested, the median formaldehyde level was lower than any standards public health agencies have proposed for indoor air.

BPA contact: Philip Thor, (503) 230-3098

Final Radon Testing Results (DOE/BP-976)

Objective: To compare radon levels in MCS homes with those in a control group built to current practice.

Results: Within four states and three climate zones the study compared radon levels in homes from both groups. It also compared radon levels across locations.

Location was found to affect radon levels much more than whether or not a home was built to the MCS. Radon levels in the MCS and control homes did not differ significantly in any state. Levels were highest in the coldest climate zones, and higher in Montana and Idaho than in Washington and Oregon. Ten percent of the homes had radon levels above BPA's action level--the level at which BPA offers mitigation assistance to homes in its weatherization program.

BPA contact: Philip Thor, (503) 230-3098

Control Home Characteristics (DOE/BP-990)

Objective: To investigate thermal characteristics of current practice control homes used as a reference in the RSDP, and determine the insulation levels of their windows, doors, ceilings, walls, and floors.

Results: More than half the RSDP control homes were less than 5 years old in 1985, and 49 percent had one story and no basement. Approximately three-quarters of the homes were built with a standard-framing attic ceiling, standard-framing stud walls, crawlspace floors, single or double-glazed aluminum sliding windows, and solid, wood-core exterior doors.

The average insulation level for control-home ceilings was R-30 with R-11 for floors, exterior walls, and basement walls. However, since only 14 percent of the houses in the sample had a basement, basement findings may not be typical of current construction trends.

BPA contact: Albert Lou, (503) 230-5475

The Occupants of Residential Standards Demonstration Homes: Are They Unique? (DOE/BP-635); Occupant Survey Analysis (DOE/BP-13795-17)

Objective: To compare the occupants of MCS homes with those of homes built to current practice, and determine whether differences in the occupant's energy-related behavior could distort comparisons of energy efficiency between the two types of homes.

Results: The MCS and control-home occupants were generally similar in household size, ages, employment patterns, number of major appliances, and attitudes.

However, important differences did emerge which could affect comparisons of energy efficiency. Though they had purchased more energy-efficient homes, MCS occupants did not exhibit energy-efficient behavior. They were more likely to have air-conditioners, less conscientious about closing off rooms when heating, and set thermostats an average 1.3 degrees higher than control-home occupants. Such behaviors tended to counteract the greater energy efficiency of MCS homes.

Occupant surveys also gathered information not obtained through mechanical monitoring. Condensation was a commonly reported problem in both types of homes. Although less common, mildew and mold were also a problem--one affecting the control group more frequently. Approximately 25 percent of each sample found their homes stuffy or humid. In the MCS group, half the respondents reported problems with the air-to-air heat exchanger.

BPA contacts: Kenneth Keating, (503) 230-5758 or Jane Selby, (503) 230-7518

Findings on Model Conservations Standards (MCS) Cost Effectiveness and Consumer Economic Feasibility

Objective: To determine whether the MCS proposed by the Northwest Power Planning Council were cost effective for the region and economically feasible for consumers.

Results: BPA evaluated the MCS recommended for each climate zone and revised them for each zone based on the cost effectiveness of their electric energy savings to the region.

The study found that for homeowners, the added cost of MCS is offset through energy savings and increased resale value. In the long run, MCS homes are cheaper for consumers than homes built to current practice.

An appendix to the report presents public comments on cost effectiveness issues, BPA responses, and detailed technical results of the analysis.

BPA contact: Jeffrey Harris, (503) 230-3307

The RCDP implements the MCS and addresses questions of cost and effectiveness raised by the earlier RSDP. The RCDP also investigates alternatives for meeting the MCS. It tests new energy saving construction methods and products that may offer builders new ways to meet the MCS or reduce the costs of meeting those standards.

During Cycle I of RCDP, 165 homes were built incorporating at least one of five innovations:

- advanced drywall approach (ADA)
- air-to-air heat exchange with supply-air tempering
- exhaust air heat pump
- high R-value walls, and
- prepackaged modular housing

Cycle I data analysis is underway.

In Cycle II, Future House--a super energy efficient house; energy-efficient appliances; active ventilation systems; air leakage control; energy-efficient manufactured housing; and the practices of volume builders are being examined. Construction of 200 Cycle II homes is nearing completion.

In Cycle III, BPA will respond to questions posed by Pacific Northwest utilities. This project is being designed.

As RCDP progresses, findings will be summarized in three major reports--on costs, thermal performance, and ventilation and infiltration characteristics of the homes. BPA will also evaluate some of the unique features of individual innovations.

Construction Cost Analysis: Cycle I (DOE/BP-1031)

Objective: To determine added costs of using innovative, energy saving building techniques. These techniques included constructing highly insulated walls; sealing walls, floors and ceilings against air leakage; and ventilating with fresh air while capturing heat from exhaust air.

Results: New wall-framing techniques decreased costs of constructing an R-19 wall. The tested method of sealing walls, floors, and ceilings was not more costly, on average, than other new sealing techniques. The cost of heat recovery ventilation systems depended on system complexity.

BPA contact: Cole Barnett, (503) 230-5492

A third group of Residential Technology Section projects is not directly related to either the RSDP or the RCDP. Research and development projects range widely, from testing refrigerator efficiency to pinpointing where manufactured houses leak air. These projects help support current conservation programs as well as develop and analyze new technologies.

Air Leakage Tests of Manufactured Housing in the Northwest USA

Objective: To identify air leaks in double-wide, manufactured homes and determine which house-tightening practices could conserve energy.

Results: The study found current practice manufactured homes had moderately lower air leakage rates than homes built on-site. Major leaks occurred at the marriage line where the two halves of the home joined, and in the link between the furnace on one side of the home and heating ducts on the opposite side. Leaks were also found at plumbing holes; around electrical panels; and in gaps around showers and bathtubs. Though windows leaked, no statistical correlation was found between the amount of glass in a house and overall leakage rates.

Doctoring the leakage areas with caulk, tape, gaskets, and foam, reduced air leakage about 20 percent and cost approximately $200 per house.

BPA contact: Steve Onisko, (503) 230-5490

Reflective Foil Insulation Study

Objective: To determine R-values for reflective foil insulation and compare its performance with that of bulk insulation.

Results: Project results will be available in spring 1989. An information booklet on reflective foil insulation will also be available for homeowners and insulation contractors.

Reflective foil insulation should not be confused with radiant barriers. It has one or more reflective surfaces with at least one enclosed air space.

A radiant barrier is a sheet of material with either one or two reflective surfaces and must face an air space. Radiant barriers do not have an enclosed air space. Radiant barrier research is being performed by the Florida Solar Energy Center, the National Association of Home Builders, and others.

BPA Contact: Roy Reinhart, (503) 230-5491

A Study of the Filling of Wall Cavities with Retrofit Insulation (DOE/BP-1017)

Objective: To determine how obstructions in wall cavities affect blown-in retrofit insulation; where voids in the insulation are likely to occur; and the best methods and materials for blown-in retrofit wall insulation.

Results: The study tested wall cavities retrofitted with blown-in cellulose, rockwool, and fiberglass insulation: all performed similarly. Inspections of wall cavities revealed that obstructions such as wiring, plumbing, or lath and plaster reduced the density of insulation in retrofitted wall cavities. Voids were commonly found at the tops of cavities, especially above headers.

BPA contact: Joseph Flores, (503) 230-3462

High-R Window Research (DOE/BP-63401-1)

Objective: To develop and evaluate a high-R window--a window designed to absorb more heat (from solar energy) than it loses.

Results: In Phase I of the project, researchers developed a window prototype with an R-value of R-6 to R-8 using commercially available materials and technologies. The additional cost for these windows is estimated to be $1.60 per square foot.

In Phase II, high-R window performance will be compared with the performance of standard windows. Field tests will begin in demonstration homes over the 1988-89 heating season. Phase II results will be available in the summer of 1989.

BPA contact: Joseph Flores, (503) 230-3462

Vacuum Window Glazings for Energy-Efficient Buildings (DOE/BP-64357-1)

Objective: To develop and evaluate a double-pane, high-R vacuum insulated window.

Results: In Phase I, a vacuum insulated window was developed at the Solar Energy Research Institute (SERI). A vacuum created between laser-welded glass panes could potentially raise the window's R-value from R-2 to R-10--a rating more comparable to that of exterior walls used in standard construction.

The window will be field tested in homes over a heating season in Pacific Northwest climates. Phase II results will be available in the summer of 1990.

BPA contact: Joseph Flores, (503) 230-3462

In-Situ Measurement of U-Values and Overall Thermal Performance of Windows

Objective: To study the performance of five types of windows, using a new field test apparatus, and compare results from this measurement technique with results from a computer model and laboratory tests.

Results: The study found reduced heat loss should not be the only factor considered when evaluating windows with energy design improvements. A window which retains more heat inside a building often absorbs less heat from solar energy.

The other significant study result was that field tests confirmed the accuracy of the computer model.

BPA contact: Joseph Flores, (503) 230-3462

Model Conservation Standards Wall Moisture Study

Objective: To determine if moisture was present in the exterior walls of MCS homes; to reduce moisture to acceptable levels; and to obtain information on measures needed to achieve this goal.

Results: In Phase I of the study, more than half the MCS homes tested had moisture accumulations in the walls. This moisture does not appear to be linked to MCS construction. Instead, the likely causes are failure of ventilation equipment and failure of occupants to use the equipment.

In Phase II, homes with high wall moisture will be retested in the summer to determine if the problem is seasonal or occurs year-round. Homes with continuously high wall moisture will undergo mitigation measures. The following winter, these homes will again be tested to determine mitigation-measure effectiveness.

Project results will be available in 1990.

BPA contact: Joseph Flores, (503) 230-3462

Prediction of Moisture Problems in the Walls of Residences

Objective: To develop and test a computer model for predicting how moisture moves through wall constructions typical of those in BPA's service area.

Results: A computer model was developed to predict the behavior of moisture in different wall constructions. Final results will be available in winter of 1988.

BPA contact: Joseph Flores, (503) 230-3462

The Incidence of Moisture, Decay, and Insect Infestation in Residential Crawlspaces (DOE/BP-13795-17)

Objective: To determine whether installed conservation measures caused or increased moisture, decay, and pest infestation in residential crawlspaces.

Results: A study of 92 homes with moisture, decay, or insect infestation found no correlation between these problems and installed conservation measures such as floor insulation.

The study found more frequent problems in colder climates, older homes, and homes with gutter leakage or drainage problems. The crawlspace perimeter was a particular problem area, and poor ventilation aggravated moisture problems

BPA contact: Roy Reinhart, (503) 230-5491

Field Monitoring of the Wintertime Performance of a Residential Dehumidifier (DOE/BP-981)

Objective: To evaluate the effectiveness, power consumption, operating costs, and heat production of a residential dehumidifier.

Results: A residential dehumidifier in a Pacific Northwest home was monitored over the 1987 heating season. The study found that the dehumidifier reduced indoor moisture levels satisfactorily without increasing total energy use in the home. The study also found that high outdoor temperatures resulted in high indoor moisture levels and that the dehumidifier removed the most moisture on weekends when the prolonged presence of occupants produced more indoor moisture.

BPA contact: Joseph Flores, (503) 230-3462

Heat Pump Water Heater in Multifamily Housing Test

Objective: To evaluate and assess heat pump water heater efficiency in multifamily housing and compare their performance with that of conventional electric-resistance boilers.

Results: Monitoring is underway on existing heat pump water heaters installed in two 10-story, 100-unit apartment buildings. Energy savings and cost effectiveness will be measured. Monitoring will conclude in August 1989 and project results will be available in the winter of 1989.

BPA contact: Roy Reinhart, (503) 230-5491

A Case Study of Japanese Refrigerators (DOE/BP-63585-1)

Objective: To determine whether Japanese refrigerators, tested to the Japanese test procedure, are significantly more efficient than refrigerators tested by the U.S. DOE procedure.

Results: Twelve Japanese refrigerators with the sizes and features most popular in Japan and the United States were tested using the standard U.S. DOE procedure. A formula, which appears to be accurate over a wide range of models and energy use, was developed to convert annual energy use predicted by the Japanese test procedure to that of the U.S. DOE procedure. This formula shows that refrigerators tested by the U.S. DOE procedure used 43 percent more electricity than predicted by the Japanese test.

Because this was a laboratory test, twelve identical Japanese refrigerators are being field tested as described in the following summary.

BPA Contact: Albert Lou, (503) 230-5475

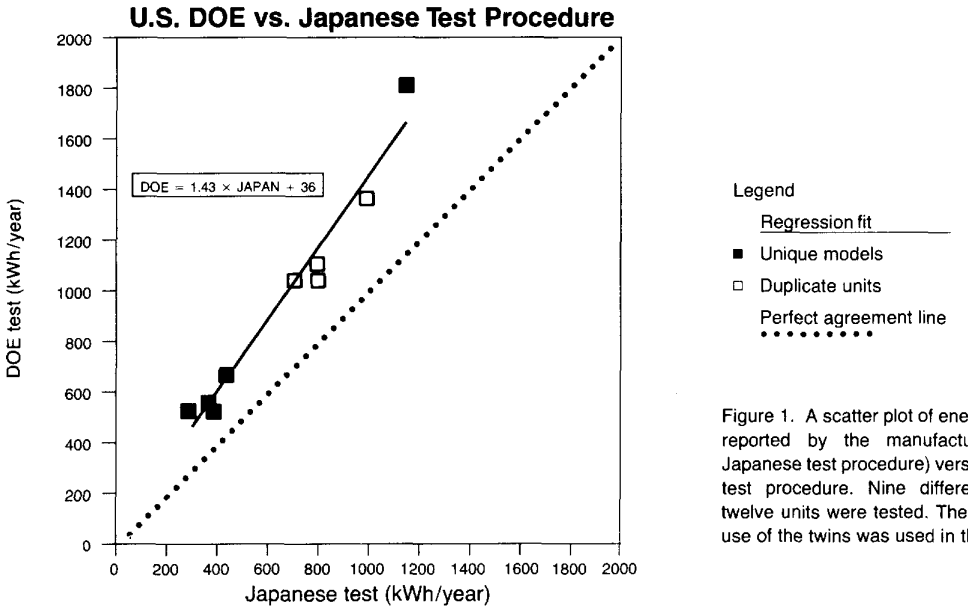

Figure 1. A scatter plot of energy consumption reported by the manufacturer (using the Japanese test procedure) versus the U.S. DOE test procedure. Nine different models and twelve units were tested. The average energy use of the twins was used in the regression.

Field Test of Japanese Refrigerators

Objective: To compare laboratory testing results and manufacturer's claims with the energy efficiency of Japanese refrigerators in actual use.

Results: This ongoing study began in 1986, when laboratory tests using U.S. DOE standards found 12 different Japanese refrigerators used approximately 40 percent more energy per year than determined by Japanese test procedures.

The second phase of the study monitors room temperature, annual energy consumption, and temperature setting while the same refrigerators operate in Portland Area and Southwest Washington homes.

A final report will be published by the end of 1989.

BPA contact: Albert Lou, (503) 230-5475

Field Performance of an Energy-Efficient Refrigerator over 29 Months (DOE/BP-115)

Objective: To determine how door openings and room temperature affect refrigerator energy consumption.

Results: For 2 1/2 years a BPA employee monitored his refrigerator's energy consumption, the number of refrigerator-door openings, and kitchen temperature. Data revealed that while the number of door openings had little effect on refrigerator energy use, its performance was closely linked to average daily kitchen temperature.

Another significant finding was that energy-efficient refrigerators in BPA's service area will likely use less energy than predicted by U.S. DOE ratings; DOE tests are performed at a 90 degree room temperature, while the temperature of the test house averaged 66 degrees. At this more typical temperature, the refrigerator used only 70 percent of the energy its DOE rating predicted.

BPA contact: Roy Reinhart, (503) 230-5491

Radon Mitigation Demonstration Project

Objective: To train contractors around the Pacific Northwest in proven techniques to reduce radon levels in homes.

Results: Through this project, not yet underway, BPA will offer contractors training and field experience in using radon mitigation measures such as subslab ventilation. BPA will contract with the U.S. EPA for training and will cooperate with relevant state agencies.

Project results will be available in the spring of 1989.

BPA contact: Charles Eastwood, (503) 230-4992

Radon 3-Month/12-Month Study

Objective: To develop a formula for predicting annual average residential radon levels, based on radon monitoring data from any consecutive 3 months.

Results: A formula for predicting annual average residential radon levels was developed. However, predictions based on summer months were unreliable.

The study also found lower residential radon concentrations in the summer and in warmer climate zones.

A final report will be available by the winter of 1988.

BPA contact: Charles Eastwood, (503) 230-4992

Preconstruction Radon Assessment

Objective: To develop techniques for measuring soil permeability at specific construction sites and for analyzing the accuracy of radon level predictions based on soil characteristics.

Results: Several methods were tested for measuring soil permeability to radon. Soil measurements taken at 100 sites will now be compared with indoor radon levels of new homes built on those sites. This research will determine whether sites can be accurately evaluated for radon levels prior to home construction.

Results will be available in the summer of 1989.

BPA contact: Philip Thor, (503) 230-3098

Radon Soils and Siting Study

Objective: To assess whether BPA measurements of radon levels in weatherized residences correlate with airborne measurements made by the U.S. Geological Survey (USGS).

Results: Preliminary results suggest the USGS data alone cannot be considered reliable for identifying sites at high or low risk for radon problems. Though the USGS data confirms the BPA radon data in some cases, the number of correlations is not high.

BPA contact: Charles Eastwood, (503) 230-4992

Radon Monitoring Results from BPA's Residential Weatherization Program (DOE/BP-1023)

Objective: To monitor radon levels in homes participating in BPA's Residential Weatherization Program.

Results: As of July 1988, BPA had monitored more than 30,000 weatherized homes in the Northwest. Of these homes, 4.53 percent had levels exceeding the U.S. EPA's indoor radon guideline, and 3.29 percent had levels exceeding BPA's action level--the level at which BPA will provide mitigation assistance to homes in its weatherization program.

BPA publishes a semi-annual report, including a map and data listing, of the updated radon monitoring results.

BPA contact: Charles Eastwood, (503) 230-4992.

A Study of Ventilation in Energy-Efficient Homes Using the Perfluorocarbon Tracer Technique

Objective: To evaluate a technique for measuring the effectiveness of building ventilation systems.

Results: This very technical study found the perfluorocarbon tracer technique of assessing building ventilation systems useful, but subject to error. Contrary to some opinions, the technique is still at the research and development stage and is not ready for builders and homeowners to use in residences.

This study led to the Northwest Residential Infiltration Study described below.

BPA contact: Jeffrey Harris, (503) 230-3307

Northwest Residential Infiltration Study (NORIS)

Objective: To resolve issues concerning the perfluorocarbon tracer method of measuring ventilation in energy-efficient homes by comparing it with another method, and to determine the ventilation rate in MCS homes and current practice homes.

Results: In the project's first year, 140 homes were tested. Preliminary results show agreement between the two ventilation measurement techniques. A preliminary report will be available in Winter 1988.

BPA contact: Jeffrey Harris, (503) 230-3307

Energy-Efficient Ventilation System Study (E-VENTS)

Objective: To place different ventilation systems in demonstration homes and evaluate system performance.

Results: The project is still in the early stages. A draft report outlining ventilation research questions has been completed. The report includes a bibliography of technical literature. The next step is to develop a consortium of participating builders, utilities, and equipment suppliers.

Research will begin after the consortium has been formed.

BPA contact: Jeffrey Harris, (503) 230-3307