ORNL/CON-434

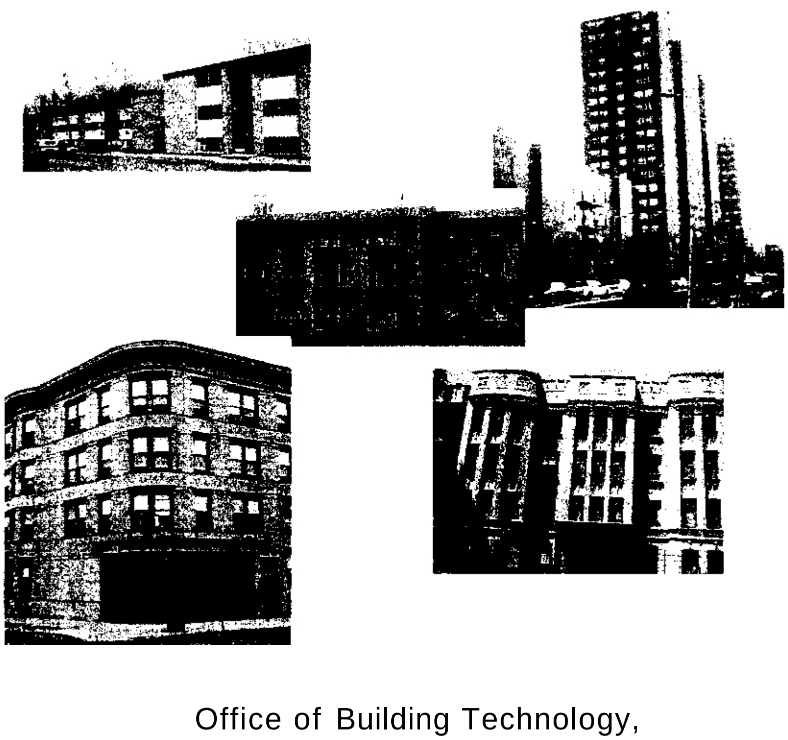
OAK RIDGE NATIONAL LABORATORY

LOCKHEED MARTIN

Five Case Studies of Multifamily Weatherization Programs

L. F. Kinney
T. Wilson
G. Lewis
J. M. MacDonald

Weatherization Assistance Program



Office of Building Technology,
State and Community Programs

U.S. Department of Energy

MANAGED AND OPERATED BY
LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

ORNL-27 (3-96)

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

600 MARYLAND AVENUE, S.W.- SUITE 306
WASHINGTON D.C. 20024

JOEL F. EISENBERG
PHONE: (202) 479-0439
FAX: (202) 479-0575

INTERNET: I2J@ORNL.GOV

April 4, 1997

Dear Colleague,

On behalf of the Department of Energy's Office of State and Community Programs and *Oak* Ridge National Laboratory it gives me great pleasure to provide you with a final version of the our study of weatherization activities in multifamily housing entitled, "Five Case Studies Of Multifamily Weatherization Programs," ORNL/CON-434.

This study, largely comprised of materials from individual multifamily case studies conducted as **part** of the National Evaluation, provides a better understanding of the approach taken by program operators in weatherizing large buildings. This brings to completion the publication of the results of the National Evaluation and its component studies.

If you have any questions or comments regarding the study itself please feel free to direct them to Mike McDonald at ORNL. He can be reached at 423 574-5187 or by E-mail at khm@oml.gov.

With best regards,

Joel F. Eisenberg
Project Manager

ORNUCON-434

Five Case Studies of Multifamily Weatherization Programs

Larry Kinney
Tom Wilson
Glen Lewis
Synertech Systems Corp.

Michael MacDonald
Oak Ridge National Laboratory

Prepared for the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
Managed by
LOCKHEED MARTIN ENERGY RESEARCH CORP.
for the
U.S. DEPARTMENT OF ENERGY
under Contract **No.** DE-AC05-96OR22464

CONTENTS

ABSTRACT

The multifamily case studies that are the subject of this report were conducted to provide a better understanding of the approach taken by program operators in weatherizing large buildings. Because of significant variations in building construction and energy systems across the country, five states were selected based on their high level of multifamily weatherization. This report summarizes findings from case studies conducted by multifamily weatherization operations in five cities: New York City; Springfield, Massachusetts; Chicago, Illinois; St. Paul, Minnesota; and Seattle, Washington. The case studies were conducted by members of the staff of the Synertech Systems Corporation between January and November 1994.

This document is the last in a series of reports to be delivered to the U.S. Department of Energy by Oak Ridge National Laboratory in support of the National Evaluation of the Weatherization Assistance Program. It builds on findings from earlier work which documented the results of an extensive survey of multifamily weatherization operations in 33 states (MacDonald 1993).

Each of the case studies involved extensive interviews with the staff of weatherization subgrantees conducting multifamily weatherization, the inspection of 4 to 12 buildings weatherized between 1991 and 1993, and the analysis of savings and costs. Draft reports of each case study were circulated to local agencies for their feedback, much of which has been incorporated into the current versions that are included in this report.

The case studies focused on innovative techniques which appear to work well.

Several highlights of findings follow:

- Weatherization program operators in two of the cities studied make it a point to gather historical energy consumption data. They use it both to inform building auditing and to develop options for energy conservation retrofits. These agencies also tend to concentrate their attention during the audit in the boiler room. Frequently, control changes and equipment revitalization or replacement are undertaken when patterns of fuel consumption and the result of instrumented audits suggest that such tactics merit implementation. Weatherization jobs in these cities are usually quite cost-effective.

  In the hands of skilled technicians, modern energy auditing tools, including audit software, can be used to determine what is likely to be cost effective, to produce a work order for contractors, and to make it clear to all parties that a professional job is contemplated. This last feature, coupled with a good record of prior weatherization work, is useful in attracting investments from building owners.

  Building owner cooperation (and investment) is further enhanced in New York City by an organization which specializes in conducting financial analyses of conservation-related cash flow and arranging for low-interest funding.

- Much multifamily weatherization work includes replacement windows. In most cases these save at least some energy (depending on the condition of the windows replaced and other factors, of course), but their expense rarely results in cost-effective work when only the reduction in energy costs is considered. This fact is used by some agencies to forge favorable financial agreements with building owners, most of whom are anxious to have new windows installed.

- Most multifamily weatherization operations now routinely include the replacement of inefficient incandescent lighting with more efficient compact fluorescent lighting or (outside) high-pressure sodium fixtures. These lighting retrofits are almost universally cost-effective.

- New efforts by weatherization organizations on water conservation and on replacement of inefficient refrigerators with high efficiency units are important for larger multifamily buildings. New York City had recently started a pilot project on refrigerator replacement at the time of our surveys, and they also had a water conservation program that targets buildings with high water usage.

Multifamily buildings tend to be complex, and it is sometimes difficult to understand how their systems interrelate. There remain a number of elements of multifamily weatherization which continue to he difficult to analyze. Even with what is known, there is substantial unevenness in **skill** levels within the weatherization community. Many analyses are conducted on more complex multifamily buildings using single family housing analysis methods. However, the multifamily buildings are often quite different, with the result that analysis results are inadequate or incorrect.

Therefore, in parallel with the advancement of practical research in building science, there is a need for effective sharing of information on any advances in methods throughout the weatherization community and beyond. Well-conceived and conducted training and technical assistance could usefully cover a range of topics, from energy auditing to the honing of skills in construction management.

All multifamily weatherization operations studied are eager for the opportunity to expand their programs and are largely well equipped to do so.

ABBREVIATIONS AND ACRONYMS

B/C	benefit-to-cost (ratio)
Btu	British thermal unit
CACS	Commercial and Apartments Conservation Service
CDBG	Community Development Block Grants
CEE	Center for Energy and Environment
cfm	cubic feet per minute
CIRA	Computerized, Instrumented Residential Audit
Con Ed	Consolidated Edison Company
CONSERVE	Collaboration of Neighborhood Stabilization Energy Rehab and revitalization Enterprises, Inc.
DCCA	Department of Commerce and Community Affairs, Illinois
DES	Department of Economic Security, Minnesota
DHW	domestic hot water
DJT	Department of Jobs and Training, Minnesota
DOE	U.S. Department of Energy
DOH	Department of Housing, Chicago
DOS	Department of State, New York State
DPS	Department of Public Service, Minnesota
DSM	demand-side management
EA-QUIP	Energy Audit Using the Queens Information Package
EERC	Environment and Energy Resource Center
EHAP	Emergency Housing Assistance Program
EILP	Energy Investment Loan Program (New York State Energy Office)
ES-QUIP	Energy Savings Analysis Using the Queens Information Package
FmHA	Fanners Home Administration
HAP	Hampden Hampshire Housing Partnership, Inc.
HDD	heating degree day
HHS	U.S. Department of Health and Human Services
HNAC	heating-only normalized annual consumption
HPD	Department of Housing Preservation and Development, New York City
HUD	U.S. Department of Housing and Urban Development
LIHEAP	Low-Income Housing Energy Assistance Program
MBtu	millions of British thermal units
MSA	metropolitan statistical area
NAC	normalized annual consumption
NMIC	Northem Manhattan Improvement Corporation
NSP	Northem States Power
NYCWAP	New York City Weatherization Assistance Program
NYSERDA	New York State Energy Research and Development Authority
ORNL	*Oak* Ridge National Laboratory
PRISM	Princeton Scorekeeping Method
PVE	Petroleum Violation Escrow
RAP	Ramsey Action Program, Minnesota
TNAC	total normalized annual consumption
ULIEEP	Utility Low Income Energy Efficiency Program
WAMS	Weatherization Analysis and Management System
WRAP	Weatherization Research and Production

1. INTRODUCTION AND OVERVIEW

BACKGROUND

In 1990, DOE initiated a nationwide evaluation of the Weatherization Assistance Program with assistance from Oak Ridge National Laboratory. This comprehensive evaluation has resulted in a number of reports, including two which reported on large-scale surveys:

- a characterization of the weatherization network's capabilities, technologies, procedures, staff, and innovations (Mihlmester et al. 1992); and
- a profile of low-income weatherization resources, the weatherized population, and the program-eligible population that remains to be served (Power et al. 1993).

Three impact studies were also undertaken:

- a study of single-family homes, mobile homes, and dwellings in small (2- to 4-unit) multifamily buildings, in which savings were determined by the analysis of fuel bills—the Single Family Study (Brown et al. 1993);

- a study of single-family homes heated primarily with fuel oil in which savings were determined by means of on-site data loggers—the Fuel Oil Study (Levins and Ternes 1994); and

- a study of dwellings with five or more units—the Multifamily Study (MacDonald 1993).

The Multifamily Study examined the nature and extent of large building weatherization work based on a national survey of activities in 1990. The survey of the states yielded direct responses from 33 states. This survey showed high levels of activity in large multifamily buildings for 11 of the 33 states, with a few indicating they do not have significant numbers of these types of buildings with more than 66% of the households income-qualified. New York was the only state which had conducted an evaluation of multifamily work under the program in large buildings in the past 10 years.

The results of the national survey showed that about 20,000 dwellings in these multifamily buildings were served by the Weatherization Program in 1990. This is 9% of the total number of all units weatherized nationally in 1990, while costs were 7% of total national costs. High levels of activity in larger multifamily buildings were reported for some states, with New York accounting for half of all the residences weatherized.

Special audit procedures for dealing with larger multifamily buildings were used by 9 of the 33 states. Strategic partnerships for multifamily buildings have been used or developed in 7 of the 33 states. Policies regarding owner investment are in place for multifamily buildings in 11 of the

33 states, and 11 of the 33 have considered or implemented policy changes regarding larger multifamily buildings recently. Nine of the 33 states offer some training related to the field inspections of buildings and the selection of measures to be installed applicable to multifamily buildings; 6 of these states have very extensive training.

A wide range of measures was installed, but the materials costs for the measures were dominated by the cost of windows (80% of the total for that year). Where the whole building was treated, $561 was invested per apartment; for partial building work, the total invested was $417. The energy savings and cost-effectiveness of the program were not estimated because energy use and cost data adequate for developing such estimates could not be obtained.

According to survey results, many weatherization programs needed better retrofit packages applicable to multifamily housing stock. A few states indicated that multifamily weatherization operations should be expanded.

MULTIFAMILY CASE STUDIES

The multifamily case studies that are the subject of this report were conducted to provide a better understanding of the approach taken by program operators in weatherizing large buildings. Because of significant variations in building construction and energy systems across the country, five states were selected based on their high level of multifamily weatherization: New York, Massachusetts, Illinois, Minnesota, and Washington. One city was selected from each of these states to provide good information on how practitioners accomplish multifamily weatherization. These cities are New York, Springfield, Chicago, Saint Paul, and Seattle.

Methodology

Sampling agencies and buildings

For all case studies, state weatherization managers were contacted by phone to apprise them of the case study work and to solicit their help in sampling agencies and coordinating logistics. The following questions were covered during this informal interview:

- How many agencies are involved in large multifamily work?
- Which do the most work? Roughly how many jobs in 1992? Would they be cooperative in case-study research?
- Is there leveraging of funds from building owners? From utilities?
- Do local agency people collect consumption information? Is it a problem to get such information from local utilities or fuel vendors? Can you help with this?
- What weatherization measures are routinely accomplished? Any special ones? Is there a multifamily or other special audit used (or a variation on the theme of single-family audit)?
- Who should be contacted for more information (key agency persons, others)?

This conversation was followed by contacting representatives of each local agency. Analogous questions were asked, and a request for data on recent representative weatherization jobs was made. Emphasis was placed on the critical need for obtaining data on consumption before and after weatherization work, where the after period included at least half a heating season and as much as a heating season and a half. (The point was to get data on relatively recent work, yet have enough after-weatherization data to draw useful inferences on savings.)

Gathering consumption data was the most difficult practical task, and the order and timing of the completion of the case studies were driven by the flow of information from each of the five cities. Preliminary analyses of building data preceded field work in all cases.

Field studies were conducted by members of the staff of the Synertech Systems Corporation from January through November 1994. The order was from east to west, their order of presentation in this report. A two-person team, Larry Kinney and Glen Lewis, undertook the New York City and Springfield case studies, while one person conducted the other three. Tom Wilson conducted the case studies in Chicago and St. Paul; Larry Kinney conducted the Seattle case study.

Field procedures

Three to five days were spent in each city. The weatherization director was extensively interviewed, as were key staff, including energy auditors and quality control inspectors. Material was gathered on all aspects of the weatherization operation, from outreach to operations and client education to fiscal-control paperwork. Innovative procedures were focused upon in hopes that readers of this report may benefit from clever ideas implemented by others.

After interviews, the buildings for which the team had data (and usually several others) were examined systematically. Both slides and prints were taken of important details whenever practical. On-site work was supplemented by data gathered over the phone from contractors, either at the beginning or at the close of the business day, and occasionally on-site. After several days in buildings, the team leader undertook an informal process evaluation, returning to the weatherization director and others with specific questions resulting from having seen the housing stock and the weatherization work performed.

Notes for the case study frequently were taken on a laptop computer and edited while still in the field, both to make sure that complete data were gathered and to produce a significant portion of the report for the case study while the information was fresh. Key elements of findings were highlighted and shared with the weatherization director in an exit interview. Finally, phone numbers and related information on relevant people unavailable during the field work were gathered before the completion of field work.

Case Study Reports

In most cases, drafts of the case studies were completed within 3 weeks of finishing the field work. They were then circulated for review and comment, first to local subgrantee operators who were the primary subjects to give them an opportunity to comment on the earliest version of the report. The primary aim was to make sure that the story told was accurate and to give local agency staff the opportunity to disagree with findings if they deemed it appropriate. A second draft, revised to reflect at least some of the changes suggested by reviewers of the first, was circulated more widely.

Each case study begins with introductory remarks on the principal features of the multifamily weatherization operation and its environment. Since the New York City case study (Sect. 2) covers an especially wide range of issues and a large number of agencies, introductory remarks there are somewhat more lengthy. Following introductory remarks, case study reports discuss housing stock and weatherization operations. These follow a natural flow, beginning at organizational structure and proceeding through outreach, certification, auditing, the work itself, client education, quality control, and evaluation. Along the way, management and policy issues are examined, ranging from leveraging of funds and dealing with contractors to the integration of new technologies and staff development.

Each case study includes a section on the buildings analyzed. These microstudies move from building descriptions through weatherization strategies employed to an analysis of savings achieved versus costs.

When warranted by findings, separate sections are included to cover special circumstances in more detail. For example, the leveraging of funds in New York City and the obtaining of landlord agreements is both a critical and an interesting ingredient in the success of multifamily work, so it was deemed likely to be of interest to others.

Innovative outreach materials, forms, and samples of audits of multifamily weatherization operations are reproduced in appendices. The order follows that of the case studies.

The Analysis of Savings

Obtaining consumption information for multifamily buildings can be a particularly difficult task, especially when agencies do not routinely collect this information. In some cases, for example, all apartments are individually metered for all fuels; in others, only electricity is individually metered, and gas or oil is used to fire large boilers that serve one or more entire apartment buildings. In all events, getting a comprehensive and fully accurate picture of before- and after-weatherization consumption which accurately controls for changes in occupancy can be a daunting task.

The approach followed here was to assemble the best information available and analyze it using either the PRInceton Scorekeeping Method (PRISM) or a simple variation of PRISM which holds the heating degree day (HDD) base constant at 65°F.

Heating fuel consumption in the postweatherization period is compared with fuel consumption in the preweatherization period to determine energy savings due to weatherization measures.

Typically, fuel bills were collected for periods of at least 1 year before and after the weatherization completion date. Estimated meter readings were eliminated by using only actual meter readings. These consumption figures were then combined with actual average daily temperature data (in machine-readable form from the National Oceanic and Atmospheric Administration National Climatic Center) for the city where the building was located.

PRISM was used to analyze these data to establish a building reference temperature and calculate the baseload, heating-only normalized annual consumption (HNAC), and total normalized annual consumption (NAC) for each study period. When the building energy data were found to be too complex for a PRISM analysis, a spreadsheet was used to produce these same indices of consumption. In these cases, the reference temperature was assumed to be 65°F.

The normalized annual consumption (total **NAC,** heating **NAC,** and baseload), as shown on the table below, are each expressed in millions of British thermal units (MBtu). Fuel cost is expressed in dollars per **MBtu.**

The heating-only consumption (heating **NAC)** is divided by the 10 year average base-65°F **HDDs,** yielding Btu/HDD. This figure is divided by the total heated square footage of the building, yielding the fuel consumption index, or **Btu/HDD/ft^2.**

Annual cost for economic evaluation purposes is generated by multiplying total **NAC** by fuel cost.

Once the fuel consumption index, heating **NAC,** baseload, and total **NAC** fuel consumption totals are computed for both pre- and postweatherization periods, fuel consumption for the two periods is contrasted to show absolute savings as well as percentage savings. Absolute savings is derived by subtracting the postweatherization total **NAC** from the preweatherization total **NAC.** The sign of the result is reflective of whether consumption increased or decreased. The absolute change in **NAC** is the fust-year savings expressed in MBtus.

Percentage change in fuel consumption is computed to indicate the relative amount of savings between pre- and post-weatherization fuel consumption. Percentage change is computed using the relationship

$$\textit{percentage change} = \left(1 - \frac{post}{pre}\right) \times 100$$

Except where noted in a fuel switching retrofit in New York City, fuel costs *are* assumed constant over both the pre- and postweatherization periods to determine annual cost. The absolute change in annual cost is the first year savings in dollars.

Lifetime savings *are* derived by calculating the total savings over an assumed 20-year lifetime of the measure at a 4.7% discount rate.

The benefit-to-cost ratio (B/C ratio) is calculated by dividing the lifetime savings by weatherization costs.

Terms

Terms used in the building descriptions and analyses used in this report are summarized in the following table.

Table 1.1. Definition of Terms Used in This Report

Terms	Explanation
Heated Area (ft^2)	Intentionally heated portion of the building such as apartments and heated common areas
Heating Degree Days (HDDs)	An index of the severity of weather derived by summing the average daily temperature difference between inside and the outside for the heating season. Base 65 HDDs are used in most analyses in this report, except for some buildings in Chicago and St. Paul, which used HDDs based on PRISM analysis.
Btu/HDD	Energy use normalized for outdoor air temperahue during the heating season.
Consumption Index (Btu/HDD/ft^2.)	Consumption efficiency adjusted for both outdoor air temperature and heated area
HNAC (MBtu)	Normalized annual consumption for heating in MBtus.
BNAC (MBtu)	Normalized annual consumption for baseload
TNAC (MBtu)	Total normalized annual consumption
Fuel Cost ($/MMBtu)	The cost of fuel per MBtu
Annual cost ($)	The wmputed cost of heating and domestic hot water fuel per annum. The product of TNAC and fuel cost
Con of Weatherization (%)	Total cost of work including landlord contribution, utility funds, U.S. (HHS), and U.S. Department of Energy funds
Annual Savings ($ First Year)	Annual wst of fuel before weatherization minus annual cost of fuel after weatherization
Benefit-to-Cost Ratio (B/C)	The ratio of savings (discounted to the present) over the lifetime of a weatherizationjob to the cost of that Weatherizationjob

2. NEW YORK CITY

EXECUTIVE SUMMARY

New York City has **126,000** multifamily buildings with more than **1.9** million apartments (Judd **1993).** Most of the over 50,000 multifamily building owners pay high energy bills due to inefficient buildings, poorly maintained and controlled heating systems, and high prices for heating **fuel** and electricity. The owner of the most buildings is the city itself, a Housing Authority that manages **3000** buildings, and a Department of Housing Preservation and Development (HPD) that manages another 5000 buildings.

Multifamily buildings in New York City consume more than a billion gallons of oil each year (Judd 1990), **0.14** quadrillion Btu, almost 1% of the energy consumed in the residential sector in the entire country. **A** typical apartment **uses 121 MBtu (865** gal **of #2 fuel** oil equivalent) annually for heat and domestic hot water (DHW) (Goldner and Judd **1989).** This is comparable to the annual energy consumed by the average single family dwelling in upstate New York, where dwellings **are larger** and beating degree days (HDDs) **are** greater by ***50%.*** Normalizing for weather and ***size,*** before-weatherization consumption in New York City averages about **28 Btu/HDD/ft^2,** as compared with 15 Btu/HDD/ft^2 in upstate New York (Kinney **et** al. **1987, 1989). Thus,** multifamily buildings in the city are very inefficient, a fact that makes them good targets for cost-effective conservation retrofits.

With strong leadership from the **state grantee,** the New York State Department **of** State (DOS), the response of New York City's Weatherization Assistance Program (NYCWAP) has been aggressive in treating multifamily buildings. Over half of the weatherization jobs in multifamily dwellings completed *nationally* in program year **1989** were in New York City (MacDonald **1993).** In the program year, which ended in March of **1995,** approximately **8300** dwelling units in **240** buildings were weatherized at **an** average investment of public dollars of $1,500 [from the **U.S.** Departments of Energy and Health and Human Services (DOE and **HHS)].**

This latter figure is supplemented substantially by funds from two **other sources:** about $400 per apartment from building owners and up to $700 from Consolidated Edison Company (Con Ed) for some of the buildings. Building owners are required to provide matching investments **through** a landlord agreement process that has been quite successful. Con Ed sponsors the addition of energy-efficient lighting on all buildings in its gas service territory plus general weatherization for buildings which **use** natural gas to provide space heating.

Improving Quality

NYCWAP has evolved considerably from its beginnings in the **1970s** and early **1980s** as a loose network of **30** subgrantee agencies in the five boroughs of the city with little central coordination. Back then, the approach to weatherization focused primarily on window replacement with little **or** no work in the boiler room. Presently, there **are 22** subgrantee agencies, each of which is a member of the New York City Weatherization Coalition, a 501.C.3 not-for-profit organization with a nine-person staff that conducts professional energy audits and develops detailed scopes of work and cost/benefit analyses for most of the weatherization jobs in the city. In the case of the two subgrantees in the city which are authorized to conduct their own audits, the Coalition's *staff* reviews the work before it is let out for bid. The result is that audits and resulting scopes of work **are** of uniformly **good** quality. All local subgrantees are involved in outreach, coordination with building owners and tenants, construction management of the job, tenant and building superintendent training, and follow-through. In the 2-year period ending in June 1994, the Coalition performed audits on 352 buildings having 12,624 units and reviewed audits performed on another 76 buildings having 2470 units. This totals 428 buildings with 15,094 units, an average of over 35 apartments per building.

The Audit Process

All multifamily building audits are conducted with the aid of billing records which reflect the recent history of actual consumption and EA-QUIP, a computer-based analytical package modified from software written by an engineering team at Lawrence Berkeley Laboratory to handle multifamily audits (Rodberg, Cherry, and Cohen 1991). The audit process covers a wide range of both mechanical and architectural opportunities for savings, but in practice the most important savings flow from work in the boiler room and heating distribution system.

Weatherization Tactics

Typical weatherization tactics range from cleaning and tuning large oil burners to installing appropriately sized vents on risers and radiators (which improve the distribution of steam) and installing new electronic controls to replacing complete boilers. Air sealing of the building envelope concentrates at the top and bottom of the common areas and usually includes interior doors to apartments. Insulation is used on distribution system pipes and in attics, rarely elsewhere.

Windows

The audit makes it obvious that replacement windows are not likely to be cost-effective strictly **as** energy savings measures. However, since building owners frequently desire new windows—and are willing to at least partially pay for them **as** a part of their matching investment—replacement windows are frequently included in weatherization jobs. The benefit to neighborhood improvement is cited by all parties **as** a key benefit obtained along with energy savings from window replacement.

Owner Investments and CONSERVE, Inc.

Professionalism in the delivery of weatherization services has enabled New York State's policy of building owner investments in the weatherization process to be particularly effective. In a number of cases, the work of a unique organization, CONSERVE, Inc., also plays a key role. Through ***service*** contracts from the New York DOS, CONSERVE does detailed financial analyses and packaging for building owners, demonstrates financial paybacks associated with weatherization work, and literally "takes building owners to the bank" to finance the owners' share of the ***costs.*** In some cases, CONSERVE's work allows comprehensive weatherization of a marginal building that might otherwise become abandoned, thus falling prey to the descending spiral of neighborhood deterioration.' A professionally prcduced audit and work scope from the Coalition, in combination with the cost-benefit analysis and the financial analysis provided by CONSERVE, has a powerful impact on building owners. The resulting investment from them allows more comprehensive work and the completion of more buildings than would otherwise be possible.

Utility Leveraging

In 1992, the nine publicly held utilities in New York began a 3-year pilot energy conservation program called the Utility Low Income Energy Efficiency Program (ULIEEP). ULIEEP was mandated by the state's Public Service Commission under Case 98-M-124 and was accompanied by a large-scale planning process in which a number of representatives of the weatherization community participated. Some utilities have elected to contract elements of their ULIEEP to private organizations, some to Weatherization subgrantees, and some to a combmation of the two. Con Ed, the utility company which serves the New York City metropolitan area, uses the Weatherization Coalition to manage all of those portions of its ULIEEP work for technical improvements on buildings. The Coalition contracts with weatherization subgrantee agencies in the city. Funds cover up to five screw-in compact fluorescent light bulbs and three hard-wired energy-efficient lighting fixtures per apartment plus a refrigerator coil cleaning kit. Other weatherization work can be carried out under this program when buildings use natural gas to provide space heating.

Growing Technical Competence

The weatherization of large buildings in our nation's largest city is a complex process. Many people have to work together in order for good weatherization jobs—those that save and keep saving energy—to happen. A growing number of technically competent engineers and contractors are involved in the weatherization program and practice such important crafts as making single-pipe steam systems work efficiently. Effective information provided to building supervisors helps them maintain and operate systems much better, with the consequence that savings are frequently substantial—and they endure.

Building Surveys

Twelve buildings were examined during our fieldwork, representing work by five subgrantees in the city. These range from a four-building complex in Brooklyn where four inefficient gas-fired boilers were replaced by a single 125-hp boiler with better controls and cheaper fuel (a retrofit which saved 48% in fuel costs, $32,500 per year) to two large high-rise complexes in the Bronx with a total of 361 apartment units which had both substantial boiler work and retrofit air sealing. In addition to those, two medium-sized buildings in Manhattan weatherized by the Northern Manhattan Improvement Corporation were examined. The weatherization program staff of this agency who were interviewed for this case study displayed a high degree of professionalism, dedication, and creativity. For example, when extensive boiler work or replacement seems likely

[1] The magnitude of this descending spiral is substantial. Quoting statistics from the *Mayor's Management Report, New York City, 1991* and the City of New York, *Adopted Budget for the Fiscal Year 1991,* Peter Judd (1993) observes that "[i]n 1991, 44,000 occupied apartments in 3000 buildings were taken *in rem* and managed by the city at a net cost in rents of $186 million per year, plus $100 million in capital funds These costs do not reflect the negative property tax payment or water and sewer payments, all of which have to be made up by increased taxes and charges on others."

to yield cost-effective savings, videotapes are made of the boiler audit, both to document the process for subsequent analysis and to "see" hard-tc-reach areas of the interior of the boiler with the camera's lens.

The complications of weatherizing in such a large city require creative responses from dedicated people. For example, auditors go into the subway system armed with an over-the-shoulder professional energy auditing kit that includes an array of state-of-the-art electronic and other tools for doing the job. It is simply more productive than driving a van from their midtown location.

The Weatherization Coalition

A loose-knit group of representatives of subgrantees who met at irregular intervals in the 1980s has evolved into a multifunction line agency, the New York City Weatherization Coalition (Fig. 2.1). The Coalition has played a key role in improving multifamily weatherization. The Coalition's board members come from local agencies. This has resulted in quality control and efficiency of centralized auditing with the flexibility of local control. Better work is being done on weatherizing buildings and the systems that heat them. Further, building superintendents are becoming part of a continuing process of maintenance.

Fig. 2.1. The offices of the New York Weatherization Coalition and CONSERVE, Inc, are located on the same floor in this building in midtown Manhattan.

Big building weatherization has made great strides in New York City, and everyone interviewed in the course of conducting this case study conveyed the impression that they are continuing to learn—and the program is continuing to improve. "It's 'an incredibly gratifying program," observes David Hepinstall, executive director of the Weatherization Coalition. "When you see what's really going on, it just makes you want to do more. This is concrete; we really make a difference. Ultimately what drives me to stay here is that we're making a difference, and we're getting better." The delivery capacity to produce significant savings is in place. This is welcome news; the need is enormous.

Housing Stock

The multifamily housing stock in New York City is quite varied. It includes buildings built from the last years of the 19th century to the 1970s. The housing stock is predominantly mid-rise, brick with poured concrete floors and wood windows. Many of the newer buildings constructed in the 1960s and 1970s are steel structures with brick curtain walls, poured concrete floors, and metal windows. Table 2.1 summarizes the multifamily housing stock in New York City. Despite the variety of building types in New York, it is useful to organize the buildings into large categories.

"Old Law" multifamily buildings are tenement buildings, alternately known as railroad flats, three to six stories tall, which were originally constructed in the last century without central heating systems. Because of their rectangular building plans and side-by-side construction, they were inadequately ventilated and poorly illuminated. Additionally, they were often built without running water. In time, plumbing was added, typically together with single-pipe steam heating systems. These early remodeling efforts made the buildings more liveable but left them dark and stuffy.

Buildings constructed under the New Residence Law, called "New Law" buildings, differed from older multifamily buildings primarily as a result of changes in the building plans. They changed from side-by-side rectangles to dumbbell or donut shapes.

Table 2.1. Number of Multifamily Buildings in New York City, 1991

	Buildings	Share	Apartments	Share	Apts./Bldg.
Old Law Tenements	30,568	24.26%	256,671	13.48%	8.40
New Law Tenements	41,780	33.16%	693,109	36.42%	16.60
Multiple Dwellings	12,749	10.12%	766,508	40.25%	60.12
others		32.45%	187,658	9.85%	5.77
Total	125,979	100.00%	1,904,546	100.00%	

Source: Baruch College (1992–93); New York City Departments of City Planning, and Housing Preservation and Development (from Judd 1993).

These revisions to building plans encouraged by the New Law facilitated improvements in ventilation and natural light. Parallel revisions to the sanitary codes required improvements in plumbing. Usually, the New Law buildings were built with single-pipe steam heating systems as the original equipment. Buildings constructed under the New Law matched the existing neighborhood scale, and thus were often four to six stories in height, but it is not unusual to find taller New Law buildings.

The Multiple Dwelling Law came into existence in 1948 and superseded the requirements of the previous codes. Since that time all multifamily buildings in New York City have been constructed as airy, light dwellings with all the modem mechanical conveniences. In addition, all multifamily buildings retroactively must meet minimum standards for the provision of heat. Typically, the heating system must sense and respond to outdoor temperatures. The length of response time is a mandatory 40 min/h.

The staggering statistic cited earlier (865 gal of fuel oil use per apartment per year) indicates very high energy use, but the distribution of consumption is at least as interesting. In his monograph

The Overheated City: The Prospects for Improving Fuel Economy in Multi-Family Residential Buildings in New York City (1990), Peter Judd, formerly the director of the Energy Conservation Division of New York City's HPD, remarks:

> There is a 600% difference between the most and the least efficient buildings in the multi-family housing stock in New York City. That is what we at the Energy Conservation Division termed the "600 percent spread." It means that heat and hot water can be supplied adequately to an efficient building at one sixth the cost per apartment needed in an inefficient building. The "600 percent spread" means that there is both unnecessary use of fuel and that there is great potential for cost-effective measures to improve energy efficiency. The glass is both half empty and half full.
>
> It is not a matter of the age of the building and its level of insulation or even equipment. Old buildings can be operated at least as efficiently as modem buildings. No one type of structure or equipment is necessarily any more efficient in actual use than any other. The critical quality is management, meaning support for staff and close monitoring of performance.
>
> "Energy hogs" are made, not built that way. It is "nurture" (building management) over "nature" (the determining role of equipment and building envelope) as explanation for success in reducing energy use and costs. (Judd 1990)

The enormity of the job facing the Weatherization Program in New York City cannot be overestimated. Many buildings are in bad repair, have complex heating systems, and are plagued with security problems. A substantial percentage are operated under tenuous fmancial conditions. Further, until the mid to late 1980s, the core of Peter Judd's observations — that consumption data contain information key to defining a cost-effective retrofit strategy for a building and that management plus maintenance is critical — was not fully acted on by New York's subgrantees

WEATHERIZATION HISTORY

Weatherization began in the city in the mid-1970s with direct grants from the Regional Office of the Community Services Administration to several larger community action agencies, primarily Operation Open City. The weatherization program in the city was substantially reorganized between 1979 and 1982, and many community groups emerged as subgrantees. During this period, when there were more than 25 subgrantees, there was neither a city-wide program nor a single community action agency program. By and large, weatherization consisted of window work — repair of the existing, storm windows and, most frequently, replacement units — and a modicum of air sealing within apartment units. Common areas and boiler rooms were not focal points of attention, although some agencies included retrofit insulation on steam pipes "when needed." Landlord contributions to weatherization work were rare.

Prior to DOE's establishing a program managed by a state-level grantee, the availability of practical wisdom (much less genuine "technical assistance") for weatherization practitioners was quite low. In the early days of the DOE program, circumstances were not improved much. The state grantee designate, the New York State DOS, contracted with a variety of nonprofit organizations and units of local government to deliver weatherization services. In the mid and late 1980s, there were 30 subgrantees in the New York City area, ranging from neighborhood organizations serving a specific constituency (Crown Heights Jewish Community Center in Brooklyn, for example) to HPD, a $1.5 billion agency responsible for a plethora ofhousing issues in all five of New York's boroughs.

Although there was loose coordination between agencies from the beginning of the program, approaches to multifamily weatherization work in the City reflected different levels of technical and managerial acumen of the subgrantees themselves. The quality of the product was uneven and heavily tilted toward window replacement. As weatherization evolved in New York City, a coalition of the subgrantee agencies developed; this has raised the quality of service delivery and the cost-effectiveness of work accomplished. As described in the following paragraphs, this is being accomplished while retaining most of the "neighborhood flavor" of services offered by community-based subgrantees.

The Weatherization Coalition

Andy Padian, currently the senior energy auditor of the New York City Weatherization Coalition, recalls a dramatic moment in 1990 when New York State's weatherization director, Rick Gerardi, attended a meeting of the Coalition, then a membership advocacy group. "Rick threw the gauntlet down," Padian recalls. "He said very plainly, 'Either find a way to do central auditing or I'll bid it out."'

A way was found, and a strengthened Weatherization Coalition was the result. The Coalition has matured into a fully functional 501.C.3 nonprofit organization with bylaws and a for-profit subsidiary set up to do water conservation work/retrofits. Its board consists of weatherization directors or executive directors of seven New York City weatherization subgrantees.

When Gerardi ''threw down the gauntlet" in 1990, David Hepinstall was the weatherization director of the Northern Manhattan Improvement Corporation (NMIC). He became the chairman of the board of the Weatherization Coalition and, in April 1992, was persuaded by the other members of the board to take over as executive director. "Rick wanted to improve the quality and standardize the approach to audits being used throughout the City: recalls Hepinstall, "and he believed that establishing a centralized audit capacity would help to make it happen. The reality was that there were lots of independent organizations with their own people carrying out audits, not necessarily with the same degree of technical skill."

The Weatherization Coalition went through three months of consensus building to put together an organization that could respond to Gerardi's challenge. Bylaws were adopted, a board was elected, and the process of hiring was started. "Our overall aim was to develop and maintain high-quality multifamily work in New York City," Hepinstall says. "The audit is the linchpin in the process; it's not the only piece, but it's the most important piece of the puzzle." With three full-time auditors (Andy Padian, Kurtis Pender, and Lilya Shames), the Weatherization Coalition now performs audits on about 70% of the buildings in the greater New York City area. They also do post-inspections of every heating system retrofit.

Several of the larger agencies are self-auditing agencies—for example, the New York City Urban Coalition Housing Group (CHG), a large agency that serves all boroughs, and NMIC. To become an "auditing agency," a subgrantee's auditor(s) must undergo a credentialing process conducted by DOS. Further, even if an agency performs its own audits, the Coalition also reviews and "agrees with" or "disagrees with" all of the audits done by the self-auditing agencies in New York City. ("Agree" or "disagree" is different from "approve" or "disapprove," Padian points out, and sometimes agencies go ahead with a plan of work in spite of the Weatherization Coalition's disagreement.) Some subgrantees are not fully happy with the new arrangement (since audits are no longer performed in-house), but most subgrantees in the city are pleased.

Hepinstall—whose professional background is in political science, both in the classroom and in a variety of policy-level jobs in New York City government—is sensitive to the issue. "What we're trying to do is to achieve centralization at the appropriate level in a way that respects local autonomy. What's best done locally is done locally; what's best done centrally is done centrally. Balancing the approach is critical. It can't be done with a cookie cutter. For some agencies we conduct audits; for others we review them. No matter what, local agencies have the final say in what gets done."

Payment for the Coalition's services is on a reimbursement fee basis directly from the state. Presently for multifamily audits, the fee is $1000 base plus $20 per apartment for the first 20 apartments, then $15 for each after 20. Audit reviews are reimbursed at the rate of $250 each.

The Audit Process

Each of the Coalition's three auditors has had a good deal of training in the field, and all have learned much of what they know about boilers from Frank Gerety, an engineer who, in the view of everyone interviewed for this case study, "knows more about single-pipe steam than anyone else in the city."

Andy Padian is a graduate of Syracuse University's program in Energy and Environmental Policy and also studied in the Newhouse School of Communications. This background is useful both for auditing and in teaching. For the past 6 years, Padian has taught a class on energy efficiency in multifamily buildings and the craft of maintaining boilers to building superintendents (supers) and others from low-income cooperatively owned buildings.

Kurtis Pender was the second auditor to join the Coalition staff. He worked at HPD as an apprentice auditor for the Weatherization program. "I got a quick knowledge of building science at HPD," Pender reports, "and began using the EA-QUIP audit [Energy Audit using the Queens Information Package] while there. I began using it as a real tool when I came to work for the Coalition in the fall of 1992 after being certified by Dan Grau and Maurice Self [of Department of State's technical staff]."

Lilya (Lily) Shames, who has a B.S. in mechanical engineering from the University of Vermont, is the most recent addition to the Coalition's energy auditing staff. She worked for a while at Eastman Boilers in the Bronx and then with the Coalition Housing Group, where she did boiler audits, some construction management, and EA-QUIP audits.

Among them, the three auditors accomplish six to eight multifamily audits in a typical work week. The accompanying text box contains a description of a typical audit, with observations by each of the Coalition's three auditors.

and one way opening doors in the better maintained units. We prefer motion sensors at the top of the building for security. Once in **a** while we even pick up bullets! (Sometimes dumbwaiters **on** the roof *are* used for **target** practice.)

We also try to get **a** sense for **how** the people are going to accept **the** stuff that **gets** put in. But if **the superintendent is a problem,** nothmg **good** *EM* **happen. The** superintendent is key! We have **a** problem replacing **a** boiler in a building *that* isn't **maintained.** The predicted payback won't be there unless the superintendent is on the stick. We tend to come down hard **on**

important to do the apartments than the common areas when the common spaces aren't heated. Also, the work lasts longer if it's done *at the* apartment level.

We check out the top **floor apartments to** sa if there's heat there. There may be a difference in heat due to solar or height **We look at radiators to verify that they are pitched properly. If they are missing handles and vents, then typically it's the same with** the radiators in the other **apartments.** We learn a lot *about* **maintenance** by **looking** *at* the basement and the **radiators.** We check ***out*** the drip marks near and dents **on** radiators, and the l i e . Subtle stuff observed yields **useful** information about **maintenance.** ♦♦

Fig. *2.2.* Weatherization **Coalition** auditors in New York City must pack their tools of the trade in a container suitable for transport on the subway. This kit contains thermometers, a combustible gas sensor, **a** combustion analyzer, a CO sensor, a ***CO,*** sensor, a draft gauge, and a digital pressure sensor, plus sundry hand **tools,** tape measures, **lights** gloves, and safety equipment

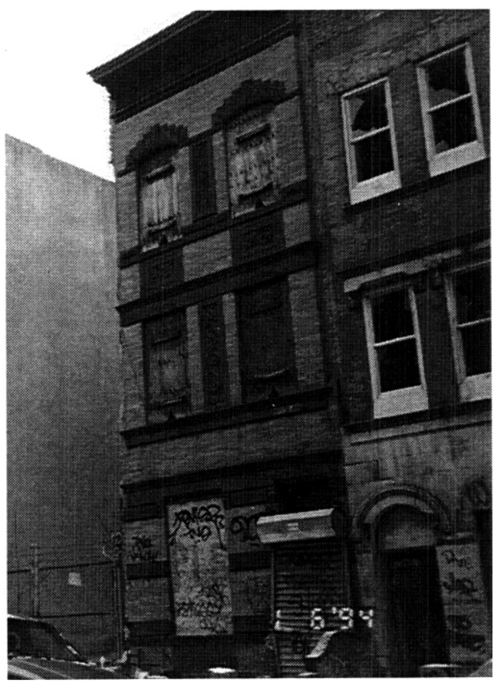


Fig. **23.** Window openings in most buildings arc the **same** size—and **with** these it's ***easy*** to decide which **need** replacing.

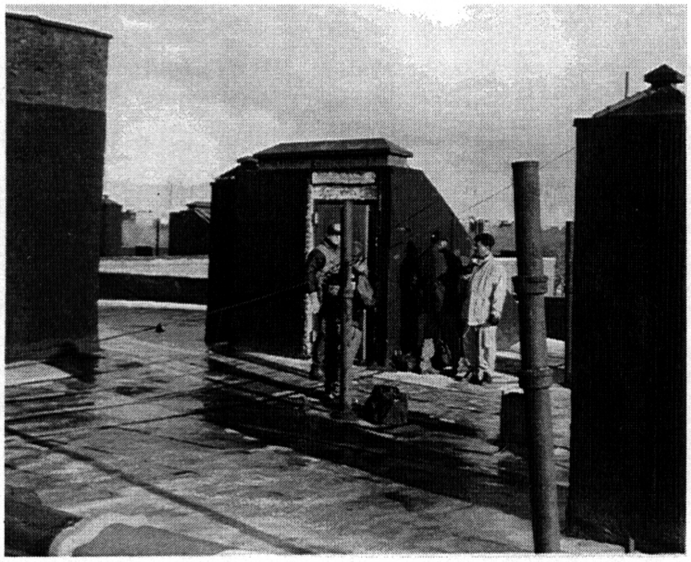


Fig. 2.4. Rooftops have lots of penetrations, some 01 which cause substantial beat loss.

Audit Software

By the time the fieldwork portion of the audit is complete., auditors have a pretty clear Sense of what measures are likely to be cost-effective and which the owner is especially interested in seeing happen. Back at the Weatherization Coalition's Offices in mid-town Manhattan, data are entered into a program universally known as EA-QUIP and ES-QUIP (Energy Savings Analysis Using the Queens Information Package). EA-QUIP is a user-friendly program for personal computers which analyzes energy use and energy conservation opportunities in single–family and multifamily dwellings. It is an impressive package with estimates of costs and benefits of various retrofit measures presented in the light of both the findings in the field and historical energy consumption of the building. (A sample printout of the results is presented in Appendix A.) Both audit packages were developed by Dr. Leonard (Len) Rodberg, a professor of physics in the Department of Urban Studies of Queens College, who has been concerned with energy and environmental issues for two decades.

The development of EA-QUIP began in 1986 when Rodberg spent a year at the Coalition Housing Group of the New York Urban coalition, a large, multiborough weatherization subgrantee headquartered in Manhattan. The object was to computerize the weatherization program generally. "We scoped out for Rick Gerardi what a general program would look like," Rcdberg recalls. "We also pulled together a group of people in the early days of the NYC Urban Coalition, and taught them how to use computers to the ends of weatherization."

About then, the New York State Energy Research and Development Authority (NYSERDA) and DOS forged a memorandum of understanding through which a number of research and demonstration projects involving the weatherization program have been co-funded over the years. An early project, which involved both Rodberg and Mike McNamara at the Urban Coalition, allowed the first key steps toward developing EA-QUIP.

"We were contracted to look at energy conservation in low-income buildings and to develop guidelines and some rules of thumb to develop an audit," Rodberg recalls. EA-QUIP was developed as an adaptation of the Computerized, Instrumented, Residential Audit (CIRA), an audit prcduced by engineers at Lawrence Berkeley Laboratory for single-family structures. It was originally designed for running on a mainframe. Rodberg's principal work involved adapting CIRA to run on IBM-compatible personal computers and making it user-friendly. MacNamara added subroutines which take into account the physical condition of the boiler and distribution system and compute energy losses due to system imbalances in portions of buildings that are overheated (Rodberg 1991).

Similarly, the Princeton Scorekeeping Method (PRISM) was adapted by Rodberg for use in NYCWAP, resulting in ES-QUIP. PRISM was originally developed to assist in evaluating the effectiveness of weatherization measures and energy savings.

A thii package, the Weatherization Analysis and Management System (WAMS), was designed as a management tool for tracking clients, taking care. of inventory, and the like. To date, it has not had much influence among subgrantees in the New York City area, primarily because. agencies like to perform these functions in their own way. On the other hand, both EA-QUIP and ES-QUIP have caught on and are routinely used on all audits in the city.

The success of EA-QUIP and ES-QUIP, according to Rodberg, is due in large measure to Andy Padian, the Weatherization Coalition's director of Energy Audit Services. "Andy Padian is the prophet, the disciple who has carried the word on EA-QUIP. He is also the major user, beta tester, and trainer." As of the present writing, EA-QUIP is the only audit approved by the DOE Weatherization Assistance Program for use with multifamily buildings.

A new version of the computer software describes work to be done, separating repair from energy savings measures, while modeling alternative retrofit improvement packages. It is meant to be responsive to the state's new category of repairs and safety and health measures. "Repair measures are things you have to do, but which don't save energy," Rodberg explains. "However, since they are a necessary condition for doing other stuff that does save energy, it's important to describe them and track their costs. There are lots of things in multifamily weatherization work that are akin to repairing roof leaks so that insulation may be installed."

The concept of "computerized audits" is laughable to many. In the end, however, what may be called "computer-*assisted* audits" have several uses, not all of which are made explicit in users' manuals. Padian's remarks from a 1994 Home *Energy* article (Padian 1994) are instructive:

> Four years of computer-assisted audits have made me a better auditor. EA-QUIP has told me on a few occasions that my building diagnosis was wrong, and "it" was right. Most interesting is what I've learned about which changes in a building reduce (or increase) fuel usage mast dramatically. To my complete satisfaction, window replacements show a virtually insignificant change in fuel usage, even when factoring in the combined effect of increased R-value and decreasing infiltration. (Owners typically want window replacements and we typically don't want to pay for them.)
>
> EA-QUIP has improved our effectiveness in dealing with larger and more sophisticated building owners, and it has supported many agencies in getting close to doh-for-dollar matching funds from owners of rental properties.

An example of the persuasive powers of an EA-QUIP audit report prepared for a building owner is shown in Appendix A.

CONSERVE

In the words of its own brochure, the primary mission of CONSERVE (Collaboration of Neighborhood Stabilization Energy Rehab and revitalization Enterprises, Inc.) is to “secure private capital to expand energy rehabilitation work performed by community-based Weatherization Programs.” The organization was founded in 1986 as a not-for-profit energy services company aimed at helping occupants of low-income buildings to become self-sufficient. After 2 years of experimenting, in 1988 the board decided to focus on financing. They hued Jack Woolams, a lawyer with a background in energy conservation work, as executive director.

This background has been useful at CONSERVE. In 1988, CONSERVE began to specialize in packaging loans for building owners using low-interest loan money available through the New York State Energy Office’s Energy Investment Loan Program (EILP). Two years later, CONSERVE developed a service contract relationship with the DOS to provide financial analyses and negotiation services to assist weatherization subgrantees in New York City in leveraging private investments for multifamily dwellings.

At present, CONSERVE operates out of an office in midtown Manhattan. The organization is partially funded through service contracts with DOS. CONSERVE has a very active board of eight people, who represent the community development and banking communities as well as weatherization. The *staff* of five includes an associate director, who does primary marketing of services to landlords and to weatherization subgrantees; a financial specialist and fiscal officer, whos is the primary Ioan packager with the loan institutions, also manages CONSERVE’s finances and helps with software design; a project coordinator, who also performs technical assistance and building financial analyses that are requested by subgrantees; and an administrative assistant who does data entry.

The job of CONSERVE is literally to take building owners to the bank to obtain financing for needed building improvements. Typical loan arrangements with the EILP involve working first with a participating bank and then with the State Energy Office. “The bank issues a note according to its terms,” Woolams explains. “In most cases, this is the community lending department of a commercial bank. Whatever terms the bank has, the EILP writes down to 2.5% the interest rate for any loan of up to 5 years; and writes down to 5% loans of terms from 5 to 10 years. As far as the bank‘s terms go, this is pretty liberal. Often there are only nominal transaction costs—no points and no mortgage-related costs.” The total costs —including attorney’s fees, credit check, application fee, etc.—can be less than $500 for loans of between $10,000 and $150,000. The loans CONSERVE packages average around $35,000.

In a wrinkle CONSERVE instituted in 1992, the energy performance impact of weatherization on building economics is combined with the impact of maintenance and repair, water conservation retrofits, and J51, a New York City program which gives building owners tax relief for certain building improvements. “With a full analysis of the impact of all of these factors on overall building economics, we try to bank people who otherwise wouldn’t be bankable,” Woolams explains. A sample of such a comprehensive analysis, which frequently serves a critical purpose during negotiations with building owners, is shown in Appendix B.

Of course, just like building envelopes and heating systems, every fiscal situation is different, and most deals worked out by CONSERVE are to some degree unique. Indeed, even information gathering can be a complicated problem. "Sometimes, the way building owners keep financial information is inconsistent with bank financing requirements," Woolams points out. "There are owners who tend to keep receipts in a plastic bag."

CONSERVE frequently works with owners of financially distressed properties, and when needed, the staff provides management counseling prefatory to packaging financing. This ranges from bookkeeping to efficient techniques for repairing and renting vacant units. "Sometimes it takes years to get a building to the point where we *can* get fmancing commitments," Woolams explains. "But it's worth the trouble when we can get a lot more work done on marginal buildings." For example, extra financing has allowed the installation of an intercom in a 20-unit building in Harlem, thus enhancing tenant security, and asbestos abatement in conjunction with boiler replacement work in buildings in the Bronx.

"We've even managed to get financing to support the upgrading of vacant apartments for homeless families," Woolams says, describing what amounts to a triple play, since filling up the vacancies with homeless people also improves both cash flow and bankability. And this doesn't even count the impact of correcting code violations, a routine consequence of weatherization work accomplished on multifamily dwellings in the city.

Under most circumstances, CONSERVE performs services directly for weatherization subgrantees, usually during or after the audit. However, CONSERVE also directly markets its services, thereby bringing buildings to weatherization. For example, CONSERVE referred an 87-unit building in Brooklyn to the local weatherization subgrantee and, through numerous negotiations, managed to secure building leveraging of more than 50% of the costs via an EILP loan. Further, although initial interest was only in replacement windows, CONSERVE's analysis resulted in securing owner investments in boiler and distribution system upgrades.

In the 1992–93 contract year, CONSERVE worked with 22 weatherization agencies and performed fmancial analyses on 134 buildings. In the current contractual period, CONSERVE has arranged for over half a million dollars of financing for improvements on more than 400 dwelling units. In short, CONSERVE can have a powerful impact on building owners and is a key factor in leveraging funds for a substantial percentage of weatherization jobs performed in the city.

"Every building becomes a project," Woolams explains, "and getting the money is key. It's not like we have a pool of funds here and the owners come and get it. But the services we provide do open up opportunities. We access the private capital that makes things happen."

NORTHERN MANHATTAN

A middle-sized weatherization subgrantee in New York City, the Northern Manhattan Improvement Corporation (NMIC), was chosen for in-depth analysis under this case study. NMIC was founded in 1979 to provide free bilingual legal services to a predominantly Hispanic community in a distressed area of northern Manhattan. It has evolved into a multipurpose, community-based organization with a staff of 45 people. The agency deals with a variety of social and housing needs, including weatherization. Figure 2.5 shows the organization of NMIC.

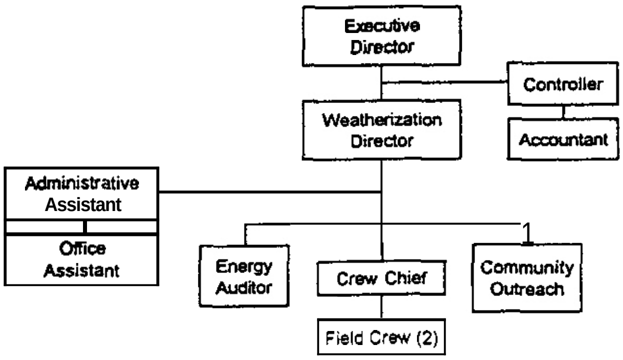


Fig. 2.5. Organizational chart of Northern Manhattan Improvement Corporation's Weatherization Program.

Intake Process

The weatherization intake process begins with the submission of an application for weatherization services by the landlord. The application is submitted by the landlord but is processed on the behalf of the tenants (66% of whom must meet the program guidelines) and the building. Along with a completed application the landlord must submit the following:

- proof of ownership (deed);
- two years of heating fuel usage records;
- two years of boiler repair records;
- one year of common area fuel usage records;
- a tenant list (or rent rolls); and
- a description of any recent (within 9 months) energy-related work and proof of its completion.

The last stipulation applies when a landlord wants to claim an owner's contribution credit for work completed prior to the application.

Once all of these materials are submitted, NMIC prepares a handout package for the building which includes a letter to each tenant introducing the agency and the weatherization program and brochures from DOS. The landlord is required to prepare a letter introducing NMIC, describing what is about to happen, and establishing a time when representatives of NMIC will conduct a meeting to further explain the process and field questions. Prior to meeting with the buildings' tenants, efforts are made to meet with any existing tenant organizations.

The process of eligibility verification for each household begins following the tenant meeting. The verification process is conducted by the staff of NMIC. The neighborhood served by NMIC is substantially Spanish-speaking, so five of the seven weatherization staff are Spanish-speaking and from Hispanic backgrounds. The length of the verification process varies from building to building, but 20- to 40-family buildings are generally completed in 1 to 2 weeks. However, it is not uncommon to have the verification process completed in one day. At the other end of the spectrum, there are times when the qualification verification process is much more difficult. The reasons include working people with schedules opposed to those of the intake workers; and the presence of illegal aliens, drugs, and the associated problems in a decayed urban neighborhood.

In some of these difficult cases a consultant (specializing in program qualification for recent immigrants) is hired. NMIC does not use a consultant routinely but has seen fit to hire one in the past where staff were not making progress in qualifying the minimum number of tenants.

Whether the process of qualification is easy or difficult, the landlord is rarely used to solicit information. There is the potential of compromising tenants' privacy. NMIC has a tenant advocacy section which has developed an agency policy that disallows landlord solicitation of income verification information in its service territory.

"There are lots of hopeful signs that the neighborhood is coming back," says Dan Rieber, weatherization director at NMIC since David Hepinstall left the agency to become executive director of the Weatherization Coalition, "but we've still got a long way to go."

The weatherization operation at NMIC is one of two subgrantees in New York City that does its own audits (the other is the Coalition Housing Group, a large agency with a citywide service area). EA-QUIP is used to do the retrofit prioritization, but the key to the auditing is what happens on site, not in the computer program. "After Bartollo Rivera finishes the client qualification work, we use two people to do the audit," explains Rieber. The process involves interviewing the owner and superintendent, sketching the building, measuring and counting windows, and the like, but most of the work is done in the basement and boiler room. "We always do a set of efficiency tests, which include carbon monoxide and smoke. When we think a major overhaul or replacement may be necessary, sometimes we shoot a short video. This covers overall shots, the exterior of the boiler, and the results of the tests we run. We open up the doors if it is a steel boiler, examine the burner, and try to get the camera to see as far into the boiler as possible."

This kind of documentation used to be submitted to the state to secure approval to do a large job. "It avoided wasting time arranging logistics for yet another field visit," Rieber explains, "but now they trust us to know what we're doing and we don't use the video as much anymore."

Richard Black is NMIC's lead auditor. Black, who used to work for the Coalition Housing Group, has extensive experience and is well qualified to do EA-QUIP audits. On complicated jobs Rieber joins Black in the decision-making and landlord-negotiating processes. In addition, finished audits are submitted to the Coalition Audit Service for Andy Padian's review. "If Andy agrees with the work scope and audit, we go ahead," explains Rieber. "If he doesn't agree and points out a problem, we rectify it. There are very few times when something goes wrong; it's usually only a typo."

Table 2.2 shows funding for program years 1994 and 1995 plus units weatherized. Note that owner investments average 30% at NMIC. The 728 units actually completed in the program year that ended in March 1994 was 20 over the goal for the year. There were 13 buildings weatherized, including one with 135 units and two with 95.

Table 2.2. NMIC Funding and Production,
Program Years 1994 and 1995

Source	PY 1994	PY 1995
DOE	$233,650	$181,661
LIHEAP	$828,395	$1,154,095
Owners	$318,613	$580,129
Con Ed	$30,000	$65,000
Total	$1,410,658	$2,581,491
No. of Units	128	1029
Av. $/unit	$1938	$2509

Note: Owners' and Con Ed figures are projections based on past performance.

At the time of the interview for this case study, January 1994, NMIC had three buildings in production, containiig over 200 units (two 40-unit apartments and one 135-unit building). "We are committed to doing 708 units this program year," says Rieber. "If I close a deal next week, we'll have finished our agreements for the year." The deal in question is an 80-unit building in which the audit concluded that a boiler upgrade is necessary. "We decided not to replace the boiler because the burner is quite new. But by upgrading it significantly, we should get some good savings," Rieber explains. The plan is to rebuild the 200-hp boiler's combustion chamber and add new controls. It already has a heat timer, an electronic device which adjusts high-fire run time to the outside air temperature and accomplishes night setbacks. However, operating and modulating controls will be upgraded, and a backup low-water cutoff and new aquastat will be installed. Finally, pipe insulation will be added. At high fire, a 200-horsepower boiler bums about 55 gal of fuel oil per hour, so saving 20 or 30% through the proposed upgrade can make a big dollar difference to the building owner. "Of course, the owner wants us to install replacement windows, too. We're trying to get him to pay about $30,000 of the $80,000 cost of the job," Rieber explains.

Like many agencies, NMIC does not use CONSERVE's services on every job but does so when it seems likely to make a difference. The key point is to identify clearly what retrofits will make a real energy savings difference, then form and package a business deal that is in the interest of all parties. Rieber is skilled at negotiating these business deals and clearly enjoys this aspect of his job.

Utility Leveraging

A welcome partner in the process is Con Ed, New York State's largest utility. All of New York's nine utilities regulated by the Public Service Commission are participating in ULIEEP. Con Ed has elected to run its quite vigorous ULIEEP through the Weatherization Coalition to subgrantees like NMIC. On buildings which use natural gas or electricity for space heating, ULIEEP funds can be used to undertake weatherization measures. These include repairing (or even replacing) heating systems, air sealing, installing insulation, and undertaking various domestic hot water (DHW) conservation measures. (Window replacement, which used to be specifically disallowed as a ULIEEP expense, is now allowed as of spring 1994.) The ULIEEP funding limit for weatherization measures is $609 per apartment.

In addition to these weatherization measures for gas-heated buildings, electricity-conserving demand-side management (DSM) measures may be undertaken using Con Ed funds on all buildings, regardless of their heating fuel. DSM measures include up to five screw-in fluorescents and three hard-wired fixtures per apartment plus a refrigerator coil cleaning kit. This program accounts for the field crew in NMIC, since all of the DSM work is accomplished by in-house crews.

'We would like to do more ULIEEP weatherization jobs, but I'm having a problem finding gas buildings," Rieber says. In the first year of the 3-year pilot program, NMIC did the majority of ULIEEP units done in the city. This year they've done fewer because most of the buildings coming into the system use oil-fired boilers. Of course, electric DSM is accomplished on all buildings.

'We view this program as designed to benefit the tenants," Rieber explains. "We try to maximize the number of fixtures in each apartment. The criterion we try to meet is to install lights anywhere the lights can be placed, verifying with tenants that it's okay with them." Installers also try to match the lumen output of the compact fluorescents with that of the existing incandescent fixtures. In practice, 23-W compact florescent fixtures are installed in most cases (Fig. 2.6). These have a bit more lumen output than do 75-W incandescent bulbs. "The fixtures we use are quite versatile, have electronic ballasts, and give out a lot of light," Rieber claims. "Once in a while we find a defective fixture, and there is some breakage, but by and large, we're pleased with them and

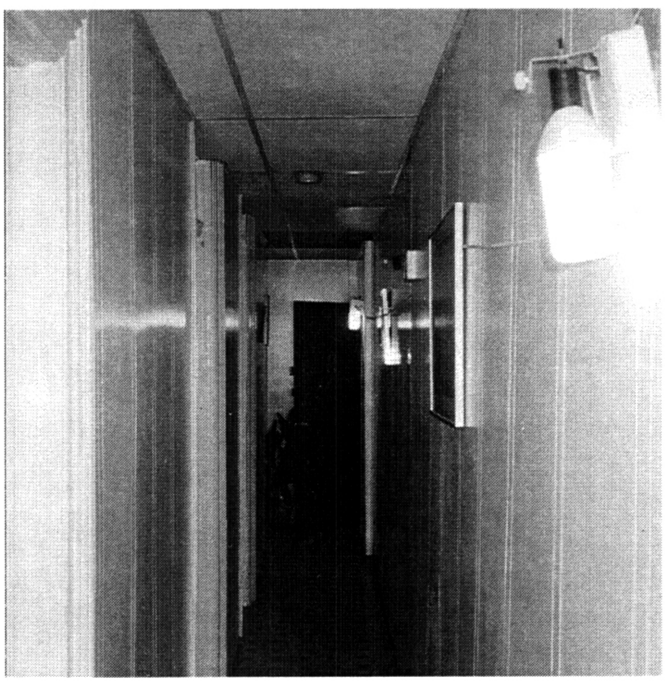


Fig. 2.6. Compact fluorescent fixtures were installed using DSM funds from Consolidated Edison. The kitchen and bathroom have energy-efficient fixtures installed, too.

with the program." Twenty-seven-watt fixtures, which have the lumen output of 100-W incandescent bulbs, **are** due out soon, and will **be** integrated into NMIC's **DSM** program **as** soon as possible.

To illustrate the healthy mix of funding (and very substantial leveraging **of** DOE weatherization funds) accomplished by agencies like NMIC, it is useful to examine the WAF' Total Job Cost Summary form reproduced in Fig. 2.7. The first column after the description of measures is 'WCWC," the Weatherization Coalition, which manages the ULIEEP and DSM funds from Con Ed. In buildings with gas-fired boilers, this quantity can be $700 per apartment or even more. The "WAP Cost" column is funding from the state's grantee, the New York **WS,** and includes funds from both **DOE** and the **DHHS through** the LIHEAP program. Finally, there is the "owner ***cost"*** column. **The** owner is required to put up 25% of the cost of a weatherization job, and frequently pays substantially more. In consequence, funds from DOE for a typical large multifamily job may amount to only 25% **(or** even **less)** of the total.

RETROFIT WORK AND CONTRACT MANAGEMENT

Agencies like NMIC do DSM work and a modicum of air sealing using in-house crews but routinely let contracts for window replacements and boiler/distribution work. This is followed up by 100% inspections of all work by the subgrantee's staff, and by field inspections and signoffs by representatives of the state grantee, **DOS.**

Boilers and Distribution Systems

"Heat delayed is heat denied," says Frank Gerety, a mechanical engineer and boiler wizard whose influence **on** the evolution of multifamily weatherization work in New York has been substantial. The author of ***How to Ger the Best from One-Pipe Steam*** (Gerety 1987), Gerety has been a full-time consulting engineer since 1985. Both the Coalition and many subgrantees **use** him to write **the** detailed specifications for complicated boiler jobs and to ride herd **on** the work done. **"You** need low tech, not high tech, to make **these** systems work," Gerety claims. "Most of the mathematics **I** do is on an adding machine with a tape."

The issue of "heat delayed is heat denied" is thematic to a book Written by John Mills **over** a century ago (1877). **The** point is to **use** good vents **on** the ends of the main risers but smaller vents on the radiators, adjusting the system so that steam reaches all radiators at the same time.

"Back in the **mid-80's,** I went **through** a few buildings for HPD and looked at some new boilers that were 'presto, chango' installations done in the middle of the winter. Some of these were just horrible installations." Gerety's reports were **taken** seriously. **"The** idea of venting was latched **onto** by **HF'D** quickly. They put master vents in everywhere!" Frequently, they overdid it. **"You** shouldn't master vent **unless** the system is **free** of water hammering," Gerety explains. "The boiler is the root cause. **I** find that most boilers **are** either badly designed, badly installed, or both. **A** lot of my remedial work is to get boilers to behave themselves."

WAP TOTAL JOB COST SUMMARY

FORM–104A

SUBGRANTEE	Date Prepared: PG 1 OF 1
	PROJECT MANAGER
PROJECT ADDRESS	ULIEEP PROJECT NUMBER
GENERAL PROJECT DESCRIPTION	RECV'D BY ULIEEP/NYCWC:
_____UNITS FUEL (CIRCLE ONE): OIL GAS ELEC	

Form #104A– Summary of total DOS Weatherization JOB COST Attach – Form #103C – for Electric DSM values.

LABOR AND MATERIAL FOR HEATING SYSTEM & WEATHERIZATION MEASURES

DESCRIPTION OF MEASURES	NYCWC	WAP COST	OWNER COST	TOTAL JOB COST	
4/5A HEAT AND DISTRIBUTION					
4 HEATING SYSTEM					
4(1) BOILER					
4(2) DISTRIBUTION					
Form 105 Line 4 *SUBTOTAL*					4
5A DOMESTIC HOT WATER SYSTEM					
Form 105 Line 5A *SUBTOTAL*					5A
	NYCWC				
5B DOMESTIC HOT WATER CONSERVATION					
Form 105 Line 5B *SUBTOTAL*					5B
6 ELECTRIC DSM MEASURES (FORM 103C ATTACHED)					
Form 105 Line 6 *SUBTOTAL*					6
7/8/9 OTHER WEATHERIZATION MEASURES					
7 APARTMENT					7
8 COMMON AREA					8
9 ENVELOPE					9
Form 105 Line 7/8/9 *SUBTOTAL*					7/8/9
10 WINDOW REPLACEMENT (NOT REIMBURSED BY ULIEEP)					10
SUBTOTAL					
	NYCWC	WAP COST	OWNER COST	TOTAL JOB COST	
TOTAL JOB COST					

Reviewed and Submitted by Subgrantee: ____________________

Reviewed and approved by NYCWC: ____________________

REVISED 10/14/93

ULIEEP FORM – 104A PAGE 1 OF 1

Fig. 2.7. Weatherization Assistance Program total job cost summary form.

Big steel boilers represent particularly recalcitrant challenges, a fact that is not helped much by information that comes from the Steel Boiler Institute. "The Steel Boiler Institute's ratings of steel boilers are about as reliable as politicians' promises," Gerety quips. "The main problem with big steel boilers is that they have inadequate steam space, so I designed a boiler with a 14-in. steam space at the top instead of 9 in. That plus extra insulation does the trick nicely," claims Gerety. The extra insulation is important. Most of the heat transfer from the fire tubes to the water in a boiler is by radiation, which goes as the fourth power of flame temperature. This is why most modem boilers are relatively smaller and have much tighter flames—there is intense radiant heat transfer. This makes for better efficiency of heat transfer to water and steam, but it also makes for hot outer surfaces of the smaller boilers—and substantial radiant heat losses to boiler rooms. "Andy Padian sold me on increasing the jacket insulation from two to three inches," Gerety says. "This works well to limit radiation losses from the jacket of the boiler."

Gerety continues to experiment with optimizing boiler performance. Interviewed in June 1994, he had just finished a successful experiment with elongated smoke boxes on a large boiler he designed. The larger smoke boxes allow for all of the tubes to get hot at a more uniform rate and also provide space for extra insulation such as a spun calcium silicate used for high-temperature industrial applications. 'You can put a hand on the front,'' says Gerety. "It's warm, but you don't get a third-degree burn."

Gerety believes that the modem trend toward downsizing boiler units is a good idea with hydronic systems but not with steamers. "The nature of a steam system is that all of the steam must go to all radiators at the same time. So an undersized steam system is an unmitigated disaster." Gerety found through testing that it is best to size steam boilers for 1.5 times the Btu capability of radiators, not 1.33 as held by conventional wisdom (based on a 1950 study in Illinois that used lightweight radiators). "Oversizing a bit doesn't waste a lot of energy up the chimney because off-cycle losses are a lot lower, and with steam, you necessarily have to cycle a lot."

Understandably, Gerety is called in on a number of weatherization jobs that involve substantial work on the boiler and distribution system. A key to Gerety's work for weatherization agencies is to write specifications for major boiler repair or replacement. "If I do a good spec, then the bids come in tight. A good, tightly-written spec can drive the bids. This tends to favor competent contractors."

Of course, once in a while a low bid is let to a contractor who may not fully understand the work or assign less than fully competent people to the job. "Renegade contractors sometimes go off half cocked and it takes a lot of time to deal with them," explains Gerety. "I try to ride herd, to make sure they meet the letter of the spec in spite of themselves. Hopefully, I'll be able to cause them to lose money and they'll never again bid on anything that I spec!"

Windows

Replacing windows in large multifamily buildings is the major activity of a number of contractors in New York City. In distressed neighborhoods, replacement windows are a very visible indication that a building (or even a whole neighborhood) is on the road to recovery. Where tenants may have no awareness of significant improvements in the boiler room, it is clear to them that improvements are being made when new double-glazed windows replace battered old windows that rattle in the wind and seem to amplify noises from the street. Building owners like new windows, too. They improve relations with tenants, and various institutional circumstances, both carrots (tax abatements and partial relief from rent controls) and sticks (energy codes) favor replacement windows (Fig. **2.8).**

Nonetheless, the wholesale replacement of windows is an expensive proposition, and hard to justify economically when saving energy is considered as the only quantifiable benefit. Peter Judd includes a thoughtful discussion of thermal windows in Chapter **2** of ***The Overheated City***. Although not directed to the weatherization program as such, his closing remarks are instructive:

> There is no basis for the massive public subsidy of thermal windows. It is wasted in terms **of** the energy savings resulting from it and partially justified only by the rehabilitation of building windows. For the majority of situations where windows will not get the care the "superior" product requires, a simpler window would do. It would need no subsidy, less maintenance costs over its lifetime. Far greater conservation of energy can be achieved with attention given to the heating system. (Judd 1990).

The Future

Weatherization of large buildings in New York City has advanced by an order of magnitude since the early days of what amounted to window-replacement-only retrofits with virtually no monetary investment by the owner. However, as Len Rodberg **puts** it, "weatherization still does a lot of windows, but boilers are where the action is. The struggle continues—the basis of the negotiation between weatherization providers and building **owners** is the tradeoff of windows and boilers." The **good** news is that the **percentage** of effort and investments in buildings represented by heating system work is increasing each program year. Nonetheless, it **seems** likely that the process of technology transfer in general —d building owner/superintendent education in particular–will continue to be a key element in the evolution of New York's weatherization program.

Education and Evaluation

In drawing parallels between the management of water resources and **energy resources** in multifamily dwellings in the city, Peter Judd made the following observations in his recent book on controlling the demand for water in apartment buildings:

> It would appear that multifamily buildings retrofitted to meet codes **for** advanced levels of insulation in **roofs** and ceilings and using combustion equipment that meets the latest standard would use less fuel than those not similarly equipped. But this was not so; in fact, many used more fuel.
>
> Where there were savings (with or without new equipment), management had instituted a *process*. The process was: monitoring fuel use, regular maintenance, and support of the building staff. It wasn't regulations from on high that got this process going and sustained it; it was the goal of saving money. (Judd 1993)

This prompts two observations. First, working with superintendents and building **owners** is a big part of successful multifamily weatherization; economics is a driving force and education can

Fig. 2.8. New windows like these in Northern Manhattan can bring beautiful old buildings back to lie.

make a critical difference. Second, the means of tracking, of monitoring energy consumption, needs to be placed in the hands of both weatherization subgrantees and owners and superintendents? Accomplishing these at a reasonable cost should be a high priority.

In this vein, in the summer of 1994 the Coalition was initiating some potentially important analyses. David Hepinstall puts it this way: "Once an audit is accomplished and a scope of work is a done deal, we will install data loggers to monitor energy use, water consumption, and relevant temperatures. After the work has been done, we intend to do a full analysis of projected savings. We will then plot actual versus predicted energy savings for the agreed-upon scope of work. This will allow us both to test EA-QUIP and to evaluate the work at the same time."

If carefully done, this analysis could result in useful enhancements to the audit and lend greater credibility to the entire multifamily weatherization process in the city.

New Initiatives

The parallel between water consumption and the consumption of *energy* is quite remarkable, as illustrated in Peter Judd's book on the subject Figure 2.9 shows the average daily water use per apartment in 47 New York City multifamily buildings ranging in size from a 4-unit to a 719-unit structure.

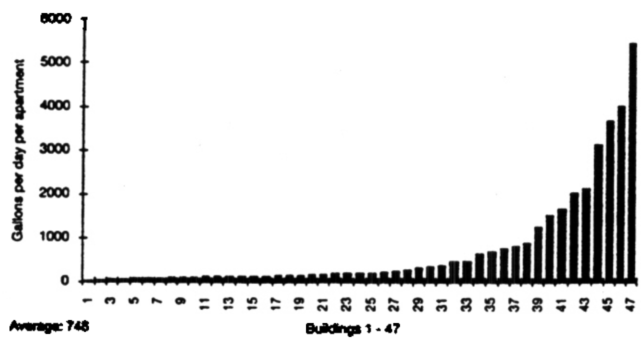


Fig. 2.9. Average daily water use in 47 New York City buildings *(Source:* Judd 1993).

It seems quite clear that a program aimed at water conservation should (1) arm itself with knowledge of consumption that is as specific as possible and (2) act with the greatest vigor to stop the hemorrhaging in the highest-using buildings. This is in the tradition of New York Weatherization's Targeted Investment Protocol System, which takes as axiomatic that "savings follow waste."

That the means of tracking performance before and after weatherization work should also be placed in the hands of the New York Weatherization Coalition is the subject of a recent initiative that is tied to the present national evaluation. ORNL has made available to the Weatherization Coalition 30 of the data loggers used in the National Weatherization Evaluation Fuel Oil Study to use in multifamily buildings f a tracking the consumption of fuel for hot water and heat versus relevant parameters before and after retrofit work. This research work is co-sponsored by the NYSERDA and the Department of State.

Recognizing from a number of perspectives (environmental, economic, institutional, and ethical) that water conservation is akin to energy conservation, the Weatherization Coalition has formed an affiliate organization devoted to the conservation of water. "Water conservation is [the responsibility of] a for-profit business affiliate called Energy and Water Conservation Services, Inc. (ENAWAC)," explains Hepinstall. "It is truly a separate organization with a separate board and separate stock holders. It is an affiliate in the sense that all of the stock holders and all of the board members are of the weatherization program and we're committed to the same purposes." The kinship with energy savings in the case of the conservation of bot water is quite direct, and many efforts are devoted to limiting the demand for hot water at the point of use (e.g., the shower head and the sink).

Although the water and energy organizations are separate, Hepinstall cannot resist sharing an image of the future. "We're already fielding a dozen people to do water audits and install measures; ENAWAC's production is up to 800 units a week. Sometime soon, I envision a single van serving buildings on the same block doing water conservation and installing compact fluorescents."

Refrigerator conservation, through retrofit or replacement, also has great potential as a serious future initiative. Con Ed has begun monitoring for power quality effects on feedlines to multifamily structures that have Green Plug installations with their refrigerators', and the Coalition is involved in experiments with Green Plug retrofits in two buildings. Monitoring energy saved may be undertaken soon.

The replacement of energy-inefficient refrigerators is also a potentially attractive addition to the repertoire of weatherization tactics employed in the city. This is particularly the case in New York because (1) electric rates are among the highest in the nation, peaking in the summer when refrigerator efficiency is at its lowest; (2) tenants typically must pay for electricity; and (3) many existing refrigerators in lower-income housing stock are low-end, inefficient models bought by landlords with low front-end fmancial concerns. Energy-efficient refrigerators, unlike replacement windows, do something visible and directly useful for tenants, in addition to having excellent paybacks (on the order of 3 to 6 years).

In consequence, a program which includes landlord and utility DSM money is under consideration by W S . "I'd like to be able to combine a refrigerator replacement program with an economic development initiative for the environmentally-friendly recycling of refrigerators in the South Bronx," says **Rick Gerardi.**

Other initiatives under consideration by various members of the weatherization community are common-area lighting retrofits, exterior lighting, and electric motors. High-pressure sodium lighting is six times more efficient than incandescent, and bulbs typically last for 30,000 hours. Modem energy-efficient electric motors can replace ancient motors to power elevators, yielding good savings when the circumstances are favorable. In addition to high electric rates, relevant circumstances for decision making for this conservation tactic are demand on the elevator, difference in consumption of the old versus the new motor, and installed cost. Makiig it happen is, of course, the primary issue. In this regard, the model established in New York weatherization shows particular promise.

[3] **Green Plugs are electronic devices that selectively lower the voltage to refrigerators by removing a small portion of each cycle. Research shows that a roughly 10% savings** *can* **be achieved with inefficient older self-defrosting refrigerators, Higher line voltages are associated with** better **savings.**

"I'm not sure I can say this precisely with all of its nuances, but I'm sure there are whole urban environments—even whole states—that could make use of the model here,'' says Hepinstall. ''Here at the Coalition we have centralization at the appropriate area-wide level in a way that respects local autonomy. We would like to have more autonomy, more flexibility, vis-'a-vis the state. The lighting issue is only a footnote in DOE's regs, but it needs to be thoroughly established. Both hard-wired and screw-in florescents should be a part of the WAF', as well as high-pressure sodiums for the exterior. We should be doing refrigerators, other electric motors, and water conservation. This stuff is all related. Water is an energy issue both because of hot water preparation and because it's a pumping and sewage treatment issue. All of this is connected to recycling. We must get rid of the refrigerators in a responsible way; how about windows? Anything that can be sorted can be recycled!"

BUILDINGS SURVEYED

Twelve multifamily buildings were visited in this case study. The building types in the survey include a four-story, low-rise, heavy construction; six-story, mid-rise, brick heavy construction; and steel frame, curtain-wall high-rise, publicly funded housing. All buildings are heated by steam. In each case except one, DHW is integrated with the heating.

Both fuel oil and natural gas are used extensively throughout the city for space heating and DHW. In some cases boilers have the capacity to bum either. Switching to the least expensive fuel is a common practice for building managers and is sometimes employed as a part of the weatherization strategy. Most large residential multifamily buildings outside of the borough of Brooklyn are heated by fuel oil.

Traditional measures employed in single-family housing stock for diminishing conductive and convective heat energy lasses are inappropriate in brick, steel, and concrete buildings which predominate in New York City. Brick buildings with poured concrete floors are very common. Building codes and governmental administration also play important roles in circumscribing weatherization measures. For example, defunct dumbwaiters which are obvious thermal bypasses cannot be permanently sealed; they must be kept available as hose chases for use by the fire department. Of further note, quality-of-life considerations imposed by the health department require passive venting at stairwell skylights.

The primary weatherization measures employed in the buildings in this case study are global in that they address building systems as opposed to utilizing an apartment-by-apartment approach to air sealing and insulation. Typical measures include heating system modifications and replacements, DHW system upgrades, roof insulation, and roof repair. Apartment-level retrofits include window repair and replacements and energy-efficient lighting retrofits and weather-stripping of entry doors.

Crown Heights Jewish Community Center
1082–1096 President St., Brooklyn, NY

Fig. 2.10. The building at 1096 President St.

Building Description

This Brooklyn block is like hundreds of others in the borough built in the first half of the twentieth century. In middle of the block there are several contiguous side-by-side sets of four-story, heavy-brick-construction apartment buildings. Taller apartment buildings are on each corner flanking the row. There are four pairs of buildings in the low-rise row section of this block. Two of those four pairs, or a total of four individual apartment buildings, were the subject of weatherization measures. The four buildings have one owner and are maintained by one building superintendent.

Each set of two apartment buildings encloses a central courtyard, creating a rectangular donut-shaped building plan. The courtyard allows natural light and ventilation to reach interior spaces that are located away from the front and rear facades. The primary stairwell for each building is located at one end of the donut hole, and they rise from the first floor to the roof level. Access to the basement, which houses the heating plant and much of the distribution piping, is via the courtyard. Emergency egress is by a fire escape: a wrought iron set of stairs attached to the exterior of the building in a location remote to the primary interior stairs.

Each building is a 20-unit walk-up (i.e., there is no elevator). The construction is brick with poured concrete floors. The public hallways and apartment baths have ceramic tile floors which are set in concrete. The remaining floor surfaces are wood, although they are often covered by linoleum. Apartment units are composed of kitchen, bath, living room, entry foyer and either one or two bedrooms. The average aparhnent size is 518 square feet with 9-ft ceilings. Typically, an apartment has windows on one side only, unless it is a coveted comer unit. The existing windows are the original wood double-hung units with no storm windows.

The four buildings are heated by one 125-hp steam boiler having a 3-in. insulation jacket and providing heat and hot water. The boiler currently bums number 6 oil as a heating fuel; it is also equipped to bum natural gas. The heating cycle is activated when the exterior temperature reaches 55°F during the day or 40°F during the night.

The boiler room, which has been consolidated in one of the interior buildings in the row, is well maintained. All distribution l i e s are insulated, and the floor and wall areas where piping passes through are sealed.

The DHW is fed through a mixing valve and then to each apartment at 120°F. The distance from the mixing valve of the hot water riser ranges from 6 ft away in the same building to 75 ft away in the remote building. The control valve allows the temperatures of the boiler water, supply water, and return water to be monitored from one location.

Weatherization Measures

The primary thrust of weatherization was upgrading the efficiency of the heating systems and switching to a lower-cost fuel. The scope of work included a daring heating system retrofit. Originally each of the four buildings involved in the project had heat and DHW supplied by its own 35-hp, natural gas-fired, atmospheric, one-pipe steam boiler. Heating system retrofit specifications called for replacement of all four units with one 125-hp steam boiler to provide heat and DHW for all four buildings. Fuel switching was also a part of the weatherization strategy, but this switch changed the building from less efficient atmospheric burners to a more efficient power burner. The new unit burns number 6 fuel oil. The new control system includes a standard heat timer, however, a sophisticated hot water mixing device was added. It continually senses return water temperature from each building and automatically mixes the required cold water to maintain each building's minimum heat requirement while providing on-demand DHW. Work associated with the boiler replacement included interconnection of the basement area supply and return l i e s, as well as insulation of the lines, sealing of miscellaneous pipe and window openings, and whitewashing of walls and ceilings.

The second thrust of weatherization work was reduction of heat loss due to stack effect This was addressed by controlling the access door opening at the top and bottom of the central stairwell and by weather-skipping apartment entry doors. The building's lower entrance doors were typically kept closed and locked for security reasons. However, the roof door did not lock and was very often left open. The roof door is now typically closed, and a burglar alarm system was installed to deter unauthorized access. Limiting access to the roof also preserves the built-up surface.

Energy-efficient lighting was installed in the hallways and in the kitchens and bathrooms of each apartment.

Weatherization work was augmented by client education. The building residents were informed of the nature of the work and of the importance of keeping all doors throughout the building closed. Education was also provided to the building superintendent, making sure he understood the new heating system and would manage it correctly.

Savings

Pre-weatherization consumption records indicate that, despite their outward similarities, these four building consumed fuel at different rates, from a low of 23.8 Btu/HDD/ft^2 to a high of 34.2 Btu/HDD/ft^2. The composite consumption rate across all four buildings was 30.4 Btu/HDD/ft^2 for a total normalized annual consumption (TNAC) prior to weatherization of *8409* MBtu. The post-weatherkition consumption rate was 25.6 Btu/HDD/ft^2, a reduction of 16% in heating-only normalized annual consumption (HNAC).

These numbers are more impressive when the reduction in fuel cost is considered. Natural gas from the local utility costs approximately $7.20 per MBtu, whereas number 6 fuel oil costs $4.17 per MBtu. The calculated annual savings are $32,490. The. total cost of the retrofits was $99,510, and the benefit-to-cost (B/C) ratio, based on a 20-year life and 4.7% real discount rate, is 4.5.

Comments

This is an example of a creative and successful multifamily weatherization job. Contributions by all participants were necessary for success in a project as complex as this one. One of the most critical participants is the building superintendent. He is the person who manages the new system and consequently will have an impact on future savings. In this case, the building superintendent had good knowledge of beating systems and great interest in understanding the new system. He took the initiative to act on opportunities to enhance energy savings by actions such as improving air sealing (Fig. 2.11).

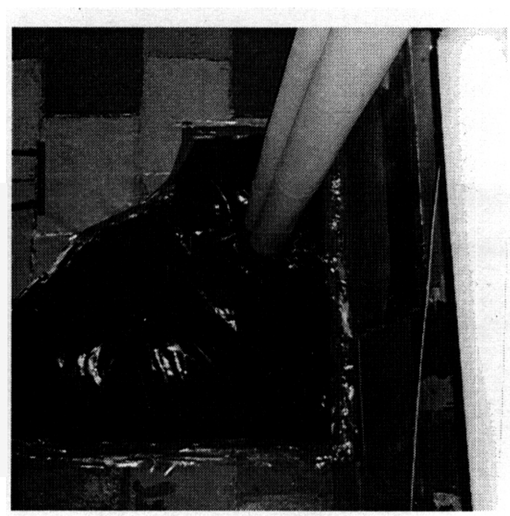


Fig. 2.11. Air sealing work completed by the building superintendent.

1082N–1096 President Street Brooklyn, New York Savings Analysis				Annual HDDs: 4868
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	41,472	41,472	0	0
Consumption Index, Btu/HDD/ft^2	30.38	25.56	–4.82	–16.7
Heating NAC, MBtu	6133	5160	–973	–15.9
Baseload NAC MBtu	3250	3250	0	0
Total NAC, MBtu	9383	8409	–974	–10.4
Fuel Cost, $/MBtu	7.20	4.17	–3.03	–42.1
Annual Cost, $	67,556	35,037	–32,519	-48.2
cost of Weatherization	$99,510			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$488,195			
Benefit-&Cost Ratio	4.5			

Northern Manhattan Improvement Corporation
600 W. 175th St., New York, NY

Fig. 2.12. The building at 600 W. 175th St.

Building Description

This structure is a solid yellow brick, five-story mid-rise New Law building which contains one commercial unit, a funeral parlor. The proprietor of the funeral parlor owns the building, which sits on a prominent comer and is generally well-maintained. The majority of its 17 residential units are occupied by long-term tenants who are not usually at home during working hours.

The heating plant is a 634,000-Btu/hour gas-fired atmospheric boiler and is controlled by a heater timer which responds to an outside temperature sensor. Steam is the heat transfer medium in a one-pipe configuration. The building contains no mechanical ventilation or air conditioning equipment. The old heating system was overheating the top floors of the building.

Weatherization Measures

The primary weatherization work was installing a new boiler with a power burner and controls, along with repairing the existing distribution system, including the radiators, valves, and vents (Fig. 2.13). Additionally, related boiler room work (i.e., whitewashing walls, insulating pipes, adding door closers and minimum ventilation) was specified according to the building code. Related to the boiler work were reductions in the supply temperature of DHW and the installation

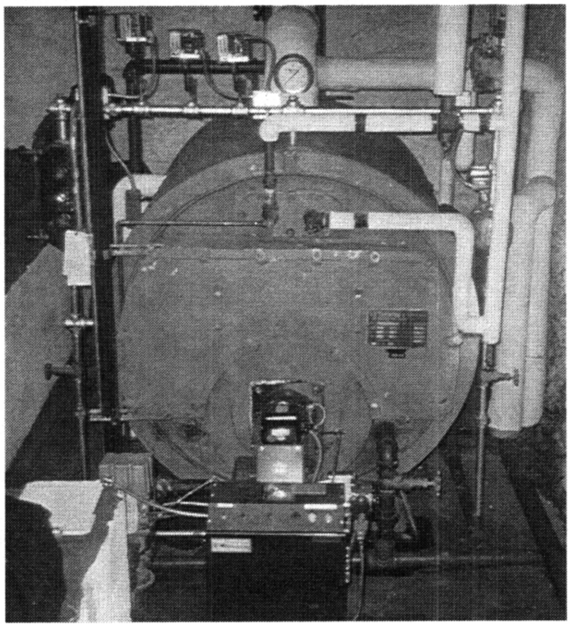


Fig. 2.13. New besting system installed in Northern Manhattan weatherization project.

of faucet aerators throughout the building. The secondary focus of work was replacing the existing wood windows with new metal double-hung, double-glazed windows. The remaining work consisted of air sealing in the central circulation space and installing compact fluorescent lamps in the bathroom, kitchen, and hall of each apartment.

Savings

The pre-weatherization baseload was adjusted to reflect an increase in occupancy from before to after weatherization of three apartments.

Heating savings on this job were a respectable 14.5%, but 20-year discounted savings were only $21,164. Since the cost of the weatherization job was $54,396, the benefit/cost ratio was well less than 1.

In general, it is difficult to have cost-effective savings when the weatherization investment for heating-related retrofits in a buildmg is over three times the annual heating bill. Yet a new boiler with controls is a major investment which does not lend itself to incremental costing. In the present case, the boiler replaced was aged and sufficiently inefficient that replacement appeared to make good sense.

600 W. 175th Street New York, New York Savings Analysis				Annual HDDs: 4868
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	15,777	15,777	0	0
Consumption Index, Btu/HDD/ft^2	24.4	22.6	1.8	–7.4
Heating NAC, MBtu	1873	1735	138	–7.4
Baseload NAC, MBtu	636	544	84	–14.5
Total NAC, MBtu	2509	2279	230	–9.2
Fuel Cost, $/MBtu	7.20	7.20	0	0
Annual Cost, $	18,065	16,408	1656	–9.2
Cost of Weatherization	$54,396			
Lifetime Savings, 20 yrs. @ 4.7% discount rate	$21,164			
Benefit-to-Cost Ratio	0.39			

Northern Manhattan Improvement Corporation
625 W. 138th, St. New York, NY

Fig. 2.14. The building at 625 W. 138th St.

Building Description

This New Law multifamily apartment building is a five-story brick, heavy construction walk-up with poured concrete floors. It contains 20 apartment units, each measuring approximately 935 ft^2. There. are adjoining buildings on both sides, one nearly identical in style and size, the other a smaller classic New York City brownstone. The heating system contains two steam boilers in tandem with a one-pipe distribution system; they bum natural gas. The DHW is provided by a separate 400-MBtu natural gas–fired boiler.

Weatherization Measures

This work was nearly evenly divided between windows ($20,000) and upgrading the heating and DHW systems ($38,000). Additionally, measures to minimize stack effects were completed.

The existing windows were wood, double-hung, and all in place prior to weatherization. They were replaced with double-glazed metal windows. The heating system's upgrade work included cleaning and flushmg the boiler, tuning the burner, replacing the control system excluding the heat timer, and installing a new tank for DHW. Faucet aerators were. installed in each apartment. A standard interior work package of weather-stripping doors and air-sealing the top and bottom of the envelope was also completed.

Savings

Savings appear to be very good on this project. The rate of fuel consumption was reduced from 14.9 Btu/HDD/ft^2 to 5.3 Btu/HDD/ft^2. Annual heating energy consumption was reduced by *64%.*

625 W. 138th Street New York, New York Savings Analysis				Annual HDDs: 4868
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	18,700	18,700	0	0
Consumption Index, Btu/HDD/ft^2	14.85	5.45	9.4	–63.3
Heating NAC, MBtu	1352	496	856	–63.3
Baseload NAC, MBtu	1,524	1,029	495	–32.4
Total NAC, MBtu	2,875	1,525	1,350	–47.0
Fuel Cost, $/MBtu	7.20	7.20	0	0
Annual Cost, $	20,702	10,979	9723	-47.0
Cost of Weatherization	$28,317			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$124, 259			
Benefit-to-Cost Ratio	5.1			

Bedford-Stuyvesant Restoration Corporation
1625 Park Place, Brooklyn, NY

Fig. 2.15. The building at 1625 Park Place **in Brooklyn.**

Building Description

This building is a four-story brick walk-up with 20 apartment units and basement. The stairwell is central and goes from the first floor to the roof. There is an adjoining set of seven of these buildings on the block. This building was the only one of the eight to receive weatherization.

Weatherization Measures

This was an owner-contractor multifamily weatherization project. The owner of the building is self-employed as a general construction contractor and is also the building superintendent. The weatherization job was a classic patch-and-repair job throughout, with the owner-contractor completing the work, which included a heating system upgrade and door and window work.

The heating system is an old 35-hp oil-fired steam boiler. Upgrade work called for cleaning and tuning the existing system, adding a barometric damper as well as a new heat timer, repairing and insulating distribution system piping (Fig. 2.16), repairing the radiator, air-sealing the boiler room area, and installing a new sump pump in the drain pit area.

Fig. 2.16. Newly insolated distribution pipes at an existing heating system.

The owner-contractor did not complete work according to specifications. His view of how the boiler operated differed from that of the specification writers. We found the limiting pressure at the boiler set at 9 psi when it should have been set at no more than 4.5 psi. Proper operating pressure was restored by the auditor during the site visit (Fig. 2.17). The owner thought that the basement area pipes should not be insulated, as the pipes provided incidental heat to the basement area that he used as leisure space. Ventilation to the boiler room was not provided according to code. Basement air sealing, including sealing of bypasses, was not completed. The new sump pump was reassigned to another building with a greater need. The remaining portion of the heating system work and the envelope measures could not be verified, as we could not gain access to the remainder of the building.

DHW is provided by a pair of 60-gal gas-fued stand-alone units. The distribution lines were insulated as a part of the general heating system distribution line work. Cleaning and tuning was specified for both units, and at the time of the site visit they were firing at the manufacturer's rating. Faucet aerators were installed in each apartment as a part of the DHW work.

Savings

Heating fuel usage is inconclusive because the fuel oil is never purchased on a fill-to-fill basis

Comments

Apparently, the critical factor of actual consumption was omitted in the development of the investment level and work scope. Another significant but unrealized opportunity for savings in this case was in the area of client energy education. The owner-contractor did not revise any energy use patterns, and yet he has the most control over the building's consumption.

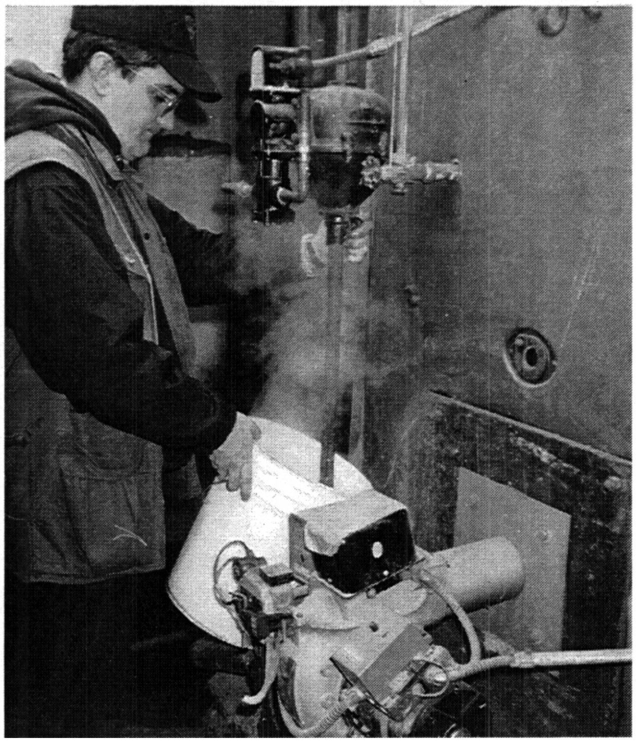


Fig. 2.17. Auditor venting steam heating system after discovering improper pressure setting.

1625 Park Place Brooklyn, New York Savings Analysis				Annual HDDs: 4868
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	12,240	12,240	0	
Consumption Index, Btu/HDD/ft^2	23.06	NA	NA	10.6 ~~NA~~
Heating N A C, MBtu	1374	1521	147	NA
Baseload NAC, MBtu	NA	NA	NA	0
Total NAC, MBtu	NA	NA	NA	10.6
Fuel Cost, \$/MBtu	4.17	4.17	0	
Annual Cost, \$	5,727	6,339	612	10.6
cost of Weatherization				
Lifetime Savings (20 yrs. @ 4.7% discount rate)	NA			
Benefit-to-Cost Ratio	NA			

OUB Housing Services
512 E. 145th St. and 545 E. 144th St., Bronx, NY

Fig. 2.18. High-rise and mid-rise buildings in the Bronx.

Building Description

These buildings are a part of 1970s high-rise and mid-rise public housing projects and are Multiple Dwelling Law buildings under the New York City building code nomenclature. They are steel-framed with poured concrete. floor decks and brick facades. Windows are steel casement type throughout. There are two entrance doors at the lobby level of each of the high-rise structures, while the mid-rise structures have one entrance door at the lobby level. Primary circulation in the building is via elevator, with emergency egress by a stairwell which runs from roof to lobby. A pressure difference of 17 Pa was measured across the front entrance of the high rise on a day when the outside air temperature was 35°F.

The weatherization project included work on 361 apartment units in a total of four structures. There are two high-rise structures of 19 and 17 stories, and two mid-rise structures of 7 and 6 stories. We visited the 19-story high-rise and the 7-story mid-rise buildings. The four buildings are currently heated with two oil-fired, 200-hp steam boilers, operating in tandem. One pair operates in tandem in the boiler room serving the 19- and 7-story buildings (Fig. 2.19); the other pair serves the 17- and 6-story buildings. Each unit is sized to provide 75% of the design heat load of the building, according to requirements of the U.S. Department of Housing and Urban Development (HUD).

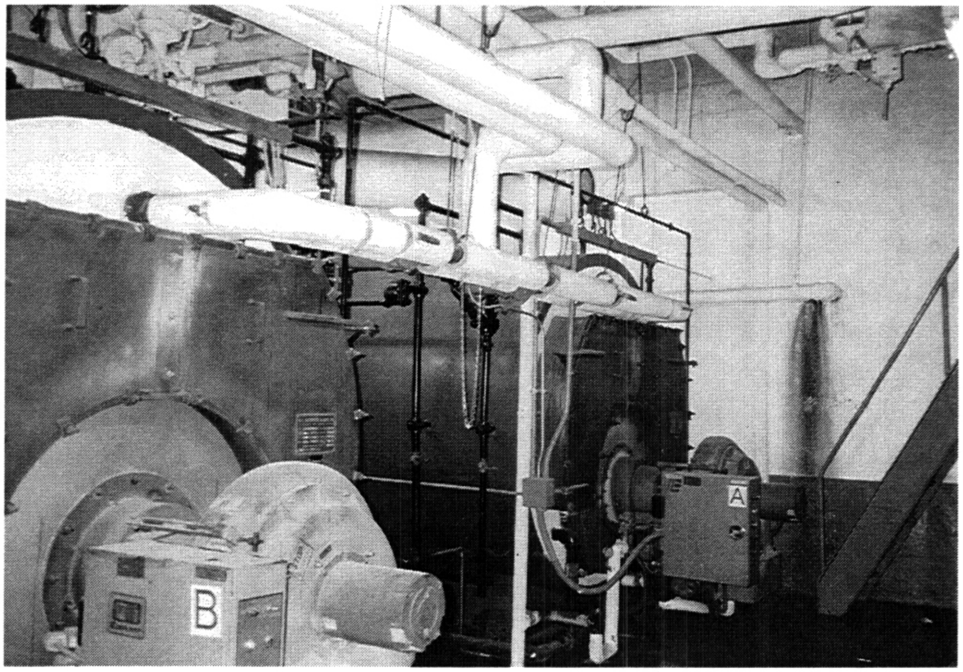


Fig. 2.19. Twin 200-hp steam boilers provide heat and domestic hot water to a 19-story high-rise in the South Bronx.

Weatherization Measures

The primary thrust of weatherization was upgrading the original heating systems. Considering the age of these buildings and the heating systems, the heating systems should not have required replacement. However, due to an extended period of poor routine maintenance, heating plant replacement was specified. Apparently, the firing chambers leaked large amounts of combustion gases; and reportedly, pump steam and water leaked throughout the boiler room. Additionally, the boiler room was underventilated and overheated. The level of deterioration of the original systems, combmed with the complexity of the new heating systems specifications, required a consulting engineer for assessment and development. Specifications for new work called for boiler and burners to be replaced. The boiler and all distribution system components (i.e., steam pipes, condensate tanks, and DHW tanks) were insulated. The boiler room was properly ventilated and painted to facilitate maintenance.

The second thrust of weatherization work was the reduction of heat loss due to stack effect.

Energy-efficient lighting was installed throughout the building.

Savings

The savings on the project were outstanding.

Comments

This is an interesting case *study* in minority community empowerment. The complex has been refinanced by a minority-owned group of investors. The tenancy is substantially of Caribbean descent. In addition, the building work force and security *staff are* minority group members, and the boiler manufacturer is a local minority-owned company.

514 E. 145th St. / 145 E. 144th St. Bronx, New York Savings Analysis				**Annual HDDs:** ***4868***
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	523,266	523,266	0	0
Consumption Index, $Btu/HDD/ft^2$	7.0	2.84	4.16	–59.4
Heating NAC, MBtu	17,831	7,234	10,597	–59.4
Baseload NAC, MBtu	10,203	6,724	3,479	–34.1
Total NAC, MBtu	28,034	13,958	14,110	–50.3
Fuel Cost, $/MBtu	4.17	4.17	0	0
Annual Cost, $	116,901	58,205	58,696	–50.2
Cost of Weatherization	384,806			
Lifetime Savings (20 yrs. @ 4.7% Discount Rate)	$750,135			
Benefit-to-Cost Ratio	1.95			

Bronx Shepherd
1625–31 Fulton St., Bronx, NY

Fig. 2.20. High-rises at 1625–31 Fulton Street.

Building Description

This is a **New** Law NYC multifamily building. It actually consists of four contiguous buildings in a U-shape with a central courtyard. Technically, the building is a six-story walk-up, although **there are** only five full stones above **grade. The** basement is only half above grade. Each building contains 24 apartments units, a **total** of ***96*** units in the complex. The building **has** a recent history of high vacancy **rates** and inconsistent management, according to the building superintendent and the weatherization program director. As a result of the near abandonment of the building, the interior spaces suffered water damage and vandalism. Several tenants complained of sporadic interruptions of utility services, including heat. Assessment of the energy savings for this building in either dollars or **Btus** is difficult **because** of the erratic pattern of consumption.

The building currently has an occupancy rate of almost 90%, substantially higher than its pre-weatherization occupancy.

Weatherization Measures

Weatherization work focused on sealing the building interior from the elements and reviving the heating system. Most of the effort and money went into windows (Fig. 2.21). According to auditor reports, more than half the glazing was broken, and nearly all the original wood windows required repairs.

The heating system work consisted of repairs and upgrades to the existing unit. Heating upgrade work called for cleaning and tuning, adding a new heat timer, repairing the distribution system and radiator, and adding ventilation in the boiler room area.

Efforts were made to reduce heat loss due to building stack effect by installing roof insulation and apartment door weather-stripping.

Fig. 231. New replacement windows were required to make this building habitable.

Savings

This building had –34% HNAC savings, due in part to the building's status as abandoned during a period prior to weatherization. The utility service during the pre–weatherization period was interrupted intermittently and consequently was artificially low. The post-weatheridon period had normal heat and DHW supplied throughout the year.

Comments

It will very difficult to assess the energy savings for this building in dollars and Btus because there is such an erratic pattern of consumption. In some cases, the summertime consumption is double that in winter.

There is no assurance that the doors at the top and bottom of the envelope are closed at all times, and in fact, they were ajar on the day of our visit. Roof doors are locked, but they *can* be opened by anyone choosing to do *so.*

1625–31 Fulton Street Bronx, New York Savings Analysis				Annual HDDs: 4868
	Re-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft²	62,608	62,608	0	0
Consumption Index, Btu/HDD/ft²	13.16	16.68	3.52	–16.7
Heating N A C, MBtu	4010	5084	1074	–15.9
Baseload NAC, MBtu	10,329	10,329	0	0
Total NAC, MBtu	14,338	15,413	1075	+
Fuel Cost, $/MBtu	4.17	4.17	0	0
Annual Cost, $	59,740	64,215	4,475	+
Cost of Weatherization	$99,510			
Lifetime Savings (20 yrs. @ 4.7% discount rate)				
Benefit-to-Cost Ratio	–0.57			

3. SPRINGFIELD, MASSACHUSETTS

INTRODUCTION

HAP, Inc., the Hampden Hampshire Housing Partnership (formally, the Housing Allowance Project), is a nonprofit regional housing agency which has the principal mission of "the improvement of housing conditions for low and moderate income families and individuals" in a two-county region in western Massachusetts.[1] Initially founded to research rental subsidies for low-income tenants, HAP provides a range of housing services including rental assistance, building rehabilitation, and the provision of emergency shelters. A principal weatherization subgrantee in Hampshire County, HAP's service territory covers the city of Holyoke, which has numerous multifamily dwellings occupied by lower-income families.

HAP, like all subgrantees in Massachusetts, has experienced what its staff calls "roller master" funding for its weatherization program. Several years ago, when HAP's annual funding for weatherization was $1.9 million, its staff of ten included five energy auditors, and 80 percent of its work was in multifamily dwellings. In June 1994, the time of the interview for this case study, annual funding for weatherization was only $300,000, 85% of the work was in single-family dwellings, and the entire weatherization staff numbered two people.

Such boom-and-bust funding was the result of the infusion of Petroleum Violation Escrow (PVE) funds, popularly known as "oil overcharge money" for weatherization. Prior to the availability of PVE funds, Massachusetts supplemented federal weatherization funding with $5 million of state support, but with $52 million of PVE money available for weatherization in the late 1980s, the state set-aside was rescinded. The state's weatherization grantee, the Executive Office of Communities and Development, Bureau of Energy Programs, exercises strong leadership with the subgrantees. "We were told that we had three years to spend the PVE money," recalls David Perry, HAP's weatherization director. "We worked as hard as we could and managed to spend it in three and a half years. But now the well's about run dry and the state legislature shows no signs of renewing the set-aside."

Funding from public utilities to supplement weatherization activities is quite limited, a fact that reflects the overall poor economic conditions and utility over-capacity in western Massachusetts. Accordingly, HAP now conducts weatherization operations principally with U.S. Department of Energy (DOE) funding, with the Low-Income Housing Energy Assistance Program (LIHEAP) supplying 16% of the funding to weatherize an annual total of 160 dwelling units. The practical consequence is that production quotas are down to only 13 units per month, from a high of 91 units per month just 3 years ago.

[1] The quotation is from HAP's Corporate Brochure, newly written on the occasion of its 20th anniversary in 1994.

Housing Stock

The multifamily housing stock that is the subject of this case study is in the city of Holyoke, close to Springfield (and HAP's main office) in southwestern Massachusetts. It is composed primarily of wood-framed, brick-veneer buildings with flat roofs. These structures were built in a variety of early-twentieth-century architectural styles and are generally between three and five stories tall (Fig. 3.1). Buildings observed ranged from a dozen to as many as 80 units.

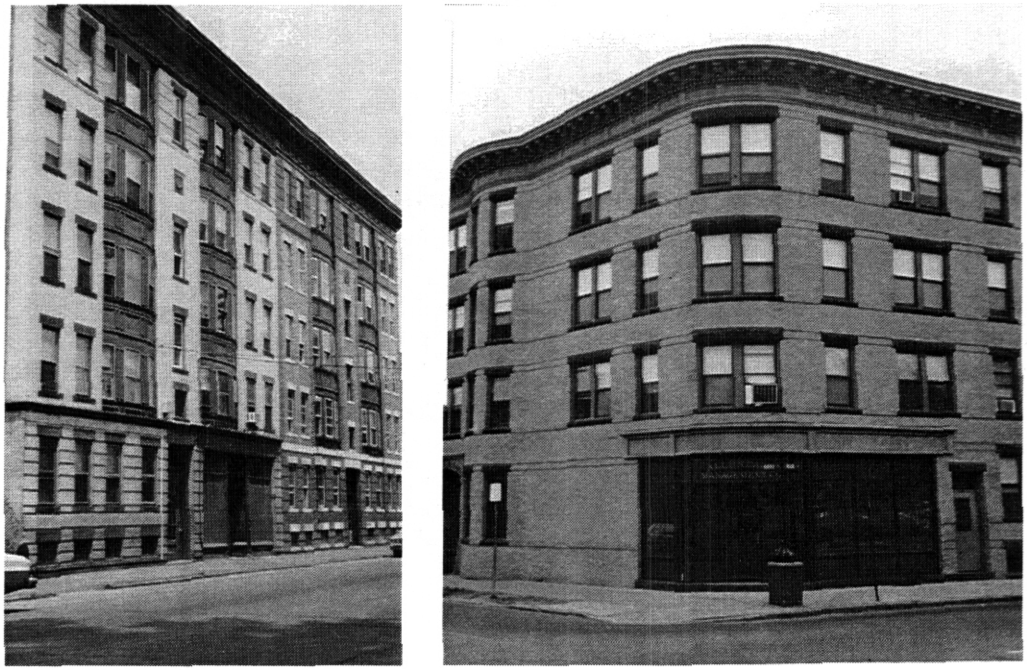


Fig. 3.1. Multifamily buildings in Holyoke.

Most buildmgs have exterior wood stairs as a second means of egress (Fig. 3.2), and interior light and ventilation shafts or building configurations which include courtyards. The attics are typically below a low-pitched, flat roof and are accessible only through an interior trap door which most often is installed during weatherization. Basements are not accessible to tenants. Figure 3.3 shows two buildings typical of those weatherized by HAP.

In general, the mechanical systems of the buildings are in fair to marginally good condition. Systems observed are of two varieties: central steam or hot water from gas-fired boilers, or local vented heaters which double as cook stoves. In many cases, a single stove with only crude thermostatic control heats an entire. apartment (Fig. 3.4).

Fig. 3.2. Typical exterior wood stain found on many multifamily buildings in Holyoke.

Fig. 33. Both of these buildings in Holyoke were weatherized by *HAP*.

Outreach

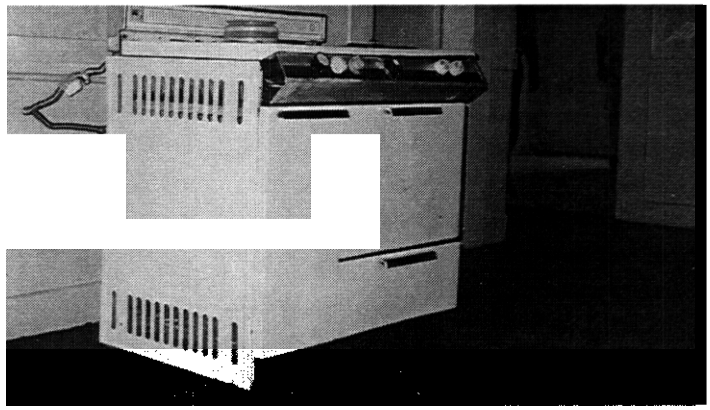


Fig. 3.4. This stove provides cooking and heating energy for an 800 ft^2 apartment.

During boom times, HAP would seek out building owners and even managers of public housing stock to involve them in the weatherization process. Since most of the larger multifamily buildings are in an area with a substantial welfare population, certification for eligibility is rarely a problem.

Audits

The audit is akin to a single-family audit and concentrates on envelope measures. Measures recommended follow a prescribed list which comes from the state office by way of its detailed *Weatherization Assistance Program Technical Manual.* There are no heat loss calculations associated with the audit, and preweatherization consumption information is not used in the decision-making process.

Measurements of window openings, for example, are given to the subcontractors in the form of "estimates" to ensure that contractors measure critical items again. Contractors are responsible for making certain that replacement windows and other retrofit measures that are sensitive to measurement precision do indeed fit.

Weatherization Measures

Most work undertaken directly by the weatherization program is concentrated on envelope measures. Typical measures include attic insulation, window repair and air sealing as well as replacement, and air sealing, concentrating on entry doors to individual apartments (Figs. 3.5 and 3.6). Some of the door work is undertaken as a security measure (Fig. 3.7). State policy requires that property owners be responsible for heating system repairs in multifamily weatherization work. When most or all windows are replaced, building owners are required to shoulder all costs beyond those that would be necessary for thorough window repair and weather stripping.

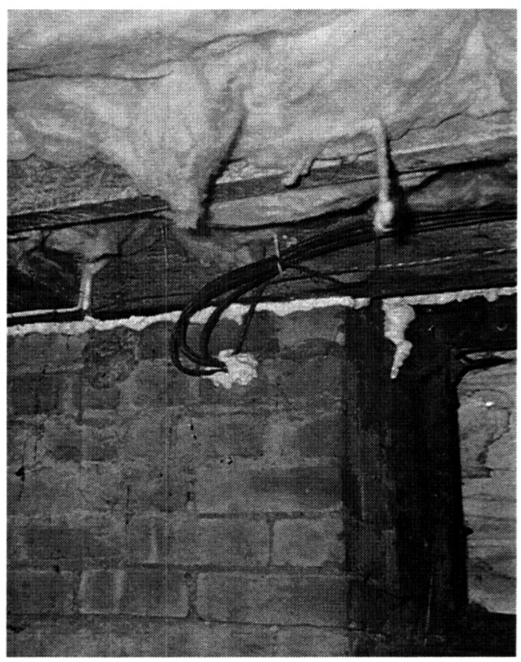


Fig. 3.5. Plywood is used to block off basement windows in this 10-family unit. Urethane foam aids air sealing and fiberglass serves as floor insulation.

Subcontractors

HAP, which subcontracts for weatherization labor, has an annual competitive bidding process to establish rates for accomplishing various weatherization measures. The practical consequence of the process is that 10 to 12 subcontractors are hired for various weatherization jobs through a program year to do similar work for identical pay. Jobs are let out on a rotating basis in blocks by means of detailed purchase orders attached to the generic contract that covers a program year. Quality control measures include ensuring that contracting firms that do good work have the opportunity to do more good work.

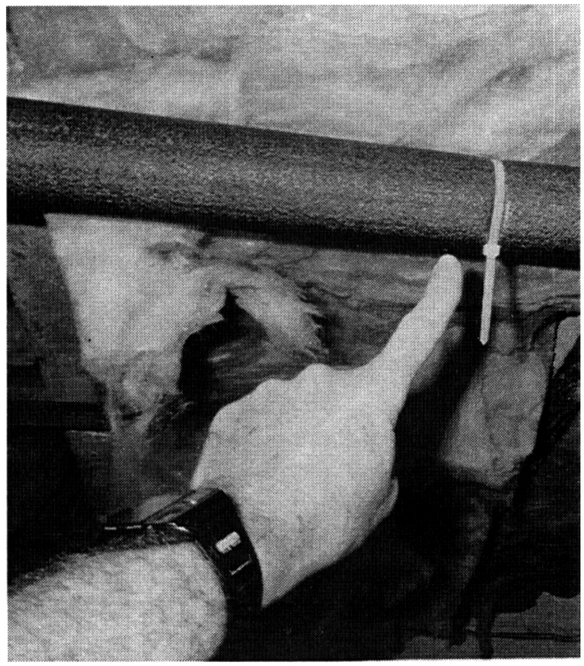


Fig. 36. When basement floors are insulated, it is all the more important to insulate pipes, both hot and cold.

Overall, this process appears to be well-managed and fiscally sound, and it results in good relations between HAP and its subcontractors.

Owners

Several building owners interviewed during the field visit displayed impressive levels of interest in both energy and water conservation. They also showed sophistication in management and technical practices aimed at minimizing waste and increasing efficiency. HAP has forged informal alliances with several of the major building managers in the Holyoke area, with results that are in the interests of all parties (including tenants.)

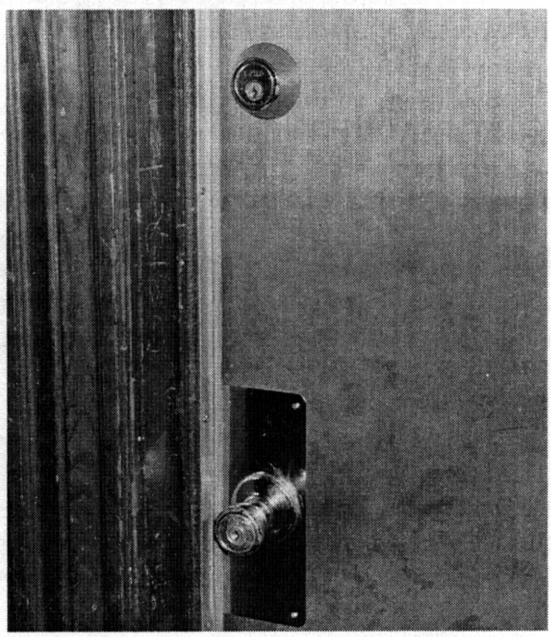


Fig. 37. New door-locking mechanisms and weather stripping provide security and lower convective losses.

Lead Abatement

Recent legislation in Massachusetts requires extensive lead abatement work, which can *cost* up to $1000 per apartment, according to the building manager of a large complex visited during the field work. Significantly, accomplishing lead abatement simultaneously with window replacement results in economies of labor and logistics. HAP was instrumental in securing a U.S. Housing and Urban Development (HUD) grant to undertake lead abatement in Springfield, Chicopee, Holyoke, and Westfield which allows building owners to secure no-interest loans for lead abatement. HAP has plans to enhance the coordination of lead abatement work with weatherization work.

WEATHERIZATION OPERATIONS

David Perry, who was hired by HAP in 1983 to do energy audits and then rose through the ranks to become weatherization director, finds himself doing audits again. "It's tough running a program that doesn't have enough money," he laments, recalling a time when he had five auditors, a quality control person, and three administrative assistants. Now the key person for HAP's operation is Maria Gomes. She handles the fiscal and administrative paperwork, schedules weatherization jobs, and interacts with contractors.

"Maria makes sure that the contractor rollover system is intact," explains Perry. After the audit, she mails a purchase order. Within five working days, the contractor calls with a scheduled completion date, which is usually withiin a month. Because of fiscal cutbacks, contractors are not as busy as they used to be, and turnaround is faster. The contractors call HAP's office when they are going out to coordinate their work with HAP's staff. This helps Perry, who may be in the area and could do some process inspection and quality control.

"I like to be able to verify blower door d i n g s while the contractor is on site," Peny explains. "That way I can interact with the contractor and save the time of setting up a blower door again during the post inspection."

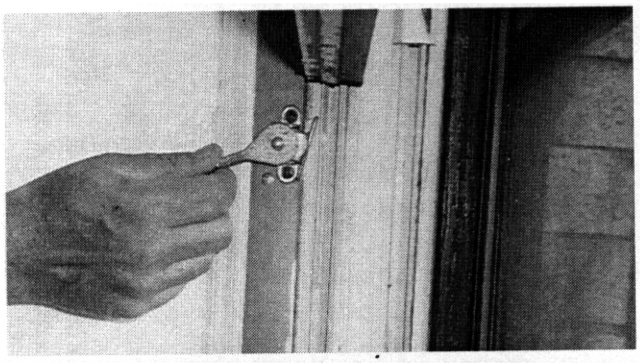
Perry does final inspections and sign-offs on all dwellings. Inspection is accomplished within five working days of a contractor's submitting an invoice, and the agency pays invoices in 30 days or less.

Blower-door-aided air sealing is routine on single family weatherization work, but the exception on multifamily buildings. In multifamily jobs, the emphasis is on air sealing in basements, window and door work in the apartments, and insulation in the attic.

In multifamily weatherization at HAP, window work is becoming oriented more toward replacement than repair so that building owners can solve lead abatement problems while weatherization work takes place. Figures 3.8 and 3.9 illustrate repaired and replacement windows, respectively.

Insulating attics in multifamily dwellings in the Holyoke area usually requires that crews gain access to a space which may not have been entered since construction many decades ago. Accordingly, the choices are to use a reciprocating saw to make a hatchway from the inside or to make a hole in the roof which will ultimately be replaced by an attic vent. Both techniques require skill and craftsmanship. In each case, the aim is to avoid cutting through load-bearing members. In the case of an attic hatch, it is important to leave an access door which is both tightly air sealed and aesthetically acceptable. In the case of a roof job, the primary aim is to avoid roof leaks.

Fig. 3.9. Good-quality, double-glazed vinyl replacement windows are used in HAP's program. Installed costs are $150 to $200.



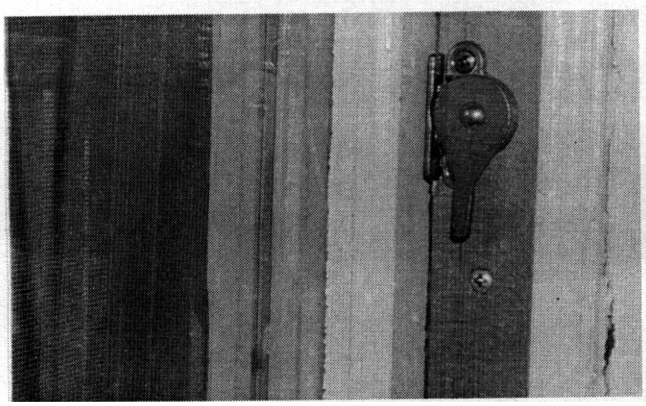


Fig. 3.8. This mechanism has a cam lock which squeezes a window against a blind stop or weather strip. The open position is shown in the top photo, and the closed position in the bottom. The mechanism is used by HAP contractors in the repair of existing windows.

Insulation installed in the attic is routinely blown cellulose, which has the advantage of being transported to its final resting place by means of a blower motor (Fig. 3.10). Of course, tight spaces make distribution to the entire attic difficult, but experienced hands have developed special tricks for getting the widest distribution possible. For example, Bill Kelley of K&B Energy Associates, Inc., uses a technique of pushing the blowing hose as far into tight spaces as possible, then rolling it around while blowing insulation with a bit of extra air. "The extra air allows for the hose to spray insulation further," Kelley explains. "But, since it tends to settle more, we blow to a higher level than usual, ten inches or so."

BUILDINGS SURVEYED

Six buildings, two of them with appmximately 80 apartments each, were examined during this case study. The fuel records for five were available, but two buildings showed extremely erratic patterns of consumption both before and after weatherization. The three buildings for which we were able to analyze fuel consumption were selected by the local weatherization agency from the cases completed during program years FY 1990 and FY 1991. The only qualifying criterion for selection was submission of usable pre- and postweatherization fuel consumption data.

Each of the buildings contains apartments which are individually metered. This would appear to be an ideal situation for evaluation of fuel savings. Unfortunately, the available fuel consumption data do not include gas meter read dates. Consequently, monthly fuel use is only loosely correlated to the calendar and corresponding heating degree days (HDDs). Additionally, two of the buildings had high vacancy rates and significant tenant turnover.

To determine energy savings due to weatherization measures, heating fuel consumption in the postweatherization period (typically 1992–93) was compared with fuel consumption in the preweatherization period (1990–91). Similar periods were picked which were as long as possible given the constraints of the availability of meter reading data.

Techniques used for determining savings were as described in Section 1.

Fig. 3.10. Bill Kelly unclogs a blowing tube, a tedious job that must be done quickly to avoid slowing production.

197 High Street
Holyoke, Massachusetts

Fig. 3.11. The building at **197 High Street** in Holyoke.

Building Description

This is an early-20th-century building which contains eight residential and two commercial units. The entire building was rehabilitated and thus had roofing, exterior facade, interior surface, and major mechanical system work completed. Weatherization was the last and crowning phase of work in the overall upgrade of this building.

Weatherization Measures

Weatherization measures were applied to the residential units only and were selected to satisfy a state-mandated priority list. The audit surveyed the building for application of measures from a predetermined list. Even without the benefit of an instrumented audit, the weatherization staff was able to find floor cavity bypasses and attic spaces with insufficient levels of insulation. Ventilation, which is a routine feature of attic insulation work, was completed along with domestic hot water pipe. insulation and door weather stripping. Eighty-six percent of the job dollars went for replacement windows throughout the building (Fig. 3.12).

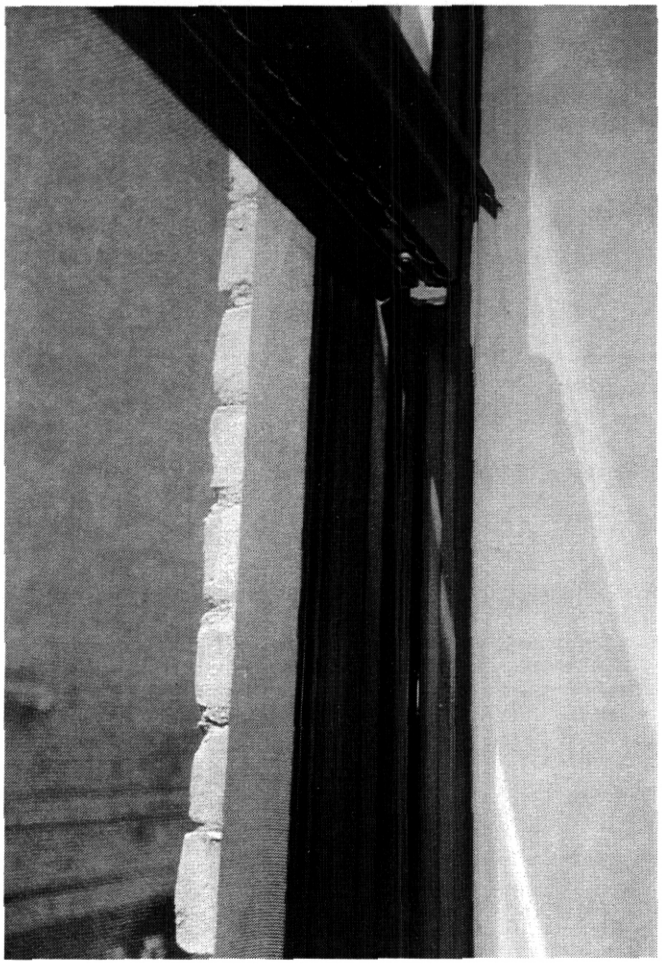


Fig. 3.12. Detail of new replacement window installed at 197 High Street.

Savings

The computed savings for heating on this building are 20 MBtu, or about $130 at the current price of 65 cents per therm ($6.50/MBtu) for natural gas. However, since baseload consumption increased, overall savings were quite modest. In commenting on an earlier draft of this case study, David Perry speculated that such meager savings probably reflect substantially more occupancy after retrofit than before, and the fact that some of the windows replaced were already double glazed.

197 High Street **Holyoke, Massachusetts** **Savings Analysis**				Annual **HDDs: 5953**
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	3830	3830	0	0
Consumption Index, Btu/HDD/ft^2	13.45	12.57	0.88	–6.5
Heating NAC, MBtu	307	287	–20	–6.5%
Baseload NAC, MBtu	150	163	13	8.7%
Total NAC, MBtu	457	449	–8	–1.8%
Fuel Cost, $/MBtu	$6.50	$6.50	0	0
Annual Cost, $	$2971	$2919	–$52	–1.8
Cost of Weatherization	$12,431			
Lifetime Savings 20 yrs. @ 4.7% Discount rate	$655			
Benefit-to-Cost Ratio	0.05			

47–49 Vernon Street
Holyoke, Massachusetts

Fig. 3.13. The building at 47—49 Vernon Street in Holyoke.

Building Description

This three-story, wood-framed brick veneer building was originally built by a local manufacturer to house employees. It is actually two distinct structures with a common firewall partition that divides the building from attic to basement.

There are a total of ten apartment dwelling units and one commercial unit (which is not in use) contained in the combined structures. Individual heating and domestic hot water units are located in each apartment. The hot water units are gas-fued with stand-alone storage tanks. The heating units are in combination with the cookstove (Fig. 3.14). The heating portion of the unit is controlled by a thermostat and is vented; however, the cooktop is **not** vented.

Fig. 3.14. Heat for the apartment is provided by this combination unit. Hot water units are located within each apartment.

Weatherization Measures

From the beginning of the weatherization process, attention was paid to the safety of the mechanical systems. Inspection of the knob- and-tube wiring throughout the building was ordered, with special attention given to areas to be insulated. Electric panel box repairs were made prior to the start of other work. The combnation heater/cookstoves, which provide the primary heat for each apartment, were inspected. Several were found to burn inefficiently. Cleaning and tune-up adjustments were completed as required, however, neither pre– nor post–weatherization carbon monoxide readings were recorded on either the audit or inspection documents. (Both procedures are now routinely accomplished on all weatherization jobs in Massachusetts.) Gaps around the vent stacks of domestic hot water heaters, which are also located within the living space, were repaired.

Blower door testing was specified to be completed in conjunction with insulation and air-sealing work on this project. One apartment on each floor of the building was selected to be tested before and after weatherization measures were installed. Air leakage reductions in individual apartments ranged between 300 and 1000 cubic feet per minute (cfm) at SO pascals. The test apartment with the lowest postweatherization flow rate measured 2659 cfm, an indication that these apartments are still twice as leaky as the safe lower limit for most dwellings. Wholebuilding measurements were not taken.

Unfortunately, blower door testing was completed by a contractor whose only part in the work was the testing. Consequently, the insulation and air-sealing crew did not have the benefit of knowing the impact their work was having on the house while work was in progress.

Priority was given to controlling heat loss at the bottom of the building envelope. Air sealing with spray foam was completed at the basement sill, basement windows, and mechanical penetrations (Fig. 3.15); additionally, bypasses were blocked with blue foam board. The batt insulation installed at the basement ceiling was doubly secured by staples and wire supports (Fig. 3.16). However, air sealing beneath the existing fiberglass batts in the attic was omitted.

The major cost category on the job was storm windows. They were 37% of the total cost, or $3400 of the total job cost of $9199 for this ten-apartment building.

Savings

The computed savings on this project were significant: 49% of heating energy alone. The $1157 for first-year savings would have been substantially greater if baseload had not increased by half. Perhaps this indicates an occupancy increase or a maintenance problem with the domestic hot water system in the post-retrofit period.

Fig. 3.15. Basement air sealing at 47—49 Vernon Street, Holyoke.

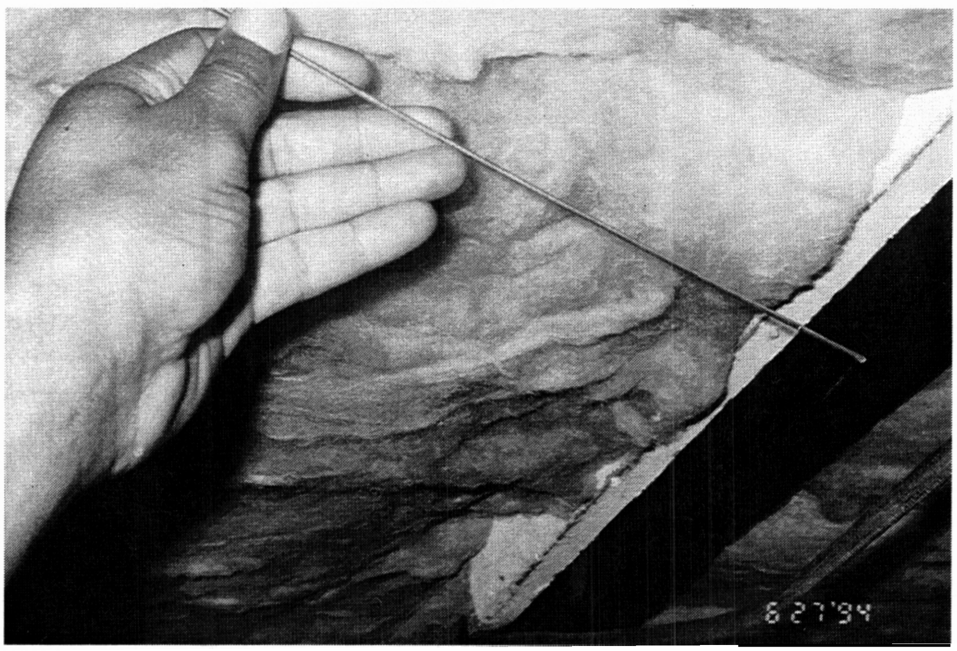


Fig. 3.16. Wire support installed to hold ceiling insulation in place.

47–49 Vernon Street Holyoke, Massachusetts Savings Analysis				Annual HDDs: 5953
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	4275	4275	0	0
Consumption Index, $Btu/HDD/ft^2$	20.0	10.2	9.8	48.8
Heating NAC, MBtu	509	261	−248	−48.7
Baseload NAC, MBtu	133	204	71	53.4
Total NAC, MBtu	642	464	-178	-27.7
Fuel Cost, $/MBtu	6.50	6.50	0	0
Annual Cost, $	4175	3018	−1157	-27.7
cost of Weatherization	$9199			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$14,578			
Benefit-to-CostRatio	1.58			

851 Main Street
Holyoke, Massachusetts

Fig. 3.17. The building at 851 Main Street **in** Holyoke.

Building Description

This building is located next door to the Vernon Street property; the two buildings share a rear courtyard. Its construction and interior configuration is similar to that of its neighbor except that it is five stories tall and has two apartments per story, ten units total. The ceiling height is 9 ft 6 in., and the apartment doors have transom windows.

Each apartment unit is heated by a combination heater and cookstove.

The domestic hot water units are located within the apartments. Several apartments had window trim coated with lead-based paint.

Weatherization Measures

The Holyoke and Vernon Street properties are serviced by the same building manager. Weatherization work occurred concurrently and utilized the same approach. The first phase of work, which dealt with minimizing general heat waste, was completed by the building management team, who were directed by HAP's staff. Work descriptions were written and inspections were performed by the weatherization staff. Blower door testing was subcontracted to a local contractor.

Weatherization measures on this project were subdivided and completed in two phases. The first phase was one in which the owner, who also manages the building, served as contractor. Work in phase 1 was completed at the owner's expense and prior to the expenditure of weatherization funds. This deal was struck because the owner was most interested in addressing the building's windows and the weatherization agency requires that general heat waste items be completed prior to window work. Additionally, the owner was required to make a significant contribution to cover a portion of the cost of the new storm windows. The specifications for the initial phase of work were produced by the weatherization agency, which also inspected the work upon completion.

Initial work included air-sealing the basement sill plate, basement windows, and bypasses in the basement and attic. The mechanical system vent pipe opening was also sealed. Cellulose insulation was installed in the attic, and fiberglass batts were installed at the basement ceiling.

Pre- and post-weatherization blower door testing was completed in the same manner as the work at 47–49 Vernon Street, with a contractor not involved in air-sealing or insulation completing the testing on selected apartments. The initial air leakage range was 3550 to 5980 cfm. The rates were reduced to a range of 2940 to 4420 cfm. This is a substantial reduction, but not nearly approaching safe lower limits.

Most (64%) of the weatherization funding went for window work. New storm windows were installed throughout the entire building. The transom windows were sealed, and prime windows received sundry repairs, including installation of new sash locks and vinyl sash tracks, weatherstripping, and trim coverage or replacement. In apartments where lead paint existed, window trim was either removed and replaced or covered with aluminum coil stock.

Savings

This building showed a 23.4% reduction in heating energy, for a savings of $709 versus an investment of $8 171. If only the heating energy were considered, the benefit-to-cost ratio would have been 1.09. However, an increase in baseload energy during the post-weatherization period diminished the benefit-to-cost ratio to 0.94.

851 Main Street Holyoke, Massachusetts Savings Analysis				Annual HDDs: 5953
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ff	9405	9405	0	0
Consumption Index, Btu/HDD/ft²	8.26	6.32	-1.94	-23.5
Heating NAC, MBtu	462	353	-109	-23.4
Baseload NAC MBtu	239	254	15	6.3
Total NAC, MBtu	701	607	-94	-13.4
Fuel Cost, $/MBtu	6.50	6.50	0	0
Annual cost, $	4557	3946	-612	-13.4
cost of Weatherization	$8171			
Lifetime Savings (20 yrs. @ 4.7% discouat rate)	$7711			
Benefit-to-Cost Ratio	0.94			

4. CHICAGO

INTRODUCTION

This case study of the U.S. Department of Energy (DOE)-funded low-income multifamily weatherization assistance program in Chicago, Illinois, is based on information obtained during visits to the Chicago city offices between June **20** and **23, 1994,** and discussions with program personnel. It includes the results of a review of a sample of client files, the PRInceton Scorekeeping Method (PRISM) analysis of pre- and post-retrofit utility billing data from seven buildings, and visits to four completed job sites.

Since the city program had recently undergone significant organizational and policy shifts reflecting federal and state initiatives to institute a whole-building approach to multifamily weatherization, the buildings covered here, which were weatherized in **1992,** do not accurately reflect present program policy or procedures. Nonetheless, important lessons *can* be learned from both the case studies and the present **structure** and future directions of this large city program. Movement toward a whole-building approach, in which both architectural shell measures and heating systems are dealt with in a comprehensive and unified manner, offers great promise.

One of the ***case*** study buildings in particular, however, demonstrates that in a well-maintained larger building where building owners pay close heed to heating system operation and control, wholesale window replacement and other air leakage control strategies can have a very positive impact on energy usage, including a very favorable savings-to-invesbnent ratio for the use of federal weatherization funds.

BACKGROUNDANDMETHODOLOGY

In January 1992, the Illinois Department of Commerce and Community Affairs (DCCA) multifamily program underwent a major revision, according to Edward Haber, supervisor of the Technology Development Unit at DCCA. At that time, new guidelines and building intake forms for the **1991–92** program year were published which stressed a whole-building approach and a new emphasis on mechanical systems modifications. At the time the buildings examined in the case study were weatherized, however, these new policies had not yet been integrated into the Chicago program.

The following sections include lessons learned from billing analysis and on-site inspections of buildings weatherized in **1992,** with primary attention to window and shell measures. **In** addition, however, there **are** descriptions of program operations observed in the summer of **1994,** as well **as** projections to the future, **as** indicated by program personnel.

Before the agency visit and on-site inspections, pre- and postweatherization utility data was collected by the Chicago Department of Housing (DOH) for seven multifamily buildings weatherized between March **25** and December **15,1992.**

Normalized savings analysis was done on all seven buildings using PRISM. The quality of the billing data presented for these buildings was most often sketchy at best. Four buildings were finally selected to receive site visits and field evaluations, although later it was determined that only two had sufficient data and met the whole-building multifamily retrofit goals of this study to warrant inclusion in this report.

Of course, an analysis of only two buildings is a poor measure of an entire program's performance. This experience and others across the country clearly indicate that to achieve a comprehensive and on-going appraisal of such a vital program, mechanisms should be instituted that require both program operators *and* prospective retrofit building owners to maintain careful utility billing records for both pre- and post-retrofit analysis. Only in that way can we hope to track our successes fully and to learn from those less successful projects.

Housing Demographics

According to 1990 census data, the city of Chicago includes 449,208 housing units in multifamily buildings of five or more units. This represents 40% of the total city housing stock and 47% of the large multifamily units in the state of Illinois (see Table 4.1).

Table 4.1. Building Demographics by Number of Housing Units, United States and Illinois

Location	All Building Types	5-9 units	10+ Units	Total Large Multifamily	Multifamily % of total	% of Stale Multifamily	% of U.S. Multifamily
USA	102,263,678	4,935,841	13,168,769	18,104,610	18		100.0
Illinois	4,506,275	290,519	663,448	953,967	21	100	5.3
Chicago PMSA[b]	2,380,355	212,950	528,868	741,818	31	78	4.1
Cook County	2,021,833	192,379	470,796	663,175	33	70	3.7
Chicago City	1,133,039	124,604	324,604	449,208	40	47	2.5

"Multifamily is defined here as a building with five or more units.
[b] PMSA = primary metropolitan slatistical area (a subset of the metropolitan slatistical area).
Source: 1990 Census of Population and Housing: Summary of Population and Housing Characteristics, U.S. Department of Commerce, Economics and Statistics Administration, 1990

Most Chicago multifamily buildings are solid brick, often with lath and plaster on exterior walls. Buildings are typically three-story (including basement or ground-floor) walk-ups with some larger units up to four stories (Fig. 4.1). Heat is almost always supplied by natural-gas-fired boilers, with either steam or hydronic distribution systems predominating.

PROGRAM OPERATION

Within the city limits of Chicago, all weatherization activity is handled by the Chicago DOH. Before 1980, weatherization services were provided by several community action agencies. Since then, all weatherization work in the city has been consolidated under DOH. In the remainder of the county, outside the city limits, weatherization services are still provided by the Community and Economic Development Association of Cook County, a nonprofit agency.

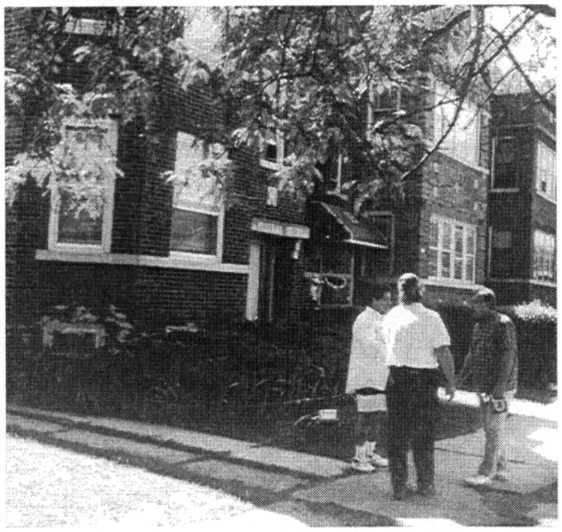


Fig. 4.1. Auditors James Dundee and Tom Stone discuss past work with a building owner in front of a typical walk-up apartment building.

In the program year ending March 1993,3641 units in Chicago were. weatherized with DOE funds. Of these, 948, or 26%, were. in multifamily buildings (those with 25 units per building). This represents a 22% reduction in multifamily retrofits since 1989 (see Table 4.2).

Production has been declining, according to Mike Acciari, director of Special Rehabilitation Programs, largely as a result of the reduction in oil overcharge funds. Nonetheless, doing such a large percentage of multifamily projects helps the city's production numbers, according to Acciari. "We don't go out and push multifamily work just to boost our production, but it certainly does help."

For the state of Illinois as a whole, in the program years ending 1989 and 1993, completion figures are shown in Table 4.3.

Table 42. Weatherization Completions, City of Chicago

Type of Unit	1988–89	1992–93
Owner Occupied"	2315	1369
Single-Rentef	321	222
2–4-Unit	1590	1102
510-Unit	332	227
11+ Unit	884	721
Total	5442	3641

[a]Owner-occupied and single-renter-occupied homes include both single-family homes and a very small number of mobile homes.

Table 4.3. Weatherization Completions,
State of Illinois

Type of Unit	1988–89	1992–93
Owner-Occupied	7604	4690
Single-Renter	3234	1844
2–4-Unit	2740	1437
5–10-Unit	513	269
11+ Unit	1189	759
Total	15,280	9003

Statewide as of 1989, only 11.5% of the work being done was on larger multifamily units, while over 69% of all large multifamily work in the state of Illinois was performed in the city of Chicago. In 1993, multifamily units made up about the same percentage of the state completions, but Chicago's share of that total jumped to over 92%.

In 1988–89, the average total cost per unit for all building types in the city was $1479, including an average materials cost of $594, for a total program cost of $4,815,513.[1] In 1992–93, the average cost per unit was $1319, with an average materials cost of $536, for a total program cost of $2,849,057 (see Table 4.4).

Table 4.4. Weatherization Costs,
City of Chicago

cost	1988–89	1992–93
Prog. Support	$826,764	$1,190,244
Labor	1,121,918	
Mat. Handling	273,053	173,421
Contractor Cost	2,593,778	1,485,392
Total	$4,815,513	$2,849,057
Av./Unit	1,479	1,319
60/40 Split	56/44	56/44
Av. Mat. Cost	$594	$536

Intake

The DOH multifamily program seems to be quite popular in the city. Although some outreach is done through the Chicago aldermen's offices, most building owners learn of the program simply by word of mouth. Mike Acciari reports that buildings are processed on a first-come, first-served basis, and that the program already has enough eligible applicants to last through next year. Particularly since the federal regulations now allow for the reweatherization of buildings that were

[1] All dollar figures are the nominal value at the time recorded.

retrofitted before September 1985, "the word is out on the street," and many landlords are reapplying.

It used to be that all potential applicants had to come to the downtown offices to sign up. Now there are 12 satellite offices where people can file applications. Drake Johnson of the City Housing Office reports that there are "some pretty astute landlords out there. The program is to their benefit as well as to the benefit of the clients themselves, so everybody knows about it. There is both a need and a demand out there for our services.'' Occasionally city staff workers go to the applicant's building to collect eligibility data, but most often landlords take the initiative to bus or otherwise transport clients to the downtown office—sometimes with small incentives to help gain full cooperation.

Although the administration M a s k s for utility bills when clients apply for services, this is not a criterion for acceptance.

Eligibility and Landlord Contributions

Under the present program, when at least 66% of a building's occupants are income-eligible, the program can provide replacement windows and/or a replacement of the heating system on a 50/50 basis. That is, the building owner pays 50%, and DOH pays 50%. (Heating system replacement is dependent on the restriction that the present system is either inoperable, unsafe, or sufficiently inefficient for the replacement to be cost-effective.) If the building owner is not interested in paying that fraction, DOH can fund the total cost of heating plant tune-ups, new controls, balancing, storm windows, and other measures but not boiler or window replacements.

Even if the 66% eligibility criterion has been met, replacement windows and storm windows are initially installed only in the apartments of eligible clients. After that, if there is any money left over from the $1 150 materials allocation for each eligible unit, this extra can be applied to storm or replacement windows in other non-eligible apartments, the "66 percenters" as they are called.

"We're not doing partial buildings now," reports multifamily auditor James Dundee. "We now demand at least 66% eligibility. We used to do individual apartments and essentially deal with them as single-family units."

The Audit Process

At the time the assessments were made on the buildings reviewed for this study, each apartment unit was audited independently. Each client file includes eligibility documentation, apartment dimensions, and the measures to be applied to that unit, costed out for both labor and materials. All units in the building are audited, even if they are not income-eligible.

More recent building files include heating system combustion analysis and bids from the mechanical contractors, but as of yet do not include overall building audit data such as building footprint, floor plans, examination of common area concerns, or even historical utility billing data. Whole-building heat loss calculations had not yet been instituted, although a few individual client files included a computer printout indicating estimated energy use, estimated savings, and equivalent leakage area per apartment unit. Since blower doors are not used by the program, default numbers from the state single-family computer audit based on apartment size, window dimensions, building height, etc., are used.

The city audit is essentially a walk-through survey which identifies the number of windows, if storms or replacement windows are indicated, and other envelope measures including weather stripping, sweeps, glass replacement, and caulking.

According to Edward Haber, the state is interested in making use of a computerized multifamily energy audit and is considering using the EA-QUIP audit developed for the New York City weatherization programs.

In all, there are 32 inspectors (16 in weatherization) who do both pre- and post-retrofit inspection among all the various city- owned housing programs. The weatherization completion inspection is done by a different assessor from the one who did the initial audit, in order to avoid both a perception of conflict of interest, and to get a "second pair of eyes" on the project.

Since September of last year, James Dundee has been doing all of the weatherization audits for privately-owned multifamily buildings. Dundee completes the job order for the envelope work and prices the work before assigning it to one of the 14 approved contractors. Generally the department assigns jobs as it sees fit.

Under the new program, in addition to the building envelope work, there is a multifamily building mechanicals file that concentrates on the proposed heating plant modifications. Dundee completes a heating system assessment form and performs pre-retrofit steady-state analysis on the boiler, being sure to check for carbon monoxide and other safety factors. The building is then turned over to the four city-approved heating contractors, each of whom makes an assessment of the system and presents a bid (or a non-bid letter if the contractor chooses not to do the job) including recommendations and costs.

Typical retrofit measures other than total system replacement include cleaning and tuning, redundant low-water cutoffs, outdoor reset controls, and new thermostats. Dundee reports that in multifamily projects, the choice of thermostats is up to the owner in light of recommendations by the heating contractor.

Not all measures can be paid for with weatherization funds. "We do a lot of multifamily work with CDBG [Community Development Block Grants] and other funding," reports Dundee. "We would like to mix weatherization funds with the others for a more total package."

The Weatherization Process

Once the building audit is complete and agreement has been reached with the owners as to the nature of work to be done and who will pay for what, a work agreement is signed and the building owners write a check for their share of the project.

After the work agreement is signed, the program's sole window provider, Republic Aluminum, is called in to measure each window and build aluminum storms or vinyl replacement units for the entire building. The replacement windows are a high-quality, double-glazed product with sturdy vinyl sashes. Storm windows are identified as "roller glide" and have very smooth operation. Building owners have a choice of white or brown fmish.

For larger buildmgs, the window manufacturer does the installations as well, while on the smaller buildings, one of the city's approved contractors does all the architectural work, including the window installations. In all cases seen in this case study, installations were well done, and building owners were pleased. According to Drake Johnson, typically 20-30% of the buildings get replacement windows—usually the larger buildings. In a typical brick multifamily building retrofitting is applied to doors, windows and "enclosed living space"—porches and additions that have been converted to heated living space and typically have a lot of problems. "We discussed adding roof repair, but it proved to be too expensive," Drake reports.

Materials other than the windows and heating system components are provided by the city through its sole materials subcontractor, Arrow Lumber, which delivers them to the contractors' private warehouses. The contractors still warehouse some basic stock on their own and provide a weekly inventory report to the city.

Bob LeRoi—the largest and, according to some, the most thorough and reliable contractor working for the program—observes, "This is the only program that gives absolute help [to low-income city residents] that results in measurable results with the least amount of investment."

Program Evolution

A. B. O'Brien, presently Director of Weatherization, has been in charge of the Chicago weatherization program only since 1993, but is overseeing significant changes in the city's weatherization operations.

In the past, inspectors performed both single- and multifamily inspections. Now the multifamily work is concentrated in one individual, James Dundee, as the principal investigator for larger buildings.

Another change recently instituted is the personalized recordkeeping process. There are six teams, each of which includes an assessor, a final inspector, a clerk, and a senior data entry operator. A single team has responsibility for each individual client.

Timing has also been tightened up. In the past, bid offers were sent out, and the city waited until the contractors got back with their bids. Bids would come in 6 months apart. Now there is an official bid opening date assigned, and all contractors either have to return a bid or file a letter declining to do so by that date.

The plan for the future is for the city to go with a single general contractor who will subcontract out all the work for the city program. The city's contract with this contractor will include both materials and labor. At present, the inspectors have to check up on a basic weatherization contractor, Republic Aluminum for the window work, and a heating contractor for each job. Under the new system, the one contractor will give one final report. This is seen as allowing the weatherization inspector to focus on the correctness of the installations, rather than on tracking multiple contracts.

Much of the multifamily work is now done under the 50/50 plan, whereby building owners Write checks (payable directly to contractors) at the beginning of the job for half of the full amount for heating system work. Previously, owners' checks were held in an escrow account, and the contractors had to wait until job completion before receiving any payment. The result was that contractors did not have up-front cash to support their operations.

Department employee Al Frazier has useful insights, due both to his longevity with the program (having been with the Chicago weatherization community action programs since their beginnings in 1974) and to his present job, which includes resolving complaints from both landlords and tenants. Typical complaints are about issues like buildings' not receiving enough storm windows or doors, or a desire by owners to have a major rehabilitation effort beyond weatherization's mandate. He reports, however, that people are generally very pleased with the program. "In multifamily programs, the money seems to go much further and people are satisfied."

Staff Training

Staff training, particularly for auditors, is a comprehensive and ongoing process. Each prospective auditor has to take three courses offered by the state and pass a certification test on each. Auditors also attend periodic one-day clinics on specific technical issues such as thermostats or flue gas analysis. In addition, the city is doing in-house training to make sure all its contractors see buildings the same way–and that the training represents actual city housing stock.

Client Education

There are plans to institute client education on a program-wide basis, but it is felt that additional funds and staff training are required before that can be instituted

Working within Regulations

The city program is a large and complex operation spanning several departments and shared services. (See the two parallel organization charts provided in Figs. 4.2 and 4.3.) Serving both the city and the state provides particular challenges. For instance, under city regulations, auditors presently cannot relight a furnace, and although they cannot fill the role of building inspectors, they are required to judge unweatherizable buildings based on their present conditions.

DOH used to have 110 employees but was cut back to 42 due to weatherization funding cuts. This is part of the reason for the presently planned single-contractor arrangement and other efficiency improvements.

Combining weatherization operations with other city and state funding sources allows for more comprehensive services. In the Household Services program there is a roof and furnace replacement option, so DOH works with that program to add additional services as needed. If a building owner has income exceeding weatherization guidelines but cannot raise half of the money, the Emergency Housing Assistance Program (EHAP) for heating services can be applied. EHAP gets the funding from the Household Services program and DOH does the installation and the rest of the weatherization work.

DOH would like to be able to replace water heaters for health and safety reasons, as well as be able to spend more money on roofs, since roofing failure is frequently why people have to leave their homes. Director A. B. O'Brien would like to see weatherization funding raised so that more money can be spent per unit. She characterizes the present program as a Band-Aid approach to the whole housing needs of the city. She points to the fact that one can calculate how much is saved in energy bills, but in fact, the preservation of housing is an equally important contribution, even if it may be more difficult to quantify.

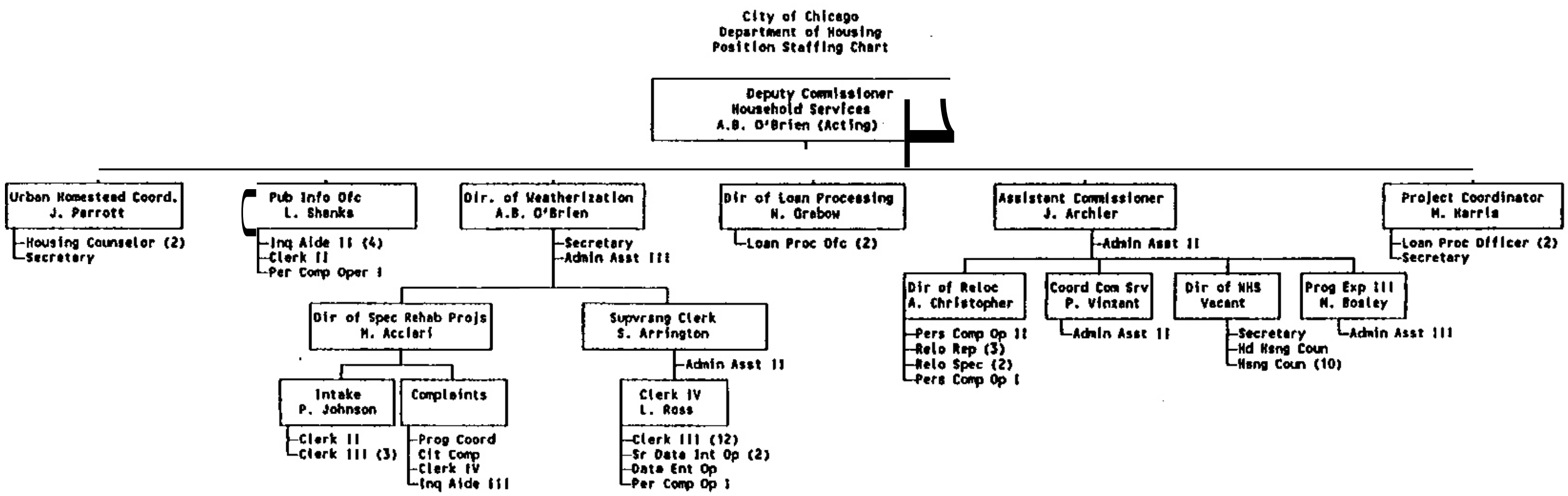


Fig. 4.2. City of Chicago Department of Housing position staffing chart.

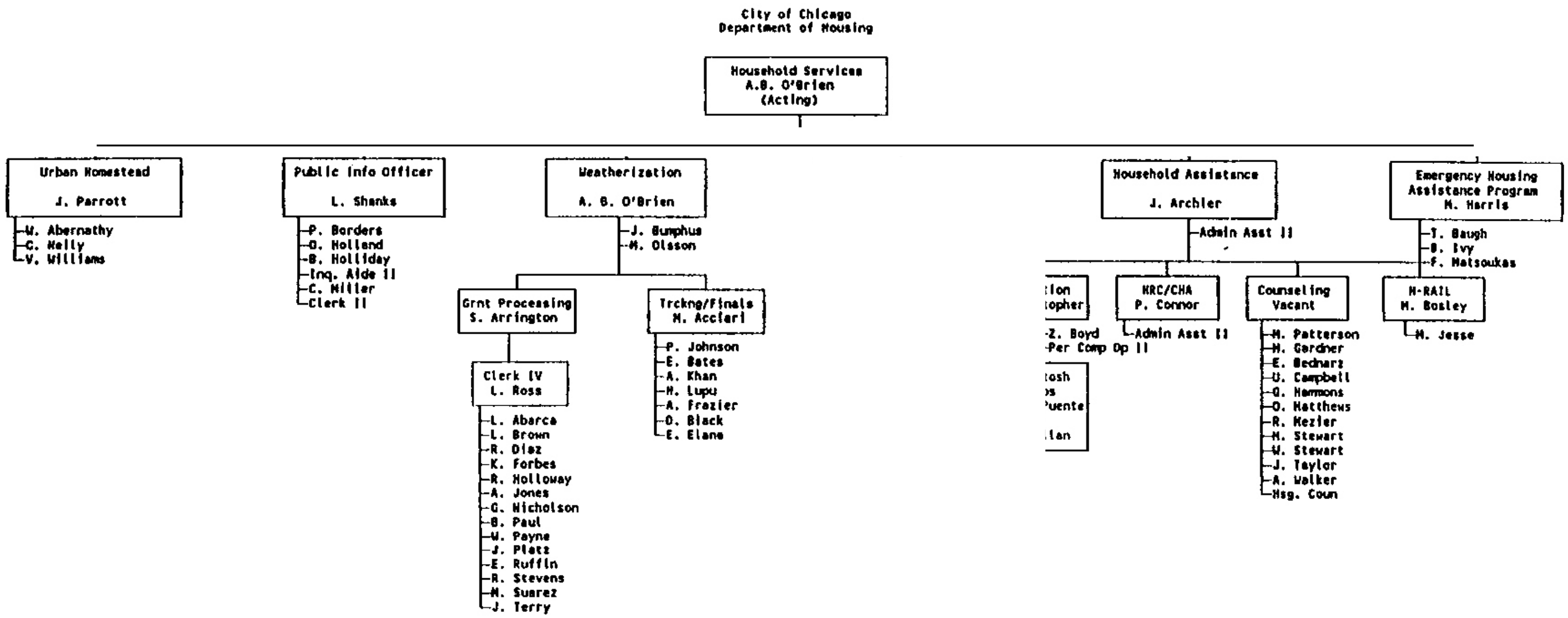


Fig. 4.3 Ciω of <hicago Department of Housing.

SUMMARY

Bill McMahon, who has been with the Chicago weatherization program for 13 years, observes that "the program is a success as a result of everybody putting their heads together. It's an evolving product The city has had the program for 14 years now. If something doesn't work, we change it."

Drake Johnson attributes the success of the program largely to its pool of excellent contractors. "To be sure, many of our buildings are in pretty bad shape before we get to them, and there are some atrocious heating systems." James Dundee isn't sure that the new approach to multifamily projects is a complete success. "We haven't gone through a whole heating season yet since we started. As long as the building owner is happy, we've lowered costs, stabilized rents, improved aesthetics and are helping the neighborhood, I guess you'd have to call it a success. I just wish we had more material dollars per apartment so we could deal more effectively with the whole building."

Director O'Brien indicates that she is proudest of the number of people served by DOH. She observes that over 110,000 people in Chicago receive utility fuel assistance and probably most of them deserve weatherization assistance as well. Although at present DOH can serve only about 3000 clients per year, she would like to see the program grow. The challenges of running a big city program are formidable, but she looks forward to increasing both the quality and quantity of services provided.

BUILDINGS SURVEYED

The city of Chicago provided natural gas billing records for seven representative multifamily buildings to be included in the building case study reports. As initial DOH information arrived on each of these seven buildings, it became clear that completion dates were often later than had been anticipated and that more recent billing data on five of the seven buildings would be required. Further inquiry to People's Gas resulted in updated billing records. Examination of the full records indicated a preponderance of estimated readings. Consolidation of estimated periods with actual meter reading dates resulted often in full year records with very few actual data points.

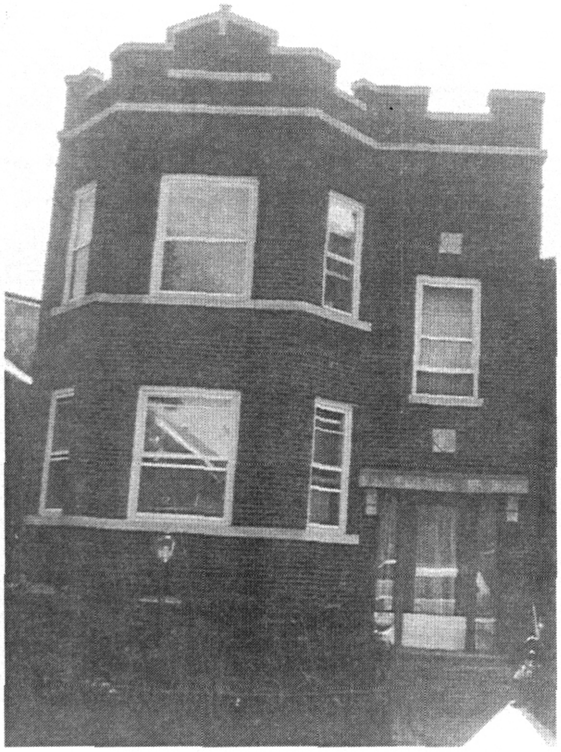
PRISM analyses were run on the data. Often the results were exceptionally low R^2 values, negative baseloads, unreasonable reference temperatures, and sometimes refusal of PRISM to evaluate the data at all for lack of sufficient readings.

Upon examination of DOH client files and of the buildings in question, other problems arose. For instance, in one case fewer than half the units in a large building were occupied by eligible tenants, resulting in only a fraction of the units having received retrofits. In addition, for aesthetic reasons the landlord wanted storm windows added only to the back of the apartments. The resulting piecemeal retrofit opportunities understandably led to little or no savings and did not reflect the whole-building multifamily perspective currently being used by DOH.

In another case, each apartment in a six-unit building had its own furnace and gas meter, but billing data had been collected for only one unit.

As a result of these problems, evaluations are presented here only for the two buildings which received full-building treatments and for which reasonable billing data were available. One of these buildings is fairly typical of the smaller end of the multifamily scale—a five-unit, two-story-plus-basement building. The other, at 72 units, represents the other end of the scale—at least for privately owned multifamily buildings served by DOH.

NORTH LINDER BUILDING
1509 NORTH LINDER
CHICAGO, ILLINOIS



. Fig. 4.4. Tenants in all five units of this three-story walkup were income-eligible.

Building Description

This smaller two-story-plus-basement building has two apartments per floor plus an added apartment in the front of the basement. The boiler is an older 240,000-Btu-output single-zone hydronic unit with a separate 75-gal 75,000-Btu-input domestic hot water system.

The main body of the building is brick with what was originally a two-story frame rear porch. The porch has since been enclosed and is now considered part of the heated space of the two rear apartments (Fig. 4.5).

Weatherization Measures

Work on this building was done in the first half of 1992, with a completion date of July 31 of that year. Work done was exclusively of an architectural/building shell nature. Retrofits included 45 storm windows installed on all apartment windows (but not common areas) (Fig. 4.6), a few new window sashes, rehanging of doors, glass replacement, weather stripping, door sweeps, locks, and smoke detectors (Fig. 4.7).

The rear of the building had settled considerably, and it was obvious that the contractor had to make fairly extreme fill-in repairs to achieve the effective air sealing work in this area.

All of the work inspected looked good, and high-quality materials had been used.

costs

Table 4.5 presents the retrofit costs from the individual client files.

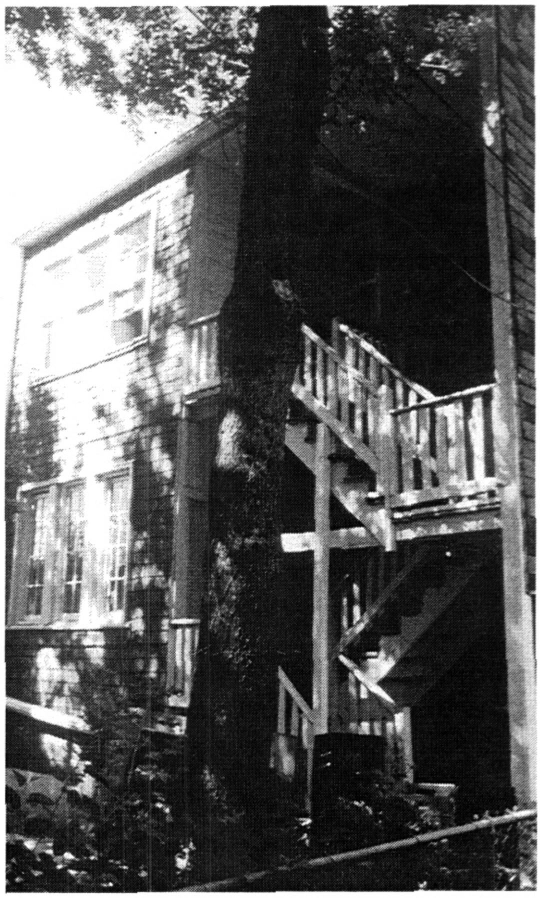


Fig. 4.5. Enclosed porches provide real challenges for Chicago multifamily contractors.

Savings

Billing data were selected for the periods between June 17, 1991, and April 21, 1992, and August 14, 1992, and August 13, 1993. The R^2 for the PRISM analysis (a measure of the internal consistency of the analysis indicating the quality of the data set) was 0.977 and 0.994 for the pre- and post-retrofit periods. PRISM projected a 60°F reference temperature for both periods. PRISM analysis indicated heating energy use for this building was reduced a moderate 10%, but this was largely offset by a 25% rise in baseload energy use. There was no clear explanation for this phenomenon, but it may relate to the fact that hot water can be provided by both the central heating–source boiler and a separate tank hot water heater. Although both are fired by natural gas, summertime usage of the boiler system as opposed to the separate tank unit could greatly exacerbate the baseload usage.

Overall, the building owner was pleased with the program. He liked the storm windows that he received and wanted to buy the same units for the common areas windows of the building. He also indicated that the apartments were more comfortable but was surprised that he did not see larger savings? He claimed the thermostat was kept the same after the work was done.

Tor this account, there was a 12% rise in the midwinter natural gas cost between the pre- and post-retrofit periods.

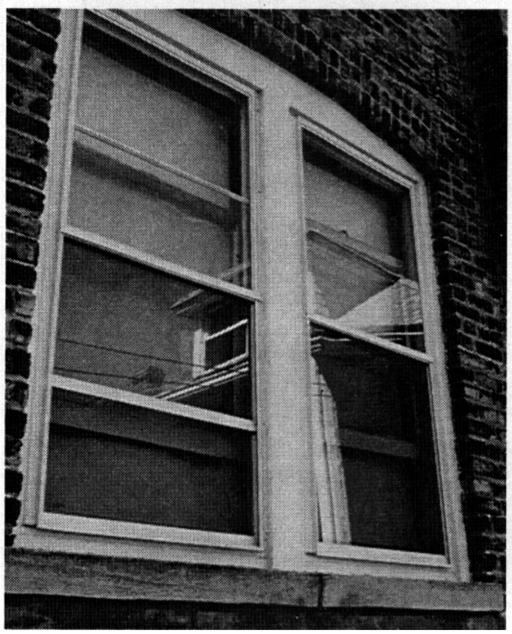


Fig. 4.6. New "easy-glide" storm windows and other air-sealing measures made up the retrofit.

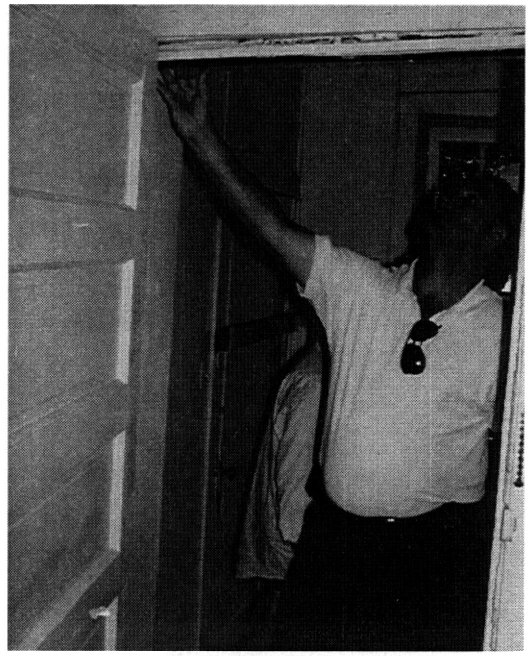


Fig. 4.7. Inspector Dundee examines the work done to air-seal a door frame that has distorted substantially due to building settling.

Table 4.5. 1509 North Linder Costs from Client Files

cost	Basement Front	Floor 1 Front	Floor 1 Rear	Floor 2 Front	Floor 2 Rear
Travel	$27	$27	$54	$27	$27
Mat.	$313	$361	$325	$360	$565
Labor	$91	$109	$367	$103	
Total	$431	$497	$746	$490	$932
Total for project	$3.096				

1509 North Linder **Chicago, Illinois** **Savings Analysis**				Annual **HDDs: 6625**
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	4323	4323	0	0
Consumption Index, Btu/HDD/ft^2	10.89	9.76	-1	-10
Heating NAC, MBtu	312	280	-32	-10
Baseload NAC MBtu	97	122	25	25
Total NAC, MBtu	409	401	-8	-2
Fuel Cost, $/MBtu	6.02	6.02	0*	0*
Annual Cost, $	2462	2416	-46	-2
Cost of Weatherization	$3096			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$571			
Benefit-to-Cost (B/C) Ratio[a]	0.18			

[a]For purposes of calculating the B/C ratio, energy costs were assumed to have remained constant, although, in fact, natural gas costs for this account increased approximately 12% in the interval.

DREXEL AVENUE BUILDING
5220 SOUTH DREXEL
CHICAGO, ILLINOIS

Fig. 4.8. The elegance of this larger building is maintained while serving primarily lower-income tenants.

Building Description

Built in 1926, this four-story (three stones plus basement), 72-unit building was originally the Drexel Residence Hotel in the fashionable Hyde Park area of Chicago. The building is solid brick with 18-in.-thick firewalls between each apartment. It features a stylish facade and a clean, well-maintained interior.

This was apparently the first large privately owned building weatherized by the city of Chicago. The corporation that owns the building has several others which are presently in line for weatherization or have weatherization in progress. Keith Leckrone, partner in the firm that owns and runs the building, is proud of the fact that the building has "the cheapest rents in Hyde Park," with most apartments renting for $400 or $425 and the studio apartments renting between $300 and $350.

The building as a whole is very well-maintained, and the owners are both informed about and concerned with energy efficiency and other critical residential issues such as lead paint. Leckrone notes with some satisfaction that the building was purchased in 1980 for $280,000, whereas individual townhouses recently built across the street are selling for up to $240,000. His satisfaction comes not so much from his own good fortune, but rather, from the fact that he can take some credit for contributing to the economic and social development of the neighborhood.

At present, over **40%** of the tenants in this building are "on disability," implying some sort of handicap, and the owners intend to convert unused ground-floor space into additional apartments in order to make effective use of the handicapped access to that area. In preparation for this addition of apartment units into the ground-floor *area,* Leckrone has collected typical period cast iron radiators.'

The heat and hot water *are* supplied by a large 2 MBtu/h gas-fued Kewanee boiler (Fig. 4.9). At one time there was supposed to be an ammonia-based air conditioning system installed, but there is no evidence remaining of this historical system. Originally, each apartment also had its own gas-fired refrigerator.

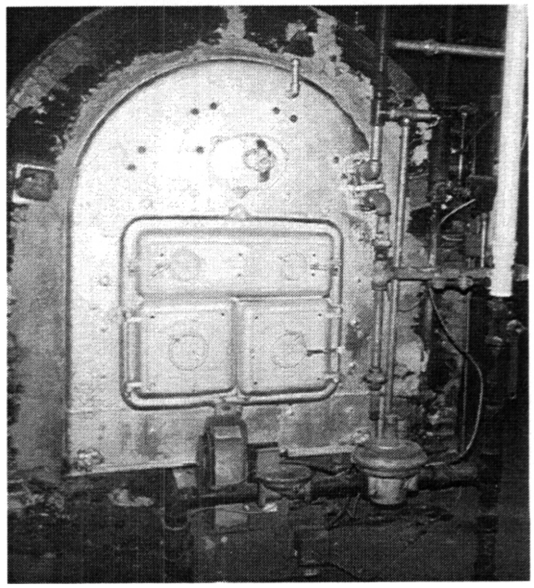


Fig. **4.9.** Under present city policy, this aging **2** MBtu/h boiler would likely **now** be eligible for replacement, with the building owner contributing **50%** of the replacement costs.

Weatherization Measures

The weatherization included replacement windows for ***55*** apartments installed on a 50/50 basis of landlord contribution, plus windows for an additional five apartments paid for completely by the owner.

Due to the difficulty of mustering so many tenants to complete eligibility applications, the building was done in two stages. In the first year, 33 units were weatherized, and then 22 units were weatherized the next year-plus ***5*** units done by the building owner. The first 33 units were completed by December of 1992 and the remaining by May of 1993.

Concurrent with the weatherization work, the owners installed smoke detectors and new doors for each apartment and new steel *fire* doors in the stairways. These added measures in combination with the window replacements undoubtedly contributed significantly to reduce the stack-effect air leakage patterns, allowing better control over the building temperatures and heating system operation.

The windows installed *are* high quality, double-glazed, vinyl-framed units. In some cases, original pairs of 40-in.-wide (glass size) windows were replaced with three 24-in. units for both *cost* and *safety* reasons. It should be noted that although this strategy changes the exterior appearance of the building somewhat, it is not incongruous or offensive to the overall building style (Fig. 4.10).

[3]Thii is in keeping with the *Preservation Brief: Healing, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approach* published by the U.S. Department of the Interior National Parks Service and available from the U.S. Bookstore, an excellent source for guidelines regarding such issues.

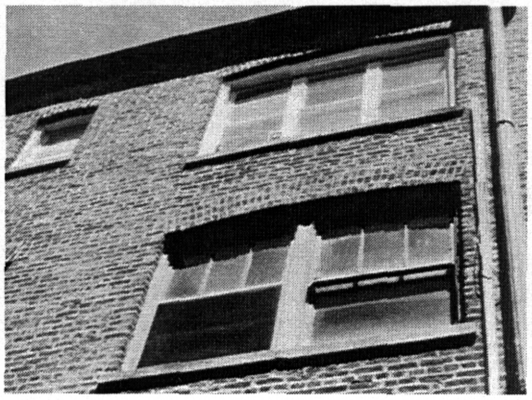


Fig. 4.10. Replacing two oversized windows with three narrower units does **not detract from the aesthetics of this property.**

costs

Since the files for this building consist only of individual apartment files and the job **was** done in two ***stages,*** it is not clear **from** the city's records what the **total** *costs* were. **One** bid **from** Republic Aluminum was for **$21,408,** but it is not clear if this **was** for all ***55*** units or whether it includes installation labor. In individual files, **typical** labor costs accounts for about **25%** of the total. Also **from** the client files, it **seems** that each window ***cost*** about **$90** -materials and labor—and that each apartment received between four and seven windows. Put together, **these** assumptions imply that the total cost for the job was about **$29,000.**

Savings

Utility bill analysis on this building **was** done for **periods** between **June 18,1991,** and **October 20, 1992,** and between February **18,1993,** and April **25,1994.** R^2 numbers for the pre- and post-retrofit periods were 0.994 and **0.9466,** respectively, and the reference temperature rose **from 63°F to 66°F.**

Heating energy usage was reduced some 27%, for a savings of nearly **10,500** therms of natural ***gas* per** year. Including a 10% reduction in ***annual*** baseload energy **use** results in a total savings of nearly 12,500 therms. Although they do not closely track energy usage, the building owners' estimates of a one-third reduction in heating load matched our savings figures for the retrofit application. Counting only DOE's share of the retrofit costs and assuming a **20-year** life of the retrofit measures and a **4.7** discount **rate,** this results in a very impressive **2.71 B/C** ratio.

Such impressive fuel savings and payback **from** a window replacement focus seems both counterintuitive and counter to the savings **that** would be predicted by a standard steady-state heat loss calculation. If one **assumes,** however, that, prior to retrofit the building was essentially running out of control due to high air-leakage rates and **extreme** stratification **from** air **flows** through common **spaces,** the added control resulting **from** isolating individual apartment zones and restricting exfiltration would allow for heat to be delivered effectively throughout the building in a far shorter period of time. In fact, the building **owners** reported that the reduced load and better control reduced the length of steam cycles for the boiler **from** about **2** hours to **1.5** hours.

Besides the energy savings, Leckrone recognizes the additional benefits of the replacement windows, for which he had to contribute 50% of the costs (as opposed to storm windows, which would have been provided at no cost to the owners). These benefits include greater air tightness with fewer drafts, greatly reduced maintenance costs, improved appearance both inside and out, and the elimination of a major source of lead dust.

Since the owners have also replaced the interior doors and stripped the wallpaper from the walls, the ceiling paint and miscellaneous interior trim are the only remaining possible sources of lead paint contamination. These surfaces are well encapsulated under more recent coats of paint, so there is probably little danger of future hazard for the tenants.

Leckrone recognizes that there were probably still much greater savings available through mechanical improvements. The present boiler is "getting thii on the bottom" and demands $1500 to 2000 per year in maintenance. The distribution system clearly needs balancing, as the front of the building is still cold, while the rear tends to overheat (the boiler is at the rear). Since all domestic hot water is also supplied by this boiler, there are certainly extreme inefficiencies during summer operation. Because there are no central mixing valves and separate hot and cold water taps in many of the apartment bathrooms, water can be delivered at a scalding 180°F.

The owners are very pleased with the work accomplished, says Leckrone. "It's a great program, and it certainly made a difference here. We've had two buildings completed so far and are working on two others. All of the others include boiler work as well." They were very satisfied with the contractor's installation and have hired the same firm to complete the job on common areas and ineligible apartment windows.

The only problem Leckrone reports is occasional mildew collection on some exterior walls, which can sometimes be an indication of a faulty air vent on the steam system, but may also be due simply to the reduced air leakage rates and higher indoor relative humidity resulting from the tighter building shell. "A little Clorox takes care of the problem, and that's a small price to pay for the benefits we've seen."

5220 South Drexel Chicago, Illinois **Savings Analysis**				Annual HDDs: 6625
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	56,000	56,000	0	0
Consumption Index, Btu/HDD/ft^2	10.46	7.64	-2.82	-27
Heating NAC, MBtu	3879	2834	-1046	-27
Baseload NAC	1944	1742	-202	-10
Total NAC,	5824	4576	-1248	-21
Fuel Cost, $/MBtu	5.05	5.05	0[a]	0[a]
Annual Cost, $	29,418	23,116	-6302	-21
Cost of Weatherization	$29,000			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$78,652			
Benefit-to-Cost (B/C) Ratio[a]	2.71			

[a]For purposes of calculating the B/C ratio, energy costs were assumed to have remained constant, although in fact energy costs increased approximately 13% in the interval.

CONTACT PERSONS

State Employees

Edward Haber
Supervisor of Technology Development Unit
Truman Eisley
Department of Commerce and Community Affairs
620 East **Adams St.** Fifth Floor
Springfield, IL **62701**
217/524-8032
2171782-1206 Fax

City Employees

A. B. O'Brien
Director of Weatherization
Department of Housing
City of Chicago
318 So. Michigan
Chicago, IL **60604**
312/747 9498
FAX: **312/747-9207**

Mike Acciari
Director of Special Rehabilitation Programs
Department **of** Housing
City of Chicago
318 So. Michigan
Chicago, **IL 60604**
312/747 9780
FAX: **312/747-9207**

Al Frazier
Department of Housing
City of Chicago
318 So. Michigan
Chicago, IL **60604**

Drake Johnson
Department **of** Housing
318 So. Michigan
Chicago, IL **60604**
3121747 6165
Fax **312/747 9207**

Harvey Lupu
Department of Housing
City of Chicago
318 So. Michigan
Chicago, IL **60604**

Auditors

James Dundee
Department of Housing
City of Chicago
318 So. Michigan
Chicago, IL **60604**
3 121747-9593

Bill McMahon
Department **of** Housing
City of Chicago
318 *So.* Michigan
Chicago, **IL 60604**

James Rideaux
Department of Housing
City of Chicago
318 So. Michigan
Chicago, IL **60604**

Tom Stone
Department of Housing
City of Chicago
318 So. Michigan
Chicago, **IL 60604**

Building Owners/Supervisors

Keith Leckrone
5220 South Drexel

Arthur Lee
4501 No. Beacon Street

Jose Sandoval
1509 North Linder

Others

Bob LeRoi—Contractor
Bob Pendlebury
People's **Gas**
3121431-4926

5. ST. PAUL, MINNESOTA

OVERVIEW

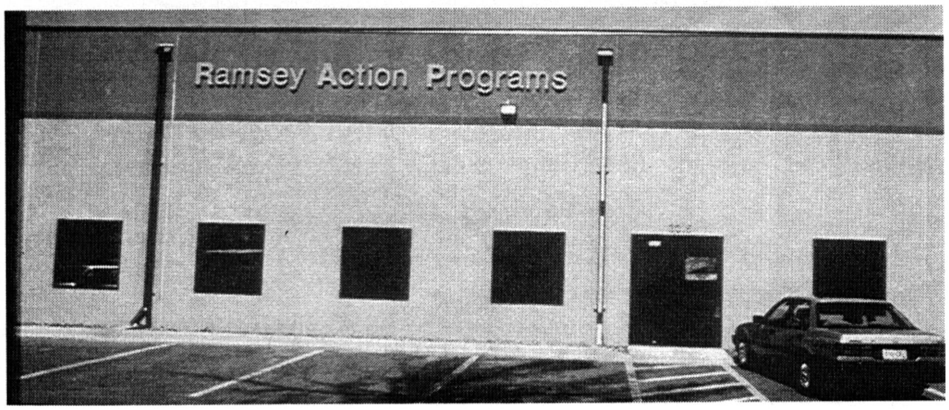


Fig. 5.1. The Ramsey Action Program weatherization facility includes both administrative offices and a large, well-organized materials warehouse.

The following draft case study of the U.S. Department of Energy (DOE)–funded low-income multifamily weatherization assistance program in Ramsey County, Minnesota (St. Paul and surrounding county) is the product of visits to the Ramsey Action Program (RAP) weatherization offices between April 11 and 15, 1994 (Fig. 5.1 and Fig. 5.2). It is based on discussions with program personnel, reviews of all available client files, PRISM analysis of pre- and post-retrofit utility billing' data from seven buildings, visits to four completed job sites, inspections of eight buildings, and interviews with building managers and maintenance supervisors. State program officials, contractors, and consultants to the state program were also interviewed in person or on the telephone.

RAP provides sound, cost-effective multifamily weatherization services to its target population. The personnel demonstrated dedication to both the spirit and execution of the low-income weatherization mandate. Working in concert with a strong cadre of experienced contractors with whom RAP has maintained long-standing relationships, the program offers directed services to meet the needs of individual buildings as identified by their staff of energy specialists. Relying on an extensive state-mandated manual and audit mechanism to assist the agency's own performance experience, they offer a wide range of retrofit opportunities focusing primarily on mechanical retrofit options.

It is widely recognized that RAP has a long track record and extensive in-house expertise in multifamily retrofit—a view borne out in this study from both the quality of work observed

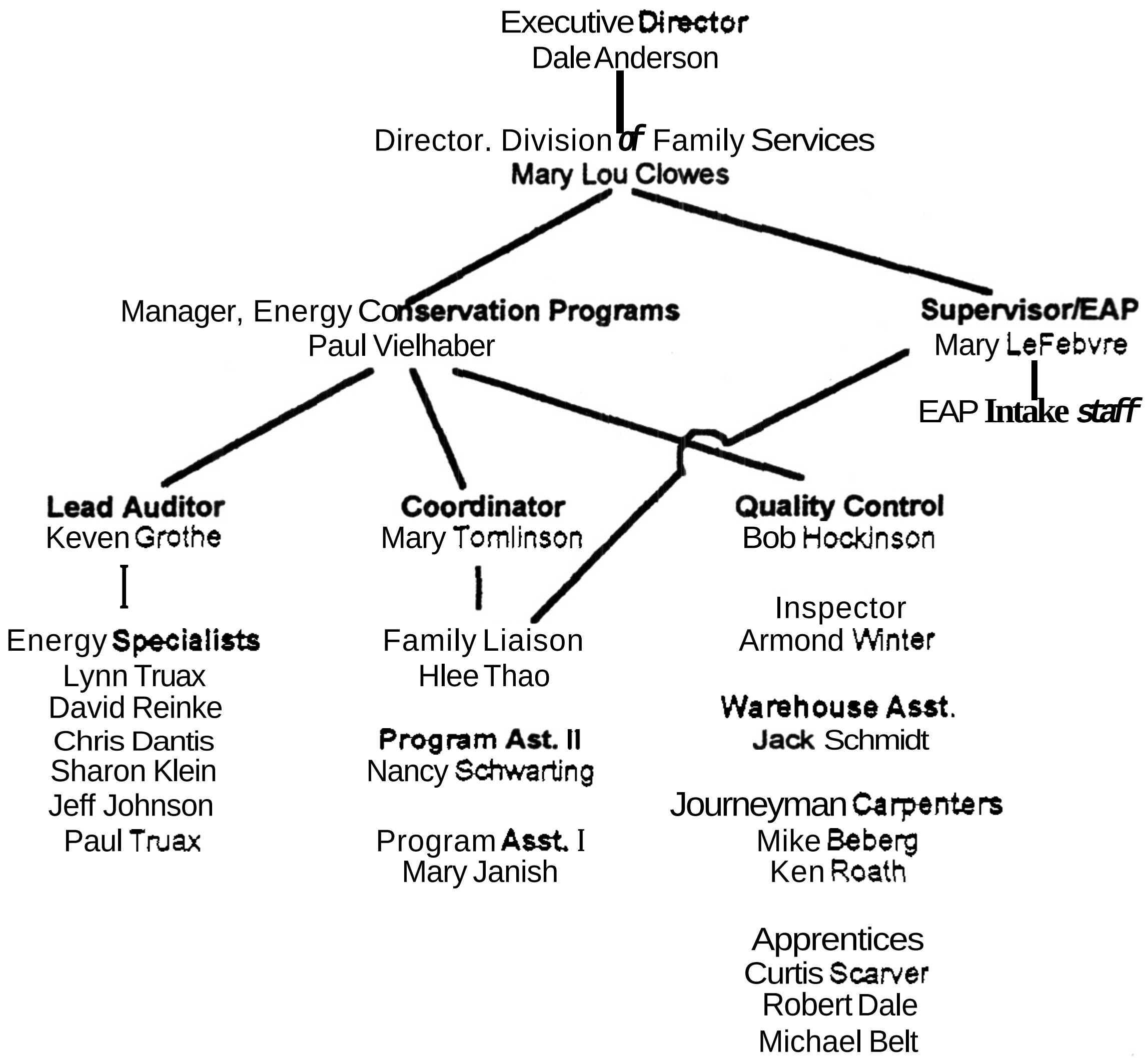


Fig. 5.2. Ramsey Action Program organizational chart

and the consistent energy savings shown from the utility billing data analysis. Nonetheless, state officials understand that throughout the state there are many other agencies with far less experience in multifamily issues for whom special training and guidance may be in order. A concerted effort to unify the resources available to rectify that situation is a primary focus of the state offices for the months ahead. A primary concern expressed by numerous individuals interviewed for this report was the desire for the institution of funding mandates that would allow longer-term follow-up and evaluation of these more complex multifamily projects in order to improve efforts and ensure persistence of savings.

INTRODUCTION

Nationally recognized groups and individuals located in the state of Minnesota and in the greater St. Paul/Minneapolis metropolitan area in particular have long demonstrated creativity and dedication in undertaking both effective conservation practices and careful research in the field of multifamily housing. An extreme heating load climate combined with progressive state and city governments have resulted in policy trends that consistently stress conservation and efficiency. Efforts from government, utilities, community action programs, other nonprofit groups, and private industry have resulted in a region-wide atmosphere of creative activity in this field.

Although RAP, the local community action program serving the greater St. Paul and Ramsey County community, is the primary focus of this report, it is important to identify other key players in the local energy conservation community. These include the following:

- the State Weatherization Office, under the Department of Economic Security (DES);
- the Underground Space Center;
- the Center for Energy and Environment (CEE);
- the Environment and Energy Resource Center (EERC);
- Northern States Power (NSP);
- Weatherization Research and Production (WRAP);
- Jim Fitzgerald Contracting; and
- the Energy Conservatory.

Weatherization in Minnesota is administered by DES, the designated grantee. Services are provided by 35 subgrantee community action agencies and Indian tribes. Both the state's and RAP's weatherization administrations have traditionally demonstrated an independent, can-do attitude toward program structure, technical innovation, readiness to adapt to changing regulations, and increased understanding of building science. They have been on the cutting edge of technology and innovation, instituting use of blower doors, infrared thermography, and other advanced diagnostics well ahead of most of the rest of the country. During the 1980s when DOE weatherization subgrantees were being urged to diversify and develop for-profit arms, RAP raised the eyebrows of its peers by establishing a profitable commercial fire-proofing business in Hawaii.

However, the core staff is universally concerned that the present administrative structure and program funding cycles restrict the long-range commitment needed to ensure the success of individual projects. More flexible funding allocations, particularly in the multifamily sector, would allow the agencies to maintain a longer-term involvement with the larger projects, evaluating post-retrofit performance and fme-tuning complex systems. At present, it is difficult to learn from past projects to improve savings opportunities and future service delivery.

Housing Demographics

According to 1990 census data, the area served by RAP has 59,241 housing units in multifamily buildings of five units or more (see Table 5.1). This represents 29% of the county's housing stock and 18% of the large multifamily units in the state of Minnesota. The larger Minneapolis/St. Paul metropolitan statistical area includes 240,299 housing units in

Table 5.1. Building Demographies by Number of Housing Units, United States and Minnesota

Location	All Building Types	5-9 units	10+ Units	Total Large Multifamily[a]	Multifamily % of total	% of State Multifamily	% of U.S. Multifamily
USA	102,263,678	4,935,841	13,168,769	18,104,610	18		100.0
Minnesota	1,848,455	45,190	276,475	321,665	17	100	1.8
Mpls/St. Paul MSA[b]	988,735	26,305	213,994	240,299	24	75	1.3
Hennepin County	443,583	12,182	119,924	132,106	30	41	0.7
Minneapolis	172,666	6.955	52,496	59,451	34	18	0.3
Ramsey county	201,016	6,824	52,417	59241	29	18	0.3
St. Paul	117,583	5,292	32,450	37,742	32	12	0.2

[a] Large Multifamily is defined hen as a building with five or more units.
[b] MSA = metropolitan statistical area
Source: 1990 *Census of Population and Housing: Summary of Population and Housing Characteristics,* U.S. Department of Commerce, Economics and Statistics Administration, 1990.

multifamily buildings of five units or more. This is 24% of the area's housing stock and 75% of the large multifamily units in the state.

Multifamily Housing Stock

Most of the rural multifamily projects across the state are typical Fanners' Home Administration two- or three-story frame walk-ups with a brick or stucco facade, according to Alan Chapman, Weatherization Coordinator at the State Department of Jobs and Training. Most of them have hydronic heat, but some have electric baseboard heat. This size and style of construction is also extremely common in the metropolitan areas, but the buildings served by RAP also include a wide variety of other styles ranging from row house configurations to 20-story high-rises. As in the smaller towns and cities across the state, there are also many mixed-use buildings with rental units above retail establishments.

The most common buildings in the St. Paul area are clusters of fairly similar two- and three-story walk-ups, built by the same contractor, which may or may not be under the same management firm (Fig. 5.3). To the extent that these clusters can be processed and retrofitted at the same time, substantial economies of scale can be attained. Not only may multiple unit completions be achieved in the same audit and contract process, but also multiple buildings may be simultaneously processed.

Multifamily Weatherization

During the program year April 1993–March 1994, 940 large multifamily units were weatherized statewide using DOE funds out of a total state production of 4163 dwellings (22.5%). If units weatherized with Petroleum Violation Escrow funds are included, these figures change to 996 and 4499, respectively (still about 22% of the total). Of these nearly 1000 multifamily completions, some 585 units (59%) were weatherized by the three agencies

Fig. 5.3. Three-story walk-ups are typical of the Twin Cities multifamily housing stock.

that serve the greater Minneapolis/St. Paul metropolitan area. Four other agencies located in smaller urban centers in the state reported 230 multifamily completions (23% of the total), and the remaining 182 (18%) were divided among nine primarily rural agencies. Nineteen agencies and tribes reported no multifamily completions at all. Although data are not readily available for other years, state officials report that the mix has not radically changed over the years.

Paul Vielhaber, the housing director at RAP, reports that his agency's involvement with multifamily weatherization has varied quite a bit over the years, depending primarily on varying funding/payment requirements. This year the multifamily mix was about 30% of the total of 413 completed. Last year, however, about 50% of its work was multifamily. Generally, the agency did more multifamily work in the late 1980s than it is doing now.

PROGRAM OPERATION

Building Identification

Weatherization program manager Mary Tomlinson is usually the first person at RAP contacted by a prospective landlord. If the owner is interested, he or she has to make a request in writing with a variety of building and occupant specifications. Typically, the building owner will also provide a list of tenants who are. likely to be income eligible.

Occasionally a building may be unoccupied and RAP will agree to weatherize the building with an agreement from the building owner that the building will be occupied with eligible clients within 180 days of the job completion. Tomlinson observes that it may be questionable to invest staff time in establishing client eligibility if there is little that the program can offer in terms of energy savings. "It's a chicken and the egg issue; do you look at the building before you do the intake or vice versa? The building may be either too beat or there is nothing cost-effective left to do. In that case we've wasted all the energy doing the intake. But do we want to do an audit, and then find out the building isn't eligible?" Sometimes the building has already received a utility audit indicating savings potential.

The process of outreach to building owners is one of the major areas of recent innovation in RAP's multifamily program. According to Tomlinson, RAP used to have a list of all multifamily buildings in the area and would simply call the building managers "cold turkey" to ask basic questions such as who pays for the heat, the type of building, and occupancy. Ideally, she would like to see RAP weatherizing more multifamily buildings where tenants pay for their own heat, but for now, working through the landlords seems to be most effective.

At present, many referrals come from the outreach workers in other RAP offices who process Low-Income Housing Energy Assistance Program (LIHEAP) fuel assistance payments. Tomlinson notes, however, that there is a scheduling conflict here. The intake staff wants to work on weatherization intakes only in the off-season (summer) when they are not processing fuel assistance claims, while the production side typically is seeking more winter multifamily work.

Among the new initiatives recently instituted is closer integration with an important utility-funded energy services company that does a lot of work with St. Paul multifamily building owners. At the time. of the interview, Tomlinson had met with Dave Ledo of EERC and expected that group to be making referrals regularly (see also "Working with Other Organizations" in this chapter).

Eligibility Verification

Family liaison worker Hlee Thao, the *primary* weatherization client outreach person at RAP, is responsible for most multifamily client eligibility confirmations. She observes that "usually the neighborhood building centers contact the agency first. Occasionally other agencies will make references or tenants will ask for services. I write to the owners and schedule appointments to do the client intake. Most tenants don't have transportation, so I go to the building and set up shop in an empty apartment to receive intakes. It usually takes a minimum of two days, but so far we've had a 100% success rate at getting our 66% minimum eligibility." Since the landlords benefit from having the work done, they will sometimes offer an incentive for the tenants to cooperate with the eligibility process. Some landlords will offer partial rent payments to the tenants or perhaps a $25 leveraging fee if they will sign up with the program.

Landlord Contributions

Vielhaber suggests that an agency should "stay away from multifamily projects unless you can leverage lots of money from the owners." At the time of our site visit, the agency had just received the new paperwork for landlord contributions, and it was seen as an additional administrative burden. Besides the paperwork, the multifamily auditor now has to negotiate an agreement with the building owner as to who pays for what.

Chapman says, "Our new rental agreement is not as tight as the one in New York. It is still seen as more work for the agency staff and may result in more turn-downs from the building owners. For a few hundred dollars per unit, why should they promise no rent increases?"

In Minnesota and elsewhere, many building owners see their investment as an accelerated depreciation under subsidized low-income regulations. They typically keep a building for 6–7 years and sell it. The new owners are then likely to perform a major rehabilitation on the property. (Such was the case in the Maryland Avenue Buildings discussed in the case studies at the end of this chapter). Since these renovations usually involve mostly building shell components, the emphasis on mechanical systems retrofits on RAP appears useful, as the savings potential persists beyond each building rehabilitation cycle.

The Audit Process

In the early 1980s, when the mandate to create a Commercial and Apartments Conservation Service (CACS) audit was put before the Minnesota state government, state government took the challenge as being an important adjunct to an already progressive statewide energy policy. When the CACS program was allowed to die nationally, the Minnesota Department of Public Service (DPS) chose not to let that momentum fail and developed its own Multifamily Building Energy Audit, technical manual, and accompanying training program. This included a substantial packet of resource materials outlining the present state of the art in multifamily retrofit possibilities. Designed for both weatherization auditors and inspectors for utility and Fanners' Home Administration programs, the "Maxi Audit," as it is generally known, is in keeping with the Minnesota tradition of local decision-making, similar in approach to the Minnesota High Level Study and the M-200 program. Like these two single-family weatherization initiatives, these multi-family resources provide decision makers (auditors) with the knowledge and the tools to make informed decisions rather than imposing hard-and-fast limitations on retrofit opportunities. The massive document stresses both first principles and the wide range of options available for particular circumstances.

The Multifamily Audit Handbook was put together by DPS in 1986 based on the Residential Energy Service and CACS audits. Up to that point, there had been no statewide multifamily weatherization manual or standards. Two years ago, the Department of Jobs and Training, which operated the weatherization program at the time, offered the DPS manual as the state weatherization multifamily guide, and it was approved by DOE except for the lighting measures. The audit includes five pages of detailed intake information characterizing the present structural and mechanical systems. To this is attached a two-page summary of recommended measures, including inputs for savings, costs, and payback. Records and calculations of present energy use from a variety of fuels are an important adjunct to each package and are considered essential by the RAP auditors.

The balance of the paperwork consists of 45 single-page "fact sheets" explaining the function and rationale behind each recommended retrofit and summarize the savings opportunities for each. These sheets are more for the benefit of the building owner than of the auditor. The actual calculations relating to each sheet are. included in the remaining 144 pages of formulae, charts and tables. It is not a neat, concise package and is hardly user-friendly. Further, substantial effort is required for an auditor to master all this material. The end result, however, is an understanding not only of how to come up with savings numbers, but also of the basis for those calculations and decisions.

The auditor is *not* required to run all these calculations on every building. The audit is not a modeling program, but is used most often to calculate the savings from specific proposed measures identified by the auditor. Hence, past experience of successful retrofits and a knowledge of the condition and possibilities with the present building are the driving force behind the measures selection. The calculations are completed primarily to verify those assumptions and to provide documentation for the building owner and program administrators of the basis for the decisions made and the measures selected.

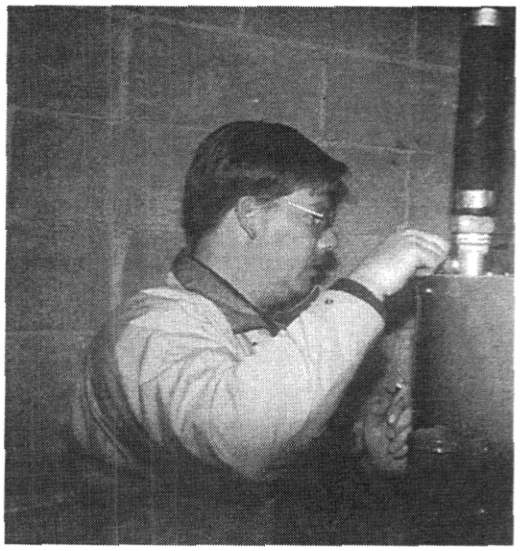


Fig. 5.4. Pad Truax, a multifamily weatherization auditor, is a key figure in the RAP multifamily program.

The most important individuals in the RAP multifamily weatherization operations are the energy specialists who are responsible for auditing all buildings, negotiating with landlords for their contributions, and assigning contracts for the actual work to be done. One such energy specialist, Paul Truax (Fig. 5.4), explains, "We fill out the audit forms as relevant. There is no sense in doing unnecessary calculations. It might be more useful to have the forms computerized, so we can easily calculate a building gain correction factor, for example." He does not see a fully computerized audit as being the answer because such audits tend to model ideal buildings rather than address an existing structure.

The actual selection of proposed retrofits is based primarily on known, proven procedures and the programmatic and financial limitations of the case at hand, rather than on a computer printout. Although the Maxi Audit includes extensive opportunity for performing steady-state modeling of many possible changes in the building shell and its systems functions, savings calculations are typically run only on those measures already selected as being most promising. These numbers are used primarily to justify the retrofit decisions that have been made. Occasionally other measures evaluations are. also performed—such as for replacement windows—but these are usually for dissuading the building owner from carrying out a desired retrofit. Truax explains, "I'll talk to the owner as to what they want to do, and then run the calculations to either justify those requests or to explain why they are not cost-effective. We now have a new form for the landlord contribution, but essentially we let him do what he wants with his own money."

Chapman observes: "Two years ago we submitted the Maxi Audit as our DOE audit, but only for DOE-approved measures. We want to move toward a 'New York approach.' We are finally going to deal with the envelope and its interactions with the mechanicals and distribution system. We are looking to the New York high-user process [the Targeted Investment Protocol System]."

At one time, the multifamily weatherization auditors at RAP contracted out all large-building mechanical analysis to a consulting engineering firm. The combined experience gained from this work, along with extensive in-house and statewide training programs, has produced a level of confidence in the in-house staff that enables multifamily auditors to tackle all but the most complex systems. Even now, however, they will listen carefully and respond to the recommendations of their mechanical contractors. Truax comments, “Before 1988 we had an outside engineer do a report for each building. I still ask myself, is it worth the risk to prescribe stuff that I’m not really sure of? But then why just pay $3,000 to an engineer? On the other hand, we’ve had enough single-family experience to go ahead with confidence, but I don’t feel we have enough multifamily experience for that level of confidence.”

The RAP auditors always get utility data before going out to look at the building. Their relationship with the utility is very good. NSP will send out 12 months of billing data on a fax in response to a phone call (although it needs a written formal request for 24-month data).

Auditors perform a quick-and-dirty normalization process on the consumption data and subtract out the baseload. Particularly interesting in this process is the way they calculate the baseload if energy for domestic hot water (DHW) is included in the consumption record. Rather than assuming the DHW baseload is constant throughout the year and multiplying a typical summer month load by 12, they multiply it by 15. This approach is consistent with findings reported by the CEE, which showed a significant seasonal variation in urban incoming water temperatures (Mississippi River water) from the long winters in this northern city.

“I do calculations on the heating curve to determine when the boiler comes on line and determine the design load,“ Truax reports. He also performs a fuel price analysis on each building since costs vary greatly by building or meter type. Finances are important because the project has to have both a benefit/cost ratio greater than 1 and a payback of less than 10 years. Electric usage for the building is also examined, but electric consumption for individual apartments is not obtained unless electricity is a primary heat source. A utility-funded lighting program is becoming a more important part of the overall operation.

THE WEATHERIZATION PROCESS

Measures

Most multifamily weatherization dollars at RAP go into mechanical system retrofits. Bypass sealing and added attic insulation are common in smaller buildings, but there is usually very little window work or air sealing in the individual apartments. With the rapid tenant turnover rate and the frequent building turnover rate, apartments are frequently repainted and even gut rehabbed. Often, air conditioner covers are the only architectural measure applied to individual apartments (Fig. 5.5). Apartments also regularly receive shower flow restrictors and sometimes lighting retrofits under other funding sources. Common areas may get some architectural work such as storm panels on single-pane glass or door rehab.

Fig. 5.5. Air conditioner covers are one of the few building shell retrofits regularly applied in the RAP multifamily program.

"We look largely to mechanical measures," Truax observes. "There is little opportunity for cost-effective shell measures." Two-pipe steam systems are usually good candidates for hydronic conversions, and existing hydronic systems seem to be most often retrofitted with a clean-and-tune and improved controls—typically outdoor cutout/resets and more reliable zone valves. Truax admits that he has a bias against clock thermostats and a bias for outdoor reset/cutouts.

Working with Contractors

Once the energy specialist has completed the audit process, negotiated the landlord contribution, and reached agreement on which measures will be applied, Mary Tomlinson requests bids from the contractors and notifies the building superintendent that the contractors will likely be coming by to view the proposed work site. RAP acts as its own general contractor. Requests for bids are sent out to approved contractors with all the necessary licenses and insurance. One of the RAP subcontractors specializes in building insulation, one does pipe insulation and air conditioner covers, one sheet metal, one electrical, and another is a lighting wholesaler. RAP has two lighting contractors for its utility work and one contractor for heating system control work. For typical jobs, it will have one mechanical and one shell contractor.

RAP does not hold pre-bid conferences with the contractors, but long histories of involvement with the program usually mean few misunderstandings. "Not all contractors are equal in all tasks," observes Truax. "One won't install reset controls. He doesn't understand them and can't set them up right. He doesn't want the call backs." Upon receipt of the contractor bids, the energy specialist recontacts the building owners, informs them of the selection, and sends out the proceed to work order. RAP supplies and warehouses all the major materials for the contractors. That way all the labor and fringe benefit costs for warehouse activities go into the materials side of the equation. In turn, contractors are not paid for loading time, just per job according to their hid.

"The shell guys are the same as our single-family contractors," reports Truax. Weatherization Research and production (WRAP), once a for-profit subsidiary of RAP, is now disassociated from RAP but still does 70% of the shell weatherization work. PEC and CW, two other major contractors, are also staffed by former WRAP workers. When RAP had its own crews, they were all union workers; all of the contractors are still union shops, and all pay union scale.

Vielhaber explained how the agency structure evolved from its "delegate agreement" with WRAP, a semi-autonomous "sister" agency that did most of RAP's retrofit work. RAP determined that it had more crews than it needed, so in 1989 the agency reassessed its role and established an approved contractor list that now has four firms. "We are going to bring crews back on board soon—two hot crews," reports Vielhaber. "With contractors, it's hard to encourage change orders. Contractors also have to watch their bottom line. They want to do a good job, but contractors are too busy. Writing more reworks is costing contractors dearly. At the rework, the crew and the crew chief are back there with Armond Winter and Bob Hockenson doing it right. Bob Hockenson performs 100% visiting on-going jobs while in progress, but quality control is expensive. We do only one audit per day. The rest of the time is bird-dogging contractors."

The energy specialist also often goes out and visits the jobs in progress. Armond Winter is the full time post-retrofit inspector who ensures that the work was done properly and gets the building owners' sign-off on the completion certificate.

Weatherization Research and Production

WRAP generates most of its income from

- installing commercial and residential insulation, spray-applied thermal barriers, soundproofmg, and basement and crawl space insulation
- providing construction management
- performing infrared and blower boor inspections
- contracting energy-efficient house remodeling

Gregory Harris, president, observes, "In **1986,** we broke away from RAP, and we are free of the federal bureaucracy/bond requirements." Although WRAP still runs a union shop, Harris is quick to point out that a major component of the contractor's perceived mandate remains training under-skilled workers. WRAP now has nine crews working in five counties. "We have strong roots in service to low-income and employment." WRAP has a for-profit subsidiary, but, as Harris indicates, "even the nonprofits have to generate a positive cash flow."

Working With Other Organizations

Chapman observes that in multifamily housing weatherization, the community action programs have often been integrated with other groups in the region, such **as** the housing authority. "It runs hot and cold. Northern States Power had projects for set-back thermostats, and there has always been a funneling of buildings from that utility. When a new program comes up, the [community action programs] are flexible enough to make use of it."

Chapman looks forward to the possibility ***of*** coordinating with U.S. Department of Housing and Urban Development (HUD) programs. "HUD built them; we should be able to fix them with their own dollars." Truax notes that **as** RAP works with numerous funding sources, the level of bureaucracy depends on who is backing the project. The Public Housing Authority needs a lot of paperwork for requests and approval. Under new DOE requirements, it will need owners' approval and sign-off on all jobs. NSP does not even demand a sign-off. Dave Ledo of EERC does many of the multifamily audits for NSP and regularly makes referrals to RAP. Truax admits, "If we can fit his numbers to fit our paperwork, great, we'll use it."

Tomlinson says that in the past there may been an overlap of services, **as** building owners were not always forthcoming **as** to previous history of involvement with other agencies. New arrangements coordinating with other agencies will mean less likelihood of following up **on** same building. "You don't want to have to go through all the front-end work, only to find you can't weatherize the building because it has been done before." Ideally, Tomlinson would like to see a statewide computer database of all energy and social service providers, which would not only allow them to avoid such conflicts but even eliminate the need to repeat the eligibility intake process for each separate program. "The percent of Section VIII eligibility in each building should be sufficient documentation." Additionally, she sees great advantage in being able to leverage resources from various funding groups. To that end, RAP is already leveraging funds through EERC and the landlords. There is even some talk ahout possibly turning over portions of RAP's multifamily work to EERC. As Vielhaber observes, "We both do audits on the same building, crunch our findings into one job order, pool our resources and do the right thing. What's wrong with that?"

Environment and Energy Resource Center

EERC is a nonprofit energy service company funded by NSP to provide in-depth conservation services for multifamily and small commercial customers in the St. Paul area. Ledo explains that EERC is funded by NSP on a 2-year renewable contract to do multifamily audits and construction management. "Typically we have done 200 audits per year and 85 construction management agreements per year. This year, however, we are up to 600 buildings and 20 construction management contracts."

EERC clients are all Minnesota NSP customers, both apartment and small commercial buildings, but each customer must use over 75,000 ccf per year. "We *can* give a lot more to bigger buildings with greater need." NSP markets the program through its building centers as well as through mailings and bill stuffers with gas and electric bills offering free audits. EERC examines the building, does the audit, and talks with the building owner, who will receive either a 20% rebate on the construction costs or a $7,000 loan at 5% interest. Ledo observes, "We work as a salesman to the landlords. The biggest question we have to answer first is, what is the budget we have to work with? The goal is to get them to agree to let us take over the building. We take over building operation, do spot inspections during construction, provide training for the supers, and track the building with PRISM for the next year."

EERC has a very structured protocol which selects measures based on the need of the building, and it tracks all buildings for the first year following retrofit. Its savings estimates appear to be among the best in the country. Ledo explains, "We try to hit large complexes where there is a multiplier effect on the audit and economies of scale. Larger buildings, larger loans. We also lie to do steam buildings where we can get big savings. To balance the system we go into each apartment and take measurements once a week for 10 weeks. We like to stay with what we know." He sees the possibility of working much closer with RAP. "We could he both feeding buildings to RAP and overseeing the construction management. We have an overabundance of buildings, and RAP has the resources to get the job done."

Evaluation

Vielhaber observes,

> The agency itself has had to bite the bullet to do any evaluation. That is the shame of the program. We don't know if we are effective or not. We are so pressured to meet production, we don't have the time or the resources to evaluate our own work. It's a double-edged sword. We have to get out to those homes that don't show savings and see what are the causes of the anomalies. We need funds to keep in communication and fine tune these projects—not necessarily to go in and reweatherize them, but fine-tune them. We need to stay committed to the buildings done in the past and design quality assurance into the program.

Chapman agrees, as he addresses the needs for a new multifamily initiative. "No project will work unless there is continuous feedback."

A recent in-house evaluation at RAP of the single-family program showed disappointing savings this year, so it is rethinking some processes. "We want to gear the program to track post high users and find out what's not working. For some, the ability to do that now exists. We want to change the term from 'auditor' to 'program manager' so they can go back and track performance," Chapman observes. "I am convinced that there will be no success in the new initiative if there is not a team approach. We've got to work with crews and contractors and we've got to provide them with both feedback and education."

Vielhaber also recognizes the need to continue to offer an intellectual challenge to his staff "There is a need to keep the auditors doing something interesting. We need to keep their attention to keep them on board. But that too gets expensive."

Client Education

Multifamily client education is less developed than most at RAP would like to see. Family liaison worker Thao is of Southeast Asian descent, speaks fluent Hmong, and can therefore communicate effectively with one of St. Paul's major minority populations. She has also produced a client information flyer in the Hmong language. Client advocates from one of the other RAP offices are called on when there is a need to communicate with Spanish-speaking clients.

Thao indicates that auditors do more client education than she does. She did attend a few sessions at state conferences but does most of her education work with clients who live in single-family homes and duplexes. She recognizes the importance of client education and would like to receive more training so she can effectively deliver tenant energy education. She would also like to work more with other agencies and see what they do on this issue so they can avoid overlap.

Chapman says, "I am hoping that client education will be integrated with the upcoming program. Bonnie Esposito, of the Center for Energy and Environment and a nationally-recognized authority on client education, has trained all of the auditors. Some have worked with senior groups, but it is not consistent. Client education is strongest for single-family programs. With multifamily programs, the hardest part is trying to meet everybody's schedule. Do we fit into the clients' schedules or will they fit into ours? If education works, it will be a major contribution to the program. If the results are there, they won't mind doing the up-front work."

PROGRAM EVOLUTION

Chapman reflects on how the multi-family program has evolved statewide since the mid-eighties:

> In the past, most programs typically did no bypass work until recently. Now they tend not to bother with ineffective air sealing. In the state, we haven't done much window work. In the early 1980s they did a 100-unit high-rise, including new windows and blueboard and sheetrock on the interior. Now we try to stay away from window replacements. Boiler work used to be mainly

> incidental repairs. The Center for Energy and Environment, formerly associated with the city of Minneapolis Energy Office, did some demonstration projects on steam-to-hot water conversions which showed great promise. As a result, we now tend to spend less money, do less envelope work, and direct more money toward mechanicals.

Vielhaber, an 11-year veteran of the weatherization program, has important long-range perspectives on these trends: "The program hasn't changed all that much over the years. We've been using the Maxi Audit since the mid-80s. We used the Maxi Audit before the state adopted it statewide. We haven't felt restricted in the past."

The Future

The Minnesota program has begun what may prove to be the most important initiative so far by letting a contract to three major organizations with strong backgrounds in energy and multifamily work: CEE, the University of Minnesota Underground Space Center, and New York City's Urban Coalition. The goals are to establish a statewide procedure that will meet the federal whole-building guidelines and to codify an audit procedure that will base retrofit investment on the magnitude of preweatherization consumption. Critical to this initiative is having local agencies provide significant input to the effort. The aim is for them to claim ownership and buy into the process. At this point, the details of this process are still vague, but progress is expected soon.

BUILDINGS SURVEYED

Building Selection

Building selection for the work done by RAP was straightforward. RAP routinely requires collection and review of pre-retrofit energy use for all its weatherization clients. Typically, 24-month pre-retrofit utility records are already in the files. The agency personnel needed only to pull representative files for a variety of buildings weatherized during the period under study. Files for 18 buildings in 5 building clusters, plus 1 stand-alone high-rise building, were selected for closer review. NSP then updated records for all buildings with post-retrofit data.

PRISM was used in analyzing fuel data from RAP's multifamily structures. PRISM was run in a variety of modes, including 24-month data sets, reduced 12-month data sets, and both variable and fixed 65°F reference temperature (tau). Using mostly the 12-month, variable-reference temperature analyses, buildings were selected that had the best R^2 results (.90 or better), indicating the quality of the utility data files to be consistent with the expectations of the PRISM algorithm. (The only exception to this rule was the high-rise Front Street building. Since most of the retrofit activity for this building focused on summer water heating and lighting retrofits, the PRISM algorithm is not as applicable.)

The approach resulted in satisfactory data sets for both pre- and post-consumption analysis for ten buildings from all but one of the building clusters (which were not significantly unlike other buildings which were included). These files were reviewed with Truax, and on-site surveys were conducted with the building owners and/or managers. For each building cluster, at least two buildings were inspected.

Savings Analysis

Heating fuel consumption in the post-weatherization period was compared with fuel consumption in the pre-weatherization period to determine energy savings due to weatherization measures.

Fuel bills were tabulated for each building for at least 1 year both before and after the weatherization completion. Estimated meter readings were eliminated by combining estimated consumption figures with the next actual meter reading, resulting in actual multimonth consumption rates. PRISM analysis combines these consumption figures with actual average daily temperature data for St. Paul/Minneapolis to establish a building reference temperature and calculate the baseload, beating-only normalized annual consumption (HNAC), and total normalized annual consumption (NAC) for each study period.

The NAC (total NAC, HNAC and baseload), as shown on the tables associated with each study building, are all expressed in millions of Btus (MBtu). For ease of computation, fuel cost is expressed in $/MBtu. The HNAC where the reference temperature, ***tau,*** is fixed at 65°F is divided by the 10-year average base-65°F heating degree days (HDD) for St. Paul (7733), yielding Btu/HDD. This figure is divided by the total heated square footage of the building, yielding the fuel consumption index or Btu/HDD/ft^2.

Annual cost for economic evaluation purposes is generated by multiplying total NAC by fuel cost.

Once the fuel consumption index, HNAC, baseload, and total NAC fuel consumption totals are computed for both pre- and post-weatherization periods, fuel consumption for the two periods is contrasted to show absolute savings as well as percentage savings. Absolute savings is derived by subtracting the post-weatherization fuel consumption from the pre-weatherization fuel consumption. The resulting difference is assigned a positive or negative sign based on whether consumption increased or decreased. The absolute change in NAC is the absolute annual savings expressed in **MBtu.** The percentage change in fuel consumption is computed to indicate the relative amount of savings between pre- and post-weatherization fuel consumption. The percentage change is computed using the formula: change in normalized annual consumption = first year savings in Btu.

For purposes of this evaluation, fuel costs were assumed to be constant over both the pre- and post-weatherization periods to determine annual cost. The absolute change in annual cost was the first year savings in dollars. Lifetime savings was derived by calculating the total savings over an assumed 20-year lifetime of the measure at a 4.7% discount rate. The benefit/cost ratio was calculated by dividing the lifetime savings by the DOE contribution to the weatherization effort.

Hazelwood Avenue Building
1252 Hazelwood Ave.
St. Paul, Minnesota

Fig. 5.6. This building at 1252 Hazelwood showed a 12% savings for a benefit/cost ratio of better than 2.

Building Description

The building at 1252 Hazelwood Avenue is a 24-unit, 3-story structure built in 1966 as part of a larger complex. A brick facade encloses this H-shaped building. Total heated space is 21,432 ft^2.

Heat is provided by a central three-stage, six-zone, gas-fired, hot water boiler system. Originally, one boiler would fire and then the other two, so that the firing rate would step from 250,000 to 750,000 Btu/hour. DHW is provided by two separate gas-fired tank heaters (76 and 92 gallon) run in parallel with a circulating motor.

Weatherization Measures

Work was completed on September 21,1992. Mechanical retrofits included

- cleaning and tuning the boilers
- replacing zone valves with more. reliable units
- adding pipe. insulation in boiler room
- completing staging controls for three-stage boilers so that the firing rate went from 250 to 500 to 750,000 Btu/hour

Apartment-based measures included

- cleaning the fin tube radiators
- installating air conditioner covers
- installating low-flow shower heads

Additionally, numerous screw-in compact fluorescent light bulbs were installed in individual apartments using utility funds.

Costs

Installation costs for the building were $6000.

Savings

The energy savings was 12%, for a benefit/cost ratio of slightly over 2.

James A. Ward, the building superintendent is a licensed engineer. He was pleased overall with the savings resulting from the work that was done, but made some suggestions for improving the durability, tenant satisfaction, effectiveness, and quality of the work. His observations were as follows:

- The Sylvania 18 W compact fluorescent light bulbs blow out quickly, especially in bathrooms. (Truax had noted the high failure rate with these units and reported that RAP is now using different bulbs).
- Most people did not like the shower heads that were installed, and many of the shower heads broke. Hence most have been replaced.
- The air conditioner covers worked well, but they became damaged because people had no place to store them. (RAP is now using more durable fiberglass covers).
- The subcontractors who cleaned fin tube baseboard radiators used a blower (as opposed to washing them with a solvent) and did not have a vacuum cleaner with them (despite a clear statement in the contract that one would be used.) Ward received several complaints about that work, but still thinks it made a difference in the heat delivery.

Ward was particularly pleased with the choice of the Honeywell replacement zone valves, as the valves formerly used had to be replaced frequently.

1252 Hazelwood St. Paul, Minnesota Savings Analysis				**Annual HDDs: 7733**
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	21,432	21,432	0	0
Consumption Index, Btu/HDD/ft^2	8.34	7.28	–1	–13
Heating NAC, MBtu	1382	1207	–175	–13
Baseload NAC MBtu	405	361	–44	–11
Total NAC, MBtu	1787	1568	–219	–12
Fuel Cost, $/MBtu	4.71	4.71	0	0
Annual Cost, $	8409	7378	–1030	–12
Cost of Weatherization	$5992			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$12,861			
Benefit-to-Cost Ratio	2.15			

Lakewood Apartment Buildings
Maryland Avenue
St. Paul, Minnesota

Fig. 5.7. The similarity of the buildings in a large complex allows **for important economies of scale for RAP's administrative efforts.**

Building Description

These buildings are among eight similar apartment structures making up the Lakewood Apartment Complex. The larger buildings have 23 units each, and the smaller have 11 units. The three-story, flat-roofed structures have brick and stucco facades with aluminum sliding windows and aluminum storm windows. Each building is heated with a central, multizone, two-stage, gas-fired, hot water boiler system. Each also has two separate gas-fired domestic hot water tanks.

Weatherization Measures

Weatherization was completed on six of the eight buildings in the complex on March 30, 1992.

Measures accomplished on all buildings included

- cleaning and tuning the boilers
- installing resets and cutouts
- installing electro/mechanical vent dampers on all boilers (Fig. *5.8)*
- installing thermal vent dampers on domestic hot water units

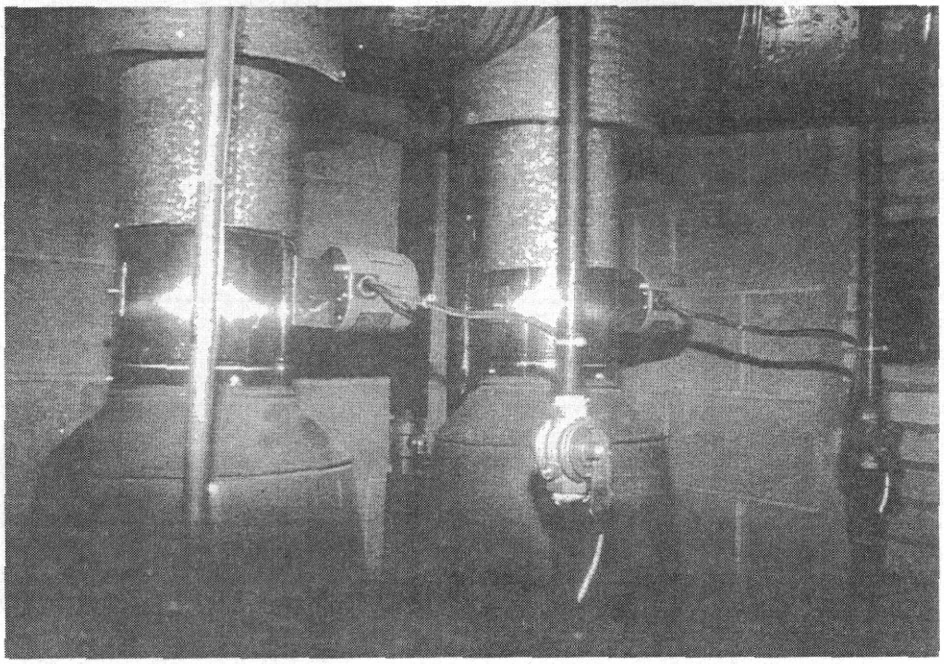


Fig. 5.8. *Mechanical retrofits including* these electro-mechanical **vent dampers** resulted in better than 25% savings in all four buildings included in this *case* study.

- insulating boiler supply pipes
- insulating of domestic hot water pipes
- installing air conditioner covers in apartments
- installing storm windows in common areas
- installing low-flow shower heads
- weatherstripping doors
- calibrating thermostats
- replacing zone valves (with a 40% landlord contribution)

costs

Total costs for all six buildings were $33,401, representing an investment of ***$23,945*** from DOE and $9,456 from the landlord contribution, primarily for replacement zone valves and thermal vent dampers for the water heaters. This latter measure is recommended by RAP only when the DHW systems share a flue with an already dampered heating system. The average cost per building was approximately $4000 of DOE funds.

Savings

PRISM analysis is reported on only four of the six buildings, as data were available for only five buildings and one building had an unacceptably low post retrofit R^2, a measure of data quality in the PRISM analysis program. In all other cases, there was at least a 25% savings as well as substantial reduction in the PRISM reference temperatures, indicating that after the retrofit, the building does not need heat until the outdoor temperature is colder.

As of June 23, 1993, a new management firm had taken over the Lakewood Apartment Complex. At that time, the buildings were "trashed out" and sold with only two or three apartments occupied. At the time of our inspection, all 11-unit buildings were closed down, and several units in the larger buildings had recently been renovated and were empty. Dorothy Keating, the new resident manager of the Lakewood Apartments, has managed other buildings RAP has worked on, and she was very pleased with their work.

1331 Maryland St. Paul, Minnesota Savings Analysis				Annual HDDs: 7733
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	15,600	15,600	0	0
Consumption Index, Btu/HDD/ft^2	10.69	4.55	–6	–57
Heating NAC, MBtu	1289	549	–741	–57
Baseload NAC MBtu	42	464	422	1002
Total NAC, MBtu	1331	1013	319	24
Fuel Cost, \$/MBtu	4.58	4.58	0	0
Annual Cost, \$	6098	4638	–1460	–24
Cost of weatherization	\$4000			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	\$18.223			
Benefit-to-Cost Ratio	4.56			

1335 Maryland St. Paul, Minnesota Savings Analysis				Annual HDDs: 7733
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	7425	7425	0	0
Consumption Index, Btu/HDD/ft^2	15.24	6.88	–8	–55
Heating NAC, MBtu	875	395	–480	–55
Baseload NAC MBtu	32	280	248	776
Total NAC, MBtu	907	675	–232	–26
Fuel Cost, $/MBtu	4.58	4.58	0	0
Annual Cost, $	4154	3093	–1061	–26
Cost of Weatherization	$4000			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$13,244			
Benefit-to-Cost Ratio	3.31			

1339 Maryland
St. Paul, Minnesota
Savings Analysis

Annual HDDs: 7733

	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	15,600	15,600	0	0
Consumption Index, Btu/HDD/ft^2	10.32	7.79	–3	–24
Heating NAC, MBtu	1245	940	–305	–24
Baseload NAC MBtu	50	27	–23	–45
Total NAC, MBtu	1295	967	–328	–25
Fuel Cost $/MBtu	4.58	4.58	0	0
Annual Cost, $	5931	4431	–1500	–25
cost of Weatherization	$4000			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$18,726			
Benefit-to-Cost Ratio	4.68			

1351 Maryland St. Paul, Minnesota Savings Analysis				Annual HDDs: 7733
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft²	7425	7425	0	0
Consumption Index, Btu/HDD/ft²	16.04	7.02	–9	–56
Heating NAC, MBtu	921	403	–518	–56
Baseload NAC MBtu	-166	113	279	–168
Total NAC, MBtu	755	516	–239	–32
Fuel Cost, $/MBtu	4.58	4.58	0	0
Annual Cost, $	3458	2363	–1095	–32
Cost of Weatherization	$4000			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$13,661			
Benefit-to-Cost Ratio	3.42			

Pullman Avenue Buildings
316,332, and 348 Pullman Avenue
St. Paul, Minnesota

Fig. *5.9.* Two of the Pullman Ave. buildings

Building Description

These three buildings are outwardly identical three-story, wood-frame structures owned by the Housing Resource Authority (HRA). They all have brick front facades and stucco side and rear walls. Each building has a total of 8,950 ft^2 of living space, a volume of 54,600 ft^3, and six apartments. Each building had fiberglass insulation in the walls and 6 inches of insulation before weatherization, and all have through-the-wall air conditioners and aluminum slider windows with aluminum storm windows.

Although all three buildings were built at the same time by the same contractor, 316 Pullman has individually metered electric baseboard heaters in each apartment, while 332 and 348 Pullman have central gas multizone hydronic heat. Pre-retrofit blower door measurements were made on the whole building for numbers 316 and 348, and for one representative apartment in each building (Table *5.2).* The results were startling in that they show that the air leakage rates for individual apartments were over 47% of the total building air leakage in both cases. This figure clearly indicates a great deal of communication among individual apartments and common spaces and demonstrates how unreliable individual apartment blower door measurements can be in predicting actual unit ventilation rates.

At the time of our visit, we found high relative humidity (60%) in one second-floor apartment in the electrically heated building, without any apparent interior sources, implying some

Table 5.2 Apartment-Based Blower Door Measurements

Space	cfm50
Building # 316	2607
Apartment # 5	1236
Building # 348	3894
Apartment # 2	1850

interior bypass source. The tenant reported that the condition is worse when people shower, but the occupants do not use the bathroom fan because it is noisy.

Weatherization Measures

RAP began weatherization of all three buildings at the same time, and the work was completed in March 1990. Architectural measures in all three buildings included

- sealing bypasses in the attic
- increasing attic insulation from R-22.5 to R-44
- insulating a small crawlspace under the front entrance
- installing covers over through-the-wall air conditioners

New stucco and roofs were added by the building owners at the same time that the weatherization work was done. HRA also chose to replace the boilers at that time (against weatherization program recommendations, as the new units were no more efficient than the ones being replaced). In the centrally heated building, the weatherization program installed new outdoor reset and cutout controls on the boiler and added pipe insulation to all exposed distribution lines.

costs

Total *costs* for the three apartments in this complex were slightly over $5000. The electrically heated building, which received only architectural measures, cost **$1223;** the centrally heated buildings cost about **$1941** each.

Savings

The buildings included in this study were particularly interesting because we could compare two otherwise identical buildings that had *two* different heating systems and had different sets of measures applied. The apartments in the electrically heated building **(316** Pullman) are individually metered, which facilitated an apartment-by-apartment comparison of pre- and post-retrofit fuel use patterns. In **332** and **348** Pullman, where both architectural and heating system retrofits were applied, the overall energy savings were significantly greater than in the electrically heated building **(95** versus **15 MMBtu)** although higher installation costs and significantly lower fuel price result in a lower benefitkost ratio **(2.59** versus **3.92).**

An inspection of the boiler room of 332 Pullman revealed several dysfunctional systems. One possible reason was that there had been no superintendents in these buildings and the boiler room shared space with laundry facilities, leaving access to controls by tenants. Problems included the following:

- The outdoor reset system was disconnected from the gas valve.
- Pipe insulation that was rated at 225-240°F had melted and had to be removed, possibly the result of the system's running at a higher temperature than it was designed for.
- Warm slab temperatures indicated that a main heat delivery line was probably leaking beneath the slab. (The agency had replaced several deteriorated baseboards and a rotten heating main under the slab in a similar building in this complex.)

332 Pullman **St. Paul, Minnesota** **Savings Analysis**				**Annual HDDs: 7733**
	Pre- Weatherization	**Post-** Weatherization	Absolute Change	Percentage Change
Area Heated, ft²	8950	8950	0	0
Consumption Index, Btu/HDD/ft²	4.22	3.90	0	–8
Heating NAC, MBtu	292	270	–22	-8
Baseload NAC MBtu	[illegible]	75	–73	–49
Total NAC, MBtu	440	345	–9s	–22
Fuel Cost, $/MBtu	4.24	4.24	0	0
Annual Cost, $	1866	1463	–403	1–22
Cost of Weatherization	$1941			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$5027			
Benefit-to-Cost Ratio	12.59			

It is interesting to note that although 316 Pullman showed moderate overall savings from the architectural elements applied, individual apartment usage varied widely (Table 5.3). Looking at individual apartment usage defies precise analysis because heat transfer among apartments is inevitable; occupancy rates may also skew the data. There were many low R^2s in the PRISM data for individual apartments, but a cursory look at the consumption data still shows some important patterns. Apartment 1 obviously was showing bad data (probably a pre-retrofit vacancy), but the trend is still apparent.

Table 5.3 Pre- and Post-Retrofit Energy Use by Apartment at 316 Pullman

Apartment	1	2	3	4	5	6
Floor	1	1	2	2	3	3
Pre-Weatherization NAC (MBtu)	8	29	40	31	38	40
Post-Weatherization NAC (MBtu)	60	35	43	13	25	18
Savings ($)	-52	-6	-3	18	13	22
% Savings (%)	-650	-21	-8	58	34	55

Apartments on the lower floors seemed to have lower pre-retrofit consumption than those on the top floor. This likely is because only the top-floor apartments were exposed to cold ceiling temperatures from the poorly insulated attic. After retrofit, the third-floor apartments showed not only the greatest savings but also the lowest post-weatherization energy bills. However, first-floor apartments actually increased their energy use. How can this be explained? The attic insulation not only reduces energy use for these apartments, but may in fact cause these units to overheat as warm air rises from the lower units. If the overheating is great, the occupants are likely to open windows to alleviate the situation. This, of course, simply increases the impact of the stack effect, and more heat is drawn from the lower apartments, thus increasing their energy use.

In extreme cases, such dynamics could actually lead to a condition whereby the addition of attic insulation in a multistory building could increase overall building energy use. In support of this *theory,* it should be noted that, on the morning we visited these buildings, the outside air temperature was 42°F, but the previous day had been unseasonably warm. We noted during our visit that all of the third-floor apartments in all three buildings had at least one open window.

316 Pullman St. Paul, Minnesota **Savings Analysis**				Annual HDDs: 7733
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	8950	8950	0	0
Consumption Index, Btu/HDD/ft^2	1.80	1.89	0	5
Heating NAC, MBtu	124	131	7	5
Baseload NAC, MBtu	93	71	–22	–24
Total NAC, MBtu	217	202	–15	–7
Fuel Cost, $/MBtu	25.45	25.45	0	0
Annual Cost, $	5526	5142	–384	–7
Cost of Weatherization	$1223			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$4790			
Benefit-to-Cost Ratio	3.92			

Front Street Building
727 Front Street
St. Paul, Minnesota

Fig. 5.10. The 20-story 727 Front St. building.

Building Description

The building at 727 Front Street is a 151-unit high-rise owned by the St. Paul Public Housing Agency. Built in about 1970, it has 112,194 ft^2 of conditioned space with a pre-retrofit calculated energy index of 12.2 Btu/ ft^2/HDD (agency calculations). It has a central (10,000 cfm) ventilator with a heat exchanger with air return back to central halls. Heat is generated by two large Kewanee boilers with variable firing rates between 4.4 and 5.5 million Btu/hour, which provide multizone, two-pipe steam heat and hot water. These boilers are on interruptible peak gas control with fuel oil as a backup.

Weatherization Measures

The weatherization work was completed in April *1991.* Almost all the work was with either the mechanical systems or lighting retrofits. The only building envelope measures or individual apartment retrofits were. the installation of room air conditioner covers.

RAP installed two modular boilers **(2 × 240,000 Btu/hour output)** for summer DHW (Fig. **5.11)** and recommended that the two larger boilers be run only in winter as staged units. Although the larger boilers were. subsequently shut down in the summer, the building operator chose not to run the two units in a staged sequence as recommended. RAP had also recommended installing turbulators in the boiler firing tubes, theoretically to improve the heat exchange and efficiency; but the service contractor requested they not be installed, as it would make cleaning the fire tubes more difficult. Hence, little work was done here that was likely to have a significant impact on heating energy use.

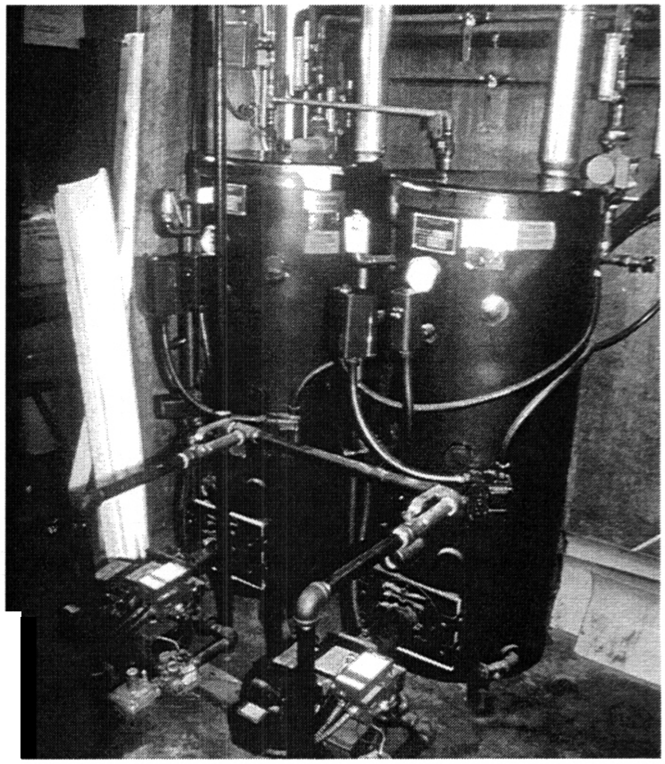


Fig. **5.11**. The addition of these two-staged boilers provide adequate hot water for **151** units. These units showed significant savings while operating only during the summer months.

RAP insulated all exposed **DHW** pipes and the condensate **return** line from the boiler. Prior to this retrofit, boiler condensate, returning at 180°F, would freeze as it passed the large combustion air intakes for the boiler. The freezing problem was further mitigated by correcting operation of combustion air damper louvers, which had been damaged. RAP also accomplished extensive lighting retrofits in common areas, including replacing incandescent fixtures with fluorescents in both exit signs and in stairwells. In addition, the existing fluorescent fixtures in the common areas were retrofitted with new reflectors and more efficient ballasts.

costs

The total installed cost of $39,080 included **$22,420** for lighting retrofits. Proper disposal of old lighting ballasts, which may have contained polychlorinated biphenyls, was funded with a grant from **NSP.** Work relating to installing the two front-end Triad boilers was $10.130, and the pipe insulation was approximately $900.

Savings

Heating savings analysis is unreliable for this building, primarily because the main boilers are on interruptible gas with oil backup, and no records were available for oil usage either before or after the retrofit work. Limited post-retrofit winter gas usage figures were available. PRISM analysis yielded unreasonable reference temperatures, unacceptably low R^2 numbers and negative baseloads, indicating unreliable fuel use data. The two main boilers have not been run as staged units as recommended. Rather, the building operators chose to turn on the two new boilers from May 15 through September 15 to provide DHW, but to run both larger boilers simultaneously for the rest of the season (Fig. 5.12). Since the new boilers are being used exclusively during the summer months when there are no gas interruptions, it was possible to compare two comparable months of both pre- and post-retrofit gas usage data (interpolated to represent a full 5 months of summer consumption). The results demonstrated that the retrofit was cost-effective, even when the entire strategy was greatly under-utilized.

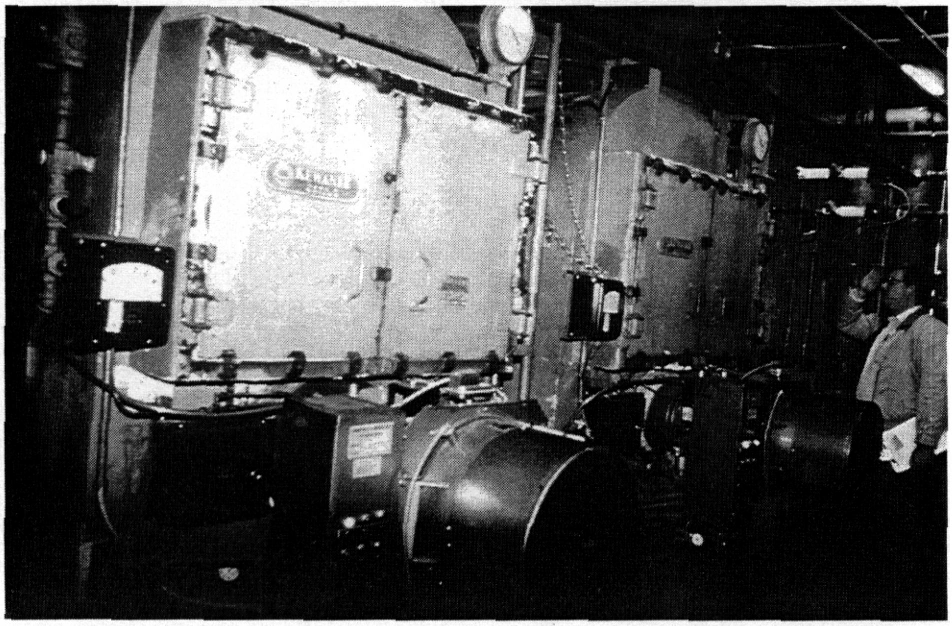


Fig. 5.12. Although either of these boilers could heat this building during most of the winter, tbe building operator runs both units all beating season.

Electricity savings from the lighting retrofit was 170,000 kWh per year, appmximately 20% of the electrical consumption for the building. The benefit-to-cost ratio is 4.0, which illustrates the cost-effectiveness obtainable through a thoughtfully designed lighting retrofit job. Since lights in common areas are typically illuminated 12 to 24 hours per day, good savings are often possible (Fig. 5.13). This component of the retrofit package was so successful that the St. Paul Public Housing Agency plans to base all future building lighting retrofits on this model. Unhappily for the local agency, this retrofit was completed before lighting retrofits were. an approved measure for WE-sponsored weatherization work. As a consequence, RAP was required to repay to the state the $22,420 cost of this portion of the job. Under the new rules, DOE allows all agencies to install screw-in compact fluorescent fixtures, and hard-wired fixtures if the state uses a DOE-approved audit procedure.

Fig. 5.13. Lights that burn 24 hours a day are particularly attractive retrofit options.

727 Front St. **St. Paul, Minnesota** **Savings Analysis**				
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Summer Gas Usage				
Baseload, MBtu	919	673	–246	–73
Fuel Cost, $/MBtu	3.44	3.44	0	0
Annual cost, $	3161	2317	–844	–27
Cost of Weatherization	$10,130			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$10,534			
Benefit-to-Cost Ratio	1.04			
Electric Usage				
Total Electric NAC, MBtu	2953	2374	–579	–20
Fuel Cost, $/MBtu	12.43	12.43	0	0
Annual Cost, $	36,703	29,505	–7198	–20
Cost of Weatherization	$22,420			
Lifetime Savings (20 yrs. @ 4.1% Discount rate)	$89,826			
Benefit-to-Cost Ratio	4.01			

CONTACT PERSONS

State Employees

Alan Chapman
Weatherization Coordinator
Department of Economic Security.

Rich Huelscamp
Department of Public Service
Energy Information Center

Ramsey Action Program

Paul Truax, Energy Specialist
Paul Vielhaber, Program Director
Mary Tomlinson, Program Manager
Hlee Thao, Family Liaison Worker
Bob Hockenson, Quality Control Supervisor
Armond Winter, Inspector

Others

Gregory Harris
President
Weatherization Research and Production

Martha Hewett
Tim Dunsworth
Mary Sue Lobenstein
The Center for Energy and Environment

Jim Fitzgerald
Jim Fitzgerald Contracting

Dave Ledo
Building Energy Specialist
Environment and Energy Resource Center

Lester Shen
Research Associate
The Underground Space Center
University of Minnesota

Building Managers and Supervisors

Dorothy Keating
Resident Manager
John Anderson
Building Maintenance Supervisor
Lakewood Apartments

James Ward
Building Maintenance Supervisor
Hazelwood Apartments

Ray Conklin
Head of Rental Property Maintenance
Washington County Housing Resource Authority

6. SEATTLE, WASHINGTON

INTRODUCTION

Seattle, Washington, is in one of the fastest-growing parts of the country. The city has unusually high average rainfall. Precipitation, in the form both of rain in Seattle and snow in the nearby mountains, also accounts for the area's having the lowest electric rates in the country; retail rates are about 4 cents per kW hour. Almost all of the power distributed by the municipally owned, not-for-profit utility, Seattle City Light, is generated from its own hydropower resources. About 20% of City Light's power is purchased from the Bonneville Power Administration (Bonneville), a regional wholesaler of electricity to 137 local companies, of which Seattle City Light is the largest. In fact, Seattle City Light is the third largest municipally-owned utility in the nation; the company sold 8915 gWh of electricity in 1993 and had sales of $320 million.

It is the policy of both Seattle City Light and Bonneville, in keeping with the Northwest Power Planning Act of 1983, for conservation to be the first option for meeting the demand for new power. Since western Washington already uses over 25 percent of Bonneville's output and is growing rapidly, many conservation activities are concentrated in the area. Seattle's weatherization program is a major beneficiary of this policy.

The city of Seattle itself is the weatherization subgrantee. The program is administered by the Department of Housing and Human Services (DHHS), a unit of local government. Using seven subcontractors, DHHS weatherizes both single-family and multifamily dwellings with funds from the U.S. Department of Energy and the U.S. Department of Health and Human Services, along with some matching funds from the state of Washington and from Petroleum Violation Escrow decisions. These are administered by the state of Washington's weatherization grantee, the Department of Community, Trade, and Economic Development. In addition, DHHS receives substantial funding from its sister branch of local government, Seattle City Light, to retrofit electrically heated dwellings in the utility's service territory. (As noted, some of these funds from Seattle City Light come from Bonneville.) Finally, Community Development Block Grant funds provide a portion of the administrative costs to run the weatherization program.

Seattle's DHHS weatherized about 4100 dwellings in the 1993–94 grant cycle with a weatherization budget from four sources of almost $10.5 million and an energy program staff of 23. Over 50% of the units weatherized are in multifamily dwellings. Primarily because of the support of Seattle City Light, the average per-dwelling cost of weatherization is $2500, a figure that includes administrative expenses.

In the spring of 1994, Patricia Gibbon was hired as the energy program manager of the Housing and Community Services Division, a division within DHHS responsible for conducting Seattle's weatherization program. An innovator with a varied background including environmental planning, newspaper reporting, and state energy office conservation program management, Gibbon launched a grass roots reorganization of the low-income weatherization program. A task force composed of ten workers and managers was formed to undertake vigorous self-examination aimed at streamlining the weatherization program and making it more costeffective and customer oriented.

The timing of this reorganization—or mid-course correction—was particularly fortuitous for this case study, which was conducted in the fall of 1994 as the process was unfolding. Accordingly, this case study includes observations on a range of operational issues from the standpoint of a large weatherization operation that has been successful but feels the need to enhance its effectiveness. The picture that emerges is of the evolution of a large-city multifamily weatherization program that has developed creative responses to weatherization problems in an area of the country whose electric energy costs and housing stock are unique.

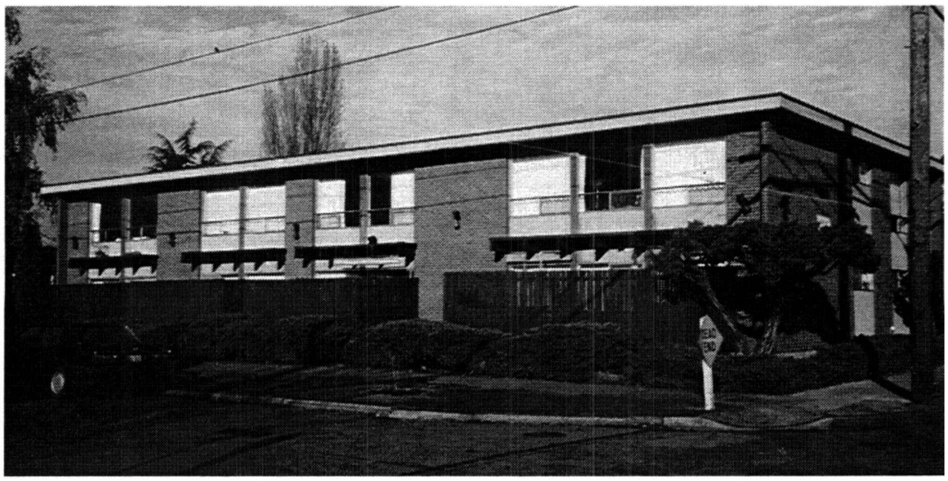


Fig. 6.1. This is an example of a World's Fair" building, a common multifamily structure in the Seattle area built just before the 1962 Fair. Although poorly insulated, the concrete block construction with brick facade, flat roofs, and no chimneys and flues results in only moderate convective heat losses.

HOUSING STOCK

According to the 1990 census, the city of Seattle has 249,032 dwelling units, of which 90,505 or 36% are in multifamily buildings of five or more apartments. Most of this multifamily housing stock is two- to three-story low-rise buildings of 15 to 30 units (see Fig. 6.1). The typical multifamily weatherization job is accomplished on a low-rise building of 21 (the 1993 average) to 25 units (the 1995 average), although the program has weatherized a 15-story building with 110 dwelling units.

A substantial percentage of the older housing stock has electric baseboard heaters and electric water heaters, although natural gas is used for heating and water heating in newer units, a trend that is supported by Seattle City Light even though the utility does not sell natural gas. Summers are mild in the Seattle area and air conditioning is found infrequently, even less often in lower-income housing stock. However, winters are chilly; Seattle's average heating degree days (base 65) are 5121, slightly higher than either New York City or Philadelphia Nonetheless, wall insulation in multifamily housing stock is the exception, and ceiling insulation tends to be either absent or minimal. On the other hand, because of local construction techniques and the lack of flues and chimneys, the buildings appear to be fairly airtight. The airtightness, in combination with Seattle's humid climate, sometimes results in moisture problems.

ORGANIZATION

Figure 6.2 is an organizational chart of Seattle's DHHS. Although weatherization is one of the largest programs administered by the Division of Housing and Community Services, there are 18 other programs conducted through the division. Figure 6.3 shows the organization of the portion of the Division of Housing and Community Services that is involved in energy programs. The staff under the supervision of Gibbon numbers about 30 people, 22 of whom are involved in some aspect of the weatherization program part-time or full-time. Of these, 10 full-time equivalent positions are in the client intake, outreach, and information unit of the weatherization program under the overall management of Pamela Green. In addition, there are seven energy conservation representatives (whose principal duties are energy auditing, the preparation of work orders, and quality control) under the supervision of Phil Snyder. Three energy conservation contract administrators are involved in the day-to-day dealings with the seven weatherization subcontractors, with overall supervision by Linda Franklin.

Outreach

As in most American cities, larger multifamily structures tend to be owned by professional landlords who own a number of buildings and hue professional property managers and maintenance personnel to deal with daily operations. Buildings owned by "mom and pop" landlords tend to be smaller and are frequently less well-maintained. Finally, there is great cultural diversity among tenants and, to some degree, landlords. All of this impacts outreach for weatherization. "We have done all kinds of marketing of the weatherization program,'' explains Pamela Green. "We have used radio, TV, bill boards, booths at community and cultural fairs, and have given presentations to all of the social service agencies in town. People can read about us on their City Light bill, but lots of referrals come via word of mouth." Of course, a successful weatherization job on a building owned by a professional landlord is an obvious entree into the landlord's other buildings. Further, word of mouth between landlords is a powerful sales mechanism.

The unit is particularly proud of the brochures and related written material developed in conjunction with professional advertising agencies and Seattle City Light (Fig. 6.4). This material, used in direct mailers, at community fairs, and on the doorsteps of tenants, is routinely translated into five languages: Vietnamese, Cambodian, Laotian, Cantonese, and Spanish. "The weatherization program started using translators and translating marketing materials in the early 1980s," Green says. "Now most departments in the city have materials translated." Treating weatherization outreach as a full-blown marketing effort is unique in the weatherization world, and Green finds herself called upon to help others develop their marketing programs. For example, in the summer of 1994 she was instrumental in helping an outreach worker she met at a conference make a TV advertisement for the Eugene, Oregon, Water and Electric Board. "Our TV advertisement showed her what could be done," Green explains. "The people in Oregon were just thrilled."

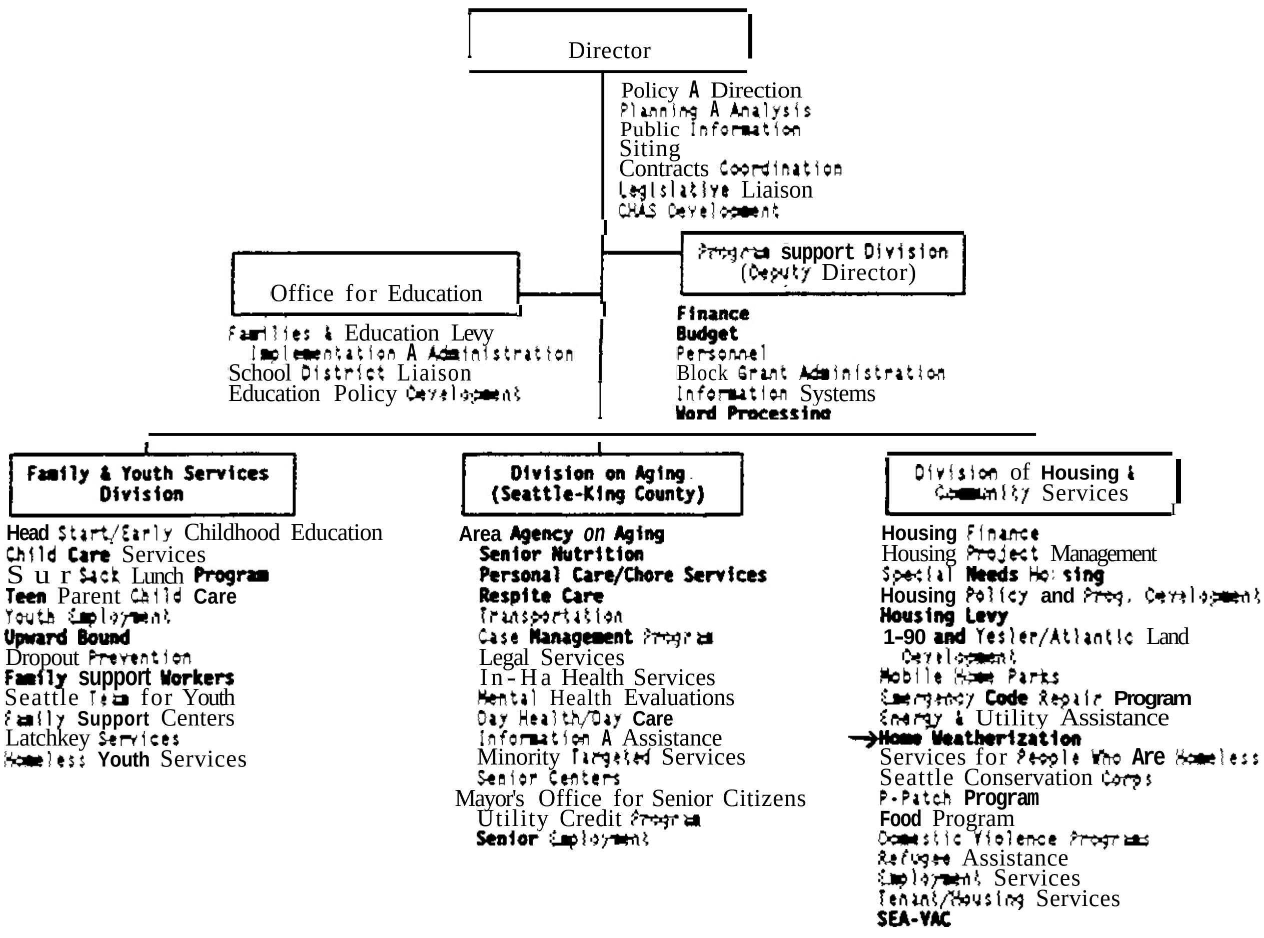


Fig. 6.2. Organizational chart for the Seattle Department of Housing and Human Services.

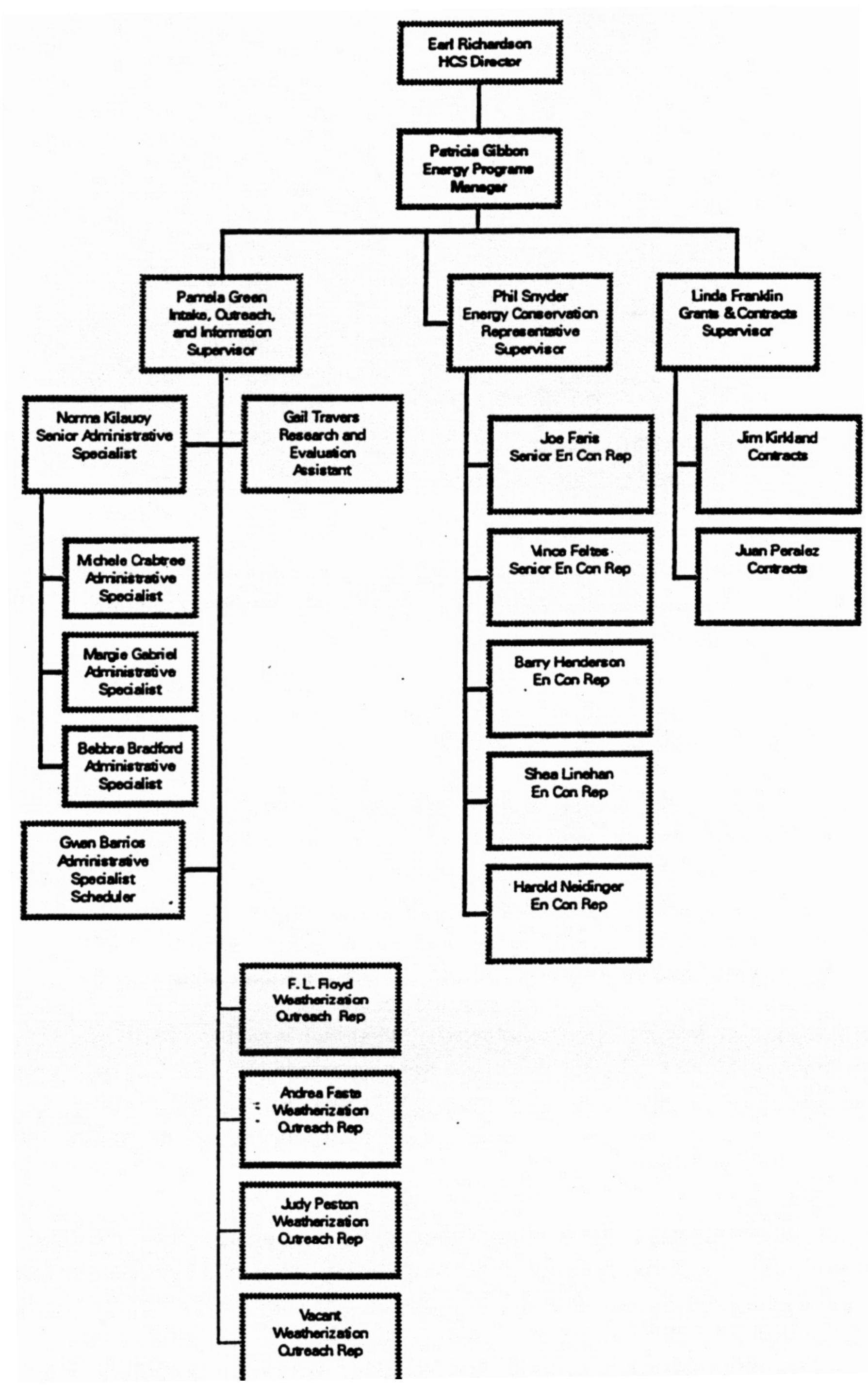


Fig. 63. Organizational Chart of the Energy Programs Section of the Housing and Community Services Division (does not include Energy and Utility Assistance Section which has seven people.)

Fig. 6.4. Pamela Green displays professionally produced weatherization brochures, a notebook of marketing material, and a video advertisement.

Certification and Landlord Agreements

Seattle has 11 local Neighborhood Community Service Centers, which are akin to small-scale city halls. There are weatherization outreach representatives working in five of these offices. These representatives also perform income verification by going door-todoor in multifamily buildings. In the interests of both safety and efficiency, the weatherization outreach representatives usually operate in teams of two people, particularly in larger buildings. The staff estimates that it can take from as little as a week to as long as 9 months to certify a building, with the average being 6 weeks. According to several staff members, the reason for the longer time is that tenants don't want to admit they are low income. Nonetheless, "we do what we have to do to certify a building," one outreach representative says. "We have done interviews in cars and in taverns. We even managed to interview one elderly gentleman while he was on a walk!" With the scale of the Housing and Community Services Division's multifamily operation, the staff usually works on certifying 10 to 15 buildings at once.

Building owners are the key to the whole process. Sometimes owners want to be involved at every step; others sign the landlord agreement and are not seen again. After certification of the income status of the tenants, the Department requires a 4-year covenant with building owners, the most rigorous in the state. It carries a requirement for a 10% owner contribution to the total cost of the weatherization job for non–electrically heated buildings of five or more units. This can be in the form of either cash or "in-kind" contributions like repairs or materials. For example, if a building owner repaired the roof, renovated the heating system, or undertook energy-efficient lighting retrofits within a year before weatherization, the work counts toward the 10%. (In 1995, all owners of buildings with 15 or more units, regardless of heat source, are required to pay 10% of the cost of window replacement. See the discussion under "Management and Policy Issues.")

The covenant with the landlord also has other provisions. For the first year of a 4-year commitment, the rent must be frozen. For the remaining 3 years, the building owner is asked to try to keep at least two-thirds of the building occupied by low-income tenants. Finally, if the owner sells the building, he must transfer or cash out at a pro rata basis. The net result of weatherization itself, coupled with these agreements with building owners, is the improvement of housing stock and the stabilization of neighborhoods.

Working with Contractors

DHHS puts out a very detailed request for proposals (RFP) toward the end of the calendar year to solicit bids for performing both single-family and multifamily weatherization work in the following year. (Exceptionally, in 1995 the period is for 18 months.) Bidders are required to meet a number of criteria including business licenses, bonding, certificates, warranties, liability insurance (naming the city of Seattle as an additional insured) and work force composition. (At least 18% of the work must be done by minority-owned businesses or subcontracted to minority-owned businesses; 9% must be done by woman-owned businesses or subcontracted to woman-owned businesses.) The RFP includes specifications for 533 weatherization measures and requires bidders to give a quotation for the installed price for each measure. The quotes are provided in terms of units natural to the installation of specific measures; for example, insulation and window installation are quoted on a square-foot basis, pipe insulation on a linear foot basis, electrical inspections of knob and tube wiring on a per apartment basis.

Only 7 contractors responded to the RFP for the 1994 weatherization work (down from 11 the previous year), so each was awarded a contract of about $700,000. After bids were submitted, DHHS was able to negotiate a standard price for all items by throwing out high and low bids and then averaging the rest. This practice simplifies logistics, paperwork, and payments substantially and allows DHHS to treat each contractor equally. In 1995, a new procedure is being instituted of randomly sampling price quotes for specific measures for rating purposes. The weatherization staff members believe it will result in more cost-effective work and more equity for all parties

Audits and Work Order Preparation

Shortly after a building is certified and the landlord agreement is signed, an energy audit is scheduled. This is performed by one (for smaller buildings) or two (for buildings of over 14 units) energy conservation representatives. On particularly complicated jobs, energy conservation representatives are also accompanied by a representative of the contractor selected to do the work. "We evaluate the whole building," explains Vince Feltes, a senior energy conservation representative who has been on the job for 4 years with DHHS. "We look at the building shell, lighting, the heating system and the domestic hot water system; we do a complete evaluation."

Tools taken to the site for auditing include a flashlight, ladder, tape measure, crow bar, screwdrivers, thermometer, calculator, camera, and toxic fume detector. Blower doors are added to this list for single-family jobs but are not presently used in assessing multifamily buildings. The audit includes producing drawings of both floor plans and elevations, with dimensions of critical items that are destined to become part of a work order. Field notes are taken to furnish all of the information necessary to produce work orders, a job that is completed back in the office. The existence of the RFP, which already includes specifications for 533 weatherization measures, plus an itemized *cost* sheet resulting from the annual contracting process, facilitates the production of a work order.

The need for repairs to precede weatherization is assessed, and if **necessary** a small repair contract is let to deal with these. "We **run** into asbestos problems in perhaps 20% of the multifamily dwellings we see," explains Phil Snyder. "Frequently, these are piping issues in the crawl space, and we are usually successful in getting the landlord to deal with them if the problem is severe."

Work

The output of the energy conservation representatives' labor is work orders placed in the in-box of the **Grants** and Contracts Section. "We mail them out or have the contractor come in to pick up work orders," explains Jim Kirkland. "If we haven't met with the contractor before work orders **are** prepared, on complicated jobs, we make it a point to meet or even go out to the site before the job **starts."**

Contractors have 40 working days to complete the job. Although they *can* get extensions for just cause (e.g., a labor strike affecting a key supplier), in practice, the 40-day limit is almost always adequate. If **necessary,** an electrical contractor takes care. of knob and tube and other unsafe wiring problems before the attic is insulated. First, a certified journeyman electrician must examine and evaluate the condition of the exposed **knob** and tube wiring to ensure that it is not damaged or frayed. If **necessary,** the usual retrofit is to splice in mmex in the attic, repair exposed boxes, and install S-type IS-amp fuses or IS-amp circuit breakers on circuits associated with hoband-tube wiring. These tactics for dealing with knob and tube wiring are undertaken so that baffles (which *can* cause thermal bridges in the finished insulation job) *can* be avoided. (DHHS has a **written** agreement from the **state** of Washington that allows the weatherization program not to have to baffle knob and tube wiring if it is in good shape.)

Attics are carefully prepared for insulation. Preparation includes sealing bypasses, baffling around ventilation ducts and recessed lighting fixtures, and air sealing and insulating attic hatches. Cellulose blown to **R-38 (12** inches) is usually the measure of choice (Fig. 6.5). If **necessary,** attic ventilation is **also** added in the ratio of 1 ff of **free** air ventilation for each 300 ft^2 **of** attic area. The floors in crawl spaces frequently are insulated, specifications call for **R-30** batts to be held in place with either nylon twine or wood lath; "tiger teeth" (spring steel wires installed between floor joists) are not allowed (Fig. 6.6). Occasionally a crawl space is treated as part of the heated envelope. **In** this case, perimeter insulation is installed and existing crawl space ventilation is sealed.

On perhaps **40%** of multifamily weatherization jobs, walls are insulated by installing blown cellulose from the inside. Although working from the inside requires having access to each apartment and being especially careful with aesthetics, it is much easier than trying to penetrate exterior masonry walls. "Interior wall blow installations also eliminate costly outside application *costs* and problems such as rental equipment like scaffolding, cranes, and tall ladders," Snyder observes. Further, our contractors **are** very careful about meeting the needs of the tenants while they do the work and take *care* not to damage personal property. We do in-progress inspections to minimize client inconvenience and check at the end of the installation to verify that a thorough cleanup job has been accomplished."

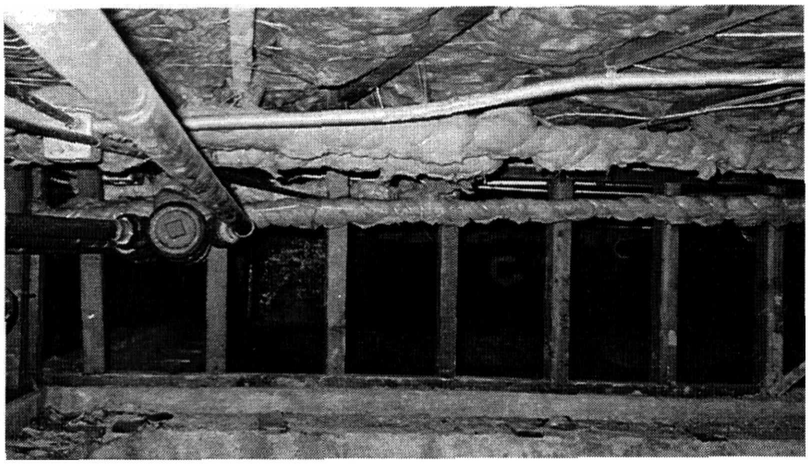


Fig. **6.5.** Batt insulation installed in a crawlspace under a multifamily building. It is held in place **by** means of nylon twine tightly strung between **nails** hammered into floor **joists. Note** that pipe insulation has **also** been installed **to** prevent freezing.

Fig. ***6.6.*** **A** completed **attic** insulation **job** in **an** apartment building. Blown cellulose is **used** except in the hatchway area, where fiberglass batts provide a better, cleaner fit The empty bag **near** the **hatch** provides product information for inspectors and others.

The two-hole, low-density method is favored by Seattle's contractors, although this may just be a matter of custom (Fig. 6.7). The high-density technique, which uses a small-diameter hose inserted well within each stud bay, has the advantage of requiring many fewer holes and therefore less drilling, filling, and clean-up. The resulting dense pack has been shown to produce better energy savings because voids are avoided and convection is reduced.

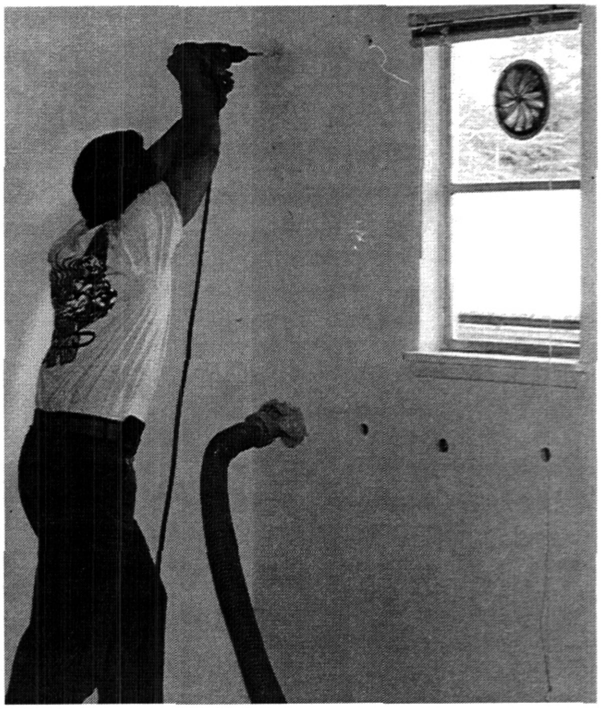


Fig. 6.7. The two-hole technique is used to blow cellulose into side walls from the inside. After each stud bay is filled, the gypsum board is plugged and finished.

Air sealing beyond wall insulation and the work associated with preparing attics and installing insulation and new windows is usually accomplished by weatherstripping perimeter doors when common spaces are heated. When common spaces are not heated, individual apartment doors are also weatherstripped.

Replacement windows are frequently employed. High-quality, double-glazed vinyl units are routinely installed to replace single-glazed units (Fig. 6.8). The new windows are fabricated locally by three manufacturers: Insulate Industries, C.D.I., and Milguard. Each company is able to produce units to exact size specifications within 5 working days. Seattle's program has evolved from one in which existing windows were repaired and weatherstripped and storm windows were routinely installed, to the replacement option presently favored. As elsewhere, how to deal with the issue of windows is a matter of debate. However, in Seattle, some careful engineering work went into making the decision to use replacements on multifamily weatherization jobs in most cases.

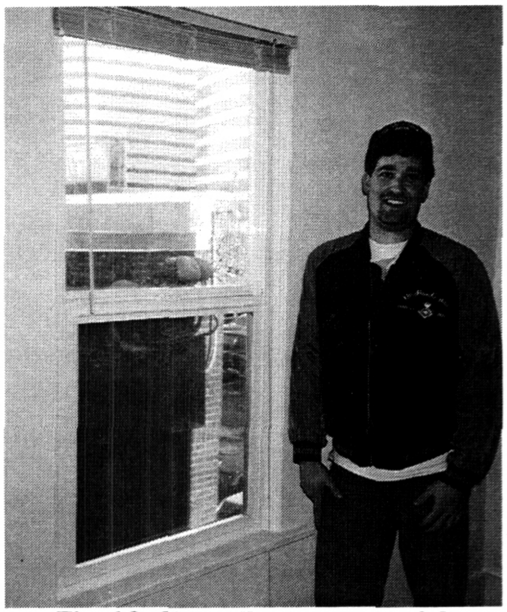


Fig. 6.8. Tom Allen, manager of the Williamsburg Apartments in Seattle, shows off the new vinyl replacement window installed during the weatherization job.

In the mid-1980s, Seattle City Light retained Ecotope, a local energy research and development firm with a national reputation for excellent work, to study the cost effectiveness of various conservation measures in multifamily dwellings. The firm released its study, *Conservation Potential for the Multifamily Sector*, by Baylon, Kennedy, and Delahunt of Ecotope in July 1987. Dave Baylon, principal author of the study and president of Ecotope, recalls that when the study was performed, storm windows and conversions cost $6.50 per ff and replacements were $9 per ff; but since replacements did a better job of limiting convective losses in multifamily buildings, the replacement window option was deemed cost-effective in 1987. Interviewed in the fall of 1994, Baylon maintains that "Everything looks better now than then owing to better technology and higher costs of energy." The improved technology comes from fewer edge losses with vinyl windows and the availability of low-emissivity "hard coat" glazings.

All parties agree that replacement windows are a primary marketing tool for weatherization; they inevitably get the attention of landlords. Accordingly, since 1987 all multifamily buildings that are electrically heated have had new windows installed, as well as most non-electric multifamily buildings. In 1995, with Seattle City Light funding, DHHS has expanded window replacement into 1- to 4-unit dwellings on the basis that it is "regionally cost effective" (from the utility perspective) to do so. Two other weatherization measures are routinely accomplished on multifamily jobs—shower head replacements and lighting retrofits. In 1994 the Seattle Conservation Corps, which like weatherization is administered through DHHS, was used to change out shower heads. Shower heads are passed out as part of the initial audit. Inefficient incandescent lighting in common spaces is routinely replaced by hard-wired fluorescent fixtures using certified journeymen electricians in accordance with the Washington State Electrical Code.

Follow up and Certification

On jobs that involve work that is covered up—like the installation of wall insulation —nergy conservation representatives routinely do spot inspections while work is in progress. When the work is finished, contractors are required to submit the following documentation:

- an inspection report,
- a certificate of insulation,
- a knob and tube wiring certificate,
- a copy of the invoice for electrical work,
- a warranty for the replacement windows, and
- a pre-site and post-site form.

Samples of several of these forms are included in Appendix D. This packet goes to a scheduler who coordinates post-inspections by the energy conservation representatives. In the case of single-family weatherization work, the person who does the pre-inspection work is usually not the person who does the post-inspection; for multifamily work, the overlap is about half. The inspection covers each item contracted, and everything must pass before the payment to the contractor is processed. A contractor whose work fails is given 14 days to correct the problem, and the inspection process is repeated. when a job passes, normally about a week and a half elapses between a contractor's submitting paperwork on a job and an inspector's submitting fmished reports to the Grants and Contracts Section. From there, the paperwork goes to accounting for about 3 days and to the comptroller for several days before a check is cut and mailed to the contractor.

"If it's a big payment, we rush it," Kirkland reports. "We try not to string out the contractors and if needed we can get the system to respond in 2 or 3 days." In 1995, DHHS is providing partial payments to contractors on large multifamily projects that are 60 to 70% complete. The resulting improvement in cash flow will undoubtedly be welcomed by both contractors and their suppliers.

Management and Policy Issues

When Gibbon was hired in the spring of 1994 to manage DHHS energy programs, she was given a mandate to institute needed changes. She put together a 10-person task force to identify and help solve problems. The task force includes both key managers and other members of the energy staff whose membership is based uniquely on their willingness to work hard. "My management style has been influenced significantly by the Woman's Movement and Total Quality Management, in which there is total participation by all and decision making is by consensus. If you give people information, everybody can make an informed decision," explains Gibbon. "When we formed the Task Force, I told them, 'this is your program; let's work together to make it work better."'

Judging from interviews with staff and a review of Task Force reports, this managerial openness is being warmly received and real progress has already been made on a number of fronts. Early in the summer of 1994, the task force identified an overall objective–to streamline all weatherization operations—and 9 specific areas that needed immediate attention. Here is an abbreviated version of the list:

- Windows—establishment of a maximum number of replacements per weatherization job, installed costs, and cost-effectiveness,
- Audits of dwellings with oil or gas-fired heating systems—appropriateness of co-funding by Seattle City Light.
- Repairs—possibility of pooling funds from several resources and expanding the range of repairs undertaken.
- Program efficiency and client responsiveness—a range of issues related to productivity and streamlining.
- Dual funding of weatherization jobs—an exploration of the best ways to mix funding sources for each weatherization job to do what is most efficient.
- Blower door testing and air sealing—how to optimize blower door use and air sealing work while controlling costs.
- Building envelope measures—a number of details aimed at improving cost effectiveness, simplifying procedures, and maintaining good quality control.
- Landlord covenants—how to reduce program costs and make them more stringent (by requiring a 10% cash contribution, for example) without losing Seattle landlords' enthusiasm for the weatherization program. (The covenant presently requires a first-year rent freeze as well as mandatory 10% cash contribution for the cost of the windows by owners of structures with more than 15 units. Whenever possible, this is followed by a 3-year requirement to rent to low-income families.)
- Client education—there is a need to do much more, but it costs money.

Not surprisingly, several of these issues were dealt with quickly; for example, it was decided that Seattle City Light should not have to co-fund audits on fossil-fuel-heated dwellings. Other issues, such as building envelope measure specifications, are still being worked on. All of the issues were handled by subcommittees and now appear to be largely resolved. Seattle City Light agreed to fund a full-time slot for an energy educator, who is to be hued at the beginning of 1995. Interest in implementing a number of client education activities appears high.

On the general subject of streamlining, the weatherization program now manages to get more done with two fewer full-time-equivalent staff. (No firings were necessary, because new program measures kept three people busy.) DHHS is initiating a new way of subcontracting in 1995 which the staff believes will result in both more cost-effective weatherization work and simplified fiscal and other administrative procedures. The process initiated with the task force is continuing and Gibbon remains open to good suggestions and consensus decision making. "I let people make decisions, but both they and I know that I'm ultimately responsible."

Several new initiatives not directly related to the task force work are also likely to affect the multifamily weatherization operation soon. As mentioned, blower doors are coming into routine use. in single-family weatherization work, but not yet in multifamily work. It may be that their principal use will be to identify units where moisture and related indoor air quality problems need to be solved. "We plan to get involved in some environmental initiatives in the coming year," reports Snyder, "and that means that we'll get into more ventilation. We want to know when to do it and when not to bother." Gibbon's vision is broader still. "I'd like to get started on what we might call a 'sustainable green' program," she says. "Often low-income areas have become dumping grounds. I'd like to make their homes and neighborhoods as green as possible. This includes getting rid of toxics and improving indoor air quality." She envisions beginning with a small-scale demonstration program.

DHHS also plans to strengthen its evaluation component. Seattle City Light has an evaluation unit in its Energy Management Services Division which produces periodic reports on costs and calculated savings for the conservation programs it sponsors, but DHHS would like to be able to measure savings on a sample of buildings it weatherizes to verify actual savings and compare figures to original savings estimates. "The proof of the pudding is what kind of energy you save," observes Phil Snyder, "and we'd like to have a better handle on just which measures are saving us how much." Emphasizing this area could result in adjusting the mix of conservation retrofit measures to achieve more cost effectiveness.

In a report released in December 1994, Seattle City Light estimates that in 1993 the low-income multifamily program weatherized 43 buildings averaging 19.7 units, for an overall first-year energy savings of 1450 mWh and a load reduction of 0.166 MW. This is about 1711 kWh per dwelling unit savings, or 17.5 **MBtu** at the power plant. (This last number follows the usual convention of the National Weatherization Evaluation that power plant savings = 3 times the savings at the meter.) The authors estimate a cumulative savings for the 418 multifamily buildings weatherized since the inception of the program in 1986 of 10,273 mWh and a cumulative load reduction of 1.173 MW per year.

Beverly Corwin, manager of Residential Energy Management Services for Seattle City Light, puts these results into perspective. About the relationship between Seattle City Light and DHHS, Corwin observes that "There is a natural difference in focus when you talk about a social service program and a utility program, which is interested in energy primarily for purposes of obtaining resources. Both Seattle City Light and Bonneville look at energy conservation investments in terms of negating the need to build new power plants. However, it's natural for City Light to be a strong contributor to low-income weatherization." City Light has a strong tradition of social concern, with a policy of targeting residential conservation at dwellings of low-income customers before funding conservation for other residential buildings and end uses. This works well for weatherization in Seattle, a solid program that is improving the scope and quality of its services.

BUILDINGS SURVEYED

Five sets of multifamily buildings were inspected as part of this case study. The apartments in each have electrical resistance heating. Weatherization work was examined, pertinent details were photographed, building managers (and sometimes tenants) were interviewed, and paperwork associated with costs and retrofit measures was reviewed. In addition, four other buildings were visited briefly to observe and photograph work in action (e.g., inside sidewall cellulose blowing), special features of a dwelling (e.g., a passive ventilation system built into the frame of an energy-efficient window), or interactions with a subcontractor (e.g., making final decisions on aesthetic details of a window retrofit job.)

For the five buildings examined in detail, consumption information from individual apartment and common area bills over a 3- to 4-year period was first recorded by Gail Travers of DHHS and then sent to the Synertech Systems Corporation, where the data were entered into a spreadsheet format. This information was combined with weather and cost data to undertake an analysis of savings and cost effectiveness. The ked-heating-degree technique (base 65°F) was used to analyze the data (see Section 1 for details). The analyses that follow are based on electricity rates in Seattle, 4 cents per kWh or $1 1.72 per million Btu.

CRESCENT ARMS APARTMENTS

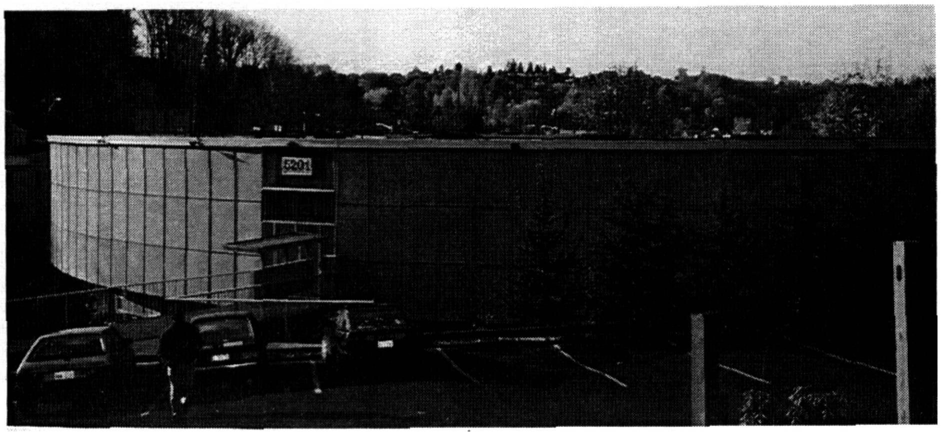


Fig. 6.9. The outer and inner circumference of the Crescent Arms apartments.

Building Description

Crescent *Arms* is architecturally the most unusual multifamily building encountered in this series of case studies. It bears a singularly appropriate name. The Crescent *Arms* is built in the form of a fortified annulus about 5/8s around, an architectural feature that allows each of the 37 apartments in the 3-story structure to have light from two sides and cross-ventilation. In the interest of security; the outer circumference of the structure is protected by heavy iron screening, but the inner circumference, which focuses on a picnic area and a playground, is open and visually inviting. Like most multifamily buildings in Seattle, the Crescent Arms is a frame structure with a masonry facade. It has poured concrete partitions and a flat roof. It appears to be quite tightly built; consequently, prior to weatherization, conductive losses from uninsulated walls and single-glazed windows were the predominant mechanisms of energy loss.

Weatherization Measures

Weatherization work consisted principally of several large-scale insulation jobs and new windows. Cellulose was blown into walls from inside each apartment. Insulation was installed primarily on the outer circumference because the inner circumference is effectively a window wall. The wall insulation installed measured 4200 ft^2 at a total cost of 70 cents per ft^2. The space between the ceiling and the flat roof could not be accessed, but it is believed to be insulated. The floor above the crawl space could be insulated, and 5550 ft^2 of 9-inch unfaced batts were installed using nails and nylon twine to hold them in place (Fig. 6.11). Material and labor for this measure cost 72 cents per ft^2. To protect water pipes from freezing, 1215 linear feet of pipe insulation was insulated at a cost of 67 cents per linear foot.

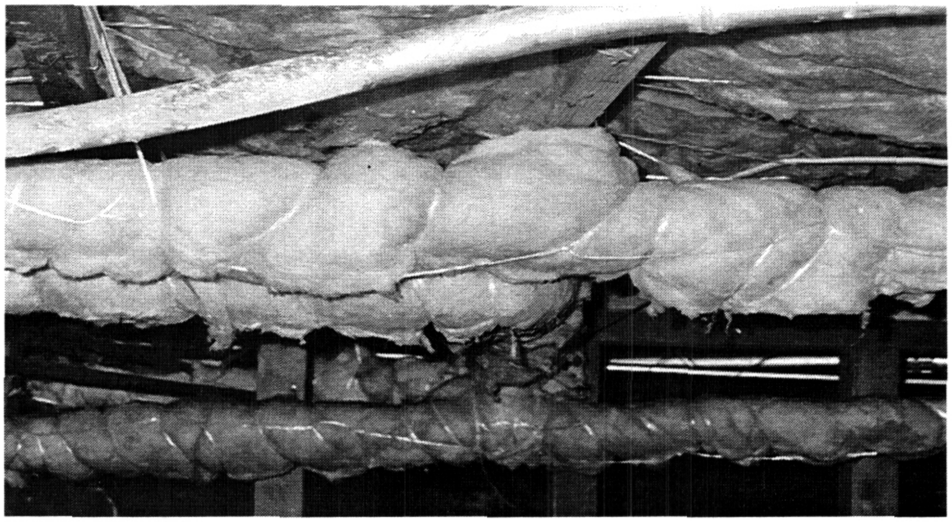


Fig. 6.10. Detail of floor and pipe insulation. Note the extensive use of nylon twine.

Each of the apartments in the Crescent Arms complex has a small electric hot water heater built into the bathroom closet behind a partition. Since it is a major operation to access the heaters, no maintenance (such as periodically draining off sediment) is performed on these units until they fail. Of course, insulating tanks and water lines is not feasible, either.

costs

A total 239 double-glazed vinyl windows were installed at the Crescent Arms at a cost of $56,650, 73% of the total job cost (Fig. 6.11). Finally, 78 new energy-efficient lighting fixtures were installed (including 13 100 W high-pressure sodium exterior lights to aid in providing security) at a total cost of $5979. Adding several air sealing measures and 2 power vents brought the cost of the entire job to $77,138.

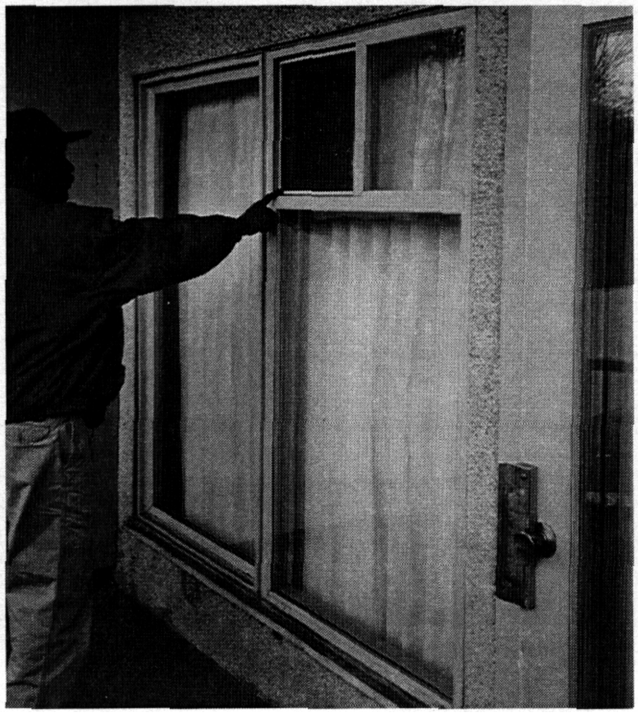


Fig. 6.11. The window wall on the interior circumference. Each of these complex units was replaced as part of the weatherization work. The upper light pointed out by Joseph Fans can be slid open to provide ventilation.

Crescent Apartments Seattle, Washington Savings Analysis				Annual HDDs: 5121
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	17,820	17,820	0	0
Consumption Index, $Btu/HDD/ft^2$	9.87	7.32	-2.55	-25.9
Heating NAC, MBtu	900.41	668.37	-232.04	-25.7
Baseload NAC MBtu	688.69	641.61	-47.08	-6.8
Total NAC, MBtu	1589.11	1309.98	-279.13	-17.5
Fuel Cost, $/MBtu	11.72*	11.72	0	0
Annual Cost, $	18,624	15,353	-3271	-17.5
Cost of Weatherization	$77,138			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$41,214			
Benefit-to-Cost Ratio	.53			

LAM-BOW APARTMENTS

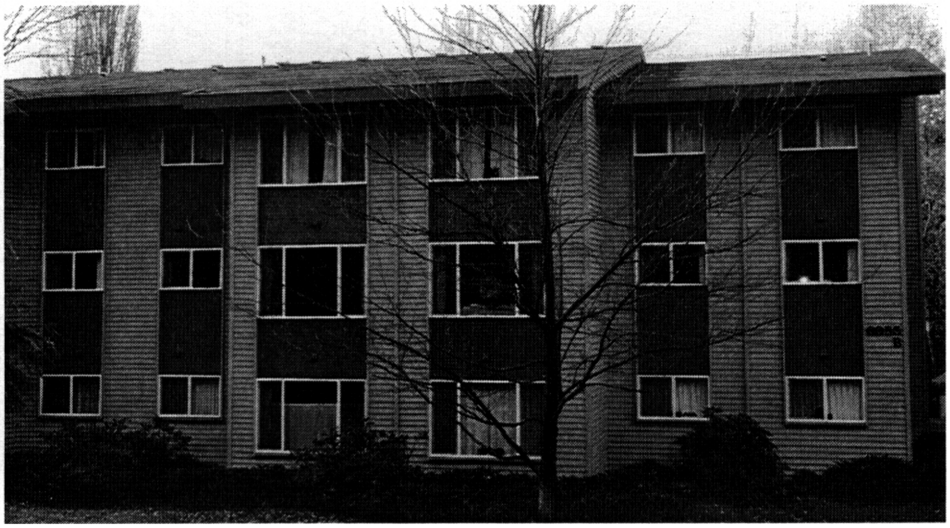


Fig. 6.12. Building B of the **Lam-Bow** Apartments.

Building Description

Lam-Bow is an attractive two-building complex with **21** units in one buildmg and **30** in the other. Both ***are*** **three-story** rectangular structures with complex wall sections and roof lines. Both ***structures*** appear to be quite **airtight,** and evidence of moisture buildup **was** observed in several **apartments.** The on-site manager has a strong interest in energy conservation and in maintaining the buildings.

The annotated drawings in Figs. 6.13 and 6.14 illustrate the care taken by the energy conservation representative in describing the dwelling. The drawing of the attic and **roof** in one of the buildings illustrates a **variety** of moisture problems *caused* in part **by** poor **air sealing** and leaky **fans** in the attic area. This single drawing makes the repair work order much easier for the contractor to **execute.** The detail of the south elevation **communicates** quite **clearly** which replacement windows of what ***sizes*** should go where.

Weatherization Measures

Extensive **air** sealing in the attic and **related** repairs **to** prepare it for insulation were needed. This included sealing around fixtures and installing exhaust fans from kitchens and bathrooms. Subsequently, insulation was installed (blown cellulose to **R-38)** and attic hatches were sealed (Fig. **6.15).** New windows were also installed throughout the complex, and hard-wired fluorescent ***fixtures*** were installed in all common areas (Figs. **6.16, 6.17,** and **6.18).**

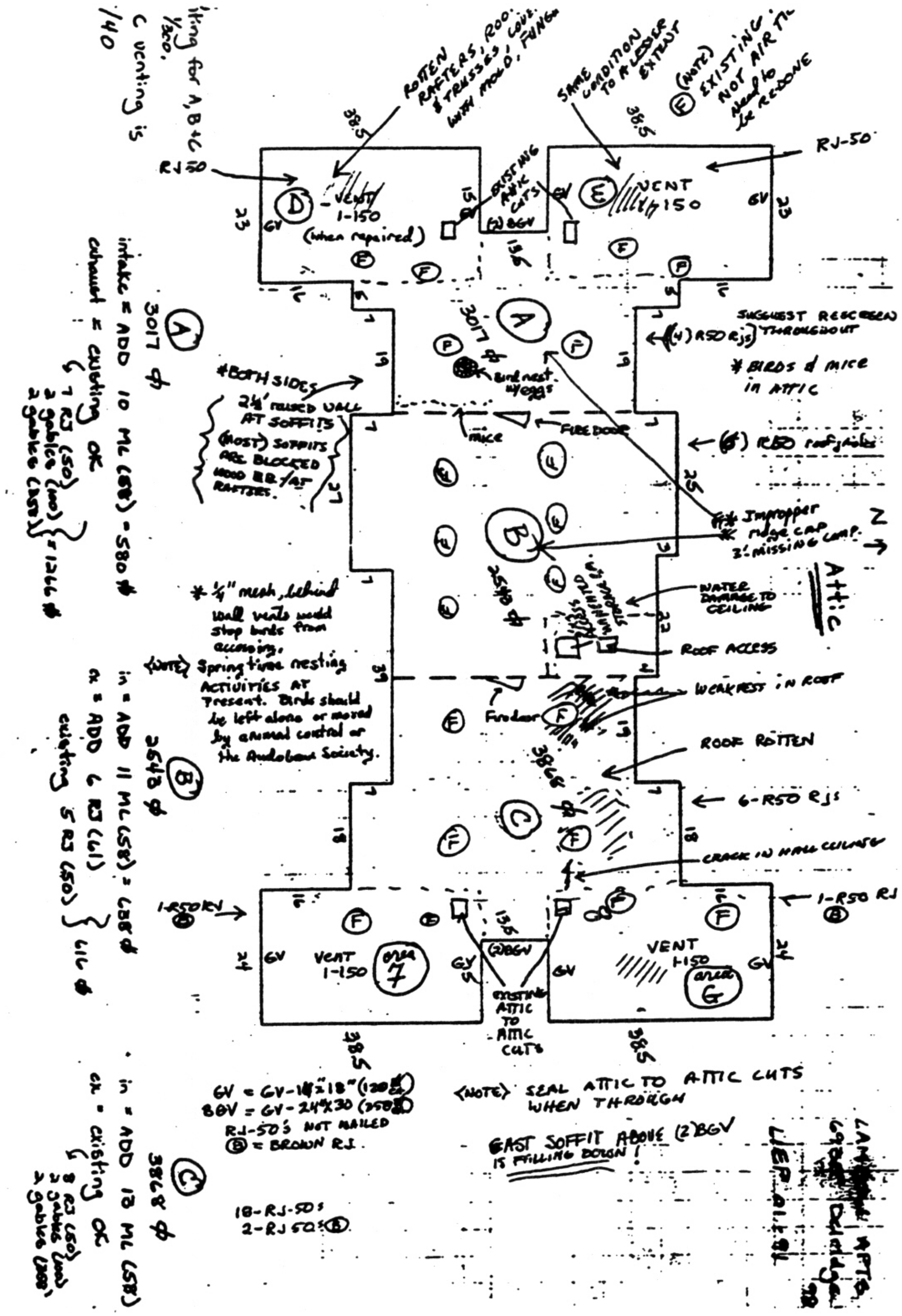


Fig. 6.13. Annotated drawings of units in the Lam-Bow Apartments detailing moisture and roof problems.

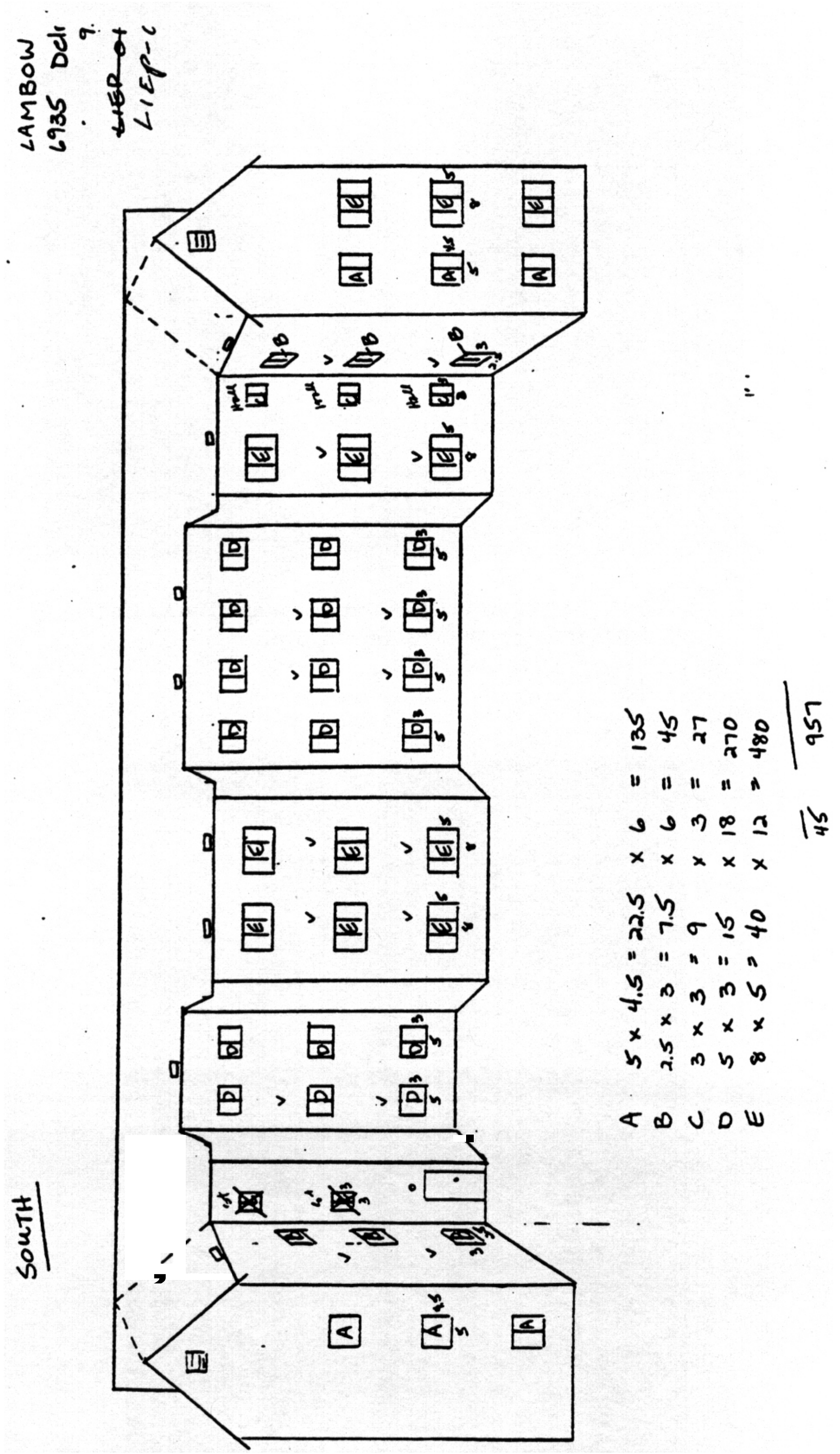


Fig. 6.14. Elevation of a Lam-Bow Apartments building indicating locations and sizes of replacement windows.

Fig. 6.15. Part of the finished attic insulation. The air from ventilation fans no longer comes into the attic.

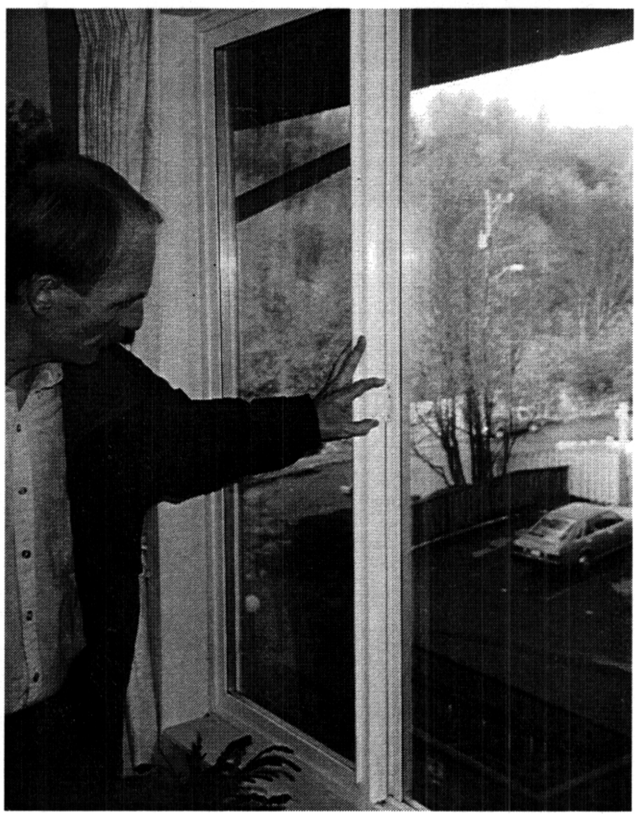


Fig. 6.16. Energy conservation representative Vince Feltes inspects the locking mechanism on a newly installed window.

Fig. 6.17. Gail Travers, of the Department of Housing and Human Services, examines fluorescent fixtures installed at the Lam-Bow apartments. Note the evidence of a moisture problem (now cured) in the ceiling.

Fig. 6.18. The interior doors are weatherstripped to provide thermal and sonic isolation. The energy-efficient lighting fixtures are cost effective since they are on 24 hours a day.

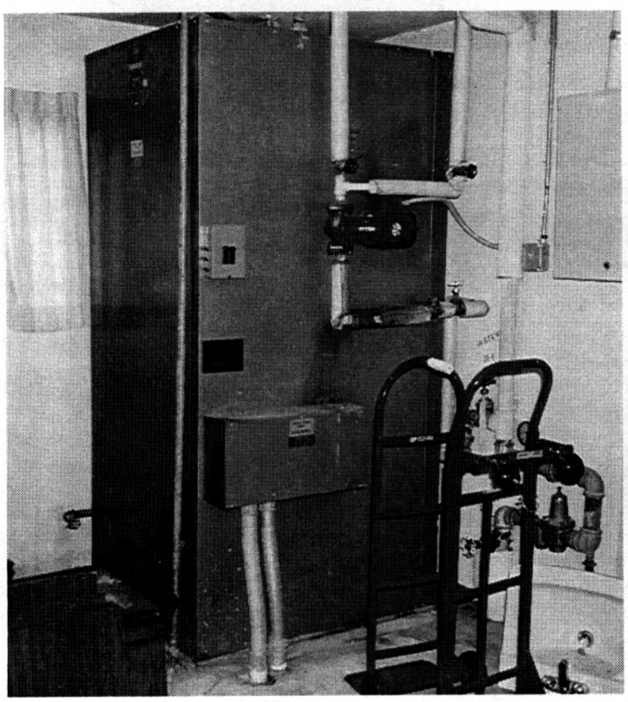


Fig. 6.19. This boiler, powered by electricity, supplies hot water to all of the apartments in the building. The circulation pump ensures that hot water is immediately available. Seattle City Light has submetered the hot water system to study the consequences of different control strategies.

costs

The total job cost for full weatherization and lighting retrofits on the two buildings was $87,187, of which window work represented 70%.

Savings

Separate calculations for the two buildings are shown in the savings analysis charts. Cumulative savings were 9%.

Lam-Bow Apartments Building 6935
Seattle, Washington
Savings Analysis

Annual HDDs: 5121
Annual HDDs: 5121

	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	15,609	15,609	0	
Consumption Index, Btu/HDD/ft^2	3.55	3.00	-.55	-15.5
Heating NAC, MBtu	283.40	240.33	-43.37	-15.3
Baseload NAC MBtu	281.26	298.32	17.06	6.0
Total NAC, MBtu	564.66	538.35	-26.31	-4.6
Fuel Cost, $/MBtu	11.72	11.72	0	0
Annual Cost, $	6617	6309	-308	-4.6
cost of Weatherization	$29,731			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$3880			
Benefit-to-Cost Ratio	10.13			

Lam-Bow Apartments Building 6955 Seattle, Washington Savings Analysis				Annual HDDs: 5121
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated ff	25,455	25,455	0	0
Consumption Index, Btu/HDD/ft²	1.54	1.23	-.31	-20.2
Heating NAC, MBtu	200.77	171.71	-29.06	-14.47
Baseload NAC	225.04	211.00	-14.04	-6.24
Total NAC,	425.81	382.71	-43.10	-10.1
Fuel Cost,	11.72	11.72	0	0
Annual Cost $	4990	4485	-505	-10.1
cost of Weatherization	$57,456			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$6363			
Benefit-to-Cost Ratio	.11			

NORMAN ARMS APARTMENTS

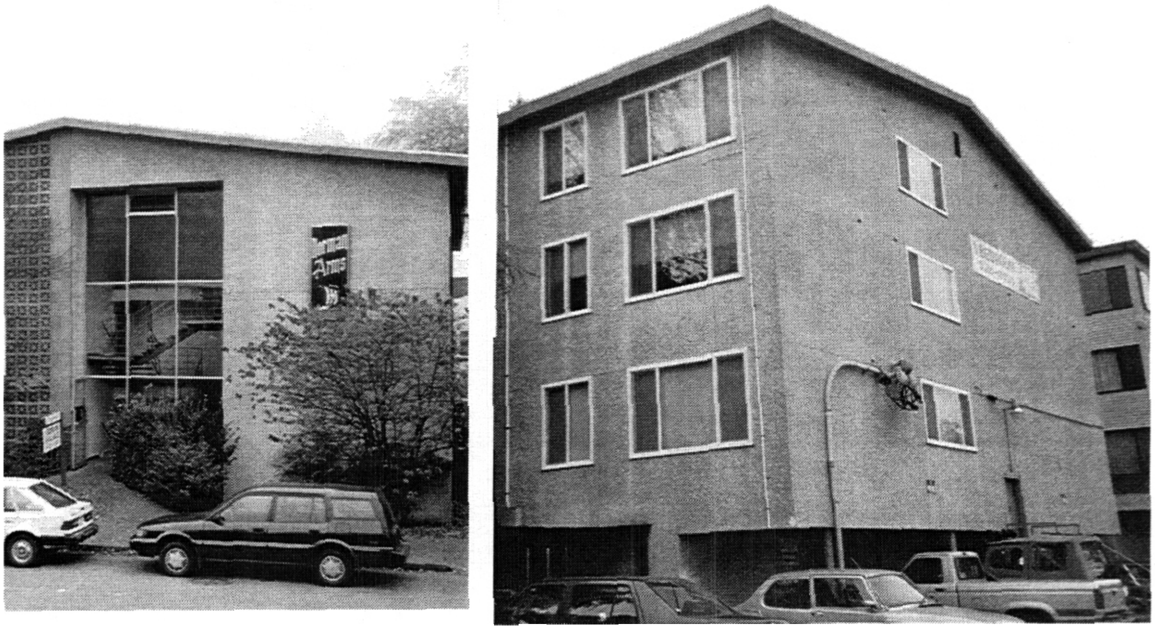


Fig. 6.20. Norman A m , east elevation (L) and rear of the building (R). Note the overhang on the right

Building Description

The Norman Arms Apartment building resembles a motel. It is a shoebox-shaped, three-story structure whose long axis is oriented east and west. Twelve apartments face south and 12 north. All have substantial glazing, and the first-story apartments have 8-foot-wide sliding glass doors that open onto small private patios. A common hallway between north- and south-facing apartments has exit doors leading to stairways. The stairways at the front and rear (east and west) of the building are in unconditioned spaces.

The structure of the Norman Arms is concrete block with poured concrete partitions. Interior stud walls are finished with gypsum board. The outer surface is finished with "Marblecrete," a cementitious material applied with a sputtering technique. Consequently, the building appears quite airtight. There is a small overhang (370 ft^2) at the back of the building, the underside of which was uninsulated before weatherization. In addition, there was a large uninsulated crawl space and only R-11 insulation in the attic.

Weatherization Measures

The attic was prepared for insulation in the standard way. Seventeen soffit vents totaling almost 7 ft^2 were added, as was a ridge vent of the same cross-section. Then cellulose was blown to produce an overall estimated R-value of 38 (Fig. 6.21). At the bottom of the structure, the small

Fig. 6.21. It is difficult to prepare an attic for insulation when ventilation pipes are so dosely interwoven with trusses.

overhang was drilled and blown with cellulose (Fig. **6.22), as** was a **613 ft^2** area in the laundry and storage area in the basement. The **2934 ft^2** crawl space was also insulated, and the floor underneath was covered with **6-mil** poly. In **addition,** 10 ff of ventilation was added in the crawl space **area,** a job that entailed drilling through the concrete block wall.

Weatherstripping was installed on the hallway exit doors Fig. **6.23),** and new thresholds were installed in high-traffic entryways. New door sweeps (the kind ***that*** flip up when doors **are** opened so that doors can swing freely) were installed on the three apartments that needed them. Twentyeight circle light fixtures were. hard-wired in the hallways. **These 32-W** fixtures produce the light of **100-W** incandescents and have a rated lifetime of over 10,000 **hours.** Even with **Seattle's** low electric rates and an installed cost of **$68** apiece, the payback period for **this** measure is less than **100** days.

costs

Nine sliding glass doors (Fig. **6.24)** and **39** new windows (Fig. **6.25)** were installed **as** part of the weatherization job. Their installed cost was **$28,756, 70%** of the total weatherization job cost of **$40,974.** (Since the conditioned space measures approximately **10,300 ft^2,** the weatherization cost was about **$4** per ft^2.)

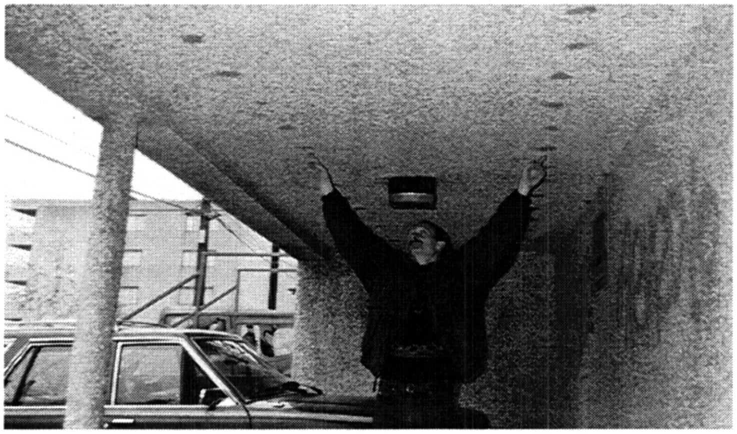


Fig. 6.22. Vince Feltes points out where holes were made to accommodate the hose for blowing cellulose in the overhang area.

Fig. 6.23. The exit doors at the end of the common hallway were weatherstripped and new energy-efficient light fixtures installed.

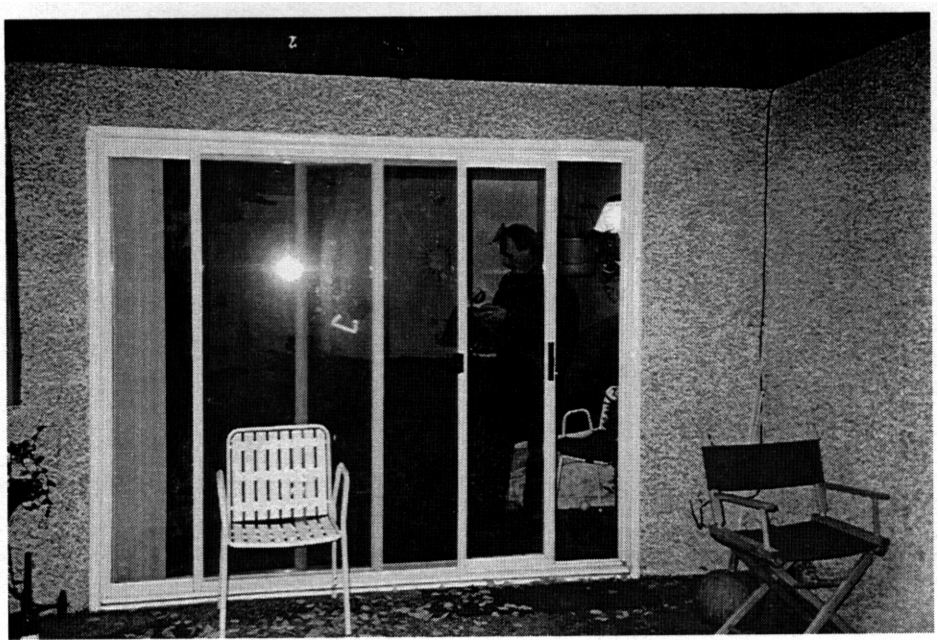


Fig. 6.24. This large sliding door make8 the patio space quite attractive.

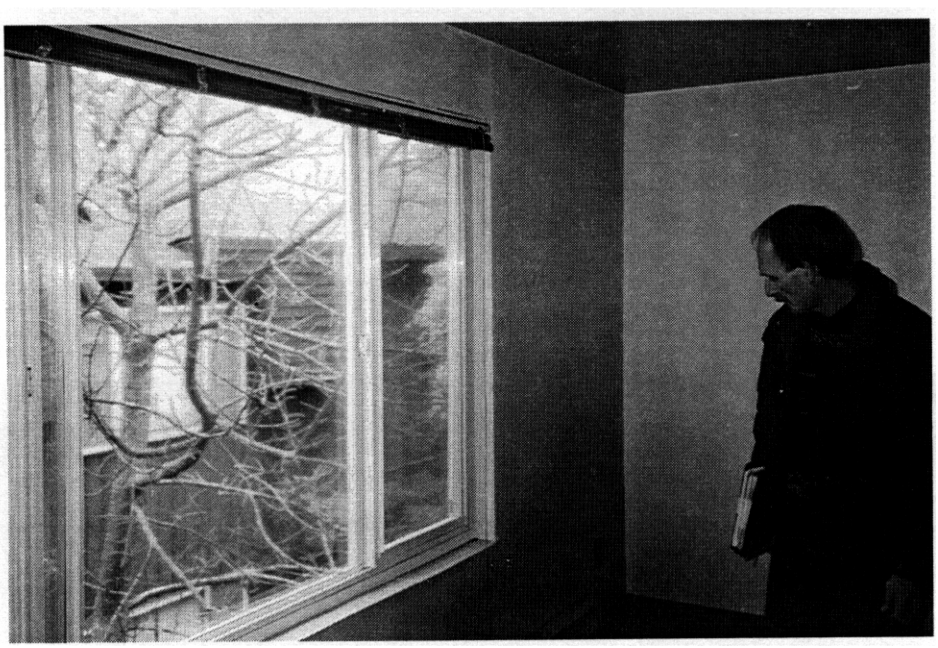


Fig. 6.25. This room is much more comfortable since the insulating glass was installed. A long strip heater under the new window is controlled by a remote thermostat calibrated in degrees Fahrenheit (rather than a thermostat on the strip heater calibrated from 1 to 10).

Norman Apartments Seattle, Washington Savings Analysis				[illegible]
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	10,300	10,300	0	0
Consumption Index, $Btu/HDD/ft^2$	3.31	2.49	-.82	-24.8
Heating NAC, MBtu	174.46	131.24	-43.22	-24.8
Baseload NAC MBtu	309.38	282.63	-26.75	-8.7
Total NAC, MBtu	483.84	413.87	-69.97	-14.5
Fuel Cost, $/MBtu	11.72	11.72	0	0
Annual Cost, $	5670	4850	-820	-14.5
Cost of Weatherization	$40,974			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$10,332			
Benefit-@Cost Ratio	.25			

ROXBURY VILLAGE

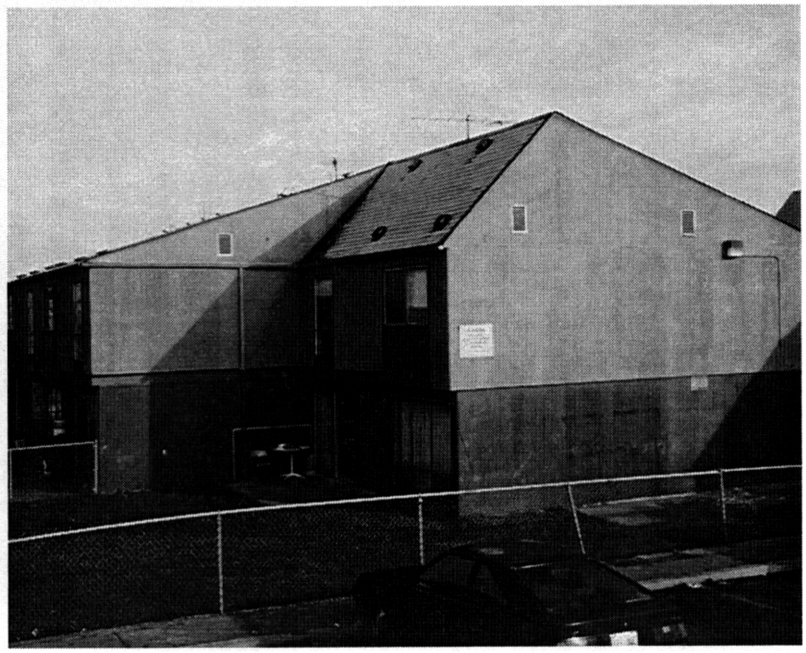


Fig. 6.26. The Roxbury Village complex has a number of five-unit buildings like this one.

Building Description

This structure, housing five apartments, is in a complex of public housing buildings. The apartments are two-story townhouses of about 1250 ft^2 each. The building is a frame structure with wooden sheet siding (texture 111). Four of the five apartments have single-glazed aluminum framed windows and patio doors; the fifth has insulated glass with aluminum frames. The building nonetheless appeared airtight, and the two units examined showed signs of moisture buildup.

Weatherization Measures

This job consisted of adding attic insulation and some extra attic venting, plus weatherstripping the entry doors.

costs

The total job cost was $1972. This was the most costeffective job examined during this case study.

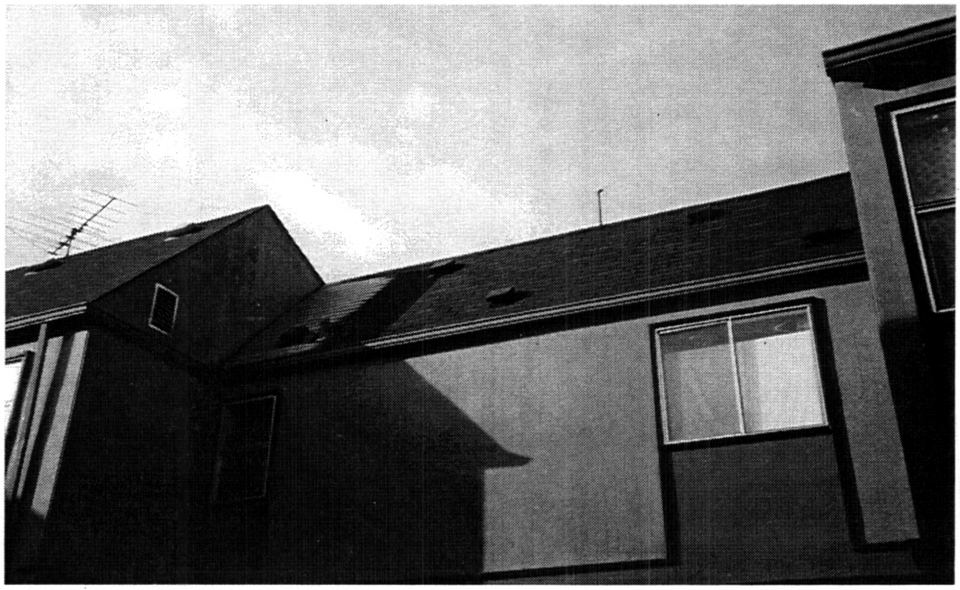


Fig. 6.27. Mushroom vents high and low were added to ventilate the attic area.

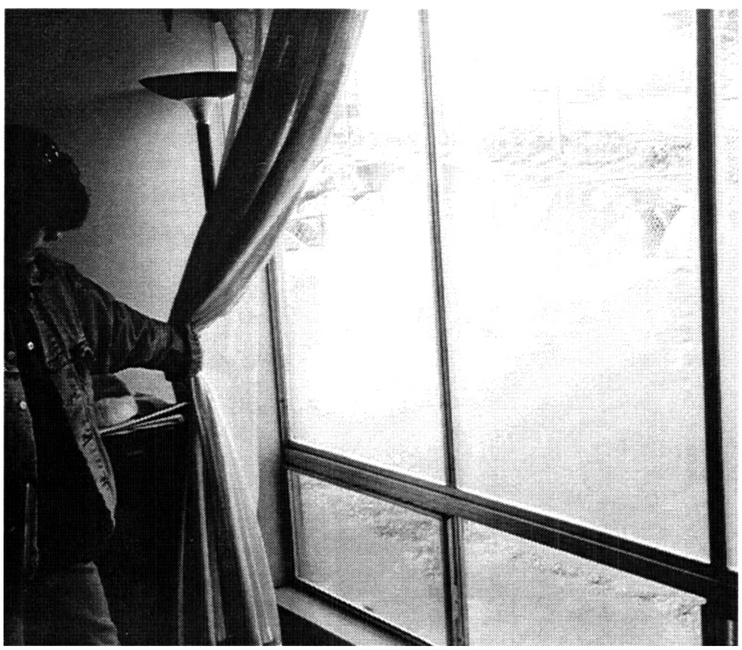


Fig 6.28. Energy conservation representative Tracey Reid shows the aluminum-framed window area.

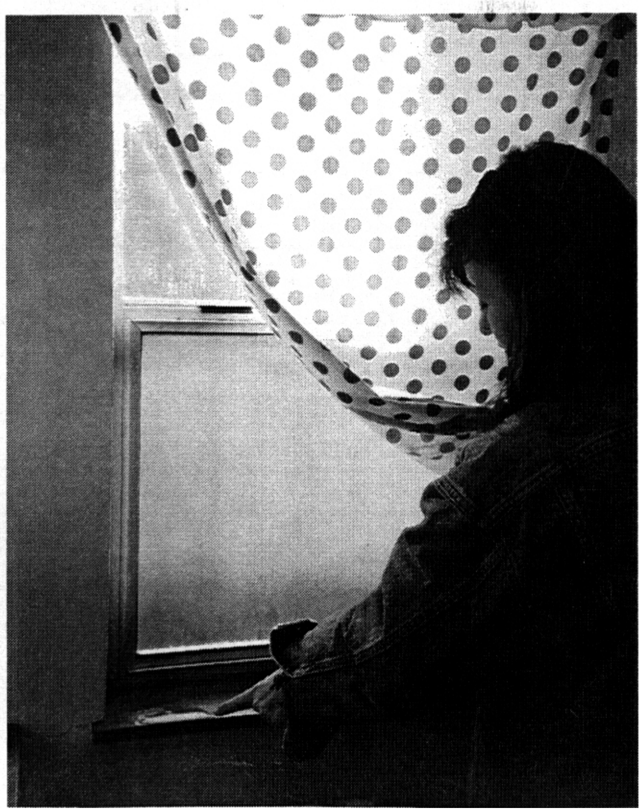


Fig. 6.29. This pool of water on the sill resulted **from condensation from *the* window in the bathroom.**

Roxbury Village Apartments Seattle, Washington Savings Analysis				**Annual HDDs: 5121**
	Pre-Weatherization	Post-Weatherization	Absolute Change	Percentage Change
Area Heated, ft^2	6250	6250	0	0
Consumption Index, $Btu/HDD/ft^2$	3.48	1.80	-1.68	-48.3
Heating NAC, MBtu	111.39	57.67	-53.72	-48.3
Baseload NAC MBtu	2894.91	3050.66	155.75	5.3
Total NAC, MBtu	3006.30	3108.33	102.03	3.3
Fuel Cost, $/MBtu	11.72	11.72	0	0
Annual Cost, $	35,233	36429	1196	3.3
Cost of Weatherization	$1972			
Lifetime Savings (20 yrs. @ 4.7% discount rate)	$15,069			
Benefit-to-Cost Ratio	7.64			

WILLIAMSBURG COURT

Fig. 6.30. Williamsburg Court Apartments.

Building Description

This attractive three-story apartment building is built in a U-shape around a courtyard. It has 49 apartments ranging in size from 300 to 672 ft^2. All the units are heated by electric resistance ship heaters with somewhat crude temperature controls. A typical one-bedroom apartment has a 1000-W heater under the window in the living room (Fig. 6.31) and a 750-W heater in the bedroom. These deliver a peak output of only 6000 Btu per hour, but this is adequate for even the coldest days in Seattle.

Hot water is produced by a dual-fuel gas/oil-fired boiler in the basement, which serves the whole complex (Fig. 6.32). The apartments appear to be quite airtight and well maintained, although the basement and storage areas are rough and show glimpses of the old building before plumbing and electric retrofits were. undertaken.

Weatherization Measures

The principal work on the dwelling was accomplished in the attic (sealing, insulating, and venting) (Figs. 6.33 and 6.34) and in individual apartments (new windows) (Fig. 6.35 and 6.36). Insulation was also added in a small (445 ft^2) section of the crawl space. All work appears to be of excellent quality. The attic preparation included installing sheet metal ducting around ventilation ducting and electric conduit where wires pass through the attic floor (Fig. 6.37).

costs

The weatherization job costs were $61,536, of which *84%* was for replacement windows.

Savings

The analysis of savings associated with this building was impossible owing to complications with occupancy changes and related phenomena that caused random apartment-by-apartment results.

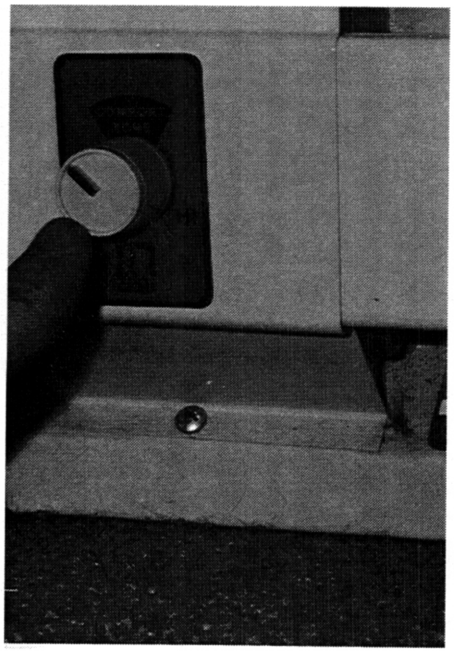


Fig. 6.31. **This is the control for the 1000-W strip heater** found **in the main room** of **most apartments.**

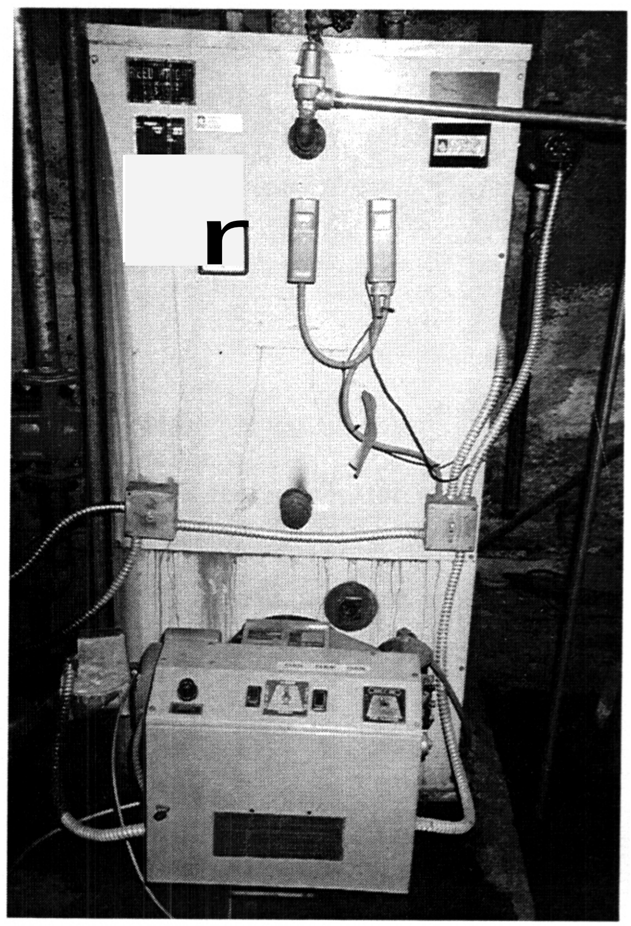


Fig. 6.32. This **dual-fuel hot water boiler is usually fired with natural gas. Installing insulation on as many** of **the hot water pipes as possible would he a good investment and might allow for lowering the temperature** of **the aquastat**

Fig. 6.33. The attic insulation job shows good, even coverage to R-38 (12 inches).

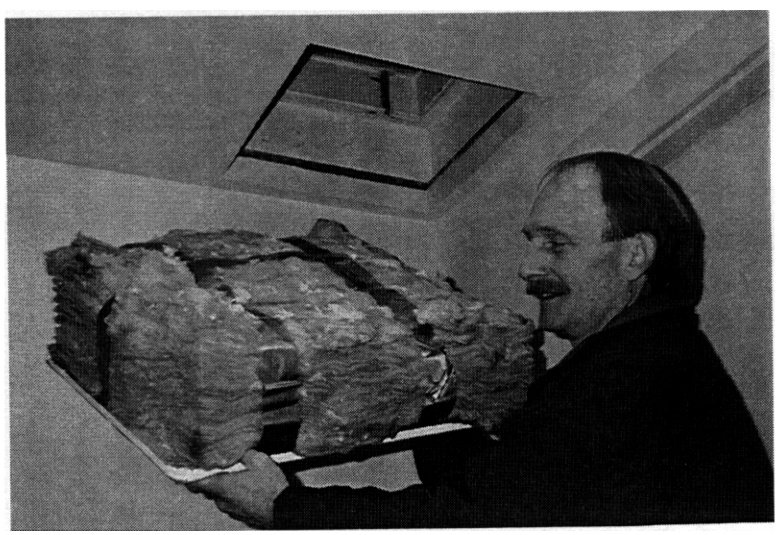


Fig. 6.34. Vince Feltes shows the technique used to insulate the access hatch to the attic. The access hatch fits tightly.

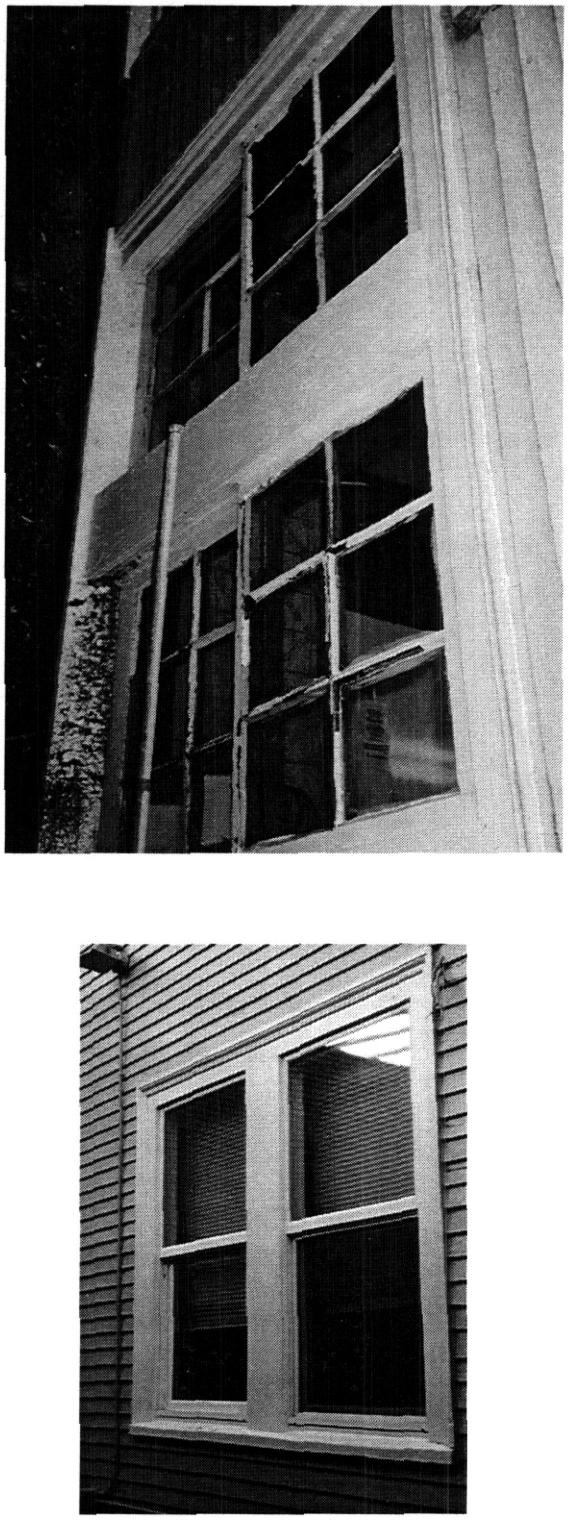


Fig. 6.35. The upper photograph shows an old single-glazed window left in the laundry room. The lower photograph shows details of the new windows. Note the high-pressure sodium light future that illuminates the courtyard in the evening. More efficient than incandescent lights by a factor of 5, it has a rated lifetime of 30,000 hours; a sensor turns it off when sufficient daylight is available.

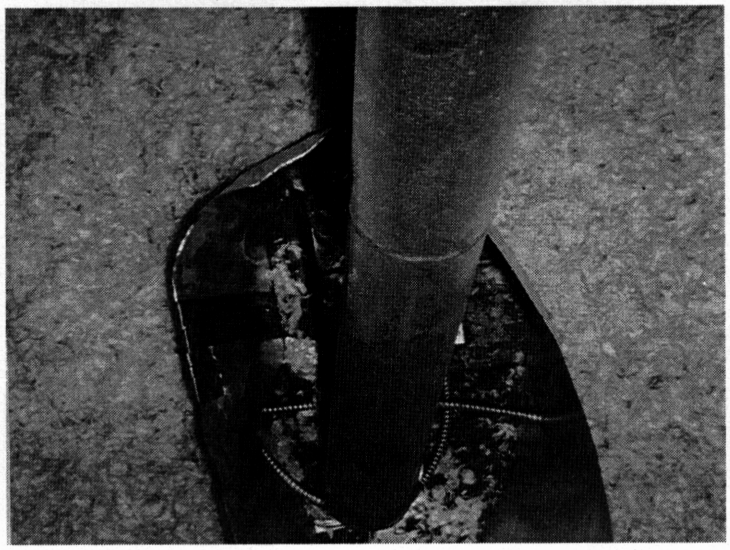


Fig. 6.36. Sheet metal around tbe electric conduit and ventilation pipe. The finishedjob appeared tight, but a bit of foam around the metal sheathing around the electric cable where it comes through the attic floor would be useful without being unsafe.

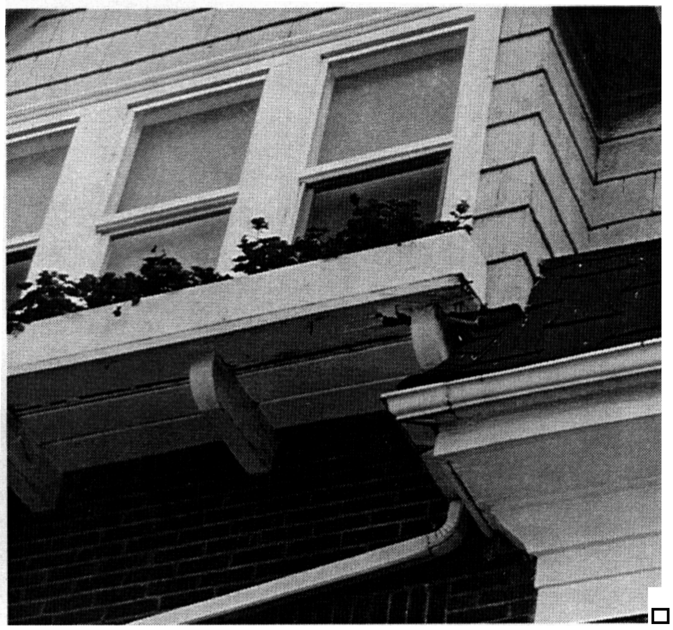


Fig. 637. Window and flower box detail.

7. CONCLUSIONS AND RECOMMENDATIONS

LESSONS LEARNED

The world of multifamily weatherization is exciting, evolving, and reflective of local circumstances. **A** wide variety of building types, fuel **types,** fuel *costs,* and weather are represented by the five case studies. Multifamily buildings tend to be more complex than single-family units, and **their** mechanical systems, in particular, can pose barriers to **energy** retrofit work. However, sometimes complicated matters, once understood, can yield dividends; and the agencies that concentrate their attention in the boiler rooms tend to show both better savings and higher ratios of benefits to costs.

Of course, there is **no** magic button that yields the ideal prescription for an energy-efficient retrofit. However, a good deal of practical wisdom has emerged from these case studies and other work in the multifamily conservation sector. The following paragraphs outline what seem to be some of the more important findings:

Patterns of Consumption

Knowing how much **energy** a building **uses,** and its patterns of **use** of both electricity and heating fuel, is a critical ingredient in makiig good decisions ahout energy-related retrofits. Since savings follow waste, quantifying **use** is important in undertaking appropriate measures for achieving cost-effective retrofits. **Unless** there is a real opportunity to save at least half of **the** energy used by a building, from the energy-savings point of view, it is not likely to be cost-effective to invest five **times** the annual energy bill for weatherization retrofits. (Of course, in some instances, there **are** distinct benefits that justify the retrofit nonetheless; these range from neighborhood improvement and tenant satisfaction to environmental improvement and jobs.) In all events, analyzing patterns of consumption is also important in evaluating the results **of** retrofits, comparing **actual** savings with estimates. **Most** agency weatherization **directors** want to do **more** evaluation of their work.

Uncertainty in Predicting Savings

There still **are** significant discrepancies between **expected** and **actual** savings. Many buildings save about **as** much energy **as** expected, while others save significantly more or **less. A** major study of the energy performance of large multifamily buildings is in progress in New York. It is to be hoped that a better understanding of large building weatherization performance will be forthcoming.

Uncertainty in Savings as a Constraint on Investment

Energy audits, which provide the recommendations for energy-efficiency measures to be installed in **a** building, **are** typically based **on** some estimate **or** expectation of **energy** savings to be achieved. In turn, the capital to be invested in energy-saving measures for a building is typically based on the cost savings resulting from the expected energy conservation. Factors that cause actual savings to vary from expected savings increase the risk of investing capital. Thus, the uncertainty in savings constrains the amount of savings that can be achieved. In short, improved audits and savings estimates are needed to increase long-term capital investment in the weatherization of multifamily buildings. In this regard, the work of CONSERVE in New York City merits emulation.

The Criticality of Good Audits

Overall, good estimates of savings are critical to increase the level of owner investments. We found solid evidence that the quality of energy audits in these larger multifamily buildings increased significantly from 1989 (the program year of record for the National Evaluation) to 1994. Unfortunately, we also found that the increases in quality were not evenly distributed. A national effort to help all practitioners reach reasonably comparable levels of expertise would increase owner investments and improve savings.

The quality of energy audits has been enhanced through development of computerized audits such as the EA-QUIP Program developed in New York and now used by several weatherization organizations. Over the last few years, auditors in all locations have adopted methods to increase the accuracy of their audits, but too many work in relative isolation. Further improvements may be expected when feedback to auditors on actual savings relative to expected savings is more widely available. Additional methods should be pursued for transferring knowledge between auditors on the most effective methods for auditing and weatherizing multifamily buildings of various kinds. These might include the development of training and technology tools, conferences devoted to multifamily issues, and professional staff development via dedicated institutions.

Investment Decision Method

We found that some programs undertake what amounts to a cost-benefit analysis before deciding what level of investment in energy efficiency is appropriate for the building. Other programs undertake retrofits based on recommended measures for particular building configurations.

The situation in Seattle raises an interesting issue concerning the benefit/cost calculations. There, the weatherization effort is achieving significant energy savings, but benefitkost ratios are often less than one. (However, one case study building—which did not include window replacement—had a ratio of over 7.) The cost for electricity in Seattle is less than half of the national average (4 cents vs over 8 cents), so benefitkost calculations demonstrate savings of less than half as much money as is the case in most other cities.

Comprehensive Weatherization

Our results reaffirm the results of an earlier analysis of the weatherization of 191 buildings (Goldman 1988): many measures are available to achieve high savings at low cost for buildings that are heated with fuels other than electricity and that have central heating systems. Buildings heated with electricity typically require higher-cost shell measures to achieve significant savings (as is the case in Seattle). Central heating systems fired by oil or natural gas are often appropriate for control system retrofits that save significant energy at relatively low cost. Modification or adjustment of the central heating plants also frequently provides good savings at relatively low cost. Many of these systems are operated very inefficiently, and there is a need for more operators who understand the proper functioning of the controls on these systems. The presence of central, fossil-fuel-fired heating systems is an important indicator of expected total savings that can be achieved. In short, creativity in the boiler room deserves much more emphasis. Consideration of the efficiency with which domestic hot water is produced, stored, and distributed is also crucial.

Savings in water consumption, both hot and cold, are also very important in multifamily buildings. Retrofit work in this area usually produces cost-effective dollar savings.

Shell Sealing

Building shell measures can be effective, but building configuration and outside investment play important roles in cost-effectiveness. Taller buildings tend to benefit more from sealing air leakage paths such as those to or from chases and core areas, so building height can influence benefits. Windows can be an important factor affecting overall heat loss and air leakage, but again the height of the building can be an important influence. New York tends to have higher-rise buildings, while the other four cities we visited tend to have lower-rise buildings. Better understanding of shell configuration influences on measured savings is needed.

Leveraging Investments Related to Windows

Outside investment can be tremendously important in achieving greater savings, making programs more cost effective, and making programs more visible to owners. An effective strategy for leveraging outside investments requires firm state-level policies, commitment from every level of a program's operation, a track record of good work and significant savings, and creative salesmanship.

Replacement windows are a typical measure where owner investment is important. The energy savings from windows can be important, but the costs are very high. Owners obtain benefits beyond energy savings for new windows, including increased property value, neighborhood improvement, and tenant satisfaction. Capitalizing on these other benefits is important to increase energy savings.

Opportunities for Conserving Electricity

Except for buildings that use electricity for space conditioning, most of the electricity conservation in multifamily energy retrofit work has concentrated on lighting: the replacement of incandescent fixtures with compact fluorescents (inside) and high-pressure sodium fixtures (outside.) Electricity conservation needs more emphasis. Cost-effective savings also result from replacing energy-inefficient refrigerators with efficient ones. Although this is not yet an approved measure withii the DOE weatherization program (except on a pilot basis), excellent benefit-to-cost ratios have been achieved in utility-sponsored refrigerator replacement programs from California to New York. Multifamily dwellings lend themselves to logistical efficiency in refrigerator replacement.

The replacement of energy-inefficient elevator motors may also yield cost-effective savings, but to our knowledge, retrofit work of this kind has not yet been accomplished by weatherization subgrantees.

Professionalism in large building audits has been enhanced by such programs as EA-QUIP. Training auditors in multifamily building science and codes is a high priority. Construction management—from developing strong, clearly-specified work orders through the contracting and monitoring process to quality control—involves skills that are critical in achieving good results in large multifamily weatherization operations. Effective construction management requires knowledge and expertise that remain in short supply. Accordingly, professional training is needed to enhance multifamily weatherization operations.

Evaluation should be integrated into routine multifamily weatherization operations. It is the only way to learn from mistakes and build on successes. Good results are especially useful in gaining further support from building owners, utilities, financing sources, and the community.

SUMMARY

Overall, we have found substantial advances in methods used in larger multifamily buildings. Concern remains over disparity in methods between practitioners, uncertainty in measure performance for buildings, and the need to transfer advances in knowledge to a wider range of practitioners. Effective analysis of appropriate investment levels, leveraging of outside investment, achievement of comprehensive savings, and continuous improvement of methods are all possible (and have been demonstrated).

Achieving improvements across the country is a challenge we must meet in these times of erratic funding and national priorities.

8. REFERENCES

Fels, **M.,** and C. Reynolds 1992. *Energy Analysis in New York CifyMultifamily Buildings,* Energy Authority Report 93-3, prepared by the Center **for** Energy and Environmental Studies of Princeton University for the New York State Energy Research and Development Authority, October.

Gerety, F. 1987. *How to Get the Bestfrom One-Pipe Steam,* 2 vols. Available from City Books, 1 Centre Street, Room 2223, New York, ***NY*** 10007.

Goldman, C. A., K. M. Greely, and J. *P.* Harris 1988. *Retrofit Experience in U.S. Multifamily Buildings: Energy Savings, Costs, and Economics,* LBL-25248, Lawrence Berkeley Laboratory.

Goldner, F., and P. Judd 1989. *Building Energy Use Tracking System,* Final Project Report prepared by the Energy Conservation Division of the New York City Department **of** Housing Preservation and Development **for** the New York State Energy Research and Development Authority, December.

Holohan, D. 1993. *The Golden Rules* of *Hydronic Heating,* Dan Holohan Associates, Bethpage, N.Y.

Holohan, D. 1992. *The Lost Art* ***of*** *Steam Heating,* Dan Holohan Associates, Bethpage, N.Y

Holohan, D. 1994. *Pumping Away,* Dan Holohan Associates, Bethpage, N.Y.

Judd, P. 1990. *The Overheated City: The Prospectsfor Improved Fuel Economy in the Multi-Family Residential Buildings* ***of*** *New York City,* Peter H. Judd, 285 Riverside Drive, 3D, New York, ***NY*** 10025, June.

Judd, P. 1993. *How Much Is Enough: Controlling Water Demand in Apartment Buildings,* American Water Works Association.

Kinney, L., N. Karins, J. Morine, and G. Klein 1987. "Integrating Analytical Tactics into New York State's Weatherization Assistance Program: Project Findings," paper presented at the Third International Conference on Energy Conservation Program Evaluation, August 1987. Final Technical Report with the same title prepared by Synertech Systems Corp. for the New York **State** Energy Research and Development Authority and the New York State Department of State, September 1987.

Kinney, L., F. Baldwin, S. Bretschneider, and L. Rodberg 1989. *An Evaluation* ***of*** *the New York State WeatherizationAssistance Program* **Final** Technical Report prepared by Synertech Systems Corp. **for** the New York State Energy Office, December.

MacDonald, J. 1993. ***Description of the Weatherization Assistance Program in Larger Multifamily Buildings for Program Year 1989,*** ORNL/CON-329, Oak Ridge National Laboratory, April.

McNamara, M., and A. Telford 1990. "The Fuel Oil Pilot Program, Analysis of Fuel Consumption in Multi-Family Buildings," prepared by the EME Group for the New York City Department of Housing Preservation and Development, June.

Padian, F. L. A. 1994. "Confessions of an 'Addicted' Auditor," ***Home Energy,*** May/June.

Rodberg, L., R. Cherry, and G. Cohen 1991. ***Computerization of the New York State Weatherization Assistance Program,*** Energy Authority Report 91-13, prepared by the New York Urban Coalition Housing Group, Inc., for the New York State Energy Research and Development Authority, June.

APPENDIX A

SUPPLEMENTARY MATERIALS

NEW YORK CITY

APPENDIX A

SUPPLEMENTARY MATERIALS, NEW YORK CITY

This appendix consists of:

- A sample of an audit conducted in the summer of 1994 by Andy Padian of the New York Weatherization Coalition using EA-QUIP energy auditing software. The structure is a small (six unit) apartment building in Yonkers heated by natural gas. This building has serious health and safety problems and no attic insulation. The last pages in the audit section show a sample of the 'boiler plate' used by the Coalition to give instructions on heating system maintenance.

- A sample of an economic analysis produced by CONSERVE, Inc. This analysis is for a New York City apartment building with 20 units. The financial projection envisions an owner investment of $41,105 secured through a low-interest load plus an investment of $16,000 by weatherization.

- Instructions to local weatherization subgrantees from the NYC Weatherization Coalition concerning preliminary data which must be collected prior to an audit Building Summary Data and Fuel Consumption Synopsis forms follow.

- A Permission to Enter Premises form. Note that it includes a notice to the building owner concerning the necessity of a financial commitment prior to weatherization.

- A sample of the typical components of an owner agreement for a multifamily weatherization job.

BUILDING ADDRESS: [redacted] STREET
WESTCHESTER PUTNAM AFFIRMATIVE ACTION
FEBRUARY 18, 1994
6 APARTMENTS

E N E R G Y   A N A L Y S I S

S U G G E S T E D   S C O P E   O F   W O R K

A N D

E N G I N E E R I N G   C A L C U L A T I O N S

F O R   T H E   P R O P O S E D   I M P R O V E M E N T S

A T

[redacted] STREET, YONKERS, N.Y.

AUDIT PERFORMED BY F.L. ANDREW PADIAN

THIS ENGINEERING AUDIT WAS PREPARED IN CONSULTATION WITH
THE NEW YORK CITY WEATHERIZATION COALITION
505 EIGHTH AVENUE, SUITE 1805, N.Y.C., N.Y. 10018

C_O_N_T_E_N_T_S

This engineering audit was prepared using the most current and accurate fuel consumption data for the building. The estimates that it projects are intended to help guide the owner. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

THE EA-QUIP ENGINEERING AUDIT HAS BEEN APPROVED FOR USE BY:
THE UNITED STATES DEPARTMENT OF ENERGY
THE NEW YORK STATE DEPARTMENT OF STATE
THE NEW YORK STATE ENERGY OFFICE
THE NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

EXECUTIVE SUMMARY
BUILDING CONDITION AND SCOPE OF WORK
for
[redacted] STREET

This building poses a particular health and safety and heating system replacement issue that should be tied together. The six apartments in this building have gas fired ovens/stoves, some of which are older models that have heating capacity built into them and are direct vented. All of the apartments have gas hot water makers and separate gas space heaters in the front (north) rooms of each apartment. On the day of our visit, we found one unit heater improperly vented, and another perilously close to bed covers. Some tenants complained that they barely used the heaters because of safety fears, and in one case, the old stove was registering 110 ppm ambient carbon monoxide (CO) in the kitchen. The tenant in that apartment claimed that on a recent cold evening, her roommate had trouble awakening her after warming herself in front of the stove. This, it must be noted, is a fully vented gas stove designed for heating. The combination of these items makes this a health and safety disaster waiting to happen.

To solve this problem, we suggest the installation of combination boiler/hot water maker in every apartment, and replacement of all old unit heaters and stoves that were used for heating. To reduce the heating load, we suggest insulating the front, rear, and roof of the building, and repairing the existing windows as needed.

[redacted] STREET FEBRUARY 18, 1994

SCOPE OF WORK

This is a detailed scope of energy efficiency and related work. It includes items that shall be performed by WESTCHESTER PUTNAM AFFIRMATIVE ACTION and the OWNER(S) of the building. Cost estimates below are high, and reflect a greater quality of work and a higher level of construction management. These items are expected to be performed in the numbered order; the higher the priority, the more immediate the problem, or the more important the work is to achieve greater energy and money savings. These priorities are established using common practices in energy efficiency, building science, and recognized research results.

ALL ITEMS SHALL BE PERFORMED IN ACCORDANCE WITH ALL RELEVANT CODES

1. HEALTH AND SAFETY AND IMMEDIATELY HAZARDOUS CONDITIONS
-Reduce carbon monoxide (CO) levels through appliance replacement
ESTIMATED HEALTH AND SAFETY REPAIR COSTS..................included below

2. HEATING /DHW SYSTEM UPGRADING AND REPAIR
-Install 6 new heating and DHW boilers as per attached specifications
-Add hydronic radiation as needed in each apartment
-Tune to minimum 80% SSE; provide written results
-Add ventilation to code;
-Add new thermostat in each apartment as per specifications
-Replace all showerheads with flow greater than 2.5 gph to maximum 2.5
-Add toilet conservation kit/Replace toilets with new low flush models
ESTIMATED HEATING SYSTEM UPGRADING AND REPAIR COSTS............$20,000

3. APARTMENT AND GENERAL AREA LIGHTING EFFICIENCY REPAIRS
-Replace up to three hard wired fluorescent fixtures per apartment
-Add up to five screw in fluorescent bulbs per apartment as needed
-Upgrade lighting efficiency in hallways and other common areas
ESTIMATED LIGHTING EFFICIENCY REPAIR COSTS..................... $1,200

4. WALL AND ROOF INSULATION WORK
-Dense pack cellulose insulation into wall cavities per attached specs
-Air seal all bypasses into ceiling/roof cavity
-Insulate ceiling/roof cavity with minimum R-44 as per attached specs
ESTIMATED INSULATION REPAIR AND UPGRADE COSTS...................$2,800

5. REDUCTION OF BUILDING DRAFTS WHICH INCREASE STACK EFFECT
-Seal all basement openings and windows; insulate to minimum R-4
-Seal all unused chimneys at the roof and on all other floors
-Reduce venting at roof skylights to code minimums
-Add weatherstrip/door sweep/render self closing all common area doors
-Seal all roof leaks which allow air to escape and water to leak in
ESTIMATED REDUCTION OF STACK EFFECT COSTS....................... $500

6. WINDOW AND DOOR REPAIR WORK
-Repair 21 apartment windows at $25/window
ESTIMATED WINDOW AND DOOR REPLACEMENT COSTS...................... $525

TOTAL ESTIMATED COSTS FOR TOTAL SCOPE OF WORK..................***$25,025***

TOTAL ESTIMATED SAVINGS FROM TOTAL SCOPE OF WORK................**$1,864**

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

Prepared by: F.L. Andrew Padian   Version 8.0 - Nov 1993

[redacted].t. Yonkers N.Y. [Owner: [redacted]]

ORIGINAL bldg	14.0 btufsqftfdeg-day	9272.5 kwh
RETROFITTED bldg	4.1 btufsqftfdeg-day	6934.2 kwh
Energy SAVINGS	70.7%	25.2%

Retrofit DESCRIPTION	LOCATION	1st-Year SAVINGS ($)	Initial COST ($)	Simple PAYBACK (yrs)	Cumul. COST ($)
A-WTHSTRIP WindowsfSEAL fr -	PrimaryWINDOWS	354	450	1.3	450
B-Replace incand. w/FLUORESCENT ---	GENERAL	a7	150	1.7	600
C-INSULATE w/CELLULOSE -------	PrimaryWALLS	719	1,855	2.6	2,455
D-Install 9" loose CELLULOSE ---------	ROOF	291	765	2.6	3,220
E-Lo-flo showers & restrictors -	APPLIANCES	30	192	6.4	3,412
F-Replace INCAND. w/FLUORESCEN -	APPLIANCES	229	480	2.1	3,892
G-2" INSULATION on HW pipes ----	APPLIANCES	0	a	17.2	3,900
H-REGENERATIVE Burner/Boiler --	HEAT-SYSTEM	154	15,000	97.7	18,900
I-REPLACE w/DblThermal Pa -	Roof TopWINDOWS	13	300	22.3	19,200

BUILDING ADDRESS: [redacted] Street, Yonkers N.Y. 7/1/94

GENERAL CONDITIONS: It is understood that those contractors choosing to bid on the boiler/burner replacement specification below must visit the building site prior to bidding. Contractor is responsible for following all applicable City, State, and Federal codes and laws in the installation of this system, and is also responsible for the payment of all related fees for said installation. Contractor is responsible for ensuring that the boiler and burner specified will be able to supply heat and hot water with maximum efficiency and in accordance with all applicable City, State, and Federal laws.

ASBESTOS ABATEMENT: Contractor will be responsible for testing and removal of all asbestos containing materials (ACM's) as it pertains to the replacement of the existing heating and hot water systems only as provided in all New York State Laws in effect as of the completion of the project. Contractor will file all necessary asbestos related reports and pay all fees for the filing of said forms with all necessary government entities.

BOILER: Contractor will remove the existing space heaters and hot water makers and will construct an approved pad for the new boiler. Contractor will install six new heat and DHW boilers, one per apartment, Teledyne Laars Mini-Combo II model 50 with high temperature rigid fiberglass insulation and wrap-around steel jacket including the rear of the boiler, A.S.M.E. approved safety valves and boiler trim. Conractor shall attach this boiler to a maximum of 50 feet of hydronic radiation capable of providing adequate heat within code compliance to the kitchen, bath, and bedroom areas in each apartment. The existing gas lines will be cleaned and modified as necessary in order to accommodate the new systems and all necessary valves, pipes, fittings, and gauges will be installed as required. Contractor shall remove all debris from the site and shall leave all surfaces broom swept unless otherwise noted.

ELECTRICAL: Contractor will furnish all labor and materials to install new electrical service of adequate size to the and to connect it to the new equipment according all relevant codes.

PIPING: Install all new piping, fittings, and valves required to connect properly the new system to each apartment's hydronic, domestic hot water, and gas lines as recommended by the manufacturers and applicable N.Y.C. codes.

TIMING DEVICE: Contractor will furnish and install a Honeywell Chronotherm thermostat to control the cycling and operation of the boiler as per all manufacturer's specifications, and will locate it in the bedroom, away from the kitchen as directed by owner or his representatives..

CONTROLS: The contractor will install all of the following new controls: operating pressure control, modulating aquastat for hydronic water control; low water cutoff control; mechanical draft damper; expansion tank sized properly to the system; temperature and pressure gauge on the boiler; and all other controls required by the manufacturers of the equipment, common boiler and plumbing practice, and all applicable codes.

TESTING/SERVICE/GUARANTEE: Contractor will guarantee price quoted below for 120 days after submission of bid. Contractor will fire equipment and adjust to an efficiency of not less than 82.59, and will provide test results in writing. Contractor will instruct building owner in proper operation and maintenance of new equipment. Equipment will be fired using the smallest possible firing rate in order to decrease cyclical firing and downtime losses while still providing services as required by law. All of the aforementioned equipment will be filed with the jurisdictional departments of the City of New York under the current codes and regulations of same, and copies will be provided to owner upon filing. Contractor agrees to furnish a written guarantee of all equipment with this bid, and agrees to guarantee all equipment and labor for a minimum of one year, from the date of the start-up of the equipment. Original brochures describing all installed equipment including operating instructions and suggested regular maintenance will be left in the boiler room.

ADDITIONAL WORK NECESSARY TO COMPLETE THIS WORK: ____________________

CONTRACTOR BID PRICE: ____________________

CONTRACTOR NAME, ADDRESS, PHONE, AND CONTACT:

____

____

SIGNATURE____________________

TITLE____________________ DATE____________________

TELEDYNE LAARS

Mini Combo II

All That It's Stacked Up To Be

The Mini-Combo II stacks up to be the perfect combination for space and hot water heating...a reliable performer with a small footprint. And installs quickly too.

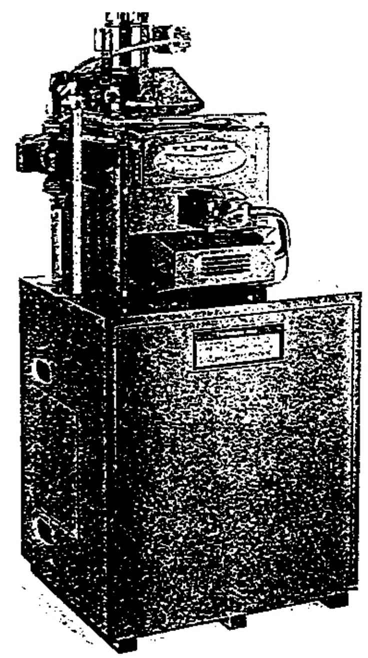
Compact enough with built-in draft diverter, to only take up 24" x 28" of floor space—just right for residential and small commercial applications where space is important.

Capacity is not compromised, even though the footprint is small. Sized from 50,000 to 125,000 BTU/hr., it has at least twice the recovery rate of a typical gas-fired water heater and five times as much as an electric heater! Always enough hot water and heating power—and when your customers demand it.

Easy installation and service. Many manufacturers say it, but Teledyne Laars means it. Mini-Combo II is pre-piped, pre-wired, and factory assembled for quick installation. It even allows for sidewall venting to simplify your job further. And when it comes to service, Mini-Combo II is on top. With modular construction, up-front controls and off the shelf replacement parts, maintenance is a snap.

Reliability is assured with the best warranty on the market today: a twenty year boiler and stainless steel tank warranty will sell even the toughest customer (see complete warranty for details).

Don't just take our word; try the new Mini-Combo II. It really is all that it's stacked up to be. Now available throughout the U.S. and Canada. Contact the Teledyne Laars factory or your wholesaler today for further details on how you can benefit from the new Mini-Combo II.



Residential Space/Water Heater
Sizes 50,000 to 125,000 BTU/hr.

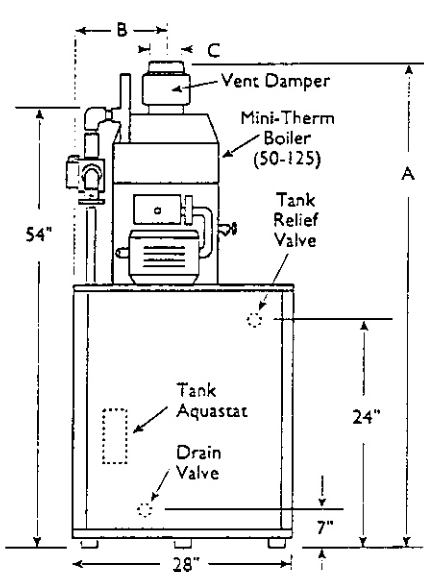
Standard Equipment and Specifications

Water Heater

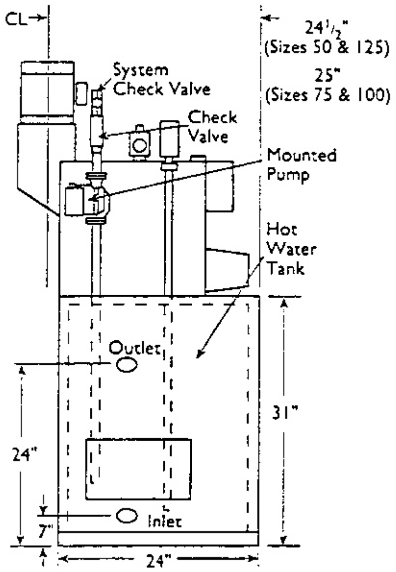
- 30 gallon stainless steel rank
- Maximum working pressure - 150 psi,
- 2" thick foam insulation. Less than $\frac{1}{2}$°F per hour heat loss (R17).
- Hydrostatic test pressure at factory - 300 psi.
- Pre-piped, factory assembled.
- Single-wall cupro-nickel heating coil.
- Circulating pump.
- Check valves, for system isolation.
- Adjustable tank-star. preset at 130°F.
- Pre-installed temperature and pressure relief valve rated at 210°F and 150 psi.
- Pre-piped $\frac{3}{4}$" drain valve.
- Domestic water prioriry.
- High recovery rates (with 65°F rise).

Hydronic Heater

- Built-in draft diverter.
- Natural or propane gas.
- Maximum working pressure - water 30 psi, ASME rated.
- Hydrostatic test pressure at factory - 60 psi.
- Maximum gas supply pressure: Natural-9" W.C. Propane-14" W.C.
- Pressure relief valve - capaciry in excess of boiler input rating.
- Water headers - cast iron per Section IV, ASME Code.
- Water tubes - pure copper with integral external fins.
- Main burners - aluminized steel.
- 115/24 volt transformer.
- Pump relay.
- Vent damper and wire harness, blocked vent safery switch and rollout safety switch (optional in Canada).



Front View



Side View

Specifications

MC Size	Gas Input BTU/H x 1000	DOE Output BTU/H x 1000	Net IBR BTU/H x 1000	AFUE % w/ Vent Damper IID, Nat.	AFUE % w/ Vent Damper IID, Pro.	AFUE % w/ Vent Damper Nat.	AFUE % w/ Vent Damper Pro.	1st Hour Rate GPH
50	50	42	36.5	84.4	85.4	**80.2**	82	87
75	75	63	54.8	84	85.2	80.5	82.5	129
100	100	83	72.2	84	85	***80.7***	82.7	148
125	125	104	90.4	83	84.5	***80.7***	82.7	168

Dimensions (inches)

MC Size	A	B	C	Boiler In/Out NPT	Gas NPT	Domestic Inlet/Outlet NPT	Approx. Weight (lbs.)
50	$58\frac{3}{4}$	$12\frac{1}{2}$					
75	$58\frac{3}{4}$	$12\frac{1}{2}$	5	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	274
100	$59\frac{3}{4}$	$14\frac{1}{4}$	5	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	280
125	$59\frac{3}{4}$	$14\frac{1}{4}$	6	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	**286**

TELEDYNE LAARS

20 Industrial Way, Rochester, NH 03867. Tel: (800) 362.5678 (603)335-6303 Fax' (603) 335.3355
480 S Sewce Road West, Ontario, Canada L6K 2H4 • Te (905) 844.8233 Fax: (905)845-2635
6000 Condor Drive, Moorpark, CA 93C21 . Tel: (805) 529-2000 Fax: (8C5) 529-5934

Litho in U S A © Teledyne Laars Document 8000D 9310
Printed on Recycled Paper

APPENDIX

A

DESCRIPTION OF THE BUILDING

PLEASE REVIEW THE DATA ON THE FOLLOWING PAGES!

The following pages are put together from our analysis of the building, and represent the majority of the data collected about the building condition. If, upon review, these do not reflect the true circumstances in the building, please let us know. We will recalculate the expected savings if the data entry is incorrect.

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

prepared by: F.L. Andrew Padian   Version 8.0 - Nov 1993

Current data on [redacted] Yonkers N.Y. [Owner: [redacted]; Date: 06-29-1994

GENERAL ([redacted]. Yonkers N.Y. [Owner: [redacted]])

Dwelling ID/LOCATION .... [redacted] Yonkers N.Y.
CITY for WEATHER data.................... New York
TERRAIN................................. Urban
SHIELDING...... .... Heavy
Ground SURFACE.. .... Old concrete
Number of HEATED FLOORS.................. 3
Number of DWELLING UNITS................. 6
kvg HEATED SPACE per floor............... 1148 sqft
Ceiling HEIGHT.......................... 9 feet
Dwelling MASS........................... Medium
Avg PUBLIC SPACE per floor..... .... 150 sqft
TYPE of public LIGHTING.................. Incandescent
Avg PUBLIC WATTAGE per floor............. 100 watts
COOLING EQUIPMENT....................... None

INFILTRATION

Infiltration MEASURED... .... Not measured
MECHANICAL Ventilation................... None

ROOF

Roof TYPE............................... Flat roof
Insulation TYPE......................... No insulation
Insulatable AIR SPACE.................... 10 in
Roof AREA .... 1275 sqft
No. of Rooftop WINDOWS................... 3
No. of Rooftop DOORS................... 1
No. of Leaking PENETRATIONS............. 1
WATER LEAKAGE through roof............... Small
Roof top MATERIAL...................... Asphalt Shingles or sheeting
Roof ABSORPTIVITY...................... 85%

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

Current data On [redacted] Yonkers N.Y. [Owner: [redacted]] :Date: 06-29-1994

BASE

Base TYPE...............................	Basement
Base INSULATION.........................	No insulation
Floor AREA..............................	1148 sqft
No. of floor PENETRATIONS...............	3
Base WALL INSULATION....................	No insulation
ABOVE-Grade HEIGHT......................	3 ft
Exterior PERIMETER......................	152 ft
No. of WINDOWS..........................	1
No. of DOORS............................	1
No. of leaky PENETRATIONS...............	0
AIR LEAKAGE through Base................	Small amount of leakage
Area of WINDOWS to be SEALED............	.1 sqft
R-value of window SEAL..................	5 F-sqft/Btuh

ECONOMICS&FUEL

Maximum EXPENDITURE.....................	32400 $
Economic TIME HORIZON...................	20 years
Real DISCOUNT rate......................	4.7 %
Space HEATING FUEL......................	Gas
Domestic HOT WATER FUEL.................	Gas
Actual HEATING DEGREE DAYS..............	5497 Degdays
Actual YEARLY Gas use...................	4362 Therms
Actual Gas BASE use.....................	152 Therms/mo
Actual YEARLY Elec use..................	20464 kWh
Actual Elec BASE use....................	1022 kWh/mo
GAS price...............................	.8 $/Therm
GAS price escalation rate...............	2.6 %
ELECTRICITY price.......................	.15 $/kwh
ELECTRICITY price escalation rate.......	.1 %

HEAT-SYSTEM

HEATING EQUIPMENT TYPE..................	Atmospheric Gas Boiler
Rated INPUT capacity....................	270 mbtu/hr
Seasonal EFFICIENCY.....................	65 %
Net FLUE gas temperature................	250 deg F
Measured FLUE gas DRAFT.................	-.01 in. H2O
Measured FLUE CO........................	50 ppm
Measured AMBIENT CO.....................	50 ppm
Barometric DAMPER.......................	None
HEATING SYSTEM condition................	Replace system
AQUASTAT condition......................	Poor
Boiler WATER volume.....................	1000 cuft
BURNER condition........................	Replace burner
Source of boiler room VENTILATION.......	Inside
Air inlet AREA..........................	65 sqin

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

Current data on [redacted]. Yonkers N.Y. (Owner: [redacted]) :Date: 06-29-1994

CTRLDIST

TYPE of DISTRIBUTION system............. Hot water
Total UNINSULATED Pipe/Duct Length...... 1 ft
Avg UNINSULATED Pipe/Duct Diameter...... .5 in
Avg INS Thickness on PIPES/DUCTS........ 0 in
Type of heating CONTROLS................ None
Avg indoor WINTER DAY temperature....... 55 degF
Avg WINTER NIGHT temperature............ 65 degF
PERCENT of dwelling OUT OF BALANCE...... 0 %

APPLIANCES

Avg DAYTIME OCCUPANTS in dwelling....... 6
Avg NIGHT OCCUPANTS in dwelling......... 12
Number of SHOWERS/day................... 12
Total DAILY hot water USE............... 198 gal/day
WATER HEATER TYPE...................... Gas - insulated
Input RATING........................... 360 mbtu/hr
Measured combustion EFFICIENCY.......... 70 %
Hot water TEMPERATURE................... 120 degF
LOCATION of water heater................ Basement
Total LENGTH of UNINSULATED HW pipe..... 1 ft
Avg HW Pipe DIAMETER................... .5 in
FLOW RESTRICTORS....................... None
DRYER type............................. None
STOVE/OVEN type........................ Gas
Typical REFRIGERATOR type............... Man. defrost & freezer
INCANDESCENT watts/unit to be REPLACED.. 200

WALLS (Primary)

NAME of wall........................... Primary
Wall ORIENTATION....................... Multiple
AZIMUTH of north face................... 0 degrees
Wall TYPE.............................. Two by Four Wood Frame
Wall INSULATION........................ No insulation
INSULATABLE wall THICKNESS.............. 4 in
NORTH Wall AREA........................ 1000 sqft
EAST Wall AREA......................... 1530 sqft
SOUTH Wall AREA........................ 1000 sqft
WEST Wall AREA......................... 180 sqft
AIR LEAKAGE though wall................. Small

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

current data on [redacted] Yonkers N.Y. [Owner: [redacted]]:Date: **06-29-1994**

WINDOWS (Primary)

NAME of windows...	Primary
Window ORIENTATION	Multiple
Window TYPE	Double hung
GLAZING	Broken double pane or storm
DRAPES & BLINDS	Shades or Blinds
Average sash FIT	Average
Physical Condition of FRAME	Fair
CRACKS between Frame & Wall	Small
Window HEIGHT	60 in.
Window WIDTH	30 in.
NUMBER of: NORTH Windows	3
EAST Windows	6
SOUTH Windows	**3**
WEST Windows	***6***
DECEMBER solar EXPOSURE - EAST	**50 %**
SOUTH	**50 %**
WEST	**1 %**

WINDOWS (Double Pane)

NAME of windows	Double Pane
Window ORIENTATION	Multiple
Window TYPE	Double hung
GLAZING	Double pane
DRAPES & BLINDS	Shades or Blinds
Average sash FIT	Average
Physical Condition of FRAME	Good
CRACKS between Frame & Wall	Small
Window HEIGHT	60 in.
Window WIDTH	30 in.
NUMBER of: NORTH Windows	**12**
EAST Windows	6
SOUTH Windows	3
WEST Windows	0

WINDOWS (Roof Top)

NAME of windows	Roof Top
Window ORIENTATION	Horizontal
Window TYPE	Skylight
GLAZING	Single pane
DRAPES & BLINDS	None
Average sash FIT	Average
Physical Condition of FRAME	Fair
CRACKS between Frame & Wall	None
Window HEIGHT	30 in.
Window WIDTH	30 in.
NUMBER of Windows	**4**

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

Current data on [redacted]t. Yonkers N.Y. [Owner: [redacted]]:Date:
06-29-1994

DOORS (Entrance)

NAME of doors.. .... Entrance
Door TYPE.............................. Plain (Hinged)
Door MATERIAL.......................... Glass w/Metal or Wood Frame
STORM doors or VESTIBULE................Vestibule
Door FIT............................... Loose
Door AREA.............................. 35 sqft
Approximate GLASS area.................. 10%

DOORS (Rear Porch)

NAME of doors.......................... Rear Porch
Door TYPE.............................. Plain (Hinged)
Door MATERIAL.......................... Wood Solid Core
STORM doors or VESTIBULE................ None
Door FIT... .... Loose
Door AREA.............................. 126 sqft
Approximate GLASS area.................. 25 %

DOORS (Basement)

NAME of doors.......................... Basement
Door TYPE.............................. Plain (Hinged)
Door MATERIAL...... .... Wood Solid Core
STORM doors or VESTIBULE................ None
Door FIT............................... Loose
Door AREA.............................. 42 sqft
Approximate GLASS area.................. 0 %

APPENDIX

B

FUEL CONSUMPTION INFORMATION

The following pages show fuel consumption for your building in three different ways. First, the information provided to us by the owner or fuel supplier for the building. Second, a computer analysis of that consumption adjusting the usage for average degree day consumption in New York City, and comparing that usage to what *a* building *of* similar size and configuration should be consuming (actual vs. predicted usage). Third, a graphic representation of the difference between actual usage and predicted usage.

Please note that predicted and actual can be very different. If your actual usage is less, it means that the building is either very efficient, or possibly suffered from regular or prolonged heating system downtime. Our only way to ascertain downtime is through repair bills and/or tenant interviews. If your actual usage is greater than predicted, there is room for savings in your building. In the best cases, the actual and the predicted usage graphs will look very similar, meaning that the owner keeps good fuel records and our audit has described the building accurately.

[redacted] Tenant and House Electric and Gas Bills

Gas expressed in therms; Electricity in KWH

APT. #	GAS BASE	GAS TOT.	ELEC. BASE	ELEC TOT.
HOUSE	86	1035	257	6260
1L	14	440	130	1920
1R (9 MOS.)	11	338	50	1676
2L (3 MOS.)	12	387	100	1500
2R	12	558	75	1020
3L	6	800	300	4080
3R (5 MOS.)	11*	804	110	4008
TOTALS	152	4362	1022	20464

BASE GAS USAGE: 1824 (42%)
HEATING GAS USAGE: 2538 (58%)
BTU/FT.2/HDD: 15.21
BASE USAGE/APT/DAY: .83 THERMS/APT/DAY

BASE ELECTRIC USAGE: 12264 (60%)
PEAK ELECTRIC USAGE: 8200 (40%)

HEATED FLOORS = 3
AVG. HEATED SQ. FT./FLOOR= 1148
TENANTS= 12
ROOF SQ. FT. = 1275

***incomplete records for gas; estimated from other apartments**

EA-QUIP-----Energy Audit using the Queens Information Package-----EA-QUIP

Prepared by: F.L. Andrew Padian version 8.0 - Nov 1993

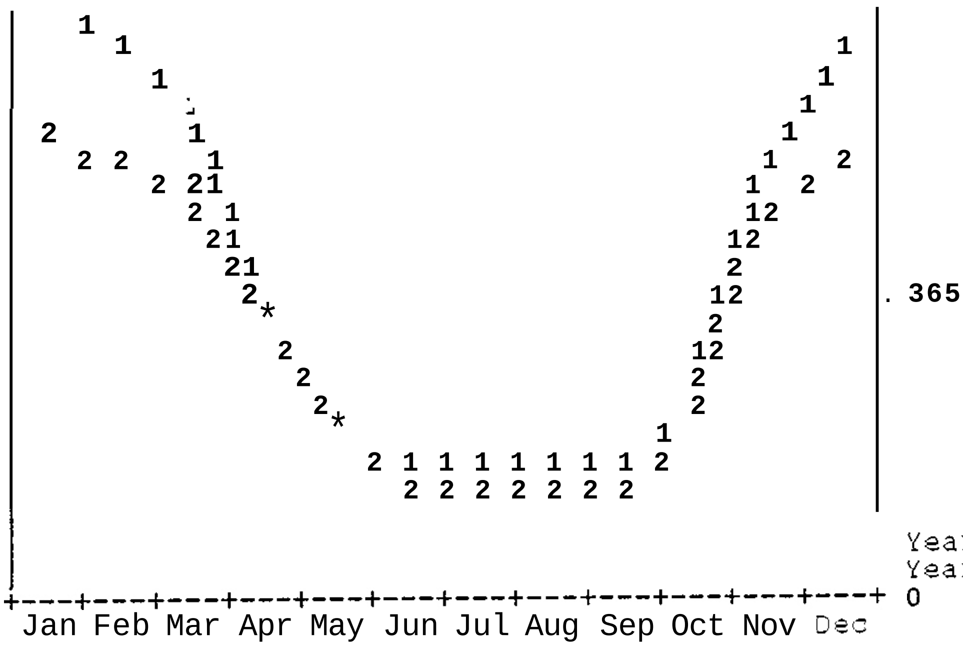
[redacted] Yonkers N.Y. [Owner: [redacted]]

	1 C gas	2 A gas	3 DayOn	4 NitOn	5 Ht Ld	6 Sgain	7 Infil	a Telec	
Jan:	725	561	17.1	46.7	34	3	1.37	0.8	:Jan
Feb:	666	531	16.6	48.2	31	3	1.42	0.7	:Feb
Mar:	583	488	7.6	40.2	24	6	1.41	0.8	:Mar
Apr:	320	327	0.0	20.2	9	9	1.03	0.8	:Apr
May:	209	193	0.0	5.2	1	12	0.86	0.8	:May
Jun:	163	152	0.0	0.0	-2	12	0.77	0.8	:Jun
Jul:	169	152	0.0	0.0	-15	12	0.69	0.8	:Jul
Aug:	169	152	0.0	0.0	-5	10	0.70	0.8	:Aug
Sep:	163	152	0.0	0.0	-2	7	0.81	0.8	:Sep
Oct:	267	238	0.0	12.8	5	4	0.94	0.8	:Oct
Nov:	532	452	7.8	36.8	21	3	1.22	0.8	:Nov
Dec:	658	530	14.0	42.7	29	2	1.23	0.8	:Dec
yr(sum):	4624	3929			131	82			:yr(sum)
yr(htg):	4624	3929			155	a2			:yr(htg)

1 = C gas - Calculated gas use (therm)
2 = A gas - Actual gas use (therm)
3 = DayOn - Daytime Heat On-time (%)
4 = NitOn - Nighttime Heat On-time (%)
5 = Ht Ld - Total heating load (MMBtu)
6 = Sgain - Solar gain (MMBtu)
7 = Infil - Infiltration (ac/hr)
8 = Telec - Overall elec use (MWh)

EA-QUIP-----Energy Audit using the Queens Information Package-----EA-QUIP

[redacted]



EA-QUIP energy data

	1 C gas	2 A gas
Jan:	725	561
Feb:	666	531
Mar:	583	488
Apr:	320	327
May:	209	193
Jun:	163	152
Jul:	169	152
Aug:	169	152
Sep:	163	152
Oct:	267	238
Nov:	532	452
Dec:	658	530
Year(sum):	4624	3929
Year(htg):	4624	3929

1 = C gas - Calculated gas use (therm)
2 = A gas - Actual gas use (therm)

APPENDIX

C

EA-QUIP COMPUTER PRINT OUTS

EA-QUIP is a computerized energy auditing program which estimates the heat losses and gains in your building, looks at the current condition of the building, and calculates the potential savings of many energy conservation improvements.

EXISTING CONDITIONS...Give you an estimate of the heat gains and losses in the building caused by numerous factors.

APPLICABLE ENERGY CONSERVATION MEASURES RATED BY LIFE CYCLE SAVINGS TO COST...Give a comparative advantage to those measures which both save substantial amounts of energy and have a long life. The higher the life cycle savings/cost number, the better the long-term investment.

ENERGY SAVINGS...Tell you how much each of the listed measures will save in percentage of total bill.

INVESTMENT ANALYSIS...looks at each measure by their return on investment–compares the investment opportunities in your building.

[redacted] Yonkers N.Y. [Owner: [redacted]]

Seasonal INFILTRATION (cfm)	612.1	383.4
AIR EXCHANGE RATE (ach)	1.18	0.74

	Overall	Roof	Wall	Wdws&Doors	Base
Conduction (Btu/hr/degF)	1593.2	294.2	606.5	356.1	492.5
Infiltration (Btu/hr/degF)	542.7	0.0	0.0	542.5	0.2

	North	East	South	West	Horizontal
Wtr SOLAR APERTURE (sqft)	116.64	119.77	66.35	36.61	60.95
Smr SOLAR APERTURE (sqft)	116.84	119.77	66.35	36.81	80.95

System & Economics:

	Heating	Cooling	WaterHtr	Electric
Type of EQUIPMENT	Atmospheric	None	Gas - insul	-na-
Day/Night THERMOSTAT (degF)	55 / 65	78 / 78	120	-na-
FUEL PRICES ($/MMBtu)	8.00	43.94	6.00	43.94
Real FUEL ESCALATION (%)	2.60	0.10	2.60	0.10

Real DISCOUNT rate : 4.70%

Economic HORIZON : 20 yrs

Real MAINT ESC rate : 3.00%

EA-QUIP-:----ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

[redacted] Yonkers N.Y. [Owner: [redacted]]

APPLICABLE ENERGY CONSERVATION MEASURES
RATED BY LIFE-CYCLE SAVINGS/COST

Savings = heating, cooling, hot water, and electrical energy saved, for each retrofit separately on the original dwelling, with no interaction among the retrofits.

	1st-year Savings ($)	Cost ($)	Life Cycle Savings/Cost
Replace incand. w/FLUORESCENT--------------GENERAL	86	150	6.1
Seal ROOF LEAKS--------------------------------ROOF	< 1	20	<.1
Install 9" loose CELLULOSE--------------------ROOF	269	765	5.7
SEAL basement windows-------------------------BASE	< 1	No cost	--
REGENERATIVE Burner/Boiler-------------HEAT-SYSTEM	510	15000	0.6
1" INSULATION on HTG pipes----------------CTRLDIST	< 1	6	0.2
Lo-€10 showers & restrictors------------APPLIANCES	30	192	2.5
Replace INCAND. w/FLUORESCENT-----------APPLIANCES	230	480	0.9
1" INSULATION on HW pipes---------------APPLIANCES	< 1	6	0.4
2" INSULATION on HW pipes---------------APPLIANCES	< 1	7	0.7
INSULATE w/CELLULOSE-----------------Primary WALLS	664	1855	5.8
WTHSTRIP Windows/SEAL frames-------Primary WINDOWS	321	450	7.6
WTHSTRIP Windows/SEAL frames---Double Pane WINDOWS	26	524	< 0
WEATHERSTRIP Windows--------------Roof Top WINDOWS	< 1	50	< 0
REPLACE w/DblThermal Pane---------Roof Top WINDOWS	13	300	<.1
Weatherstrip Doors------------------Entrance DOORS	1	200	< 0
Weatherstrip Doors----------------Rear Porch DOORS	4	200	< 0
Weatherstrip Doors------------------Basement DOORS	1	200	< 0

EA-QUI?------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

Prepared by: F.L. Andrew Padian Version 8.0 - Nov 1993

[redacted] Yonkers N.Y. [Owner: [redacted]]

ENERGY SAVINGS

Spent: **$19,200** Limit: **$32,400**

ORIG operating cost: $4,848/yr SAVINGS in **op** cost: $1,877/yr

	Heating	Cooling	WaterHtr	Electric
ORIGINAL bldg (MMBtu/yr)	264	0	168	32
RETROFITTED bldg (MMBtu/yr)	77	0	164	24
Energy SAVINGS	70.7%	0.0%	2.3%	25.2%

Retrofit DESCRIPTION	LOCATION	savings in HEATING	COOLING	WATERHTR	ELEC
A-WTHSTRIP Windows/SEAL fr	PrimaryWINDOWS	16.7%	-	-	-
B-Replace incand. w/FLUORESCENT ---	GENERAL	-	-	-	6.2%
C-INSULATE w/CELLULOSE -------	PrimaryWALLS	34.0%	-	-	-
D-Install 9" loose CELLULOSE ---------	ROOF	13.8%	-	-	-
E-Lo-€lo showers & restrictors	APPLIANCES	-	-	2.2%	-
F-Replace INCAND. w/FLUORESCEN	APPLIANCES	-1.6%	-	-	19.0%
G-2" INSULATION on HW pipes ----	APPLIANCES	<.1%	-	<.1%	-
H-REGENERATIVE Burner/Boiler --	HEAT-SYSTEM	7.3%	-	-	-
I-REPLACE w/DblThermal Pa	Roof TopWINDOWS	0.6%	-	-	-

EA-QUIP------ENERGY AUDIT using the QUEENS INFORMATION PACKAGE------EA-QUIP

Prepared by: F.L. Andrew Padian Version 8.0 - Nov 1993

[redacted] Yonkers N.Y. [Owner: [redacted]]

Type of EQUIPMENT	AtmosphericNone		Gas - insul	-na-
FUEL PRICES ($/MMBtu)	8.00	43.94	8.00	43.94
Real FUEL ESC rate	2.60%	0.10%	2.60%	0.10%

Retrofit DESCRIPTION	LOCATION	Discounted PAYBACK	Int RATE of RETURN	SAVINGS to COST RATIO
A-WTHSTRIP Windows/SEAL fr -	PrimaryWINDOWS	1.9yr	57.4%	8.6
B-Replace incand. w/FLUORESCENT ---	GENERAL	2.0yr	53.2%	6.7
C-INSULATE w/CELLULOSE -------	PrimaryWALLS	2.7yr	42.3%	6.3
D-Install 9" loose CELLULOSE ---------	ROOF	2.7yr	41.6%	6.2
E-Lo-flo showers & restrictors -	APPLIANCES	6.9yr	17.6%	2.5
F-Replace INCAND. w/FLUORESCEN -	APPLIANCES	99.9yr	-9.7%	0.9
G-2" INSULATION on HW pipes ----	APPLIANCES	30.3yr	1.6%	0.7
H-REGENERATIVE Burner/Boiler --	HEAT-SYSTEM	99.9yr	-17.5%	0.2
I-REPLACE w/DblThermal Pa - Roof	TopWINDOWS	99.9yr	999.9%	0.0

APPENDIX

D

SUGGESTED REGULAR MAINTENANCE CHECKLIST

` BOILERS AND RELATED EQUIPMENT

DAILY

Check gauge glass for color and level of water
Check fuel level–if near red marker, fill tank

WEEKLY

Blow down all water valves on boiler as needed
If chemically treated, check water chemicals
Check oil strainers for impurities
Clean fire eye and smoke detector lenses
Check condition of brickwork in firechamber
Check color and characteristics of flame
Check for soot in fire chamber--clean if any exists
Check for soot in tubes or heat exchange areas
Check barometric damper is operating properly
Check Combustion Efficiency (if you own kit)
Check level of lubrication in all motors, burners, etc.
Check Heat Timer settings, pins, and clock time
Check operation of low water cutoff by blowing down valve
Clean fuel nozzle or rotary cup
Sweep up any soot or debris in boiler room
Check for chimney soot build up, clean if necessary

WHEN OIL IS DELIVERED (OIL BOILER)

Clean oil strainer(s) prior to delivery
Check fuel tank level with petrometer and/or dipstick
Estimate the size of delivery needed to fill tank
When truck arrives, insure that new ticket is inserted into
meter prior to start of fill (ssk driver to demonstrate)
Wait outside with truck until delivery is completed
Get copy of receipt from driver
Check fuel level again with petrometer and/or dipstick
Check accuracy of delivery' (previous + delivery = full tank?)
Report any inconsistencies to management
Enter date, consumption, cost, and taxes in fuel log

WHEN GAS BILLS ARRIVE (GAS BOILER)

Insure that reading is actual, not estimated (do not pay est)
If estimated, call gas company to make actual reading
Check all readings and all calculations
Enter date, consumption, cost, and taxes in fuel log

LESS REGULAR MAINTENANCE

Have Service Company check combustion efficiency (CE)
Get boiler cleaned, water treated, burner serviced, new parts
(AT LEAST once before, once during, and end of season)
Get all service recommendations in writing (including CE)
Check pop safety valve (every six months)
Clean boiler room vent to insure adequate air for combuslion
Check condition of ail insulation in boiler room and basement
Get timing device calibrated by manufacturer every two years

DISTRIBUTION SYSTEMS

BASEMENT

Check for steam or domestic hot water (DWH) leaks; repair
Repair all torn or broken insulation (note: if you think that
it may be asbestos, call an asbestos testing firm)
Check all insulation--if warm to the touch, re-insulate
Check main vents throughout basement; if none, add them
Add extra main vents on longer main lines as needed
Listen for water hammer in mains-these may need to be pitched
Replace vents that are rusted, painted, or have blown water
Seal all basement openings that are not in use
Weatherstrip (WS), sweep (s), render self closing (rsc), and
caulk (c) all doors into basement end boiler room door

APARTMENTS

While steam is corning up, check for leaks in each apartment
Check for lines, risers, or radiators that do not get hot
Check pitch of all radiators; adjust to 1/16" per foot
Replace or repack leaking valves
Repair all valves so that they are capable of 100% shut off
Replace vents that do not work, are painted, or are clogged
Place large vent at the top of riser; more if line is cold
WS/C/S/RSC doors and windows as needed in drafty apartments

COMMON AREAS

WS/S/RSC front, vestibule, roof, and other entrance doors
Adjust chains/balances/locks on hallway windows and WS
Repair/replace cracked glass, rotted wood, and putty
Seal ail penetrations into hallways that are unused
Seal dumbwaiters in basement, hallways, and on roof
Seal all unused chimneys on roof and in apartments
Caulk skylights, window and door frames, and other cracks
Repair roof flashing as needed or where cracking

ABBREVIATIONS USED ON THIS WORKSHEET

WS=WEATHERSTRIP
S=ADD DOOR SWEEP
RSC=RENDER SELF CLOSING
C=CAULK
CE=COMBUSTION EFFICIENCY

CONSERVE, INC.

INVESTMENT ANALYSIS

FOR A 20-UNIT APARTMENT BUILDING

CONSERVE, INC. INVESTMENT ANALYSIS:

Properly:		
Owner:	**#of Rms:**	**65**
AGENCY:	**#of Apts:**	**20**

SUMMARY AND CONCLUSIONS:

The preliminary analysis has taken a close look at the long term benefits the owner will receive from the energy project in relation to the investment level requested. The benefits from the project are increased income from the building due to reduction in operating costs over the life of the improvements. This increased income has been compared to loan payments for the owner's investment cost to look at long term changes in the building's cash flow. The investment cost and increased income has also been analyzed with investment formulas to arrive at the internal rate of retum (IRR) and net present value (NPV).

Below is the numerical summary of the financial analysis. These findings are illustrated and explained in the graphs which follow overleaf.

	Project Cost Estimates
Total Labor and Material Cost:	**53.368**
Estimated WAP Investment:	**16.000**
Owner's Construction Costs:	**37.368**
Construction Management Fee:	**3,737**
Recommended Owner Investment:	**41,105**

Loan Terms (if financed):

	5 Year	**10** Year
Annual Payments (low interest loan)	**10.769**	**6.612**

Cash flow Analysis:

	current	Year 1	Year 5	Year **10**	Year20
Net Operating Inwme	**16.751**	**29.155**	**41,452**	**44,259**	**57.542**
Cash Flow	**12.871**	**25.275**	**37.572**	**40.379**	**53.662**

Investment Analysis:

	IRR	NPV
Five Year.	**15.40%**	**1,426**
Twenty Year.	**27.72%**	**28.407**

NET PRESENT VALUE AND INTERNAL RATE OF RETURN:

The analysis of projected investment income from the energy project in relation to the energy investment requested from the owner concludes that the investment would yield the following net present value and internal rate of return:

NPV **28.407** IRR: **27.72%**

RECOMMENDED LEVEL OF INVESTMENT:

Long term cash flow, net present values and intemal rates of return conclude that the benefits of !he proposed investment exceed the costs. It is therefore fair and reasonable to ask the building owner to make the following investment in the energy project: **541.105**

APPRECIATION IN BUILDING VALUE:

The capitalization of net income analysis indicates that by the third year the market value of the building should increase by $124,624 due to project related savings in operating costs. Comparing this value appreciation to an owner investment, valued in the third year at **$60,899** results in a market value increase of $2.05 for every $1 invested by the owner.

CASH-FLOW AND INVESTMENT PAYBACK:

The improvement in cash-flow to the building from project related operating cost savings is projected to repay the investment by the owner within ***7.86*** years. Total projected cash flow from the building should be sufficient to repay the investment within 1.63 years.

OPERATING COSTS AND SAVINGS:

Fuel consumption and savings:

Fuel bill analysis in the energy audit shows very high fuel consumption, $3.42 per **sq. ft.** per year. The audit projects that implementation of the recommended energy conservation measures will result in a fuel cost savings of **39%.**

Maintenance and repairs:

Maintenance and and repair savings are projected due to the replacement of the boiler and bumer and due to the replacement of the windows.

Real Estate taxes:

Real estate *tax* savings are projected for tax abatements available under the **NYC J51** program. The abatement is based upon the **J51 certified** reasonable costs mainly for the replacement of the boiler and replacement of the windows and various upgrading items.

Water Consumption:

Water metering is projected to commence the third year after project completion, and conservation of 15% is due to low-flow showerheads and faucet aerators.

POSSIBLE LOAN FEASIBILITY:

The building appears to be a good candidate for an energy loan due primarily to its moderately strong cash-flow and low indebtedness. The strong cash flow is caused mainly by the moderate operating costs and low debt payments.

No Representations or Guarantees

The conclusions of this analysis are based upon good faith estimates and projections of reasonable possible investment costs and savings in operating costs for the type of project analyzed. No representations or guarantees are made as to exactness of such estimates or that such savings will be achieved **as** projected. The costs and the savings projected might vary depending upon a variety of factors including: specifications for the recommended equipment and installation, **quality** of construction management, follow **up** maintenance **of *the*** equipment and general management of energy **usage** in ***the*** building.

The optimal **workscope Costs,** and the Owner investment needed to complete the projed is estimated as follows:

ENERGY PROJECT WORKSCOPE

ENERGY CONSER. MEASURES	COSTS	PROJECTED SAVINGS
Replace burner/clean boiler	26.000	2.266
Health & Safety	0	0
Distribution System Upgrade	1,168	749
Increase lighting efficiency	0	0
Boiler Room Measures	0	0
Domestic HW System Upgrade	0	0
Reduction of Stack Effect	0	0
Window Replacement	22.400	2,067
Roof Insulation/Resurfacing	3.800	145
TOTAL CONSTRUCTION COSTS:	53.368	5.227
Less:		
WAP Fund Investment	16.000	
OWNER Construction Costs	37,368	
Plus:		
10% Constr. Management Fee:	3.737	
TOTAL OWNER ENERGY INVEST.	41.105	

CONSERVE, INC. INVESTMENT ANALYSIS:

Property:

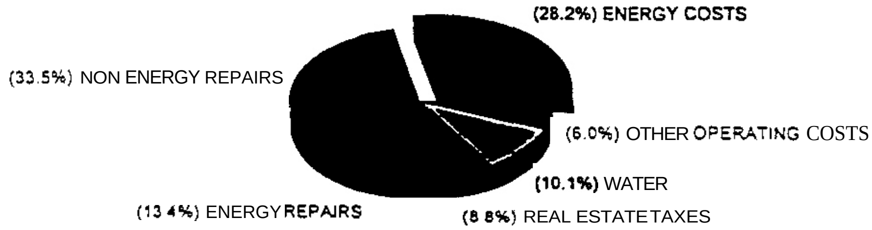
Owner:		#of Rms:	65
AGENCY		#of Apts:	20

Building Profile

Current Operating Costs (energy related):		Operating Costs Savings:	
Fuel:	15.197	Fuel:	(5,227
Maint. 8 Repairs:	7.208	Maint. & Repairs:	(5.456
R.E. Taxes:	4,607	R.E. Taxes:	(2.701
Water:	5,440	Water:	(1,500

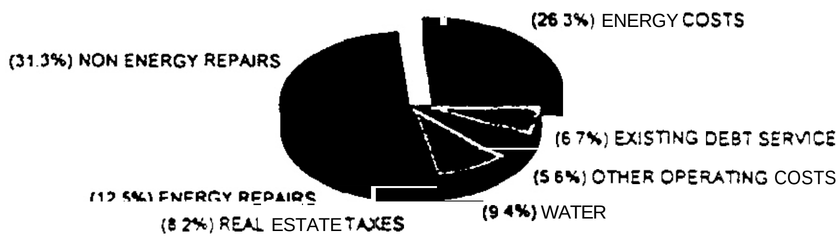
The following pie graph illustrates the percentage break down of total operating costs

Current Building Operating Expenses

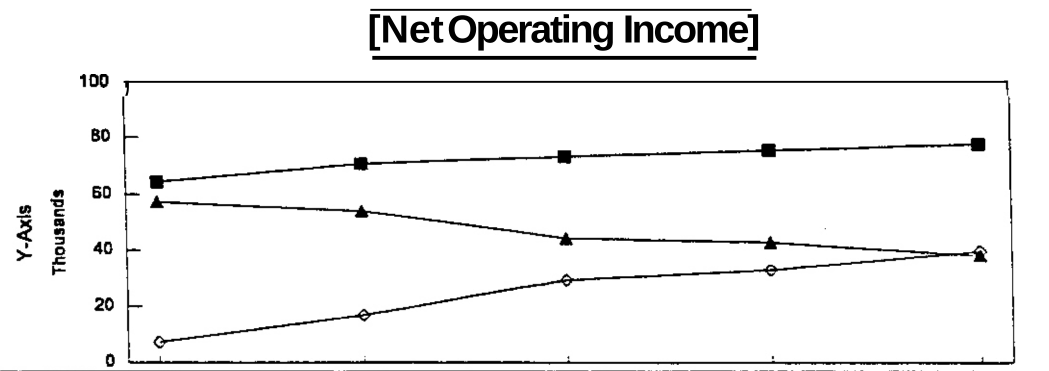


The following pie graph illustrates the percentage break down of total building expenses:

Current Total Building Expenses

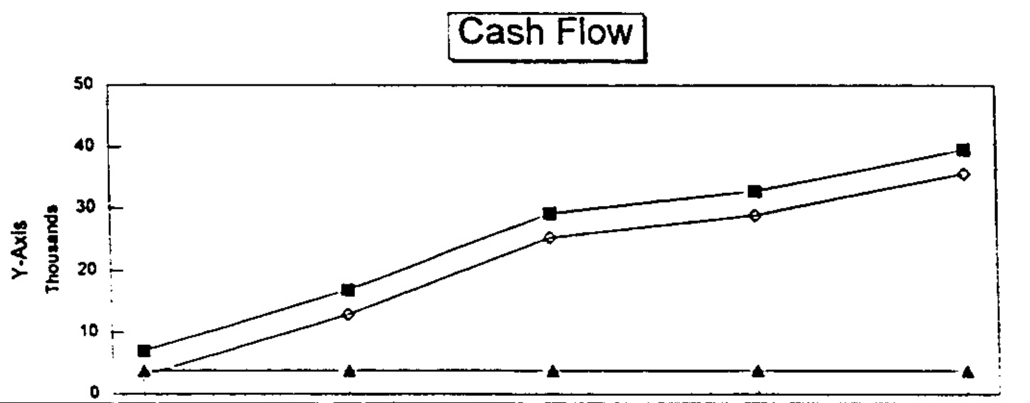


e operating costs decrease from current year to the first year after project completion. which s the effect of increasing net operating income as illustrated – after subtracting from the rental :ome



X-Axis	Last Yr.	This Yr.	Year 1	Year 2	Year 3
■ Rentals	64,253	70,671	73,233	75,430	77,693
▲ Expenses	57,226	53,920	44,078	42,699	38,093
◇ N.O.I	7,027	16,751	29,155	32,731	39,600

The existing debt service is subtracted from the net operating income to arrive at at the cash flow, represented by the following line graph:



X-Axis	Last Yr	This Yr.	Year 1	Year 2	Year 3
■ N.O.I.	7,027	16,751	29,155	32,731	39,600
▲ Debt Pmts	3,880	3,880	3,880	3,880	3,880
◇ Cash Flow	3,147	12,871	25,275	28,851	35,720

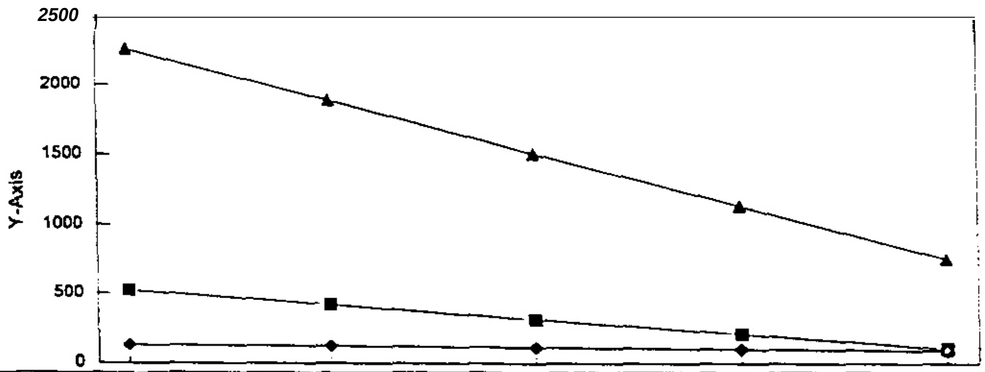
CONSERVE, INC. INVESTMENT ANALYSIS:

Property:		
Owner:	**#of Rms:**	*65*
AGENCY	**#of Apts:**	**20**

Projected Savings and Cash Flow
Cost Savings and Increases in Net Income

The following **line** graph illustrates the energy savings projected for every conservation measure (E.C.M.) recommended **by** the energy audit.

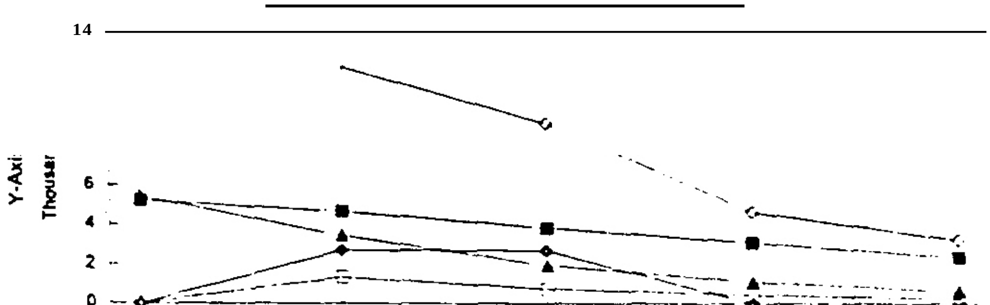
Projected Energy Savings From The Equip Audit



X-Axis	YEAR 1	YEAR 5	YEAR 10	YEAR 15	YEAR 20
■ Lo-Flo Restrictors	522	418	313	209	104
◆ HW Pipe 2" Insul.	130	120	111	101	91
▲ New BurnerBoiler	2,266	1,888	1,511	1,133	755

The following line graph represents increases in net income which directly **result from** savings in fuel. Real Estate taxes, energy maintenance and repairs. and water **/sewer** taxes over a 20 year

20 Year Investment Income
From Operating Cost Savings



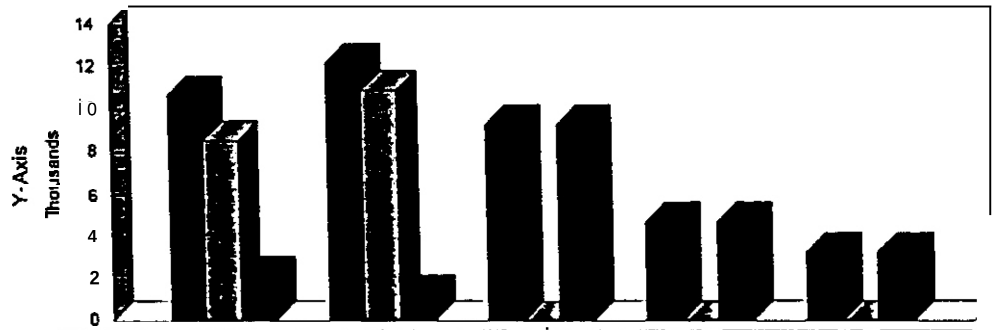
X-Axis	Yr 1	Yr5	YR 10	YR 15	Yr 20
■ Fuel	5.227	4.671	3.854	3.113	2.372
◆ Taxes	0	2.701	2.701	0	0
▲ Maint & Repairs	5.456	3.462	1.961	1.110	629
Water & Sewer	0	1.339	758	429	245
Total Savings	10.683	12.173	9.274	4.652	3.244

Refer to the appendix for graphs illustrating projected operating **costs** with and without the E.C.M.'s.

Projected Cash Flow
With Loan **Financing**

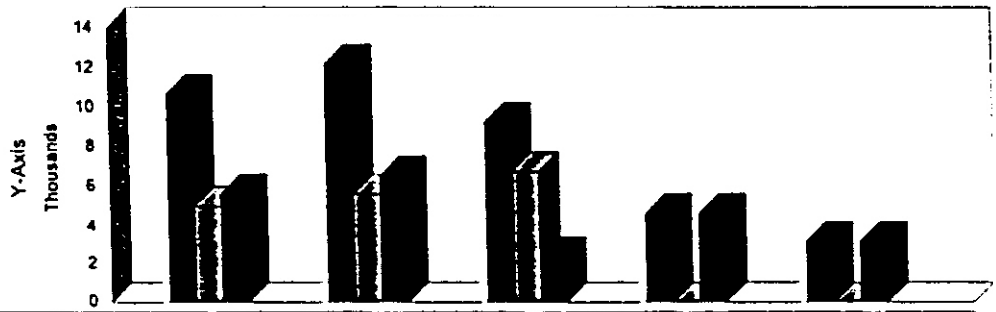
The following bar graphs represent five-yearly change in cash flow if the the project were financed with a low interest energy loan. The change in Cash flow is Calculated by subtracting annual investment costs from the investment income (savings in operating costs). The left hand bar in each duster represents increases in net income resulting from operating cost savings as illustrated in the 20 year investment income graph.

Cash Flow Increases
After 5 Year EILP Payments (2 5%)



X-Axis	Yr 1	Yr 5	Yr 10	Yr 15	Yr 20
■ Inc. in income	10.683	12.173	9.274	4.652	3.244
■ EILP Loan Pmt	8.539	10.900	0	0	0
■ Net after Pmts	2.144	1.273	9.274	4.652	3.244

Cash Flow Increases
After 10 Year EILP Payements (5%)



X-Axis	Yr 1	YR 5	YR 10	YR 15	Yr 20
■ Inc. in income	10.683	12.173	9.274	4.652	3.244
■ EILP Loan Pmt	5.044	5.633	6.775	0	0
■ Net after Pmts	5.639	6.540	2.499	4.652	3.244

CONSERVE, INC. INVESTMENT ANALYSIS:

Property:

Owner:		#of Rms:	65
AGENCY		#of Apts:	20

Proforma Investment Analysis

Investment Scenarios:

The analysis presents three investment scenarios to compare the differences between the owner performing the energy work with and without financial and technical assistance from the WAP Program. The scenarios account for varying levels of knowledge and skills of an owner concerning multifamily building energy conservation and are as follows:

The building gets the WAP funds plus all projected cost savings. This is generally the optimal scenario for the owner. since the WAP **funds** reduce the owner's investment cost, and management of the energy project by the WAP group maximizes operating cost savings and investment income.

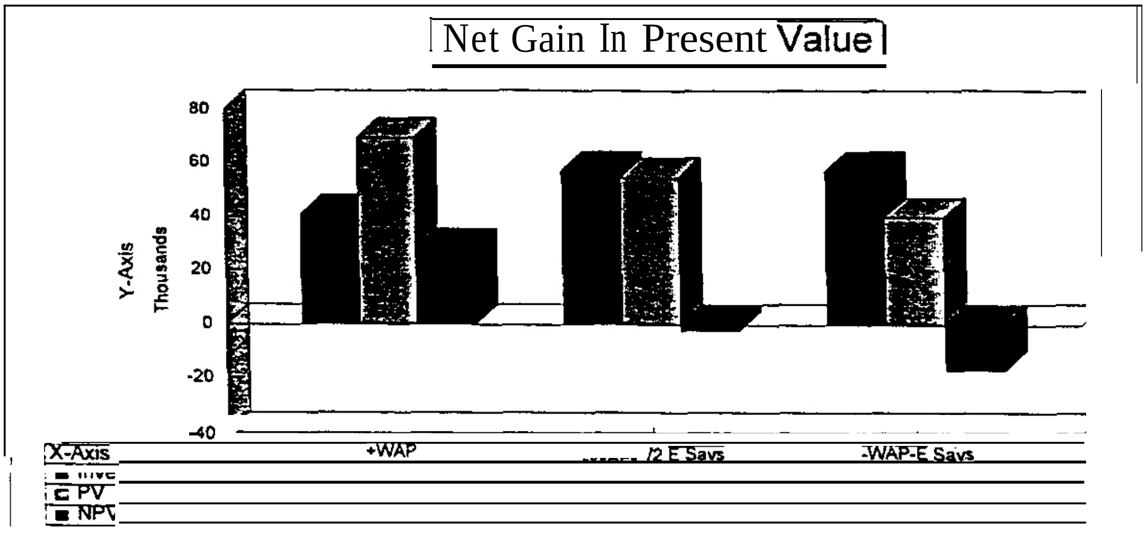
WAP-F SAVS

This scenario applies to an owner with no specialized skills in energy conservation work who performs the project without technical nor financial assistance from the Weatherization Program. The owner pays the full cost of the project with no WAP investment and achieves no energy savings, but gets all other cost savings. This is generally the worst case scenario for the building and the owner. All gains are due merely to J51 tax abatements and reduced costs for maintenance repairs and metered water.

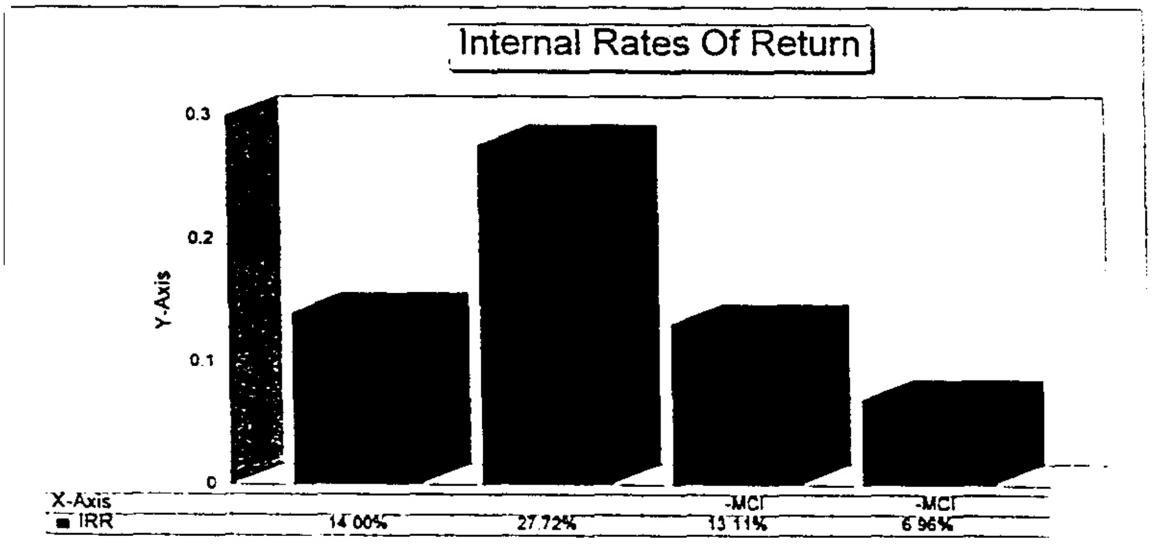
WAP -1/2 F SAVS

This scenario applies to an owner with limited specialized skills in energy conservation work who performs the project without technical nor financial assistance from the Weatherization Program. The Owner pays the full cost of the project with no WAP investment and achieves only 1/2 the the projected energy savings. but gets all other operating cost savings.

The following bar graph represents the net present values for the three investment scenarios:



The following bar graph represents the internal rate of return for the three investment scenarios:

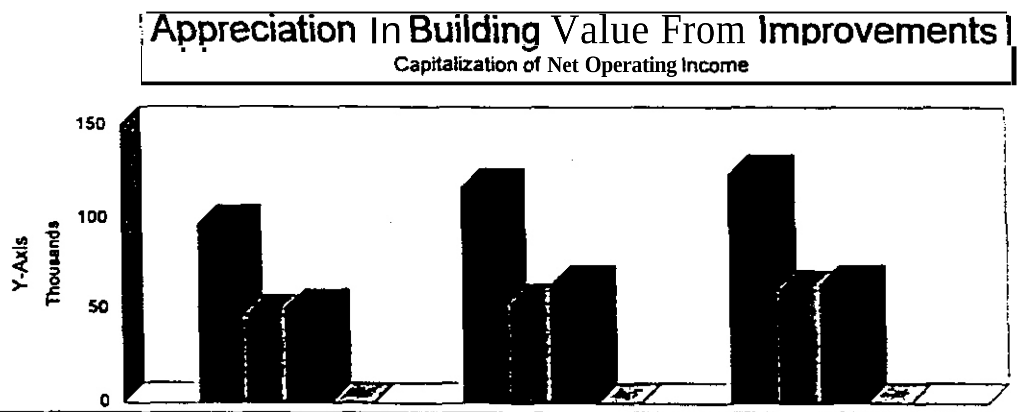


Appreciation in Building Value from Improvements:

Increases in net operating inwme result in the following appreciation in building's value.

	FIRST YEAR	SECOND YEAR	THIRD YEAR
Increases in Net Income:			
Energy Saved:	5.227	5,325	5,161
Energy Repairs 8 Maint.	5,456	4,870	4.346
Taxes Saved (J51):	0	2.701	2.701
Water 8 Sewer	0	0	1,500
Increase in Net Income:	10,683	12,896	13.709
Appreciation in Value	97,120	117,233	124.624
Divided by:			
Total Owner Investment	46.859	53.420	60.899
Value > per $1 Invested	2.07	2.19	2.05

The increase in building value is divided by the owner's investment to illustrate the above ratio (one Dollar of increase in value per one Dollar of Owner's investment).



X-Axis	Year 1	Year 2	Year 3
■ Inc. Bldg Value	97,120	117,233	124,624
■ Owner Invsmt	46,859	53,420	60,899
■ Inc. Over Invsmt	50,261	63,813	63,726
□ Per $1 Of Invst.	2.07	2.19	2.05

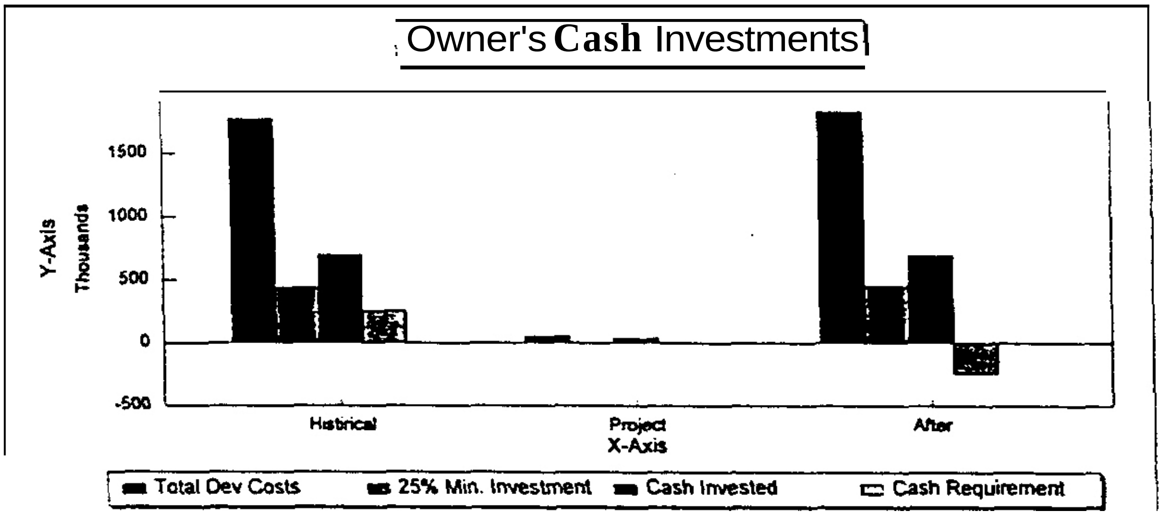
Recommend cash investment:

Recommended cash investment

A recommended investment would bring the owner's equity to a level which should be expected of an owner as a demonstration of *its* commitment to the viability of the building. Just as the bank requires this level of commitment to assure repayment of its loans, the Weatherization Program may require it to assure that the Owner maintains the improvements and complies with its agreement with the weatherization agency. It is reasonable for weatherization to make this cash investment request. in particular. if a later feasibility analysis concludes that the building cannot qualify for an energy loan, or the parties decide to proceed without loan financing (represented below).

Owner's Investment Record:

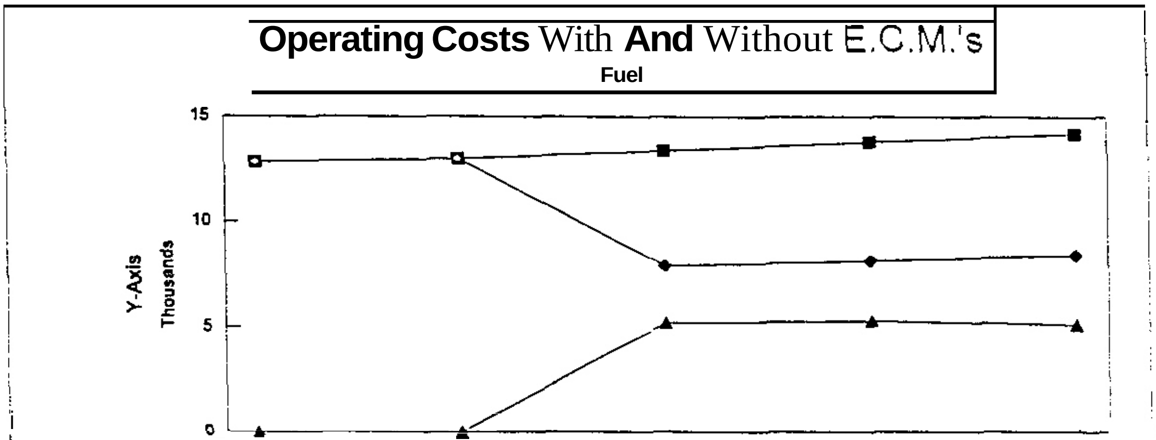
The investment record of the owner in the building discloses that the owner has invested the following amounts in cash toward the costs of purchase and improvements to the building and compares the investment to date to the minimum **25%** required by a lending institution for consideration for an energy loan:



	Historical	Project	After
Total Development Costs (1):	1,780,000	57.105	1,837,105
25% Min. Cash Investment Requirement **(2):**	445,000	14.276	459.276
Cash Investment to date **(3):**	700,000		700,000
Cash Investment lo Meet the Minimum **(4):**	255,000		0
Cash Investment for the Energy Project:			0

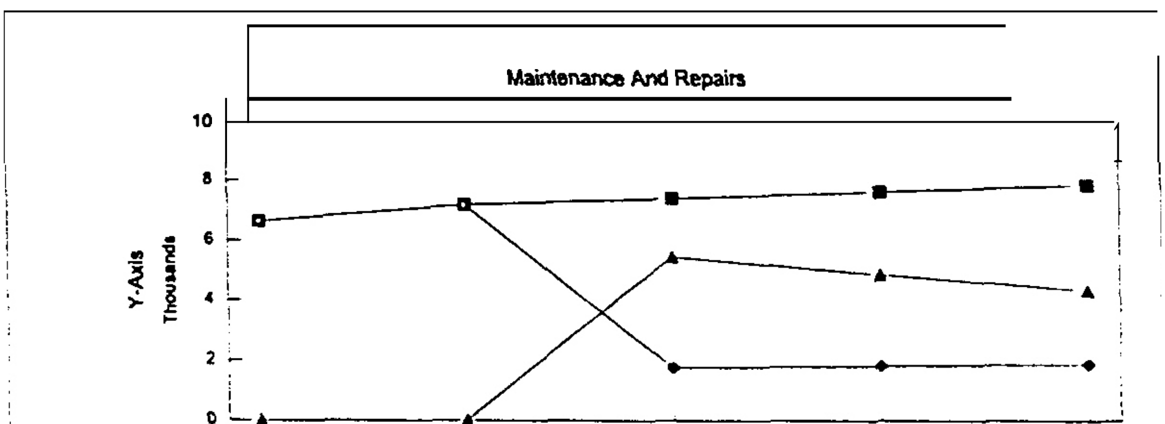
Where the minimum cash investment shows a deficit for the energy project, it is reasonable to ask the owner to make that investment into the project in cash, especially if there are any problems with getting financing from an energy loan.

The following line graph illustrates the effect of energy conservation measures (E.C.M.) on projected fuel expenditures:



X-Axis	Past Yr	This Yr	Yr 1	Yr 2	Yr 3
= Before:	112.839	13.000	13,390	13792	14,205
◆ After:	12.839	13,000	7,928	8,166	8,411
▲ SAVINGS:	0	a	5.227	5.325	5,161

The following line gragh illustrates the effect of energy conservation measures (E.C.M.) on the projected energy maintenance and repair expenditures.



X-Axis	Past Yr	This Yr	Yr 1	Yr 2	Yr 3
■ Before:	6,653	7,208	7,425	7,647	7,877
◆ After:	6,653	7,208	1,763	1,816	1,870
▲ SAVINGS:	0	0	5,456	4,870	4,346

NYC WEATHERIZATION COALITION, INC.

ENERGY EFFICIENCY TRAINING 6 TECHNICAL SERVICES AFFORDABLE HOUSING

505 Eighth Ave., 18th Floor, New York. N.Y. 10018 212 279-3902. Fax 212 279-5306

TO:

FROM: Andy Padian, Director of Energy Audit Services

RE: Getting Your Multiple Dwellings audited

DATE:

As you are probably aware, the Coalition Audit Service (CAS) of N.Y.C.W.C. Ihas been contracted **by DOS** to perform all audits of 5 unit and larger buildings in New York State. This is a task we are ready for, considering our experience in New York City and vicinity over the last year and a half.

To make the process move smoothly, we need some information on the buildings prior to visiting the site. First, and of course foremost, talk to your regional rep (Reggie, Beth, Pauline) about the building, and concur with them that it indeed does need to go through the EA-QUIP process. Some smaller multi-unit buildings are more geared towards TIPS. After talking to your rep, call us if you have any questions or special considerations about the building. Then get the attached forms into us. I know that these are just more forms, but they are necessary in order for us to do a good job.

Form A describes the building briefly. Please fill out as much about the building as you can. Form **B** is for heating and/or DWH fuel consumption. It allows you to add additional pages, and different types of fuel. Please copy this and re-use it as much as possible. We cannot process the audit without a minimum of **367** days of fuel consumption, and we want 2 years if we can get it. Finally, we need the attached Permission to Enter form and a Fuel Release form, which are also located in the Policy and Procedures manual.

That's it. Please mail this information to us at the above address. These are records which must be easy to read, as we have to enter much of this data into the computer, and clarity makes our staff's job much easier. As such, we discourage the use of the fax.

Thanks again. If you have questions, please call me.

FORM A **BUILDING SUMMARY DATA--PRELIMINARY ESTIMATE OF WORKSCOPE**

BUILDING ADDRESS: ____________________

OWNER: ____________________ PH. # ____________

AGENT: ____________________ PH. # ____________

SUPER: ____________________ APT. ______ PH. # ____________

OF APTS: ______ # OF FLOORS: ______ # OF COMMERCIAL UNITS: ______

SUBGRANTEE: __________ DATE OF VISIT: ______ DATE OF 2nd VISIT: ______

HEATING FUEL TYPE: 2 4 6 G OTHER (CIRCLE THOSE THAT APPLY) SSE= ______

CONDITION OF BUILDING (GENERAL): ____________________

CONDITION OF BASEMENT/BOILER: ____________________

SHOULD THE BOILER BE REPLACED/REPAIRED? ______

CONDITION OF ROOF: ____________________

SHOULD THE ROOF BE INSULATED/REPAIRED/REPLACED? ______

CONDITION OF WINDOWS/DOORS: ____________________

SHOULD THE WINDOWS BE REPLACED? ______

CONDITION OF COMMON AREAS: ____________________

HEALTH AND SAFETY PROBLEMS IN BUILDING: ____________________

APARTMENTS VIEWED--PROBLEMS (ADD SHEETS IF NECESSARY): ____________________

NUMBER OF APTS. W/ WASHING MACHINES OR DISHWASHERS ______ OF ______ SEEN

5/10/93

FORM B FUEL CONSUMPTION SYNOPSIS (DOCUMENTATION ATTACHED)

BUILDING ADDRESS ________________________ AGENCY _________________

FUEL TYPE: #2 OIL #4 OIL #6 OIL NAT. GAS ELECTRIC OTHER

DATE OF DELIVERY OR ACTUAL METER READING	TOTAL DELIVERY AMOUNT (GAL/THERMS/KWH)	TOTAL COST

5/10/93

PERMISSION TO ENTER PREMISES FORM
Multi-Family

07/15/92

TO THE BUILDING OWNER:

Your building is being considered for weatherization services under the Weatherization Assistance Program *(WAF').* The WAP is funded by the United States Department of Energy (USDOE) and administered in New York State by the New York State Department of State **(DOS).**

The WAP operates under the rules and regulations of both USDOE and DOS which have certain requirements of which you **as** a building owner should be aware. At the bottom of this page is a form granting your permission for the local agency to enter your building to perform **an** energy audit and collect eligibility documentation from your tenants.

Before **the** work begins on your building, you will be required to sign a Building Owner's Agreement, **a** copy of which is attached **so** that you may review it before the final signing.

DOS requires a financial commitment to the weatherization of each building containing rental units from the building's owner, except where the owner is an eligible applicant. **This** commitment can take several forms, **and** is dependent on the results of the energy audit. When the audit is complete the local weatherization agency will meet with you again to discuss this commitment, and sign the Agreement with you.

Before your building is audited, DOS also requires a good faith commitment of $500 to cover the ***cost of*** the audit. When your building is weatherized, the audit fee will be credited to your financial commitment. If for any reason your building is not weatherized, a copy of **the** energy audit and the proposed workscope will be given to you.

PERMISSION TO ENTER PREMISES

I, as owner/authorized agent for the building located at ______________________
have read and understand the above and hearby grant permission for representatives of ____________________________________ to enter this premises for the purposes of conducting an energy audit and collecting eligibility documentation from the residents. I also include the required audit fee, under the conditions above.

Name____ Date_________
Title____

Agency Representative______________________________ Date_________
Title____

WEATHERIZATION ASSISTANCE PROGRAM
MULTI-FAMILY OWNER AGREEMENT

***

This Agreement applies to buildings containing rental dwellings units, located in New York State.

***

This Agreement is made and entered into by and between

____

(The Agency) and

____

(the Owner)

____

(Premises to be Weatherized)

This Agreement shall commence on the _____ day of __________, 199__ (the commencement date) and shall terminate on the ___ day of __________________, ____ (the termination date).

WHEREAS, the Energy Conservation in Existing Buildings Act of 1976 (Weatherization Act) authorizes grants to the states to provide weatherization assistance to eligible households and New York State has received a grant fund for such purpose; and

WHEREAS, the Low-income Home Energy Assistance Act of 1981 (HEAP Act) authorizes grants to the states to provide assistance to eligible households to meet the costs of home energy and New York State has received a gram of funds for such purpose; and

WHEREAS, DOS has received an allocation of funds granted to New York State under the Weatherization Act and a suballocation of funds awarded under the HEAP Act; and

WHEREAS, said funds are to be used to weatherize the dwelling units of eligible households who are the intended beneficiaries of the assistance available under the Weatherization Act of HEAP Act; and

WHEREAS, DOS has contracted with the Agency to use said funds to make Weatherization Materials and Weatherization Labor available for the benefit of eligible households; and

WHEREAS, many eligible households reside in rental housing in buildings containing rental dwelling units which may be weatherized if *not* less than 66 percent (50 percent of duplexes and four unit buildings) of the dwelling units in the premises are eligible dwelling units;

WHEREAS, the Agency has demonstrated a readiness to make Weatherization Materials and Weatherization Labor available for the benefit of eligibie households who reside in rental housing:

WHEREAS, the eligible households residing in the dwelling units and buildings receiving weatherization assistance are the intended third party beneficiaries of this Agreement;

WHEREAS, the Department of Energy has issued a policy guidance which specifies a procedure for the States to prioritize buildings containing rental units by financial participation of the owners to avoid undue enhancement of properties as prohibited in the final rule;

***

NOW THEREFORE, in consideration of the foregoing premises the parties agree as follows:

I. <u>DEFINITIONS</u> As used in this Agreement.

A. Agency shall mean an entity which contracts with and receives a grant of funds from DOS to provide residential weatherization assistance to eligible households.

B. Owner shall mean either (1) the party holding legal title to the building located at ____________________________________ (hereinafter the Remises) which contains a total of __________ dwelling unit(s) whether occupied or not as of the effective date of this Agreement or (2) a person authorized, in writing, to enter into a contract for the party holding legal title to said building.

C. Dwelling unit shall mean a house, apartment, a group of rooms of a single room occupied as separate living quarters.

D. Household shall mean any individual or group of individuals who are living together as one economic unit in a dwelling unit and who make undesignated payments for their primary heating source in the form of rent and/or maintenance charges or pay for their heat directly.

E. Eligible household ahall **mean** a household whose income is **less** than or **equal** to the **higher** of 150 percent of the United States Office **of Management** and **Budget** (OMB) poverty level for the State of 60 percent of the **State** Median Income calculated on a monthly basis, w a **household** who **falls into a** category **all of whose** members am eligible by law or **regulation.**

F. Eligible dwelling unit **shall** mean:

1. A dwelling unit occupied **as** of the **effective** date of **this** Agreement by **an** eiigibb household. The Agency **shall not consider** any unit **to** be an eligible unit unless it **has received** sufficient **written documentation** indicating **that** the dwelling unit la occupied by an Miibb **household in** the form required by the Agency. The **name** and income of the eligible household must remain **confidential in accordance with state or federal law.** A **schedule** of **the** documented eligible dwelling units and the rents charged **therefore** is Exhibit **A;** of

2. A dwelling unit that **is** vacant M of the **effective** date of **this Agreement designated** by the Owner as a dwelling unit that **will** be **rented** to **or** occupied by an eligible household **within** 180 days of the **certification date** of **the completion of** the **work.** The **Owner** ahall include in Exhibit A dwelling units w h i i have been **so** designated, **noting them as vacant.**

G. Common **area** shall Include. **but** not be **limited to,** stairwells, hallways, basements, roofs **and** boilers, and ineligible **apartments**.

H. Weatherization Materials shall mean any and all materials that meet or exceed (1) the standards prescribed by the 10 CFR section 440 (as amended) of (2) **higher** standards as established by DOS.

I. Weatherization Labor **shall** mean the **costs** incurred by the Agency to employ labor W to engage **a subcontractor** to **install** the Weatherization Materials set forth in subparagraph I(H) of this Agreement.

J. Program Support shall mean the *costs* incurred by **the Agency** in weatherizing the unit other than those outlined in **paragraphs I.** (H) and **(I)** including **audit** and **in-house** labor **costs.**

K Workscope **shall** mean the **entire** scope of the actual work projects **as set** forth in Exhibit B and Exhibit C **if** necessary. including materials and labor, to be performed pursuant to this Agreement.

L Certification shall mean the written and signed attestation by a DOS representative that the Workscope for a **particular** eligible dwelling unit has been satisfactorily performed.

M. Pro rata share shall mean **the cost** charged to any eligible dweiling unit for **the** weatherization **materials.** labor and program **support** supplied by the **Agency** to **an eligible** dwelling.

II. <u>LIQUIDATED DAMAGES</u>

The parties agree that for the purpose of this Agreement, in the event of a breach by **either** party, liquidated damages shall be computed as follows:

A For dwelling unit liquidated damages: the **pro rata** share **shall** be divided by .94 to derive the per unit liquidated damages which ahall be multiplied by the number of dwelling units in breach to determine the total dwelling unit liquidated damages.

B. For common **area** liquidated damages: the dollar **value of** the **Agency's** Workscope for **the** common area. as itemized in Exhibit **B, shall** be divided by .94 to determine the total common area liquidated damages.

III. <u>**OWNER'S OBLIGATIONS**</u>

A1 For eligible dwelling units which are **not** subject to **statutorily authorized** rem control and rent stabilization, the M e r agrees that the rents for eligibie dwelling units as set forth in Exhibt 4 **shall not** be increased for the term **of** this Agreement.

A2 For eligible dwelling units which am subject to **statutorily** authorized rent control and rent stabilization. the owner remains able to **receive approval for normal** incremental rent increases granted by the *New* **York State** Division of **Housing** and Community Renewal **(DHCR).**

B. The Owner agrees **that** the rents for eligible dwelling units. **as set** forth in Exhibt 4 **shall** not **be** increased, solely due to the **weatherization improvements** paid for by Weatherization **Assistance** Program **Funds (10** CFR Sec. 440.22). This provision specifically prohibits the Owner's application for, **and** receipt of. a Major Capitol Improvement **(M.C.I.)** rent increase for the weatherization work completed under **this** Agreement.

The New York **State** DHCR shall be **notified** by the **Agency** in accordance with Section IV(D) of this Agreement of the weatherization **work** completed **under** Exhibit **B** weatherization **Agency's** Workscope) and Exhibt C (Owner's Worksmpe) **of** this Agreement.

C. The Owner agrees that the terms, promises and obligations **of** this Agreement **shall supersede** and **be** superior to any **inconsistent** provision of any oral or written lease or other agreement affecting the rents **collected** for the eligible dwelling units **listed** in Exhibt A

D. The Owner agrees that dwelling units identified in Exhibt A w h i i are **vacant as of** the **effective** date **of** this Agreement, **shall** be rented **to or** occupied by an eligible household within 180 days of the **certification** date. The **Owner** further agrees to submit, or cause to **have** submitted to the **Agency, written proof of** that household's eligibility. **prior** to lease or **occupancy of** such **vacancy.**

E. The Owner hereby swears or affirms that the premises is not presently being offered for sale and further agrees to give the Agency 30 days notification ofthe sale or conversion of the premises. At least 10 days prior to the sale or conversion the Owner agrees to obtain. in writing, the purchaser's consent to assume the owner's obligations under this Agreement or. if this consent is not obtained, to pay the Agency the full cost of weatherization pro rated by the number of months left under this Agreement.

F. The Owner agrees to complete or cause to be completed to the satisfaction ofthe Agency, the work as specified in Exhibit C

G. The Owner agrees to maintain the weatherization materials installed under this Agreement, in accordance with all relevant codes regarding maintenance.

H. The Owner agrees to be responsible for the removal and reinstallation (or installation where none exist and are required by cod.)of all child guards, security gates, or other items so that the installation of prim windows may proceed in an unimpeded manner. Such work must be in accordance with all applicable cdl..

I. The Owner hereby swears or affirms that the premises has not previously received weatherization assistance under any program administered by the Department of State after September 30, 1985. Failure to disclose previous weatherization shall be a breach of this Agreement. h the event of such breach the owner shall pay the Agency the full cost of weatherization work under this Agreement.

IV. AGENCY'S OBLIGATIONS

A. The Agency agrees to install, or cause to have installed, Weatherization Materials together with the Labor attendant thereto in the Premises, as itemized in the Agency's Workscope in Exhibit B.

B. The Agency agrees to commence, or cause to commence, the installation of Weatherization Materials on or about ______________ (date); provided that the Owner insures that the Agency will have access to all dwelling units and common areas to be weatherized upon seven days notice of a date certain by the Agency.

C. The Agency agrees to accept and retain the documentation required from the Owner pursuant to paragraphs III(C), III(F), and V (if applicable) of this Agreement.

D. The Agency agrees to send notification to NYS Division of Housing and Community Renewal of the agency's workscope (Exhibit B) and the owner's workscope (Exhibit C), in rent controlled and rent stabilized units.

E. The Agency agrees to duly establish an interest bearing Owner Investment Account and to deposit the moneys rendered to the Agency by the Owner pursuant to paragraph V (if applicable) of the Agreement in said account. The Agency further agrees to promptly release from this account such sums at such time as ar required in Exhibit C (if applicable) of this Agreement to such parties as are specified. Upon completion and certification of the work agreed upon in paragraph V (if applicable) of this Agreement, the interest earned on the M e r Investment Account shall be deposited by the Agency into the Agency's New York State Weatherization Assistance Program bank account and shall be expended no later than the next succeeding program year.

V. OWNER'S WORK

A. The parties agree that the Agency shall not commence, or cause to be commenced, the installation of any Weatherization Materials unless the Owner completes, or agrees to complete to the satisfaction of the Agency, the repairs or other requirements specified in the Owner's Work Agreement. if any. annexed hereto as Exhibit C. and submits written documentation of same to the Agency.

B. h the event that the Agency agrees to commence the installation of Weatherization Materials prior to the Owner's completion of the work required in Exhibit C, the Owner shall:

1. Post a performance bond in an amount equivalent to the cost of securing the completion of the required work with the Agency named as insured; or

2. Render to the Agency $____________, said sum being the cost of securing the completion of the required work. Said sum shall be deposited by the Agency in a duly established M e r Investment Account to be released to the Owner or the Subcontractor, responsible for completion of the Owner's Work to the satisfaction of the Agency.

VI. BREACH: THE FOLLOWING SHALL CONSTITUTE EVENTS OF BREACH

A. The Agency's failure to install, or cause to have installed. to the extent that funds are available, the Weatherization Materials listed in Exhibit B in a timely and workmanlike manner: provided the Agency gained access to the eligible dwelling units upon seven days notice by the Agency to the Owner.

B. The Owner's failure in a timely manner to submit to the Agency the documentation required in paragraphs III(C), III(F), and V (if applicable) to this Agreement.

C. The Owner's failure to rent or place in occupancy an eligible household in a vacant eligible dwelling unit specified in Exhibit A within 180 days of the certification date.

D. The **Owner's increasing** *of* the rent **charged** an eligible household occupying an **eligible** dwelling unit. except as noted in paragraph III(A2).

VII. REMEDIES

A. In the event that the Owner fails to submit in a timely manner to the Agency the documentation required in paragraphs III(C), III(F) and V *(if applicable)* of this Agreement the Agency shall **notify the** Owner in writing by registered mail of the nature of the breach. If the Owner does not, within seven business days from receipt of **notification. commence** to pursue diligent cure of such **breach** or **provide** the **Agency with reasonable notice** that *such* default **does not,** in fact, exist, the Owner shall pay the Agency an amount equal to ten percent of the per unit liquidated **damages** multiplied by the total number of dwelling units eligible for **weatherization**.

B. In event that the Owner fails **to rent** or **place** in *occupancy* an eligible **household** in a **vacant** eligible dwelling unit **specified** in **Exhibit** A within 180 days of the certification date, the Agency shall notify the **Owner in** writing by registered mail of the nature of the **breach.** If the **Owner** does not, within seven business days **from** receipt of **notification**, commence to pursue diligent cure of such **breach** or **provide** the **Agency with reasonable notice that** *such* breach does not, in fact, exist, the Owner shall pay the Agency the per dwelling unit liquidated **damages; provided,** however, that it said eligible dwelling unit was **counted** for determining whether common space shall be **deemed** to be eligible for weatherization the **Owner** shall in addition pay the *Agency* the common **area** liquidated damages.

C. In the **event** that the Agency fully or partially fails to install, or **cause** to have installed, the Weatherization **Materials listed** in Exhibit B **in a timely** workmanlike manner, the Owner shall notify the Agency in writing of the nature of the breach and the Owner's **intention** to terminate or suspend this Agreement for breach. If the Agency does not, within seven business **days from** receipt of **notification.** commence to. and diligently **pursue** cure of **such** breach, or if the **Agency** fails to provide to the Owner reasonable notice that *such* breach does not, in fact **exist.** the **Agency** shall reimburse to the **Owner** the amount of moneys remaining in the Owner **Investment** Account, with interest or release the **Owner from all** obligations **under** the **performance** bond.

D. In the event that the Owner increases the rent **charged** to an eligible household occupying an eligible dwelling unit, the **occupant(s)** of the eligible dwelling unit as third party beneficiaries of **the** Agreement *can* **assert** any direct claim **against** the Owner in any action or special proceeding in *any* Court of appropriate jurisdiction.

VIII. INDEMNIFICATION

The Agency shall **not** be **held** responsible or liable in any way for the failure to provide work, labor. service. or materials provided **for** by **the terms** *of* this Agreement by reason of federal. state or municipal requirements or regulations prohibiting the provision of such work. labor. **service.** or **materials.**

IX. SYNOPSIS OF TERMS

The Agency shall provide a synopsis of the terms of this Agreement to the households occupying each eligible dwelling unit **within** thirty **days** of the effective date of this Agreement. Further. the **Agency shall** provide. or cause the Owner to provide, a synopsis of the terms of this Agreement to subsequent households occupying each eligible dwelling unit and to the new and subsequent **occupants** of eligible dwelling units vacant as of the *effective* date of this agreement

X. ACCESS TO DOCUMENTS

The **Agency** shall provide *any* occupant of an eligible dwelling unit **access to** this document in accordance with federal and **state** laws regarding confidentiality and privacy.

XI. EXHIBITS

All Exhibits relevant to this agreement shall be initialed by both parties and become a part of this Agreement **upon** signing of both parties. **In the** event an Exhibit or Exhibits **cannot** be completed at signing. provisions relating to those **exhibits** shall **not** be considered binding until *such* time as they are completed initialed by both parties, and attached to this Agreement.

XII. SEVERABILITY

The provisions of this Agreement are severable. If any provision of this Agreement is found invalid, *such* finding shall not affect the validity of this Agreement **as** a whole or any part or provision hereof other than the provision so found to be invalid.

The parties acknowledge that this Agreement is under seal.

Owner	**Date**
Agency	**Date**

APPENDIX B

SUPPLMENTARY MATERIALS

CHICAGO

APPENDIX B

SUPPLEMENTARY MATERIALS, CHICAGO

This appendix consists of:

- **A description of the multifamily building approval process employed in Chicago**
- **An intake form used in multifamily weatherization work**
- **A description of the audit process and measures considered**
- **An apartment unit worksheet employed by auditors**
- **A form used for assessing heating systems in multifamily buildings**

C. Multi-Family Building Approval Process

Prior to scheduling work on multi-family buildings, agencies are required to obtain written approval from the Department to weatherize buildings that have five or more units. No more than 30% of the agency's weatherization planned production may be used for weatherizing multi-family units unless written approval has been given by the Department. In addition, agencies must submit a completed Multi-Family Building Plan and approval form (see pgs. VI-9 and VI-10) to the Department prior to starting the work.

The local agency should submit a written request to their assigned Grants Manager who will review the request with the Weatherization Specialist. The following information must be included in the Multi-Family Building Plan:

1. Name or owner/manager;
2. Address of building;
3. Number of units;
4. Heating system types configuration;
5. Type of work (general description); and
6. Preliminary assessment of the various size and type of apartments, and estimated materials and labor costs for each apartment type.

Prior to approval for the start of work, the Weatherization Specialist must visit the building and review the initial assessment. No work on the building may begin until the local agency has received an approval letter from the Grants Manager.

The local agency shall obtain the approval of the building owner/manager during the time the information is being developed for the "Multi-Family Building Plan". The landlord/owner will need to get an idea whether or not he/she will have to make a financial contribution in the event the heating system needs to be replaced.

As part of the approval process, the building owner/manager must sign the Building Owner Certification and Work Authorization (see page III.26). This form gives the local administering agency the permission to work on the property. In addition, the Rental Agreement, which protects the tenant from having the landlord raise the rent due to the weatherization work on the building, must be signed (see pages III.27-III.28).

D. Reversing Approvals and Denials per Section 440.18/Vacating Clients

As described in Section I of this manual, Section 440.18 of the DOE Rules and Regulations describes the allowable weatherization expenditures. In two specific instances, a "standard" approval or denial 'is to be overturned. These are:

1. A household is approved, but lives on a site scheduled for clearance within 12 months of the date of weatherization; and

2. A household is denied as having received prior weatherization, but the unit has been damaged by fire, flood, or act of God, and the repair of the damage to the weatherization materials is not paid for by insurance.

WEATHERIZATION
MULTI-FAMILY BUILDING PLAN

Agency ____________________

Multi-Family Building Address ____________________

Owner/Manager (Contact) ____________________

Address ____________________ City ____________ Zip ________

This Form was prepared by (Name and Title) ____________________

OUTREACH:

Have all the clients in the building been informed about the Weatherization Program?

A. Has each client received a brochure? Yes ___ No ___

B. Has the building manager/owner talked to the apartment occupants? Yes ___ No ___

C. Has the program staff talked to the apartment occupants? Yes ___ No ___

D. Has each apartment household head received notice on what documentation will be required? Yes ___ No ___

INTAKE:

How will the intake for the building be done?

A. Local Weatherization Agency office (indicate name and location)

____

B. Who will help with the application? ____________________

____

C. Are there elderly clients who need assistance to get to the intake site, if so, who will get them there?

____

D. Are the clients Spanish speaking, if so who will do the translating?

____

E. Who will help the client fill out the application?

____

F. What is the target date for obtaining completed application? ____________

SECTION VII

Assessment

A. General Overview

The assessment is one of the most important steps in the weatherization process. It is the first point at which the agency enters the client's home, and determines the structural condition of the home. The assessor's job is to conduct a thorough review of the home so that the weatherization measures to be installed will save the most energy.

The process for conducting the assessment of the home is contained in the Whole House Energy Audit (WHEA) Manual, Volume V, Section 7.2. The assessment for both the architectural and the furnace is required to be done at the same time, with the exception of an emergency (a household with no heat). The WHEA manual contains the assessment documents for both the architectural and the furnace. The assessment documents were developed to obtain both general and specific household information and used to input information in the Whole House Energy Audit which will determine the priority of work to be done. Instructions for completing the assessment documents are also contained in Section 7.2 of the WHEA manual.

B. Multi-Family Buildings

Once the agency has received approval from the Department to weatherize an entire Multi-Family Building, an assessment of the building shall be conducted. This section shall provide the agency with multi-family work priority in descending order of importance.

In addition, an apartment assessment form and heating systems assessment form shall be used by the agency. The assessment forms have been provided and are located at the end of this section.

1. Mechanical Systems - Multi-family buildings differ from single family structures in that there are greater opportunities to save energy and reduce fuel consumption. given the many designs and complexities of the various heating systems which include:

   a. Combustion components;
   b. Venting/chimney;
   c. Distribution;
   d. Control; and
   e. Replacement design and procedure.

   Changes/alterations in system design operation and proper equipment maintenance are the main elements that a qualified heating system consultant shall consider. The mechanical assessment and retrofit recommendations must address these system elements in order to properly optimize the heating performance in a multi-family building. The mechanical system components mentioned in the sections that follow are not an exhaustive listing. The list of mechanical system components is only a starting point to identifying the most appropriate work to optimize performance of mechanical systems.

1) Checking the distribution pipes for leaks;
2) Ensuring there is proper pitch for the pipes;
3) Insulating headers and supply lines;
4) Properly sizing main line vents;
5) Checking on leaks in the radiator valves;
6) Ensuring that the air vents on radiators are sized properly;
7) Ensuring return line traps are in working order;
8) Ensuring traps in radiators are clear/clean; and
9) Installing thermostatic valves on radiators and pipe insulation.

d. <u>Control</u> - One of the most effective ways to improve the energy efficiency of the heating unit is to use the most current control devices adaptable to the system. The control devices to fire the boilers at the right time are dependent on the age, configuration and specific type of heat transfer method, e.g. hot water, warm air, or steam system. The consultant or contractor shall assess whether updated control will reduce consumption. Examples of these devices are:

1) Outdoor reset controls;
2) Outdoor/indoor reset controls;
3) Averaging temperature remote sensing unit;
4) Outdoor cutoffs;
5) Steam cycle control; and
6) IID/electronic ignition.

e. <u>Replacement Design and Procedure</u> - In addition to cleaning and tuning the mechanical system(s) areas of efficiency, improvements may include:

1) Derating systems that are oversized;
2) Replacing significantly oversized units with high efficiency units; e.g., modular boilers and domestic hot water;
3) Replacing unsafe units; and
4) Replacement efficiency requirements.

The design and heating load requirements must be done by the mechanical consultant.

2. ***Attics***

Attics and roof areas in multi-family buildings should be insulated to R33. This is particularly important in buildings which have large attic/roof square footage. Good examples of multi-family structures that need insulation are row houses. Often these buildings have inadequate insulation and venting.

Sealing bypasses in the attic and basement shall be done to ensure that the R-value of the insulation is not degraded. Sealing the bypass situation at the top and bottom of the building reduces the heat loss by reducing the stack effect.

Attic bypasses. open to the basement or crawlspace, are also a common feature of the row house construction. Bypass conditions create a significant stack effect on the whole building. In some cases, there is an open space between common apartment walls that is not sealed;

multi-family building, the energy auditor has to focus on the building as a whole and must pay particular attention to the special characteristics or sections that 'are unique to multi-family buildings. Only after identifying the unique sections can appropriate retrofits and sealing be recomnended.

The objective of the assessment is to reduce the stack effect, which is accentuated in buildings of more than two stories and many apartments, when compared to single-family structures. There are two similar sets of infiltration and exfiltration areas:

a. Multi-Family Unique Components and Bypasses - Multi-family buildings often have features or building sections which do not exist in single-family structures. These building sections shall be assessed, and appropriate retrofits/air sealing shall be recommended. The following list of areas are to be addressed in the multi-family building:

1) Vestibules;
2) Stairway wells;
3) Laundry facility rooms;
4) Furnace rooms;
5) Door to the roof (roof scuttles);
6) Skylights;
7) Basement ceiling;
8) Windows in stairwells;
9) Common area doors to apartment floors;
10) Basement entry doors;
11) Uninhabited areas of basements which have windows;
12) Master meter equipment entry holes;
13) Master furnace piping and water lines which have bypasses to the first floor;
14) Opening in comnon wall to the attic between apartments (most comnon in row housing);
15) Openings on the tops and bottoms of elevator shafts and service shafts; and
16) Unused fireplace flues.

b. Windows and doors - These building components can be treated in the same manner as single family buildings by:

1) Weatherstripping;
2) Caulking;
3) Tightening window sashes and doors by installing locks to help air seal;
4) Replacing broken and severely cracked window panes;
5) Repairing window sashes;
6) Rehanging and repairing existing doors; and
7) Installing storm windows and doors.

Apartment Unit Worksheet

Apartment Number ______ Location ______________ **Job Number** ________________

WINDOWS

Wind Code	Wind Type	Glz. Type	Width	Height	Add Storm	Add Wxstrip.	Caulk Pane	Caulk Frame	Wind. Repl.	Estimate Material	Estimate Labor

DOORS

Door Code	Door Type	Width	Height	Add Sweep	Add Storm	Add Wxstrip	Caulk Pane	Caulk Frame	Door Replace	Estimate Material	Estimate Labor

Intenor Switches & Outlet Gaskets	Intenor Caulking	Caulk Utility Entnes	Mudsill Sealing	Estimate Material	Estimate Labor

Aparunent Building
Heating System Assessment

Building Address: ______________________ Mechanical Consultant: ______________________

Heating System Types

(1) Forced Air
(2) Steam Boiler (1Pipe)
(3) Steam Boiler (2 Pipe)
(4) Forced Water Boiler
(5) Gravity Water Boiler
(6) Gravity Air
(7) Conversion
(8) Space Heater
(9) Wall Heater
(10) Other
(11) None

Fuel Types

(1) Natural Gas
(2) Propane
(3) Fuel Oil
(4) Electric
(5) Wood
(6) Coal
(7) Kerosene
(8) Other
(9) None

Primary Heating System Type _______ Fuel Type _______ Fuel Costs $ _______

Manufacturer ______________________ Model # ______________________

Operational ? _______ Location _______ Central Air ? _______ Winter Temp. Of Furnace Space _______ F

IID Present ? _______ Vent Damper Present ? _______ Setback Thermostat Present ? _______

Induced Draft ? _______ Condensing ? _______ Relocate Thermostat to: ______________________

Age of Furnace _______Yrs. Furnace Condition:______Good (1)______Fair (2)______Poor (3)

Location

(1) Basement
(2) Utility Room
(3) Crawl Space
(4) Kitchen
(5) Attic
(6) Garage
(7) Hallway
(8) Closet
(9) Other

Furnace Replacement Guidelines

(1) System is Unsafe/Hazardous
(2) Cracked Heat Exchanger
(3) Unable to repair
(4) System Undersized
(5) Change of Fuel
(6) Install Central System

Furnace Combustion

Rated Input : ______.______ BTU/HR GAL/HR. KW/HR. Measured Input : ______BTU/HR.

Comments : ______________________

Furnace Venting: Vent Diameter ______/______ Spillage ? ______ Draft ______in.

Flue 02 ______.______% Temperature ______F Efficiency ______/______% CO ______PPM

Vent 02 ______.______% Temperature ______F Efficiency ______/______% CO ______PPM

Soot Smoke Test (Oil) __________ Measured Draft __________

Comments: ______________________

Mechanical System Worksheet

	Retrofit Code	Quantity	Comments	EQ Mat.	Est. Labor
Water Heater Repair					
Heating System Repairs					
Heating System Replacement System Type ______ Fuel Type ______ SSE ______ AFUE ______ Mandatory ______					
Retrofits					

Retrofit Code Guideline

1. Tune and Clean
2. Automatic Setback Thermostat
3. Intermittent Ignition Device
4T Furnace Thermal Vent Damper
4E Furnace Electric Vent Damper
5T Water Heater Thermal Vent Damper
5E Water Heater Electric Vent Damper
6. Oil Flame Retention Burner
7. Gas Fired Power Burner
8. Turbulators
9A. Outdoor Reset Control
9B. Outdoor Reset w/ ASBT Control
10. Outdoor Cutoff
11. Decouple Domestic Water Heater
12. Duct Insulation
13. Water Heater Tank Insulation
14. Water Heater Pipe Insulation
15. Boiler Pipe Insulation
16. Heating System Replacement

Comments ____

APPENDIX C

SUPPLEMENTARY MATERIALS

ST. PAUL

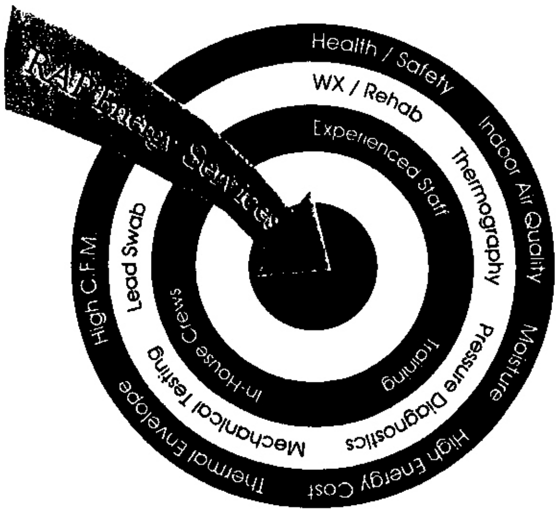
APPENDIX C

SUPPLEMENTARY MATERIALS, ST. PAUL

This appendix consists of:

- **An outreach brochure used by RAP**
- **Instructions for operation of a boiler**
- **An insulation information sheet**
- **A building owner agreement**
- **A copy of a form used to assert tenants' rights under the owner agreement**
- **A sample audit of a high rise building occupied by elderly tenants in St. Paul**

A System Approach



Your home is treated as a system. Our experience and diagnostic tools enable us to identify and address potential problems which may arise as a result of altering one or more components of your home. Treating your home as a system leads to healthier, more comfortable occupants.

Experienced Staff: RAP has an experienced energy audit staff available to solve many housing problems and provide solutions for Heat Loss, Heating, Cooling, Air Quality and Comfort Issues. RAP audit staff utilizes state-of-the-art diagnostic equipment.

Training / Workshops / Tutorials: RAP staff can provide assistance to builders, contractors, educators and housing groups. A wide range of topics for in-field trainings or classroom presentations include: M200 Weatherization, Mobile Home Weatherization, EPDM Roofs, Indoor Air Quality, Heating Systems, House as a System and Client Education Techniques.

RAMSEY ACTION PROGRAMS, INC.
Ramsey Action Programs, Inc
Energy Conservation Division
3315 LaBore Road
Vadnais Heights, MN 55110-5149

RAMSEY ACTION PROGRAMS, INC.

RAP Energy Services

A Full Service Energy Company!

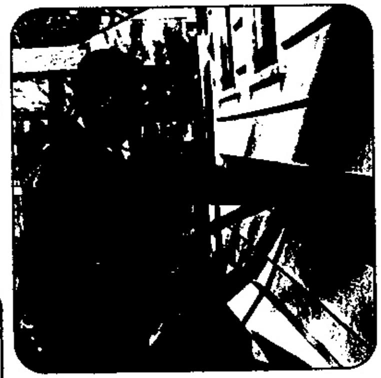
3315 LaBore Road
Vadnais Heights, MN 55110-5149
(612) 482-6135

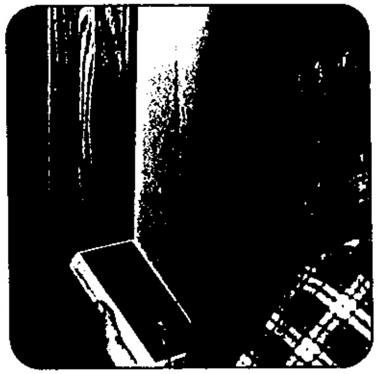
A Full Service Energy Company!

Ramsey Action Programs, Inc.

A Community Action non-profit weatherization delivery agency. Over the past twenty years we have provided low-income residents of Ramsey and Washington Counties with the most comprehensive and high quality energy conservation services in the nation. The current staff has an average of ten years experience in the energy conservation field. RAP utilizes the latest technology and most sophisticated equipment available to provide the best possible service to the homeowner. Now, Ramsey Action Programs has developed RAP Energy Services to offer our expertise to the general public.

RAP ENERGY SERVICES





I-R THERMOGRAPHY
- Analysis / Solutions
- Residential / Commercial
- Quality Control

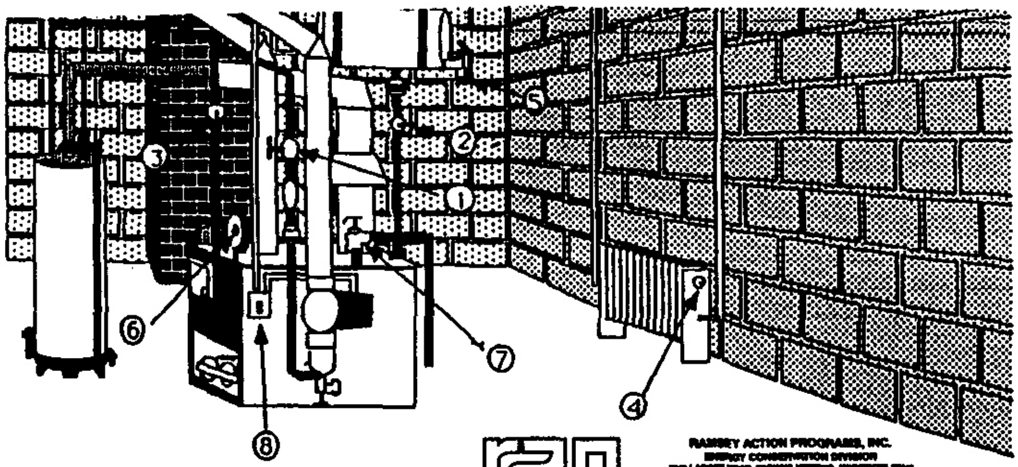
OTHER SERVICES
- Hazardous Materials Identification
- Referral Network
- Consulting

IN-HOUSE CREWS
- Journeymen Carpenters
- Rehab / Remodeling / Weatherization
- Quality Workmanship

MECHANICAL TESTING
- Safety and Efficiency Checks
- State-of-the Art Diagnostic Equipment
- Upgrade/Repair/Replacement/Referral

PRESSURE DIAGNOSTICS
- Blower Door / Pressure Point Testing
- Airtightness & Infiltration
- Indoor Air Quality / New Construction

Diagnostics → Experience → Solutions



RAMSEY ACTION PROGRAMS, INC.
ENERGY CONSERVATION DIVISION

#1 Water fill valve
#2 Expansion tank shut off valve
#3 Boiler main gas shut off.
   Lever parallel to the pipe is on.
#4 Radiator bleeder valve
#5 Expansion tank drain valve
#6 Pressure/temperature guage (min.10-12 lbs.,max21 lbs.)
#7 Safety relief valve (lets water spill when
   the pressure goes over 30 lbs.)
#8 Electrical shut off. (May also be a breaker or
   switch on the side of the boiler.)

==

FILL BOILER--When pressure goes below 10 lbs. Open valve #1, allow boiler to fill to 10-12 lbs. Pressure on gauge #6, then close valve #1.

BLEED RADIATORS--once a year, in October, or whenever a radiator gets *cold.* You only have to bleed the radiator that is cold.

DRAIN THE EXPANSION TANK--every two (2) to three (3) years or when you are experiencing a lot of air in the radiators and/or the safety relief valve (#7) repeatedly blows off (water on the floor) after a normal fill of 10 to 12 lbs. pressure. You will also notice the pressure gauge (#6) needle moves up very rapidly when filling the boiler.

BLEEDING AIR FROM THE RADIATORS--open valve #4. If water comes out---great---close the valve and go to the the next radiator. If air comes out--keep the valve #4 open until water comes out--if no water comes out--check to be sure the spout on valve #4 is open--then close valve #4 and go the the boiler and check the pressure gauge #6--it should read zero (0)--remember normal is 10-12 lbs. Now go back to the radiator and open valve #4 again--air will come out--then water will come out--when the water does come out--close valve #4 and move to the next radiator. After bleeding all the radiators check the boiler pressure on gauge #6 one more time--if water is needed use valve #1 to fill boiler to 10-12 lbs. Your heating system should now work fine and keep you warm for the winter.

DRAINING THE EXPANSION TANK--shut off valve#2. Hook a garden hose on to valve #5-located on the expansion tank. Open valve #5 and drain the tank--if water runs out for only a few minutes--the tank is NOT drained--it takes 10 to 20 minutes to drain a tank. If water does stop coming out of the tank in a few minutes air needs to be put into the tank to release the water. If you have a Drain-o valve #5 installed *on* the expansion tank-remove the center screw in the handle to allow air to enter the tank and release the water. When the water is all drained from the tank put the screw and the handle back in place. DO NOT OVER TIGHTEN the screw--as you may break off the head. *Close valve #5 and open valve* #2. Now add water to the system using valve #1--bring the system to 10-12 lbs. on gauge #6, when you have the proper reading on the gauge close valve #1.

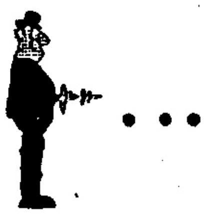
ATTIC INSULATION

The crew may have to insulate your attic from inside your home if you have access doors or scuttle entrances.

If you have alot of things stored in your attic you may have to remove some or *all of it before insulating can begin.*

If you have flooring in your attic some of it may have to be pulled up to allow insulation to be added underneath. The flooring will be put back in place when the crew finishes.

If you have questions about any of this consult with your auditor or *when scheduling the work with the crew.*



WALL INSULATION

** INSTALLED FROM THE INSIDE OF YOUR HOME **

1. The crew will be working inside your home to insulate the outer walls.

2. The insulating crew will be drilling holes and using *a hose to blow* insulation into the outer walls of your house. The holes will be about 16 inches apart.

3. It is very important that you move everything you can away from the outside walls so the crew has room to work.

4. After the walls are blown full of insulation, the crew will patch the holes.

5. You will need to lightly sand and then paint the patches.

note: drilling through the wall and blowing the insulation will be dusty and you may want to have it put in from the outside of your house if you or someone in your family have breathing problems or alergies

WALL INSULATION

** INSTALLED FROM THE OUTSIDE OF YOUR HOME.*

1. The insulating crew will be removing siding and drilling holes on the outside of your house. It your house is stucco, they will drill through it.

2. The crew will be using a hose to blow insulation into your walls. They may need to use a ladder.

3. It is very important that you move everything you can away from the outside walls so the crew has room to work. If you have special plants near the walls, you may want to move them until the work is done.

4. After the wall are blown full of insulation, the crew will either put back the siding or patch the stucco.

5. If your walls are stucco, it will make them shake when the holes ore drilled. You should move breakable things off the outer walls before /he work starts.

WEATHERIZATION ASSISTANCE PROGRAM
BUILDING OWNER AGREEMENT

It is agreed by and between ____ ("Agency") and ____, the Owner/Authorized Agent ("Owner'? of the premises located at ____ ________________________________ ("Premises"), as follows:

1 DOCUMENTATION. Owner agrees to cooperate with Agency by assisting Agency to gather all records and documents necessary for Agency to determine if tenant(s) residing at the Premises are eligible for weatherization services. Agency shall gather and keep confidential the names and incomes of the tenant(s) living at the Premises.

2 AGENCY WORK PLAN. If Agency, at its sole discretion, determines that the Premises are eligible for weatherization services, Agency agrees to weatherize the Premises in accordance with applicable codes, laws. and regulations. Attached is a general description of the full range of services that may be rendered. Agency agrees to forward a summary of the work plan to Owner (Exhibit B) after an energy audit is completed.

3 TERM OF THE AGREEMENT. In exchange for the above-named services, Owner agrees to be bound by the terms and conditions of this Agreement, as follows (check and complete one option):

______ Owner provides no financial contribution to the weatherization services. Term of this Agreement is determined by the Agency to be _____ years (not less than *2* nor greater than 5). commencing on the date signed, _______________, 19___.

______ Owner provides financial contribution to the weatherization services in the amount of $_____________. Based on this contribution, the Term of this Agreement is proportionally reduced from _____ year(s) to ______ year(s), not to be reduced to less than one (1) year, commencing on the date signed, ________________ 19____. Any work to be done directly by Owner in lieu of a financial contribution is outlined in Exhibit C.

4. TENANT(S)' RIGHTS. Owner agrees not to evict the tenant(s) during the period of this Agreement, except for documented cause. Owner agrees not to increase the rents at the Premises during the period of this Agreement except to recover actual increases in properly taxes or the costs of improving the Premises not resulting from this Agreement. Owner agrees to recover only a pro-rated share of any such actual cost increase from each tenant who pays his own heating costs. If the tenant's heating costs are included in the rent, no increases shall occur during the Agreement period. This provision replaces existing rights to raise rents. A list of units and rents must be attached to this Agreement (Exhibit A).

5. PREMISE VACANCY. During the term of this agreement, Owner will attempt to rent vacant dwelling units on Premises to low-income households. To demonstrate this attempt, Owner may choose to advertise the vacancy with a low-income housing agency.

6. PREMISE SALE/CONVERSION. Owner hereby swears or affirms that the Premises are not presently being offered for sale and further agrees to give Agency thirty (30) days notification of the sale or conversion of the Premises. At least ten (10) days prior to sale or conversion. Owner agrees to obtain, in writing, the purchaser's consent to assume Owner's obligations under this Agreement. or. if this consent is not obtained, Io pay Agency the full cost of weatherization pro-rated to the number of months remaining under this Agreement.

7 OWNER WORK PLAN. Owner agrees to make any repairs or improvements specified in Owner's Work Pian (Exhibit C) attached Io this Agreement. Agency need not commence its work until Work

WEATHERIZATION ASSISTANCE
TENANTS' RIGHTS
UNDER THE OWNER AGREEMENT

The Department of Jobs and Training (DJT) provides funds to weatherize the homes of income eligible households in your area.

Your landlord (Owner) has an agreement with ________________________________ ________________ (Agency) to weatherize your home. All or most of the costs are free to the Owner because you are eligible for this program. He/she agrees to several items that benefit you and give you specific rights. These rights are:

1. Your landlord cannot raise your rent until_____________, even if you agreed to a rent increase. However, if you pay your own heating bills, your landlord may raise your rent in some cases. He/she can raise the rent by your share of property tax increases or by your share *of* the cost of certain property improvements.

2. Any new Owner must follow all the terms of this agreement protecting you until ____________________

3. If the Owner raises your rent before ______________, you have the right to file a claim against him/her in court. (Except as stated in #1 above.)

4. You have the right to see the signed agreement. You may use a copy of the agreement as evidence in court to prove a claim. To get a copy *of* the agreement, write the agency named above at ____________________________________ ____or call the agency at ___________________________

ENERGY CONSERVATION AUDIT
FOR 727 FRONT AVENUE
IMPROVEMENTS AND RECOMMENDATIONS

Performed and submitted by
Ramsey Action Programs

March 1991

March 29. 1991

Mr. Scott Lakeberq
St. Paul Public Housing Agency
413 Wacouta Street
350 Gilbert Building
St. Paul, MN 55101

Dear Mr. Lakeberg,

This letter and report address PHA's senior high rise at 727 Front Avenue in St. Paul. Included in the package is an Executive Summary, a Table of Contents, an Energy Use Analysis, a List of Measures Performed, Calculations for Measures Performed, Measures Not Performed and Recommendations. Ramsey Action Programs thanks you for the support you've lent in the execution of this work and looks forward to working with PHA in the future to continue to provide high quality, safe, comfortable, energy efficient housing to St. Paul residents. It is a joy for us to work with a willing and supportive landlord and building operator like St. Paul Public Housing Agency.

Sincerely,

Paul Truax
Enerqy Auditor

Executive Summary

This is a summary for the work performed by Ramsey Action Programs on the senior high rise owned by St. Paul Public Housing Agency, located at 727 Front Avenue, St. Paul. This work is done with the intent of assisting in providing energy efficient, safe comfortable housing to your residents at no cost to them or to PHA. Except as noted with the modular boilers, there will be no cost to PHA for any of the improvements. Pursuant to DOE notification received at this office, it is likely that all future projects will require landlord funding contribution to some extent.

Energy Conservation Measure	cost	Savings	Payback
Install modular boilers for summer DHW heating (PHA contribution $8570)	$18700	$1013	10 years
Correct operation and size of combustion air opening	$3576	$382	9.3 years
Lighting change out (NSP rebate amount $3550)	$22420	$7932	2.8 years
Pipe insulation	63000	6301	10 sears
TOTALS	$38996	59628	4 years

Table of Contents

ENERGY ANALYSIS

Energy Index

12 month gas use	92384 ccf @ 104000 btu/ccf
Calculated #2 oil use	2637 gal @ 138000 btu/gal
Total BTU input	9,971,842,000 btu/season
Building square footage	112194 sq.ft.
Heating Degree Days (HDD) 12/89 - 11/90	7286 HDD
Energy Index	12.20 btu/HDD/sq.ft.

Weather Adjustment Factor - WAF

30 year normal HDD	8007 HDD
Seasonal HDD	7286 HDD
WAF	1.10

Total Energy Cost

Total gas cost	$30671 x 1.1 = $33738
Total oil cost	$2125 WAF incl= $2125
Total electric cost	$42400
Total demand charges	812591
	890854

Summer DHW Heating Cost

4 month summer gas use (JUN, JUL, AUG, 1/2 MAY & SEP)	7516 ccf
4 month summer gas cost	$2324 @ $.3092/ccf
4 month average gas cost	$581 @ $.3092/ccf
5 month summer gas use (MAY, JUN, JUL, AUG, SEP)	14680 ccf
5 month average gas use	2936 ccf/month
5 month summer gas cost	$4263 @ $.2904/ccf actual

Space heating

Assumed fuel cost per NSP	$.30/ccf
Fuel price escalation rate	5% to 10%/year per NSP
Contract gas escalation rate	7% to 8%/year per NSP
*Calculated oil use annually	2500 gal (1300-3000 gal range)
*Calculated days oil is used	10 to 13 days
* WAF included; 8007 HDD/7286 HDD	
Average oil use per day	208 gal
Assumed oil price	$.85/gal
Oil heat cost	$2125
Gas heat cost	$26586
Total heating cost, gas/oil	$28711
Seasonal Efficiency existing	50% average

Electrical

12 month electric use	871680 kwh
12 month average electric (kwh) cost	$42,400/year @ $.0486/kwh
12 month average demand	128 KW/month
Power Factor average	99.526%

LIST OF MEASURES PERFORMED

1) Lighting system modifications:
   a) Replace existing exit lighting fixtures on floors 3 through 20 with new fixtures and high efficiency fluorescent lamps.
   b) Replace stairwell lamps and ballasts with high eficiency lamps and ballasts.
   c) Replace all common area lighting with high efficiency lamps and ballasts with reflectors.

2) Pipe insulation:
   a) Insulate all condensate return and boiler feed lines in the compactor room, maintenence shop and boiler room.
   b) Insulate return lines on suspended heaters in the maintenence room and garage.
   c) Insulate domestic hot water lines in the maintenence room.

3) Combustion air opening:
   a) Properly size combustion air opening to requirement of boilers and seal and insuate remainder of opening.
   b) Install motor drives on operating louvers.

4) Mechanical improvements:
   a) Install infrastructure for the placement of front end boilers purchased by PHA. Work includes piping, venting, gas work, controls and pipe insulation.

CALCULATIONS

1) **Modular Boilers:**

$$7516 \text{ ccf} \times \frac{\$.30}{\text{ccf}} = \$2255 \times .4494^{*} = \$1013 \text{ saved}$$

* Potential savings as determined from similar installation at Iowa high rise, this is not a conservative estimate but is reasonable

$$\frac{\text{COST}\quad \$18700}{\text{FYS}\quad \$1013} = 18.46 \text{ YEARS}$$

$$\frac{\text{COST}\quad \$10130}{\text{FYS}\quad \$1013} = 10 \text{ YEARS}$$ with PHA co-pay $8570

2) **Combustion Air Dampers:**

Seasonal heating cost $28711 x .015* = $430 FYS

* Between 1 and 2% savings is expected by reduction of jacket losses not drawing conditioned air for combustion and raising combustion air temperature in the boiler room.

$$\frac{\text{COST}\quad \$3676}{\text{FYS}\quad \$430} = 8.5 \text{ YEARS}$$

4) **Lighting Change Out:**

Exit signs:

$$47 \text{ signs} \times \frac{50 - 12 \text{ watts}}{\text{sign}} \times \frac{\$.048}{\text{kwh}} \times \frac{1 \text{ kwh}}{1000 \text{ watts}} \times \frac{8760 \text{ hours}}{\text{year}}$$

□ $750 FYS

$$\frac{\text{COST}\quad \$3534}{\text{FYS}\quad 8750} = 4.7 \text{ YEARS}$$

Common area lighting:

Yearly energy cost existing - Yearly energy cost proposed = FYS

$11323 - $5046 □ $6277 FYS

$$\frac{\text{COST}\quad \$20195}{\text{FYS}\quad \$6277} = 3.2 \text{ YEARS}$$

Stairwell lighting:

Yearly energy cost existing - Yearly energy cost proposed = FYS

$2229 - $1323 = $905 FYS

COST 63655 = 4.0 YEARS
FYS $905

Rebates are available from NSP on these measures and the salesman for the lighting will perform the steps necessary for PHA to receive the rebate. RAP puts no stipulation on the rebate amount to PHA but suggests using the money for purchasing replacement lamps.

5) Pipe Insulation:

Heat lost $ uninsulated - Heat lost $ insulated = FYS

$170 - $25 = $145 FYS

COST $900 = 6.2 YEARS
FYS $145

(See Appendix E for breakdown)

MEASURES NOT PERFORMED

The following measures weren't performed, mainly because they aren't cost effective. They are included because they were initially viewed as options or were requested by the building operators.

1) Clean fin tube. This measure was requested by the building engineer because of the results achieved at **545** Wabasha where comfort was increased. It was rejected as an option for two reasons. Primarily, it is too expensive, the price for the easily accessible fin tubes at Wabasha was about **$6.20** per foot. The covers on Front have been screwed in place and painted many times and would be far more expensive. It is likely that the job would result in necessitating repainting all of the radiator covers due to damage during removal. Secondly, the fuel cost for Wabasha is vastly more expensive than the fuel cost for Front. District heat costs nearly as much as electric heat when use and demand charges are looked at together.

2) Install heat recovery on the exhaust air. This measure is impractical due to the exhaust equipment on the building being on the roof in four areas and the make up air being on the second floor. The ductwork for this measure would be extremely costly and unattractive.

3) Low flow shower heads. This measure is not practical due to the flow problems experienced in the past and likely to occur in the future because of pipe corrosion and scale.

4) Install an air heater for the combustion opening. This measure would result in a net gain in heating cost. Warmer combustion air may increase boiler efficiency slightly and make the room more comfortable but the same result can be obtained while conserving fuel rather than increasing fuel use. The approach that is being taken is to properly size the opening. This will keep the amount of excess air at a minimum but sufficient and make the room warmer when the boilers are in operation.

5) Install front end modular boilers capable of space heating in the marginal load requirement months. This measure was rejected by PHA based largely on the space limitations of the building. The proposed system would simply not fit in the building appropriately. The measure proves to be cost effective and RAP was willing to use a separate method for figuring payback years in order to achieve greater energy savings than are possible with a summer only system.

RECOMMENDATIONS

There is plenty of energy saving opportunity in a building this size even after RAP has been in and performed energy conservation measures. In this context energy saving can be read as cost cutting without loss of comfort level. Normally, when we weatherize single family homes, the auditor spends a half hour or so going through the customers fuel bills, maintenance schedule for mechanical systems, thermostat settings and effects on comfort and energy costs. Things as mundane as cleaning coils and ensuring tight gaskets on doors of refrigerators are addressed as well as well as low wattage alternatives to existing lighting. Information given to homeowners in these regards usually consists of verbal recommendations. Occasionally booklets or brochures on energy saving ideas are given to the resident, usually published by DPS or a local utility or infrequently a magazine article from a journal such as Home Energy Update. Usually we will train clients to try to observe the savings achieved for themselves by tracking their fuel bills. Homes with very high energy index numbers (anything over 8 BTU/HDD sq.ft. is considered a high consumer) are given special consideration during this client education time because either the building is in very poor condition or the client has a basic misunderstanding of energy costs relative to building management or lifestyle.

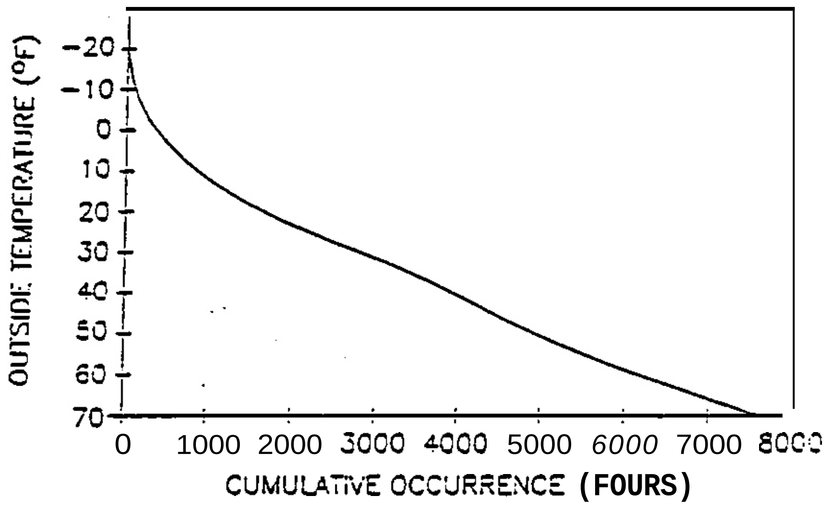
We try to emphasize the point to high consumers that maximum comfort doesn't have to go lockstep with higher energy costs. It is possible to be extremely comfortable, possibly even more than they are currently, while at the same time reducing their energy costs. One key factor in achieving this goal is mechanical systems maintenance and operation. This is something the person has control of after the building measures have been completed and can aid in the effort to reduce heating costs or eliminate all other savings depending on our educational effort. PHA has a large, knowledgeable maintenance staff that is able to maintain and operate its equipment on a regular schedule and good outside contractors that assist in overhauls, tuning, setup etc. An energy management system is in place to monitor building conditions on a real time basis and likely in historical terms as well. Front, as well as PHA's other property, continues to operate year to year without loss of comfort to the residents and is relatively easy to operate.

The goal of our agency and, I'm sure PHA as well, is to cause the building to operate as cheaply as possible. The Energy Resource Center in St. Paul has a person on staff, Valdi Stephanson who works with multifamily building owners to reduce energy costs. Valdi has been in the energy conservation business for many years and is a valuable resource for the city and the city funded organization, Energy Resource Center.

I encourage PHA to contact ERC for PRISM analysis for your buildings. PRISM is an acronym for PRInceton Scorekeeping Method, a tool used to evaluate a buildings energy use pattern in relation to weather conditions, occupancy rate and flux, fuel used and cost and other pertinent parameters. PRISM is software that is public domain and is available to PHA or anyone else that wants to use it. Valdi is very familiar with its application to multifamily buildings. Valdi is willing to do PRISM runs on PHA's buildings at no cost or very minimal cost. It would be interesting to see what effect the modifications had on buildings previously weatherized by RAP using PRISM. I looked at the fuel bills of Iowa, Edgerton and Wilson to see if the front end boilers were performing as expected and draw a realistic expectation for the modification at Front. I looked at the current fuel bills on these three buildings and compared them with the information available before the modification. The expectation for savings on those installations was **50%.** This seemed high intuitively and seems to be high from what the current gas bills show. A reasonable range of savings is 30 to **45%**. The fuel use analysis done from current bills was a coarse estimate and didn't take into account the weather, occupancy flux or anything else, just raw gas numbers. PRISM would also be a good tool to judge operational modifications. As an outside party I can't take into account all the factors that go into running the building but a suggestion would be to try running only one boiler before December 15 and after January 25. For the five week period the load exceeds the capacity of a single boiler and even for the five week period the building needs less than two boilers are capable of delivering. The maximum efficiency the boilers are capable of achieving is when they are under full load or as near it as possible.

Leaving one boiler shut down till the building approaches design conditions will allow for higher overall seasonal efficiency of the boiler system and prolong the lifespan of the boiler pair. With the existing cutouts and the energy management system it should be possible to determine when the building is going to need more than **4.4** million Btu's per hour. I think that it will be about five weeks per year. One of the bids solicited for this project was for modular front end boilers capable of space heating during the marginal heating months. The strategy is good but the equipment cost is high. The calculation used for savings on the proposal found the capacity of the existing boilers to far exceed the load on the boilers for most of the heating season. The fuel bill analysis showed that the building load to be about **14%** of the boiler capacity for the season: that is the amount of gas and oil actually used versus the output capacity of the boilers. The same rationale was used to determine that the summer boilers would be feasible and found that the summer water load required about 9 to 10% of the capacity of a single existing boiler. As far as the modular space heat boilers go, the measure wasn't undertaken mainly because the floor area couldn't be found for the new boilers. The strategy of leaving one boiler off till it's needed can save nearly as much as the modification with no capital investment. This approach would load a single boiler nearer to full capacity, improve seasonal efficiency, prolong boiler life and require no capital investment. Using PRISM would narrow the range of time more specifically when the second boiler needs to be fired and would quantify the results of the operational modification. The down side of this strategy would be more on site time by the engineers. They would have to turn valves two more times per year than they currently are. If the main operating boiler went down altogether the secondary boiler would have to be fired up in short order but considering the thermal mass of the building and the water use pattern, the only time there would appear to be a failure of service is if it happened at 7:00 am when the outside temperature dropped about 30 to 40 degrees. There should be enough water in the tanks for the whole water load in the morning and enough heat storage in the walls, floors and ceilings of the building to stay warm without additional heat input for the one or two hours it would take to get the back up boiler on line.

Normally the energy management system should let operators know when the building temperature is dropping more than 1 to 2 degrees per hour with the primary boiler firing and that should be the signal to fire the second boiler. Weather Bin data (Figure 1) shows the number of hours per year the temperature outside is below -10 degrees Fahrenheit. This is relatively few hours per season and is most likely when the second boiler will need to be fired constantly.



Cumulative occurrence of outside temperatures based on bin data for Minneapolis-St. Paul. Minnesota. The area under the curve is equal to the total number of degree-hours In an average year for a base temperature of 70 °F.

Figure 1

This recommendation is not to say that there isn't a better strategy or that the way the boilers are currently operated is wrong, I realize there are factors to consider with manpower and resident complaints, etc., but it gives an alternative outside view of operations. I firmly believe that a progressive landlord like PHA can design operating protocol for their buildings to realize maximum savings potential with maximum comfort for residents.

Lighting is another area where costs can be cut and energy saved through development and implementation of a maintenance schedule. The alternative to the strategy of changing lamps as they burn out is usually employed in commercial industrial settings where light levels are crucial to product quality and safety. The schedule calls for group relamping at **70%** of the rated life of the lamps, which in this case is about **(70%** of 11000 hours) **7700** hours or about every 11 months. In senior housing, light level at the floor is important. Group relamping ensures all of the lamps will remain lit all the time and emit the amount of light they are supposed to. At about **70%** of their rated life, fluorescent lamps lose efficacy and'become less efficient as a light source because they produce more heat. Even if the lamps are still burning it is cheaper to replace them with a new lamp and run it than to continue to run the old one. Another cost saving using this strategy is to prevent running up and down the building changing single lamps on an as needed basis. It helps to fix costs on an annual basis to know that on a specific date, X number of man-hours will be required to relamp. All lamps have a failure rate associated with them and group relamping will help in resolving claims against manufacturers if there is a higher than expected failure rate. Lamps are warranted by the manufacturers and they will provide replacement lamps at no cost because they know they have a failure rate on their product. Group relamping ensures the installation date is known. Relamping should include cleaning the fixtures to ensure that the reflectance is adequate to maintain the light level at the floor.

APPENDIX D

SUPPLEMENTARY MATERIALS

SEATTLE

APPENDIX D

SUPPLEMENTARY MATERIALS, SEATTLE

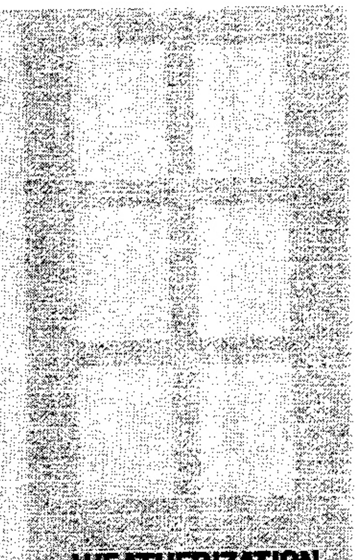
This appendix consists of:

- **A sample of four brochures used in outreach in Seattle's weatherization program**
- **An insulation work order**
- **A window and lighting work order**
- **An inspector's work sheet and report form**

FREE

Insulation
Windows
Venting
Low-flow Shower Heads, Lighting. . .

Energy Conservation Program
Department of Housing and Human Services
618 Second Avenue, 6th Floor
Seattle, WA 98104-2232



WEATHERIZATION FOR APARTMENT BUILDINGS

Seattle Department of Housing and Human Services

The City of Seattle will weatherize your rental property at no cost if two-thirds of the tenants in your apartment building meet certain income requirements.

7 Reasons to Weatherize Your Building

- Improves the appearance of your building
- Enhances the property value without causing increased property taxes
- Brings your building up to current energy standards
- Can reduce tenant vacancies and turnover. A warm, economical apartment is desirable
- Receive fewer complaints about heating costs, since tenants can save up to 30% on their bills
- Quality control is maintained through a free energy survey and work is inspected
- We choose a licensed, bonded contractor to install the materials which saves you time and effort

Each year the City of Seattle saves thousands of kilowatt hours and energy resources through conservation programs, which reduces the need to build costly power plants. When Seattle residents save energy, the City saves and *all* ratepayers benefit.

Our goal is to help low-income families reduce their heating bills and preserve Seattle's housing stock.

How To Get Started

We can weatherize most apartment buildings at no cost. They must either be electrically heated through Seattle City Light or be inside the city limits if they are heated with oil, gas or other non-electric heat.

In addition, two-thirds of the tenants must meet certain income guidelines (see chart below) in order for us to weatherize your entire building.

Household Size	Gross Income Monthly	Gross Income Yearly
8	$2,333	$28,000
6	[illegible]	22,400
4	1,186	14,230
2	925	11,100
1	690	8,275

CALL FOR NEW GUIDELINES

Call our office for more information on how you can get started, and we'll take a look at your building and see if the tenants are eligible.

Ask us about our free weatherization grant for your 1-4 unit rental property, too!

call
684-0244

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

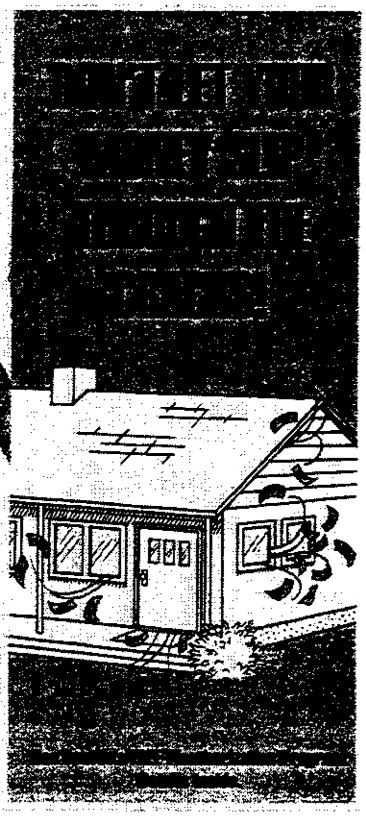
FIRST CLASS PERMIT NO. 342 SEATTLE, WA

POSTAGE WILL BE PAID BY ADDRESSEE

DSHS Energy Conservation Programs
c/o Seattle City Light
1015 Third Avenue / Room 123
Seattle WA 98104-9969

Seattle City Light
1015 Third Avenue
Seattle, WA 98104-9969

Bulk Rate
US Postage
PAID
Seattle, WA
Permit No. 9150



AFTER YOU HAVE QUALIFIED • Make your weatherization appointment as soon as possible. That way, you'll avoid wintertime scheduling delays and your home will be weatherized before the cold season begins.

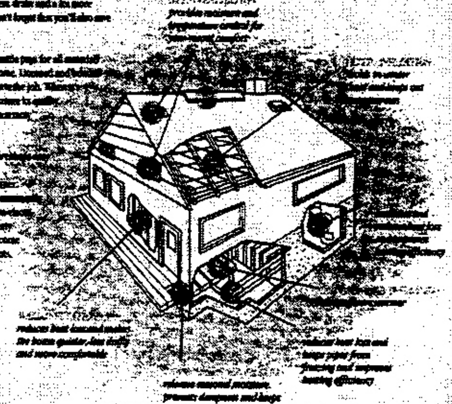
MORE INFORMATION • Call 684-4244 or return the attached postage-paid card for more information about the City of Seattle's FREE offer to weatherize your home.

YEAR-ROUND COMFORT • You'll be warm in the winter and cool in the summer when you take advantage of the City of Seattle's FREE Weatherization Program. Insulation, weatherstripping, caulking and venting will make your home quieter, less drafty and a lot more comfortable — all year round. And, don't forget that you'll also save money on winter heating bills.

WORK WARRANTY • The City of Seattle pays for all materials and labor needed to weatherize your home. Licensed and bonded contractors quickly and expertly complete the job. When work is done, the City will inspect the work to ensure its quality. You'll also receive a 12-month written warranty covering the entire job.

QUALIFYING IS SIMPLE • There are three easy steps to qualifying.

1. You must be a Seattle City Light customer.
2. You must rent or own a home with permanently installed electric heat. Or you can own electrically heated low-income rental property.
3. You must meet the City of Seattle's income guidelines for homeowners and tenants. Call 684-0244 to see if you qualify.



☐ I don't want my money slipping through the cracks. FREE home weatherization makes a lot of sense.

Name: ____________________

Address: ____________________

City: ____________________

State ________ Zip ________

Daytime Phone: ____________________

Evening Phone: ____________________

I live in a: ☐ Single Family Home ☐ Duplex ☐ Triplex ☐ 4-Plex

Homeowner: ☐

Renter: ☐

Heat Source: ☐ Electric ☐ Oil ☐ Gas ☐ Other: ____________

Nothing in life is free. WELL...
You haven't talked to the City of Seattle.
Weatherize your home for winter —it's absolutely free.

That's right. It costs nothing. If you qualify for the Weatherization Program, it's absolutely free. Cut the chill this winter and profit from a warm and comfortable home at no cost. It's yours by calling 684-0244.

The City of Seattle wants you to enjoy winter warmth and summer comfort with a completely weatherized home. Weatherstripping stops chilly drafts. Venting circulates air for total comfort. Insulation warms you up during the winter and cools you down in summer — plus, it cuts your heating bills.

Here's all it takes.

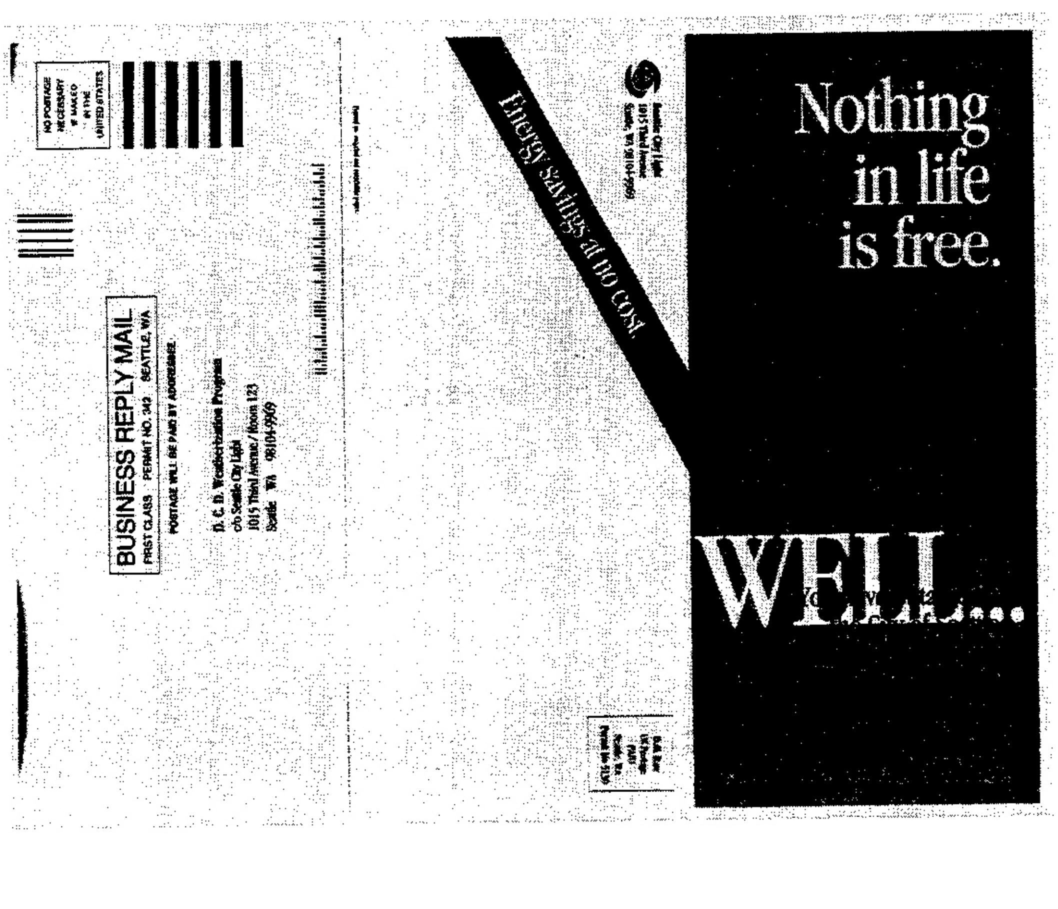
We pay for all materials and labor. Licensed and bonded contractors complete the job. When it's done, we inspect your home's weatherization improvements and back them with a 12-month warranty.

Finding out if you qualify is simple. First, you must be a Seattle City Light customer. Second, you must rent or own a home with permanently installed electric heat. Or you can own electrically heated low-income rental property. And third, you need to meet the following income guidelines. For homeowners, if you earn a gross yearly income of less than $18,960 for two persons, or $27,876 for a family of four. For renters: less than $11,100 for two, and $16,750 for four.

If you qualify, make your weatherization appointment now. That way you'll beat the first frost of the season. And you won't face wintertime scheduling delays either.

To find out more about our no-cost Weatherization Program, or other City Light programs that help you take the bite out of winter, call 684-0244. Or return the attached postage-paid card for more information.

City of Seattle Weatherization Program
Department of Community Development



Winter, Spring, Summer or Fall, home insulation can help you. . .

- Save Energy
- Save Money
- Keep warm and reduce wintertime drafts
- Keep your home cooler during the summer
- Bring your home up to current energy standards
- Improve your home's value
- Written warranty provided
- Work inspected to ensure quality

"It amazes me how much warmer the upstairs is. . ."

—Margaret White

Weatherization Grant for Homeowners with Electric Heat
You can get your home insulated at no cost to you if you live in the home, meet certain income guidelines, and heat with permanently installed electricity. Call 684-0244.

Weatherization Grant for Homeowners and Rental Property with Oil, Gas, Wood or Non-Electric Heat
Renters and homeowners with oil, gas, wood or other non-electric heat can get free insulation, venting, pipewrap, weatherstripping and caulking installed. You must live inside the city limits and meet certain income guidelines. Employed persons are allowed a 20% deduction from their gross salary in order to qualify. Retired persons can deduct 10% of their taxable pension, retirement or social security benefits. Call 684-0244.

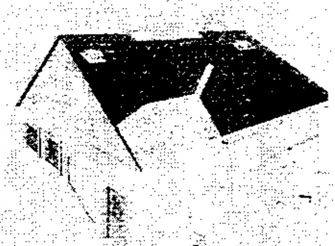
Weatherization for Rental Homes and Apartment Buildings
Rental homes and apartment buildings may be weatherized at no cost when occupied by low-income tenants who meet certain income guidelines. Landlords and property owners should call us at 684-0244.

All programs of the Seattle Department of Housing and Human Services comply with the Americans with Disabilities Act. Accommodations provided for persons with disabilities upon request.

Energy Conservation Program
Seattle Department of Housing
& Human Services 2/93

Be Wise: Weatherize!

With No-Cost Home Insulation Grants



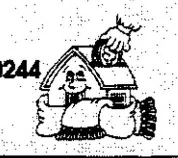
Home Insulation is a Year-Round Benefit!

EVERY SEASON IS A season that affects your household budget—holidays, vacations, back-to-school shopping, and utilities. The best reason to insulate is cost.

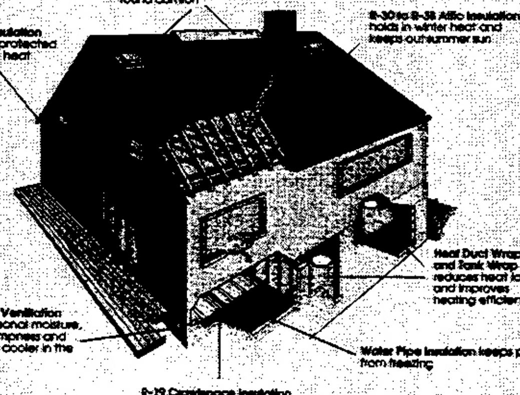
Heating bills can be expensive if your home is not adequately insulated, even if you insulated it years ago. Through the City of Seattle's free home insulation program, you not only save money but you also get up to $2,000 in labor and materials at no cost. It improves the value of your home without a tax increase, and your home is energy efficient. It's an investment you can't afford to ignore.

You'll also help the City save money and energy through reduced energy usage.

Call 684-0244 Today!



Here's What the Energy Conservation Program Offers:



"It made a tremendous difference on my light bill and the warmth in my house."

—E. K. Bullock

Your Seattle Department of Housing & Human Services

WEATHERIZATION ASSISTANCE PROGRAM

Alaska Building, 618 Second Avenue, Seattle, WA 98104-2232

INSULATION WORK ORDER

Circle One: 1, 2, 3, 4 or _____ Units

_____ Of _____ Pages REV. 6/92

PLEASE PRESS HARD — 4 COPIES

DHHS JOB # / YR

HOMEOWNER/LANDLORD

SCL ACCOUNT NUMBER 1 – – 01

MAX. AMOUNT AUTHORIZED

ADDRESS ZIP

CONTRACTOR

FUND SOURCE ☐ 125% Pvty

PHONE: HOME WORK

CONTRACTOR CONTACT PERSON

CONTRACTOR PHONE

TENANT/OCCUPANT

SECOND WORK ORDER ☐ AMOUNT_____

SEPARATE WINDOW W.O. ☐ AMOUNT_____

SEPARATE LIGHTING W.O. ☐ AMOUNT_____

ADDRESS TO BE WEATHERIZED ZIP

PHONE: HOME WORK

☐ No EBB _____ Explanation

		LINE NO.	DESCRIPTION	QUANTITY	UNIT COST	ESTIMATED COST	PRIOR-ITY	SPECIAL INSTRUCTIONS
INSULATION	ATTIC	1	Rake/Flat Add R-	sq ft				
		2	Add R-	sq ft				
		3						
		4						
		5						
		6	K&T Inspection	ea				
		7	Slope/Cathedral	sq ft				
		8	Knee Walls	sq ft				
	FLOORS	9	Crawl	sq ft				
		10	Basement	sq ft				
		11						
		12	Cantilever/Garage	sq ft				
		13	Irregular Joists	sq ft				
		14	Ground Cover	sq ft				
	WALLS	15	Walls ( )	sq ft				
		16						
		17						
		18	Ladder Time (12' +)	sq ft				
		19	Ducts	sq ft				
VENTILATION		20	Pipes	ln ft				
	ATTIC	21	Attic Intake Ratio 300/150	sq in				
		22						
		23	Attic Exhaust Ratio: 300/150	sq in				
		24						
		25	Exhaust Fan Vent	ea				
		26						
		27	Crawl/Other Ratio 300/150/Poly	sq in				
INFILTRATION		28						
		29	Caulking	ln ft				
		30	Weather Stripping	ea				
		31	Door Sweep	ea				
		32	Threshold/Shoe	ea				
MISCELLANEOUS		33	Smoke Detector	ea				
		34	Reputty Window	ln ft				
		35	Replace Broken Glass	un in				
	MINOR REPAIRS	36						
		37						
		38						
		39						

SUB-TOTAL			$
TAX	City/County	%	$
TOTAL		Est.	$
Margin of Error		%	

Radon Needed ☐ Repair $_____

NOTE: All work must meet Seattle City Light and/or Dept. of Energy Specifications

Additional Instructions Attached ☐ Sketch Plan Attached ☐

WATER HEATER: Existing Ins. _____ Wrapped by DHHS _____ Energy Eff. Model _____ Setback _____ Needs Repair _____ Shower Head _____ Fl. Light _____

ENERGY CONSERVATION REP. PHONE DATE

Your Seattle
Department of Community Development

WEATHERIZATION ASSISTANCE PROGRAM
Arctic Building . 700 Third Ave., 6th Floor . Seattle, WA 98104

WINDOW & LIGHTING WORK ORDER

Circle One: 1, 2, 3, 4 or ______ Units

______ Of ______ Pages REV. 5/91
PLEASE PRESS HARD - 4 COPIES

DHR JOB # ______ / YR

GLASS $
LIGHTING $

MAX. AMOUNT AUTHORIZED

HOMEOWNER / LANDLORD ______ 1 - - 01 SCL ACCOUNT NUMBER

ADDRESS ______ ZIP ______ CONTRACTOR ______ FUND SOURCE ☐ 125% Pvty

PHONE: HOME ______ WORK ______ CONTRACTOR CONTACT PERSON ______ CONTRACTOR PHONE ______

TENANT / OCCUPANT ______

SECOND WORK ORDER ☐ AMOUNT ______
SEPARATE INSULATION W.O. WRITTEN ☐ AMOUNT ______

ADDRESS TO BE WEATHERIZED ______ ZIP ______

PHONE: HOME ______ WORK ______

WINDOW

LINE NO.	MATRIX LINE NO.	GLASS DESCRIPTION	QTY.	TOTAL SQ. FT.	UNIT COST	EST. COST	COMMENTS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
SUB-TOTAL						$	
TAX		CITY	COUNTY		%	$	
TOTAL					EST.	$	

LIGHTING

LINE NO.	DESCRIPTION	WATTAGE	QTY.	UNIT COST	EST. COST	COMMENTS
18						
19						
20						
21						
22						
23						
24						
SUB-TOTAL					$	
TAX	CITY	COUNTY		%	$	
TOTAL				EST.	$	

NOTE: All work must meet Seattle City Light and/or Dept. of Energy Specifications
Additional Instructions Attached ☐ Sketch Plan Attached ☐

______ ENERGY CONSERVATION REP. ______ PHONE ______ DATE

DHR COPY

SEATTLE CITY LIGHT

INSPECTION REPORT COMPONENT II

Service Address: ____________________ Zip: 981___ Service Account #: ____________________ # of Units: ____

Occupant (Contact): ____________________ Home Phone: __________ Work Phone: __________

Owner's Name: ____________________ Home Phone: __________ Work Phone: __________

Owner's Address: ____________________ Zip: ______

Manufacturer: ____________________ Contractor: ____________________

APPLICABLE MEASURE & SPECIFICATIONS	P	F	NA
WINDOWS – GENERAL			
1 All windows are approved products, and are correct size, shape, and type. (102.110)			
2* Safety glass is used where required. (102.530)			
3* All free-fall and security latch requirements are met. (102.215, .220, .225, .230, .1040)			
4 All installed units operate smoothly & properly and provide a complete weather barrier when closed. All hardware is durable and functions properly. (102.515)			
5 Meeting rails of operable windows have a mechanical interlock and weatherstripping. (102.205, .210)			
6 Only undamaged materials were used. Windows have no burrs, sharp corners, or other potential hazards. (102.175, .525, 103.225, .325)			
7 Screens are installed where applicable. (102.235, .755, 103.205.6)			
8 Weep holes are present, if required, and clear. (storms–102.740)			
9 Caulking and all filler and trim materials are sloped to ensure water run-off. (102.675, .685)			
10 Units have minimum 1/2" DAS and are filled with Argon or Krypton gas. (102.145.3)			
11 A label stating manufacturer, model name and number is present on all windows. (102.135, .140, .150)			
12 All lites were cleaned. (102.697, .767, .850, 103.335)			
SLIDING FRENCH DOORS			
1 Prime openings are strucurally sound. (103.305)			
2 Minimum 9" exterior landing surface exists. (103.330)			
3 Bare wood was treated with sealer. (103.310)			
4 Conversions are not Fin Bar conversions. (103.205.3)			

*Health & Safety

APPLICABLE MEASURE & SPECIFICATIONS	P	F	NA
REPLACEMENTS			
1 Screws are installed within 6" of frame corners and the proper number of screws is evenly spaced along frame length. Screw penetrations are sealed. Drywall or bugle head screws were not used. (102.820-.840, .855)			
2 Window frames are supported to within 1" of the exterior vertical edge. (102.845, .880)			
3 Replacements which were installed without a nailing flange and are not protected by an overhang, have flashing along the top edge. (102.615)			
STORMS			
1* Operable storms were installed over operable primes; latches are accessible and operable; free-fall and egress requirements are met. (102.760)			
2 Storms are permanently and properly anchored. Primes remain operable. (102.715, .815, .830, .1020)			
3 Tight DAS of 3/4" to 4" exists between prime and storm lites. (102.725, .730, .735, .835, .1025)			
4 All cracks, joints, and holes in the storm frames are properly sealed or caulked. (102.720)			
5 Storm windows align visually with existing window frames. (102.745, .820)			
6 Existing frames and sashes are structurally sound and free of deterioration. (102.1010)			
7 Broken or cracked prime lites were replaced. (102.1015)			
8 Storms are removable for cleaning. (102.762, .830)			
OTHER			
• Cleanup			
• Caulking			
• Workmanship			
• Customer Service			

COMMENTS: ____

Insp. Status: 1st: __________ 2nd: __________ 3rd: __________ Drive By: __________

Date: __________ Date: __________ Date: __________ Call back: __________

Initial: __________ Initial: __________ Initial: __________

Warranty Written: __________

Warranty Fail Date: __________

Initial: __________

Warranty Pass Date: __________

Initial: __________

1-481-14 (6-93) ORIGINAL - Seattle City Light YELLOW - Contractor PINK - File

INTERNAL DISTRIBUTION

1	M. A. Brown
2	L. G. Berry
3	G. E. Courville
4	M. T. Eady
5	M. B. Gettings
6	L. J. Hill
7	J. M. MacDonald
8	H. A. McLain
9	A. C. Schaffhauset
10	T. R. Sharp
11	R. B. Shelton
12	R. L. Shelton
13	M. P. Temes
14	I. VanCoevering
15-50	Energy Conservation Dist., Building 3147, MS-6070
51-52	Central Research Library
53	Document Reference Section
54	Laboratory Records-RC
55	Laboratory Records
56	ORNL Patent Office

EXTERNAL DISTRIBUTION

DOE Regional Support Office Contacts

57 Ms. Marian Downs, Weatherization Program Contact, Denver Regional Support Oftice, U.S. Department of Energy, 1617 Cole Boulevard, Golden, CO 80401

58 Ms. Bernadette Cross, Weatherization Program Contact, Atlanta Regional Support Office, U.S. Department of Energy, 730 Peachtree Street. NE, Suite 876, Atlanta, GA 30308

59 Ms. Sharon Donaldson, Weatherization Program Contact, Chicago Regional Support Office, U.S. Department of Energy, 1 South Wacker Drive, Suite 2380, Chicago, IL 60606

60 Ms. Christine Reinfelds, Weatherization Program Manager, Boston Regional Support Office, U.S. Department of Energy, One Congress Street. Suite 1101, Boston, MA 02114

61 Ms. Beth Cahall, Weatherization Program Manager, Philadelphia Regional Support Oftice, U.S. Department of Energy, 1880 John F. Kennedy Blvd., Suite 501, Philadelphia, PA 19103-7483

62 Mr. Richard Putnam, Weatherizarion Program Manager, Seattle Regional Support Office, U.S. Department of Energy. 800 Fifth Avenue, Suite 3950, Seattle, WA 98104

STATE Weatherization Program Managers

63 Ms. Brenda Jones, Program Manager. Alabama Department of Economic and, Community Affairs, P.O. Box 5690, Montgomery, AL 36103-5690

64 Mr. Phil Kaluza, Program Manager, Rural Development Department, Alaska Housing Finance Corporation, 520 Fast 34th Avenue, Anchorage, AK 99503

65 Mr. Russell Clark, Weatherization Program Manager, Energy Office, Arizona Department of Commerce, 3800 North Central Avenue, Suite 1200, Phoenix, AZ 85012

66 Mr. Troy Branscum, Program Manager, Oftice of Community Services, Division of County Operations, P.O. Box 1437, Slot # 1330, Little Rock, AR 72203-1437

67 Ms. May Wait, Program Manager, Depanment of Community Services, and Development, State of California, 700 North loth Street, Suite 258, Sacramento, CA 95814

68 Mr. Rob DeSoto, Weatherization Program Manager, Governor's Office of Energy Conservation, 1675 Broadway, Suite 1300, Denver, CO 80202-4613

69 Ms. Carlene Taylor, Program Assistance Supervisor, Depanment of Social Services, 25 Sigoumey Street, Hartford, CT 06106-2055

70 Mr. G. Kenneth Davis, Weatherization Manager, Office of Community Services, Division of State Service Centers, Depamnent of Health and Social Services, 820 North French Street, Wilmington, DE 19801

71 Mr. Carl E. Williams, weatherization Program Manager, District of Columbia Energy Office. 2000 14th Street, NW, Suite 300 East, Washington, DC 20009

72 Mr. Earl Billings, Planning Manager, Department of Community Affairs, Florida Energy Office, 2555 Shumard Oaks Boulevard, Tallahassee, FL 32399-2100

73 Ms. Annette Carter, Weatherization Program Manager, Division of Energy Resources, Georgia Environmental Facilities Authority, Equitable Building, Suite **2090,** 100 Peachtree Street, NW, Atlanta, GA **30303**

74 Mr. Isaac Watson, Weatherization Program Manager, Office of Community Services, Department of Labor and Industrial Relations. **335** Merchant Street, Room 101, Honolulu, HI **96813**

75 Ms. Neva Kaufman, Weatherization Program Manager, Department of Health and Welfare, Bureau of Family Self-Support, P.O. **Box 208,** Boise, ID **83720**

76 Mr. Wayne E. Curtis, weatherization Program Manager, Department of Commerce and Community Affairs, **620** East Adams Street, Fifth Floor. Springfield, **IL 62701**

77 Mr. Randy Powers, Program Manager, Division of Family and Children, P.O. Box **6116,** Indianapolis, IN 46206-6116

78 Mr. James R. Newton, Bureau Chief for Weatherization, Division of Community Action Agencies, Department of Human Rights, Lucas State Oftice Building, Des Moines, IA **50319**

79 Ms. Norma Phillips, Administrator, Division of Housing, Department of Commerce and Housing, **700** Southwest Harrison Street, Suite **1300,** Topeka, KS **66603**

80 Mr. Rich Eversman, Section Supervisor, Department of Social Services, Cabinet for Families & Children, Commonwealth of Kentucky, **275** East Main Street, Frankfort, KY **40621**

81 Mr. Lonnie Diddier, Social Services Program Manager I, Department of Social Services, P.O. Box **3318,** Baton Rouge, LA **70821**

82 Mr. Peter Wintle, Director, Energy and Housing Services, Maine State Housing Authority, **353** Water Street, Augusta, ME 04330-4633

83 Mr. Roben C. Adams, Administrator, **Oftice** of Weatherization Assistance, Maryland Department of Housing and, Community Development, **100** Community Place, Crownsville, MD **21032-2023**

84 Mr. James Hays, Director, Executive Office of Communities and Development. Bureau of Energy Programs, Leverett Saltonstall Building, 100 Cambridge Street, Room **1803,** Boston, **MA 02202**

85 Mr. Larry Mynhier, Program Manager. Family Independence Agency, P.O. Box **30037,** Lansing, MI **48909**

86 Mr. Roger Williams, Weatherization Program Manager, Minnesota Department of Economic Security, **390** North Robert Street, St. Paul, MN **55101**

87 Mr. Bobby Pamplin, Weatherization Program Manager, Mississippi Department of Human Services, **750** North State Street, Jackson, MS **39202**

88 Ms. Cher Stuewe-Pormoff, Director, Division of Energy, Department of Natural Resources, P.O. Box 176, Jefferson City, MO **65102-0176**

89 Ms. Clarice **S.** Sabree, OLIEC Supervisor, New Jersey Department of Community Affairs, William Ashby Community Affairs Building, **101** South Broad Street, CN-806, Trenton, NJ 08625-0806

90 Ms. Liz Cordova, Manager, New Mexico State Housing Authority, **810** West San Mateo, Suite D, Sante Fe, **NM 87505**

91 Mr. Rick Gerardi, Director, State of New York, Department of State, Division of Weatherization Services, **162** Washington Avenue, Albany, **NY 12231**

92 Mr. Jeff Brown, RECAP Manager, Energy Division, North Carolina Department of Commerce, **430** North Salisbury Street, Raleigh, NC **27611**

93 Mr. Howard Sage, Program Administrator, **Oftice** of Intergovernmental Assistance, 14th Floor, State Capitol Building, **600** East Boulevard Avenue, Bismarck, **ND 58505**

94 Ms. Sara E. Ward, Oftice Chief, Oftice of Energy Efficiency, Ohio Department of Development, P.O. Box **1001,** Columbus. OH **43216-1001**

95 Mr. Sherwood Washington, Division Director, Division of Community Affairs and Development, Oklahoma Department of Commerce, P.O. Box **26980,** Oklahoma City, OK 73126-0980

96 Mr. Jack Hruska, Program Manager, Oregon Department of Housing and, Community Services, 1600 State Street, Salem, OR **97310**

97 Mr. Karl A. Kimmel, Unit Chief, Pennsylvania Department of Community Affairs, P.O. Box **155,** Harrisburg, PA **17120**

98 Mr. Michael A. Snitzer, Program Manager, Rhode Island State Energy Office, **275** Westminster Street, Providence, **RI 02903-5872**

99 Mr. Doug Keisler, Director, Division of Economic Opportunity, Office of the Governor, **1205** Pendleton Street, Third Floor, Edgar A. Brown Building, Columbia, SC 29201-3740

100 Ms. Abbie Rathbun, Program Administrator, Department of Social Services, **206** West Missouri Street, Pierre, SD **57501**

101 Ms. Zelma Waller, Program Manager, Tennessee Department of Human Services, Citizens Plaza Building, **400** Deaderick Street. 14th Floor, Nashville, TN 37248-9500

102 Mr. J. A. Almaguer, Program Manager, Administration and Community Affairs, Texas Department of Housing and Community Affairs, Waller Creek Office Building, P.O. Box **13941,** Austin, TX **78711-3941**

103 Mr. Michael **Johnson,** State Weatherization Manager, Division of Community Development, Utah Office of Energy Services, **324 South** State Street, Suite **500,** Salt Lake City, UT 84111

104 **Mr.** Jules Junker, Weatherization Programs Coordinator, Vermont Office of Economic Opportunity, Agency of Human Services, **103** South Main Street, Waterbury, VT **05671-1801**

105 Mr. William Beachy, Program Administrator, Virginia Department of Housing and, Community Development, Jackson Center, 501 North Second Street, Richmond. VA **23219-1321**

106 Mr. Stephen Payne, Managing Director, Department of Community, Trade and, Economic Development, P.O. Box **48300,** Olympia. WA **98504-8300**

107 Ms. Lisa Kesecker. Program Manager, Office of Economic Opportunity, 950 Kanawha Boulevard, East · 3rd Floor, Charleston, WV **25301**

108 Mr. Gary *Gorlen*, Bureau Director, Department of Administration, Division of Housing, P.O. Box **8944,** Madison, WI **53708-8944**

109 Ms. Jan Stiles, Program Manager, Department of Family Services, Hathaway Building. **2300** Capitol Avenue, 3rd Floor, Cheyenne, **WY 82002-0490**

110 **Mr.** Kane Quenemoen, Program Manager, Intergovernmental Human Services Bureau. Child and Family ***Services,*** Department of Public Health and Human Services, P.O. Box 8005, Helena, MT **59604-4210**

111 **Mr.** Larry Ahasteen, Weatherization Program Manager, Division of Community Development, Navajo Nation Services Department, P.O. Box **2396,** Window Rock, AZ 86515

112 **Mr.** Pete Davis, Weatherization Division Chief, Nebraska Energy Office, P.O. Box **95085,** Lincoln, **NE 68509**

113 Mr. Craig Davis, Weatherization Program Manager, Nevada State Welfare Division, **2527** North Carson Street, Carson City, **NV 89710**

114 **Mr.** Warren Leary, Weatherization Program Manager, Governor's Office of Energy and, Community Services, **57** Regional Drive, Concord, **NH 03301**

115 Mr. Rafael *Llompart*, Administrator, Energy Affairs Administration, Depament of Natural and Environmental Resources, Puerta de Tierra, P.O. Box **5887, San** Juan, PR **00906-5887**

Other Interested Parties

116 Lilia A. Abron, President, PEER Consultants, P.C., **1000** N. Ashley Drive, Suite **312,** Tampa, FL **33602**

117 Robert Bartley, Cavalier Management, **3706** Golfview Dr, Newark, DE **19702**

118 Scott Bernstein, President, Center for Neighborhood Technology, **2125** West North Ave., Chicago, IL **60647**

119 Frank Bishop, NASEO, **1516** M St **NW,** Suite 810, Washington, DC **20036**

120 Dave Bohac, CEE, **540** First Avenue North Suite **400,** Minneapolis, MN **55403-1609**

121 Kirk Bond, EnTech Engineering, **2903 NE 59th** Terrace, Suite **3,** Kansas City, Missouri ***64119-2158***

122 David Bradley, National Community Action Foundation, *2100* M *St* **NW,** Suite **604A,** Washington, DC **20037**

123 John Buckstead, National Assoc of Community Action Agencies, **1875** Connecticut Ave NW, Suite **416,** Washington, DC **20009**

124 Mimi Burbage, AHFC, 520 E **34th** Ave, Anchorage, **AK 99503**

125 Sandra Byrd, **I9** No **19th** St, Baton Rouge, LA **70802**

126 James Cavallo, Argonne National Laboratory, Building **900, 9700** South Cass Avenue, Argonne, IL **60439**

127 David Claridge, Mechanical Engineering, Texas A&M University, College Station TX **77843-3123**

128 Michael Clark, District of Columbia Energy Office, *2000* 14th Street, **NW,** Suite **300 East,** Washington, DC **20009**

129 Dennis Creech, Southface Energy Institute, P.O. Box **5506,** Atlanta, GA **30307**

130 Laurie Davidson, PERI, **1700** Rockville Pike Suite **550.** Rockville, MD **20852**

131 John DeCicco, ACEEE, 1001 Connecticut Ave NW, Suite **416,** Washington, DC **20009**

132 Rick Diamond, Lawrence Berkeley Laboratory, Bldg. *90*, **Rm 3074,** University of California. Berkeley, CA **94720**

133 Judith Dimitriu, P.Eng., Director, School of Mechanical Engineering, Ryerson Polytechnic University, **350** Victoria St, Toronto, **Ontario** M5B 2K3, Canada

134 T. E. Drabek, Professor, Department of Sociology, University of Denver, Denver, Colorado **80208-0209**

135 Jan Fox, Dept of Health and Human Services, Office of Energy Assistance, 370 L'Enfant Promenade SW, 5th Floor, Washington, DC 20447
136-145 Joel Eisenberg, Oak Ridge National Laboratory, 600 Maryland Ave SW, Suite 306W, Washington, DC 20024
146 Patricia Gallegos, Energy Conservation Association, 695 Canosa Ct, Denver, CO 80204
147 Thomas Green, Office of Community Services, P.O. Box 1437, Slot # 1330, Little Rock, AR 72203-1437
148 David T. Grimsrud, Director, Minnesota Building Research Center, Room 220, 1425 University Ave S.E., Minneapolis. MN 55455
149 Bob Groberg, HUD, 451 Seventh St SW, Washington, DC 20410
150 Walter Grodzik, P.E., 2998 Foxcoft Drive, Tallahassee, FL 32308
151 Jim Hall, E.I.S.S.A. Haven Temporary Shelter, 2480 So Yellowstone Hwy, Idaho Falls, ID 83402-4321
152 Jeffrey R. Harris, 732 Lawton St., McLean, VA 22101-1510
153 Kay Joslin, NCAT, PO Box 3838. Butte, MT 59702
154 Sheila Hayter, National Renewable Energy Laboratory, 1617 Cole Blvd, Building 17-1, Golden, CO 80401
155 Martha J. Hewett, CEE, 540 First Avenue North, Suite 400, Minneapolis, MN 55403-1609
156 Dr. Stephen G. Hildebrand, Director Environmental Sciences Division, Oak Ridge National Laboratory. Post Office Box 2008, Oak Ridge, TN 37831-6037
157 Sam Hodges, USDA/RHS Stop 0761, Independence Ave, SW, Washington. DC 20024
158 Regina Irwin, Mississippi Dept of Human Services, Div of Community Services, P.O. Box 352, Jackson, MS 39202
159 Ron Jarnagin, Pacific Northwest National Laboratories, PO Box 999, Richland, WA 99352
160 Gwen Johnson, Central Neighborhood Services Center, 1901 Pennsylvania Ave, Baltimore, MD 21237
161 W. C. Johnson. GCCAA, P.O. Box 519, Gulfport, MS 39502-0519
162 Vicky Hayes. NCAT, PO Box 3838, Butte, MT 59702
163 John T. Katrakis, J T Katrakis & Assoc, 418 North Ave, Barrington, IL 60010-3333
164-173 Larry Kinney, Synenech Systems Corporation, 472 South Salina Street, Syracuse, NY 13202
174 Paul Knight, Domus Plus. 408 North Grove, Oak Park, IL 60302
175 Ron Kroese, NCAT, PO Box 3838, Butte, MT 59702
176 Ginny Lakey, 257 East Center, Provo, UT 84606
177 William R. Mixon, Tech Support Services, 1018 West Outer Dr., Oak Ridge, TN 37830
178 Vicky Mroczek, NLIEC Contact, Ohio Dept of Development, Office of Energy Efficiency, PO Box 1001, Columbus, OH 43216
179 Michael Myers, US Department of Energy , FORS EE-421, 1000 Independence Avenue SW, Washington DC
180 Carolyn Newton, Alabama Power Co, PO Box 2641, Birmingham. AL 35291
181 Helen Perrine. Affordable Comfort, Airport Corporate Center, 894 Beaver Grade Rd. Coraopoils, PA 15108
182 Meg Power, Economic Opportunity Research Institute, 733 15th St NW, Suite 700, Washington, DC 20005
183 Wes Riley, YCCAC, PO Box 72, Sanford, ME 04073
184 Ernell Rodgers, HCDC, 163 West 125th St, New York, NY 10027
185 David Saum, INFILTEC, PO Box 8007, Great Falls, VA 22041
186 Jeff Schlegel, 1167 Samalayuca Dr, Tucson, AZ 85704
187 Scott Sklar, Solar Energy Industries Association, 122 C St NW, 4th Floor, Washington, DC 20001
188 Robert R. Somers, 2rw Consulting Engineers, 800 E Jefferson St, Charlottesville, VA 22902-5132
189 John Snell, Citizens Conservation Corp., 530 Atlantic Avenue, Boston, MA 02210
190 Curtis Taylor, 923 Old Bainbridge Rd, Tallahassee, FL 32303
191 Susan F. Tierney, The Economic Resource Group Inc., One Mifflin Place, Cambridge, MA 02138
192 Malwm Verdict Director, The Alliance to Save Energy, 1200 18th Street, Suite. 900, Washington, DC 20036
193 C. Mchael Walton, Ernest H. Cockrell Centennial Chair In Engineering and Chairman, Department of Civil Engineering, University of Texas at Austin, Austin, TX 78712-1076
194 Aryn Weyrick, Summit County HWAP, 1755 Main St, Room 208, Akron, OH 44308
195 Marjorie Witherspoon, National Assoc for State Community Services Programs, 444 North Capitol St NW, Suite 221, Washington, DC 20001
196 William A. Zwack, Energetics, 7164 Gateway Drive, Columbia, MD 21046
197 Office of Assistant Manager for Energy Research and Development, DOE Oak Ridge Field Office, P.O. Box 2008, Oak Ridge, TN 37831-6269
198-199 OSTI, U.S. Department of Energy, P.O. Box 62, Oak Ridge, TN 37831

INTERNAL DISTRIBUTION

1	M. A. Brown
2	L. G. Berry
3	G. E. Courville
4	M. T. Fady
5	M. B. Gettings
6	L. J. Hill
7	J. M. MacDonald
8	H. A. McLain
9	A. C. Schaffhauser
10	T. R. Sharp
11	R. B. Shelton
12	R. L. Shelton
13	M. P. Ternes
14	J. VanCoevering
15-76	Energy Conservation Dist., Building 3147, MS-6070
77-78	Central Research Library
79	Document Reference Section
80	Laboratory Records-RC
81	Laboratory Records
82	ORNL Patent Office

EXTERNAL DISTRIBUTION

DOE Regional Support Office Contacts

83 Ms. Marian Downs, Weatherization Program Contact, Denver Regional Support Office, U.S. Department of Energy, 1617 Cole Boulevard, Golden, CO 80401

84 Ms. Bernadette Cross, Weatherization Program Contact, Atlanta Regional Support Office, U.S. Department of Energy, 730 Peachtree Street, NE, Suite 876, Atlanta, GA 30308

85 Ms. Sharon Donaldson, Weatherization Program Contact, Chicago Regional Support Office, U.S. Department of Energy. I South Wacker Drive, Suite 2380, Chicago, IL 60606

86 Ms. Christine Reinfelds, Weatherization Program Manager, Boston Regional Support Office, U.S. Department of Energy, One Congress Street, Suite 1101, Boston, MA 02114

87 Ms. Beth Cahall, Weatherization Program Manager, Philadelphia Regional Support Office, U.S. Department of Energy, 1880 John F. Kennedy Blvd., Suite 501, Philadelphia, PA 19103-7483

88 Mr. Richard Putnam, Weatherization Program Manager, Seattle Regional Support Office, U.S. Department of Energy, 800 Fifth Avenue, Suite 3950, Seattle. WA 98104

STATE Weatherization Program Managers

89 Ms. Brenda Jones, Program Manager, Alabama Department of Economic and. Community Affairs, P.O. Box 5690, Montgomery, AL 36103-5690

90 Mr. Phil Kaluza, Program Manager, Rural Development Department, Alaska Housing Finance Corporation, 520 East 34th Avenue, Anchorage, AK 99503

91 Mr. Russell Clark, Weatherization Program Manager, Energy Office, Arizona Department of Commerce, 3800 North Central Avenue, Suite 1200, Phoenix, AZ 85012

92 Mr. Troy Branscum, Program Manager, Office of Community Services, Division of County Operations, P.O. Box 1437, Slot # 1330, Little Rock, AR 72203-1437

93 Ms. May Wait, Program Manager, Department of Community Services. and Development, State of California, 700 North 10th Street, Suite 258, Sacramento, CA 95814

94 Mr. Rob DeSoto, Weatherization Program Manager, Governor's Office of Energy Conservation, 1675 Broadway, Suite 1300, Denver. CO 80202-4613

95 Ms. Carlene Taylor, Program Assistance Supervisor, Department of Social Services, 25 Sigourney Street, Hartford, CT 06106-2055

96 Mr. G. Kenneth Davis, Weatherization Manager, Office of Community Services, Division of State Service Centers, Department of Health and Social Services, 820 North French Street, Wilmington, DE 19801

97 Mr. Carl E. Williams, Weatherization Program Manager, District of Columbia Energy Oftice, 2000 14th Street, NW, Suite 300 East, Washington. DC 20009

98 Mr. Earl Billings, Planning Manager, Department of Community Affairs, Florida Energy Office, 2555 Shumard Oaks Boulevard, Tallahassee, FL 32399-2100

99 Ms. Annette Carter, Weatherization Program Manager, Division of Energy Resources, Georgia Environmental Facilities Authority, Equitable Building, Suite 2090, 100 Peachtree Street, NW, Atlanta, GA 30303

100 Mr. Isaac Watson, Weatherization Program Manager, Office of Community Services, Department of Labor and Industrial Relations, 335 Merchant Street, Room 101, Honolulu, HI 96813

101 Ms. Neva Kaufman, Weatherization Program Manager, Department of Health and Welfare, Bureau of Family Self-Support, P.O. Box 208, Boise, ID 83720

102 Mr. Wayne E. Curtis, Weatherization Program Manager, Department of Commerce and Community Affairs, 620 Fast Adams Street, Fifth Floor, Springfield, IL 62701

103 Mr. Randy Powers, Program Manager, Division of Family and Children, P.O. Box 6116, Indianapolis, IN 46206-6116

104 Mr. James R. Newton, Bureau Chief for Weatherization, Division of Community Action Agencies, Department of Human Rights, Lucas State Office Building, Des Moines, IA 50319

105 Ms. Norma Phillips, Administrator, Division of Housing, Department of Commerce and Housing, 700 Southwest Harrison Street, Suite 1300, Topeka, KS 66603

106 Mr. Rich Eversman, Section Supervisor, Department of Social Services, Cabinet for Families & Children, Commonwealth of Kentucky, 275 East Main Street, Frankfort, KY 40621

107 Mr. Lonnie Diddier. Social Services Program Manager I, Department of Social Services, P.O. Box 3318, Baton Rouge, LA 70821

108 Mr. Peter Wintle, Director, Energy and Housing Services, Maine State Housing Authority, 353 Water Street, Augusta, ME 04330-4633

109 Mr. Robert C. Adams, Administrator, Office of Weatherization Assistance, Maryland Depamnent of Housing and, Community Development, 100 Community Place, Crownsville, MD 21032-2023

110 Mr. James Hays, Director, Executive Office of Communities and Development, Bureau of Energy Programs, Leverett Saltonstall Building, 100 Cambridge Street, Room 1803, Boston, MA 02202

111 Mr. Larry Mynhier, Program Manager, Family Independence Agency, P.O. Box 30037, Lansing, MI 48909

112 Mr. Roger Williams, Weatherization Program Manager, Minnesota Department of Economic Security, 390 North Robert Street, St. Paul, MN 55101

I13 Mr. Bobby Pamplin, Weatherization Program Manager, Mississippi Department of Human Services, 750 North State Street, Jackson, MS 39202

114 Ms. Cher Stuewe-Pormoff, Director, Division of Energy, Depament of Natural Resources, P.O. Box 176, Jefferson City, MO 65102-0176

115 Ms. Clarice S. Sabree, OLIEC Supervisor, New Jersey Department of Community Affairs, William Ashby Community Affairs Building, 101 South Broad Street, CN-806, Trenton, NJ 08625-0806

116 Ms. Liz Cordova, Manager. New Mexico State Housing Authority, 810 West San Mateo. Suite D, Sante Fe, NM 87505

117 Mr. Rick Gerardi, Director, State of New York, Department of State, Division of Weatherization Services, 162 Washington Avenue, Albany, NY 12231

118 Mr. Jeff Brown, RECAP Manager, Energy Division, North Carolina Department of Commerce, 430 North Salisbury Street, Raleigh, NC 27611

119 Mr. Howard Sage. Program Administrator, Office of Intergovernmental Assistance, 14th Floor, Stare Capitol Building, 600 East Boulevard Avenue, Bismarck, ND 58505

120 Ms. Sara E. Ward, Office Chief, Office of Energy Efficiency, Ohio Department of Development, P.O. Box 1001, Columbus, OH 43216-1001

121 Mr. Sherwood Washington, Division Director, Division of Community Affairs and Development, Oklahoma Department of Commerce. P.O. Box 26980, Oklahoma City, OK 73126-0980

122 Mr. Jack Hruska, Program Manager, Oregon Department of Housing and. Community Services, 1600 State Street, Salem, OR 97310

123 Mr. Karl A. Kimmel. Unit Chief. Pennsvlvania Deoartment of Communitv Affairs, P.O. Box 155, Harrisburg, PA 17120

124 Mr. Michael A. Snitzer, Program Manager. Rhode Island State Energy Office, 275 Westminster Street. Providence, RI 02903-5872

125 Mr. Doug Keisler, Director, Division of Economic Opportunity, Office of the Governor, 1205 Pendleton Street, Third Floor, Edgar A. Brown Building, Columbia, SC 29201-3740

126 Ms. Abbie Rathbun, Program Administrator, Depamnent of Social Services, 206 West Missouri Street, Pierre, SD 57501

127 Ms. Zelma Waller, Program Manager, Tennessee Department of Human Services, Citizens Plaza Building, 400 Deaderick Street, 14th Floor, Nashville, TN 37248-9500

128 Mr. J. A. Almaguer, Program Manager, Administration and Community Affairs, Texas Depamnent of Housing and Community Affairs, Waller Creek Office Building, P.O. Box 13941, Austin, TX 78711-3941

129 Mr. Michael Johnson, State Weatherization Manager, Division of Community Development, Urah Office of Energy Services, 324 South State Street, Suite 500, Salt Lake City, UT 84111

130 Mr. Jules Junker, Weatherization Programs Coordinator, Vermont Office of Economic Opportunity,

Agency of Human Services, 103 South Main Street, Waterbury, VT 05671-1801

131 Mr. William Beachy, Program Administrator, Virginia Department of Housing and, Community Development, Jackson Center, 501 North Second Street, Richmond, VA 23219-1321

132 Mr. Stephen Payne, Managing Director, Department of Community, Trade and, Economic Development. P.O. Box 48300, Olympia, WA 98504-8300

133 Ms. Lisa Kesecker. Program Manager, Office of Economic Opportunity, 950 Kanawha Boulevard, East - 3rd Floor, Charleston, WV 25301

134 Mr. Gary Gorlen, Bureau Director, Depanment of Administration, Division of Housing, P.O. Box 8944, Madison. WI 53708-8944

135 Ms. Jan Stiles, Program Manager, Department of Family Services, Hathaway Building, 2300 Capitol Avenue, 3rd Floor, Cheyenne, WY 82002-0490

136 Mr. Kane Quenemoen, Program Manager. Intergovernmental Human Services Bureau, Child and Family Services, Department of Public Health and Human Services, P.O. Box 8005, Helena, MT 59604-4210

137 Mr. Larry Ahasteen, Weatherization Program Manager, Division of Community Development. Navajo Nation Services Depamnent, P.O. Box 2396, Window Rack, AZ 86515

138 Mr. Pete Davis, weatherization Division Chief, Nebraska Energy Office, P.O. Box 95085, Lincoln, NE 68509

139 Mr. Craig Davis. Weatherization Program Manager, Nevada State Welfare Division, 2527 North Carson Street, Carson City, NV 89710

140 Mr. Warren Leary, Weatherization Program Manager, Governor's Office of Energy and, Community Services, 57 Regional Drive, Concord, NH 03301

141 Mr. Rafael Llompart, Administrator, Energy Affairs Administration, Department of Natural and Environmental Resources, Puerta de Tierra, P.O. Box 5887, San Juan, PR 00906-5887

Other Interested Parties

142 Lilia A. Abron, President, PEER Consultants, P.C., 1000 N. Ashley Drive, Suite 312. Tampa, FL 33602

143 Roben Bartley, Cavalier Management, 3706 Golfview Dr, Newark, DE 19702

144 Scott Bemstein, President, Center for Neighborhood Technology, 2125 West North Ave., Chicago, IL 60647

145 Frank Bishop, NASEO, 1516 M St NW, Suite 810, Washington, DC 20036

146 Dave Bohac, CEE, 540 First Avenue North Suite 400, Minneapolis, MN 55403-1609

147 Kirk Bond, EnTech Engineering, 2903 NE 59th Terrace, Suite 3, Kansas City, Missouri 64119-2158

148 David Bradley, National Community Action Foundation, 2100 M St NW, Suite 604A, Washington, DC 20037

149 John Buckstead, National Assoc of Community Action Agencies, 1875 Connecticut Ave NW, Suite 416, Washington, DC 20009

150 Mimi Burbage, AHFC, 520 E 34th Ave. Anchorage, AK 99503

151 Sandra Byrd, 19 No 19th St, Baton Rouge, LA 70802

152 James Cavallo, Argonne National Laboratory, Building 900, 9700 South Cass Avenue, Argonne, IL 60439

153 David Claridge, Mechanical Engineering, Texas A&M University, College Station TX 77843-3 123

154 Michael Clark, District of Columbia Energy Office, 2000 14th Street, NW, Suite 300 East, Washington, DC 20009

155 Dennis Creech, Southface Energy Institute, P.O. Box 5506, Atlanta, GA 30307

156 Laurie Davidson, PERI, 1700 Rockville Pike Suite 550, Rockville, MD 20852

157 John DeCicco, ACEEE, 1001 Connecticut Ave NW, Suite 416, Washington, DC 20009

158 Rick Diamond, Lawrence Berkeley Laboratory, Bldg. 90, Rm 3074, University of California, Berkeley, CA 94720

159 Judith Dimitriu, P.Eng., Director, School of Mechanical Engineering, Ryerson Polytechnic University, 350 Victoria St, Toronto, Ontario M5B 2K3, Canada

160 T. E. Drabek, Professor, Department of Sociology, University of Denver, Denver, Colorado 80208-0209

161 Jan Fox, Dept of Health and Human Services, Office of Energy Assistance, 370 L'Enfant Promenade SW, 5th Floor, Washington, DC 20447

162-171 Joel Eisenberg, Oak Ridge National Laboratory. 600 Maryland Ave SW, Suite 306W, Washington, DC 20024

172 Patricia Gallegos, Energy Conservation Association, 695 Canosa Ct, Denver, CO 80204

173 Thomas Green, Office of Community Services, P.O. Box 1437, Slot # 1330, Little Rock. AR 72203-1437

174 David T. Grimstud, Director, Minnesota Building Research Center, Room 220, 1425 University Ave S.E., Minneapolis, MN 55455

175 Bob Groberg, HUD, 451 Seventh St SW. Washington, DC 20410
176 Walter Grodzik, P.E., 2998 Foxcoft Drive, Tallahassee, FL 32308
177 Jim Hall, E.I.S.S.A. Haven Temporary Shelter, 2480 So Yellowstone Hwy, Idaho Falls, ID 834024321
178 Jeffrey R. Harris. 732 Lawton St., McLean, VA 22101-1510
179 Kay Joslin, NCAT, PO Box 3838, Butte, MT 59702
180 Sheila Hayter, National Renewable Energy Laboratory. 1617 Cole Blvd, Building 17-1, Golden, CO 80401
181 Martha J. Hewett, CEE, 540 First Avenue North, Suite 400, Minneapolis, MN 55403-1609
182 Dr. Stephen G. Hildebrand, Director Environmental Sciences Division, *Oak* Ridge National Laboratory, Post Office Box 2008, *Oak* Ridge. TN 37831-6037
183 Sam Hodges, USDA/RHS Stop 0761, Independence Ave, SW, Washington, DC 20024
184 Regina Irwin, Mississippi Dept of Human Services, Div of Community Services, P.O. Box 352, Jackson, MS 39202
185 Ron Jamagin. Pacific Northwest National Laboratories, PO Box 999, Richland, WA 99352
186 Gwen Johnson, Central Neighborhood Services Center, 1901 Pennsylvania Ave, Baltimore, MD 21237
187 W. C. Johnson. GCCAA, P.O. Box 519, Gulfport, MS 39502-0519
188 Vicky Hayes, NCAT, PO Box 3838, Butte, MT 59702
189 John T. Katrakis, J T Katrakis & Assoc, 418 North Ave, Barrington, IL 60010-3333
190-199 Larry Kinney, Synertech Systems Comoration. 472 South Salina Street, Syracuse. ***NY*** 13202
200 Paul Knight, Domus Plus, 408 Nonh Grove, ***Oak*** Park, IL 60302
201 Ron Kroese, NCAT, PO Box 3838, Butte, MT 59702
202 Ginny Lakey, 257 East Center, Provo, UT 84606
203 William R. Mixon, Tech Support Services. 1018 West Outer Dr., Oak Ridge, TN 37830
204 Vicky Mroczek, NLIEC Contact, Ohio Dept of Development, Office of Energy Efficiency, PO Box 1001, Columbus, OH 43216
205 Michael Myers. US Depamnent of Energy , FORS EE-421, 1000 Independence Avenue SW, Washington DC
206 Carolyn Newton, Alabama Power Co, PO Box 2641, Birmingham, AL 35291
207 Helen Perrine, Affordable Comfon, Airport Corporate Center, 894 Beaver Grade Rd, Coraopoils, PA 15108
208 Meg Power, Economic Opportunity Research Institute, 733 15th St NW. Suite 700, Washingion, DC 20005
209 Wes Riley, YCCAC, PO **Box** 72, Sanford, ME 04073
210 Ernell Rodgers, HCDC, 163 West 125th St, New York, NY 10027
211 David Saum, INFILTEC, PO Box 8007, Great Falls, VA 22041
212 Jeff Schlegel, 1167 Samalayuca Dr, Tucson, AZ 85704
213 Scott Sklar, Solar Energy Industries Association, 122 C St ***NW*,** 4th Floor, Washington, DC 20001
214 Robert R. Somers, 2rw Consulting Engineers, 800 E Jefferson St, Charlottesville, VA 22902-5132
215 John Snell, Citizens Conservation *Corp.,* 530 Atlantic Avenue. Boston, MA 02210
216 Curtis Taylor, 923 Old Bainbridge Rd, Tallahassee, FL 32303
217 **Susan** F. Tiemey, The Economic Resource Group Inc., One Mifflin Place, Cambridge. MA 02138
218 Malcom Verdict Director, The Alliance **to** Save Energy, 1200 18th Street, Suite. 900, Washington, DC 20036
219 C. Mchael Walton, Emest H. Cockrell Centennial Chair In Engineering and Chairman, Department of Civil Engineering, University of Texas at Austin, **Austin.** TX 78712-1076
220 Aryn Weyrick, Summit County HWAP, 1755 Main St, Room 208, Akron, OH 44308
221 Marjorie Witherspoon, National Assoc for State Community Services Programs, 444 North Capitol St *NW*, Suite 221, Washington, DC 20001
222 William A. Zwack, Energetics, 7164 Gateway Drive, Columbia, MD 21046
223 Office of Assistant Manager for Energy Research and Development, DOE *Oak* Ridge Field **Office,** P.O. Box 2008, Oak Ridge, TN 37831-6269
224-225 OSTI, U S. Department of Energy, P.O. Box 62, *Oak* Ridge, TN 37831