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A DEVELOPMENT STRATEGY FOR SUPERINSULATED HOUSING

Energy Task Force
Of The Urban Consortium

CITY OF SAINT LOUIS

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PREFACE

The Urban Consortium for Technology Initiatives was formed to pursue technological solutions to pressing urban problems. The Urban Consortium conducts its work program under the guidance of Task Forces structured according to the functions and concerns of local governments. The Energy Task Force, with a membership of municipal managers and technical professionals from nineteen Consortium jurisdictions, has sponsored over ninety energy management and technology projects in thirty-two Consortium member jurisdictions since 1978.

To develop in-house energy expertise, individual projects sponsored by the Task Force are managed and conducted by the staff of participating city and county governments. Projects with similar subjects are organized into "units" of four to five projects each, with each unit managed by a selected Task Force member. A description of the units and projects included in the Fifth Year (1983-1984) Energy Task Force Program follows:

UNIT -- MUNICIPAL OPERATIONS

Energy used to support public facilities and services by the nation's local governments in 1983 totaled approximately 1.4 quadrillion BTU's. By focusing on applied research to improve energy efficiency in municipal operations, the Energy Task Force helps reduce operating costs without increasing tax burdens on residents and commercial establishments. This Fifth Year unit consisted of five projects:

- Albuquerque, New Mexico - "Analysis of Municipal Bus Operations for the Advancement of Fuel Cell Technology"
- Baltimore, Maryland - "The Hydrate Process for Sewage Sludge Dewatering: Commercialization Assessment"
- Memphis, Tennessee - "Application of Mini-van Technology to Van Pool Services"
- Phoenix, Arizona - "Capacity Optimization of Hydronic Flows: Energy Savings in HVAC Systems"
- Washington, DC - "Facilities Energy Monitoring System: Application in a Large Municipal Government"

UNIT -- MUNICIPAL AND COMMUNITY ENERGY MANAGEMENT

Of the nation's estimated population of 232 million, approximately 60 percent reside or work in urbanized areas. The 543 cities and counties that contain populations greater than 100,000 consumed a total of 49 quadrillion BTU's in 1983. Applied research sponsored by the Energy Task Force helps improve the economic vitality of this urban community by aiding energy efficiency and reducing energy costs for public services and the community as a whole. This Fifth Year unit consisted of five projects:

- Boston, Massachusetts - "Computer-based Preventive Maintenance"
- Cleveland, Ohio - "Coordinating Preventive Maintenance with Energy Management"
- Columbus, Ohio - "Budgetary Incentives for Municipal Energy Management"

- Denver, Colorado - "Municipal Recycling Programs: Potential for Waste Management and Energy Savings"

- Philadelphia, Pennsylvania - "Energy Assistance Program Information System (EAPIS): Coordinating Residential Assistance Programs"

UNIT -- ALTERNATE/INTEGRATED SYSTEMS

Effective use of advanced energy technology and integrated energy systems in urban areas could save from 4 to 8 quadrillion BTU's during the next two decades. Urban governments can aid the realization of these savings and improve capabilities for the use of alternative energy resources by serving as test beds for the practical application of new and integrated technologies. This Fifth Year unit consisted of five projects:

- Chicago, Illinois - "Implementation Methods for an Integrated Energy System"

- Houston, Texas - "Pricing, Regulation and Competition in Cogeneration: A Method for Comprehensive Risk Analysis"

- New York, New York - "Feasibility of Water-based District Heating and Cooling"

- San Antonio, Texas - "Central Energy Systems Application to Economic Development"

- San Francisco, California - "On-site Cogeneration for Office Buildings"

UNIT -- PUBLIC/PRIVATE FINACING AND IMPLEMENTATION

City and county governments often have difficulty in carrying out otherwise sound energy efficiency or alternative energy projects due to constraints in the acquisition of initial investment capital. Many of these investment constraints can be overcome by providing means for private sector participation in innovative financing and financial management strategies. This Fifth Year unit consisted of five projects:

- Hennepin County, Minnesota - "Shared Savings in the Residential Market: Financing Single Family Energy Conservation"

- Kansas City, Missouri - "Street Light Inventory and Maintenance System"

- Pittsburgh, Pennsylvania - "Shared Savings for Energy Conservation: A Model Process for Local Governmets"

- Saint Louis, Missouri - "A Development Strategy for Superinsulated Housing"

- San Diego County, California - "Innovative Financing for a Privately Owned Waste-to-Energy Facility"

Reports from each of these projects are specifically designed to aid the transfer of proven experience to other local governments. Readers interested in obtaining any of these reports or further information about the Energy Task Force and the Urban Consortium should contact:

Energy Program
Public Technology, Inc.
1301 Pennsylvania Avenue, NW
Washington, DC 20004

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Exploring new directions in energy efficiency and housing affordability requires a special committment to the future. This project was only made possible through the cooperation and vision of the participant developers and local utility companies.

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Roger Tinklenberg, Director of the Energy Management Program and Project Co-Director, whose support made our initial demonstration project a reality and who is responsible for the community economic impact analysis in this report.

James G. Sackett
Project Manager

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Chapter 1
Overview

ABSTRACT

This project addressed the problem of introducing radically new construction principles into the residential development arena in the City Of Saint Louis which targeted substantial reductions in heating and cooling costs. Specifically, the goal was to devise a program that could explore the use of "superinsulation" as standard practice in the housing industry, both for new construction and rehabilitation. This meant that major barriers in education, design capability, financing, and technology calibration had to be overcome.

The basic approach was to implement a demonstration program that would produce a number of superinsulated housing units of a variety of types. These units would, in effect, be the "test cases" to adapt Canadian and European superinsulation standards to a midwestern United States climate. Subsequent monitoring of these units for actual energy use would "prove" the reliability and high cost-effectiveness of the technology.

The major tasks in the project included:

- Soliciting Participant Developers;
- Selecting Appropriate Housing Types;

- Providing Technical/Design Assistance;
- Providing Incentive Grants To Underwrite The Incremental Costs Associated With Upgraded Energy Efficiency;
- Supervising Construction;
- Monitoring Performance;
- Developing Software For Technical/Financial Analysis For Superinsulated Design.

The demonstration program is currently well on the way to success. By late spring or early summer 1985, the City will have 25 new superinsulated housing units on the market, ready for occupancy and monitoring - and more importantly, providing the basis for an expanded, mass-market penetration of superinsulation in the Saint Louis residential market. (See Table 7)

With the assistance of the follow-up grant for Year VI of the Consortium Energy Task Force, the City is now approaching the problem of establishing creative financing mechanisms which can accelerate full market acceptance of this technology.

PROJECT PURPOSE

This project was undertaken to demonstrate that superinsulation is a highly effective means of residential energy conservation which could be employed in a cost-effective manner in the local climate. The ultimate objective of bringing superinsulated design into the housing market <u>as standard practice</u> was seen as a method of helping to promote a number of important public policy goals:

1) Making urban housing more affordable, and thereby
2) Enlarging the consumer base
3) Making urban residential development as competitive as possible
4) Achieving significant positive impact on the local economy

Our analysis shows, for example, that superinsulated housing has the potential to be 49% less expensive on a life-cycle cost basis, with cumulative direct savings to the individual homeowner in the range of $40,000-$50,000. (Predicated on a $60,000 mortgage at 13%, with a 30 year term)

Furthermore, analysis of the aggregate financial impact of mass market development of superinsulated housing suggests an economic gain of approximately one-quarter billion dollars over a ten year period, based on a conservative energy-cost inflation rate and conservative market share. (See Chapter 6)

Chapter 2
Demonstrating Superinsulation Approaches: Rationale And Benefits

BACKGROUND

Energy Obsolescense

Like many older cities, Saint Louis has a large stock of historic brick housing. Rehabilitating these structures for future use is therefore crucial to the revitalization of the city. According to census figures, between 1980 and the year 2000, an estimated 26,806 housing units will have to be constructed in the City Of Saint Louis to meet the demands created by population growth and the loss of structures due to age and demolition. (1)

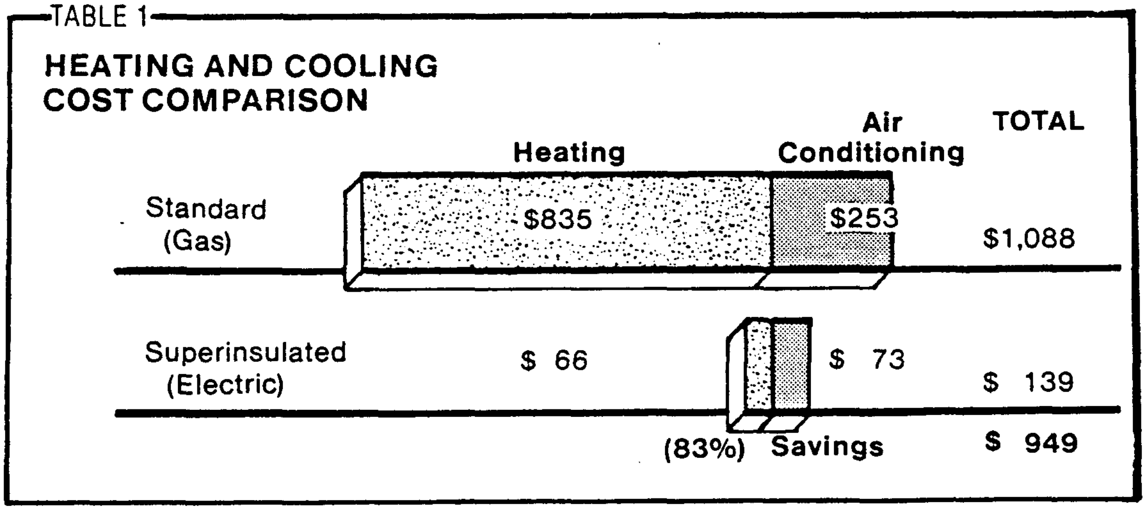
Nationally, rehabilitation has also become a significant factor in housing development. In 1981 alone, about 37% of all new housing in the United States, or 465,000 units, were created through rehab as compared to 1.3 million new construction starts. (2) With current tax laws making such projects particularly attractive to builders and developers, the number of rehab units should remain a growing part of the housing industry. Given the inevitable escalation of energy and construction costs, it is critical that the newly rehabbed housing not become "energy obsolete" in the years ahead.

In Saint Louis alone, for example, nearly 50% of the annual Community Development Block Grant is expended annually on housing subsidies (producing an average of 1,450 units-88 percent of which are rental as opposed to for-sale units). If such public expenditures are to be justified and protected, then the housing they produce must remain affordable for the owners and renters. Conventional construction/insulation practices, however, give no guarantee that operating costs (primarily heating and cooling) will remain within tolerable levels - since energy costs are expected to continue inflating indefinitely at a rate above the general inflation rate.

Rehab 2000

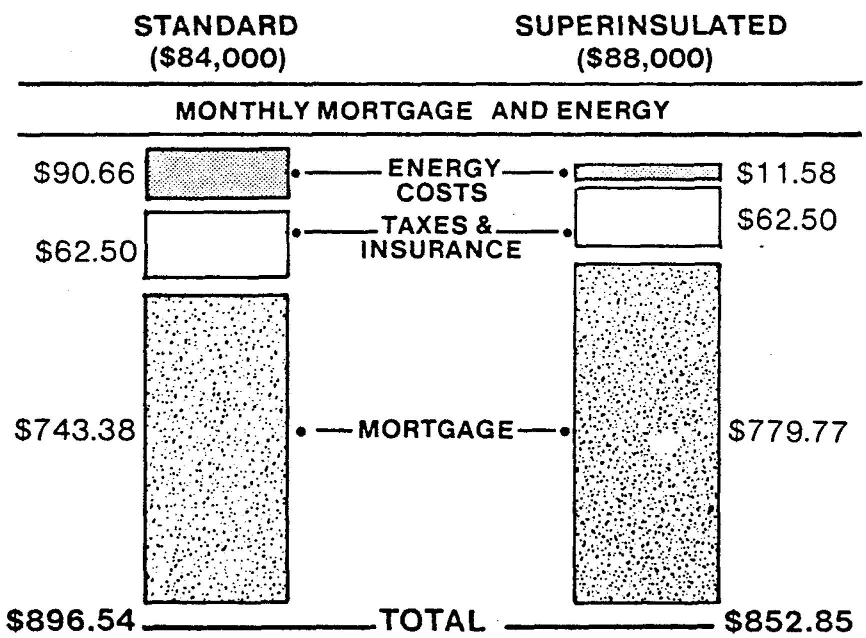
Prior to this project, the City had already begun its Rehab 2000 program, sponsored by the Saint Louis Energy Management Office, to demonstrate the cost-effectiveness of superinsulation techniques developed in Canada for new-home construction, in the rehabilitation of urban brick structures.

TABLE 1



The first superinsulated unit completed in the Rehab 2000 program was a 100-year-old single-family house in a historic neighborhood. With dramatically reduced heating and cooling costs, (See Table 1), the combined monthly mortgage and energy payments are less for the Rehab 2000 house than a conventionally rehabbed house of the same size. The energy savings more than offset the added costs of the superinsulation. (See Table 2)

TABLE 2 **MONTHLY HOUSING COST COMPARISON**



These results clearly demonstrate not only that superinsulation can make rehabbed housing more affordable, but also that dollars saved on energy can be retained in the local economy where they can further accelerate the revitalization of older cities.

Accordingly, with the assistance of the Year V Urban

Consortium grant, the City proceeded with a full-scale demonstration program, entailing the construction of 25 additional superinsulated units in a variety of housing types.

WHY SUPERINSULATION?

In order for energy-saving strategies to have a significant impact, they have to be easily adapted by the construction industry. Although impressive heating savings have been demonstrated using active and passive solar techniques, underground housing and reliance on alternative fuels such as wood, these approaches have had only limited impact in reaching the mainstream of the development community. Many of these techniques are strictly regional in application; others lend themselves readily only to "custom built" clients.

Superinsulation was chosen for the initial demonstration project because of its potential widespread applicability. Superinsulation components can be adapted to <u>any</u> architectural style and do not rely on southern orientation or large expanses of glazing. It makes use of conventional materials and construction techniques, putting it within the present capability of any builder. And perhaps most importantly from the standpoint of marketability, superinsulation is "user friendly." Living in a superinsulated house is, in fact, little different than living in conventional housing, requiring neither the fine tuning of some solar designs nor the spartan commitment of maintaining a woodstove.

Therefore, for a developer or builder, superinsulation offers a predictable, cost-effective energy conservation strategy. Superinsulated housing in Canada has demonstrated 80 to 100 percent reductions in space heating. (3) In the first Rehab 2000 project, the estimated 85 percent reduction in space heating is further enhanced by a 76% reduction in cooling costs. Because of these impressive energy savings, the benefits of superinsulation are more easily communicated to potential buyers, and the added costs of the conservation components easier to justify. _This point is critical for widespread acceptance by the construction industry, which is geared towards building and selling houses, not conducting in-house energy analysis._

SUPERINSULATION DEFINED

A superinsulated structure is one that is insulated so well and constructed so tightly that the reduced heating load is largely carried by the internal sources of heat generated by occupants and appliances. A superinsulated house is characterized by maximized wall and ceiling insulation and multi-glazed windows; air-tight construction using a continuous air-vapor barrier; stringent weatherstripping and strategies to tighten windows; and the use of air-to-air heat exchangers for ventilation and heat recovery from exhaust air.

It is crucial to recognize that although superinsulation derives its name from high insulation levels - typically two to three times that of conventional housing - simply adding more insulation will not produce the desired results. For instance, air leaks can negate the savings due to added insulation unless care is taken to ensure an extremely tight building envelope. Standard houses commonly have one to two air changes per hour (ACH); superinsulated houses have .5 ACH or less.

In short, all of the elements of a superinsulated house must work in unison. Leaving out one item will compromise the energy performance of the house.

CONSTRUCTION COMPONENTS

Insulation - Superinsulated houses generally have two to three times more insulation than the standard levels for a given region. However, determining the optimal level of insulation in a house can be difficult. Eventually the increased costs of adding more and more insulation will outweigh the resulting energy savings.

The logic in superinsulation is simply to keep adding insulation to the point where you can downsize or eliminate the conventional heating system from the house. Avoided cost for furnace and ductwork will then help offset the cost of the added insulation.

Air-Vapor Barriers - To ensure tight construction, superinsulated houses are lined with a continuous layer of polyethylene or other material. In addition to being one of the most important superinsulation strategies, the air-vapor barrier prevents moisture vapor inside the house from migrating into the insulation, where is can seriously compromise the insulation's effectiveness. Just as moisture collects on the outside of a glass of cold water, water vapor can condense in the wall insulation, as it migrates from the warmth of the interior out towards the cold exterior in winter. The air-vapor barrier prevents this.

Window Treatment - Windows require special consideration in a superinsulated house. Heat is lost through windows in two ways - conduction through the glass and infiltration through cracks between the window and frame.

Conduction losses can be minimized by using triple or even quadruple glazing. But more important than multiple glazings is the tightness of the window. About three-quarters of the heat loss through an ordinary window is caused by infiltration, as opposed to about one quarter from conduction.

Casement windows have a much tighter seal than double-hung units, but, because of architectural and historical considerations, their application is sometimes limited. A single hung unit is recommended, since only one sash is movable. One effective strategy for adding glazings to older existing sashes (and thereby virtually eliminating infiltration) is to install a magnetic inside insulating window. Because of the magnetic seal inside the window frame, air leakage is drastically reduced. These windows are much more effective than exterior mounted storms and blend better visually with historic structures.

Air Quality - In addition to odors from cooking, smoking and the typical use of a house, all building materials contain chemicals that need to be ventilated from a house to ensure safety. Since the normal cracks and crevices that bring in fresh air are eliminated in the superinsulated house, mechanical ventilation is necessary to maintain indoor air quality. This ventilation is supplied by an air-to-air heat exchanger. These devices, similar to bathroom fans, recover out-going heat and return it to the interior space in winter.

Proper use of the heat exchanger will eliminate any air pollution. A recent study done by the University Of Saskatchewan showed that none of the surveyed superinsulated houses using mechanical ventilation had indoor air quality problems.

Heat exchangers will also reclaim up to 80 percent of the heat normally lost from the exhaust air and keep it in the house. Because they are so efficient, they save far more in heating costs than it takes to run them.

Internal Loads - A superinsulated house is largely heated by the warmth generated from lighting, appliances and occupants - the "internal gain" in the house. A conventional house loses so much heat that the internal gain alone cannot maintain the temperature (See Table 3). But a superinsulated house has its heating load so reduced that these internal sources of heat can provide most if not all of the required heating. Back-up heating, in the form of a woodstove, baseboard or portable heater, can be all that is needed in even the most extreme weather.

The same insulation that keeps heat in during the winter keeps it out during the summer. Superinsulated houses in northern climates do not require air-conditioning at all, and rely instead on night-time ventilation for cooling. In Saint Louis, only a small apartment-sized air conditioner is needed for cooling and dehumidification in a 1,500 square foot house.

TABLE 3 **HEATING LOAD COMPARISON**

Area	R-Level		Therms Used	
	Standard	Rehab 2000	Standard	Rehab 2000
Ceiling	R-33.46	R-63.46	28.06	14.8
Walls	R-14.9	R-41.9	203.03	72.2
Basement	R-3.46	R-33.46	271.00	28.0
Infiltration	1.5 ACH	.3 ACH	428.8	79.7
Doors	R-15	R-15±	3.1	3.1
Therms			1027.0	251.14
Internal Gain			192	192
Required Therms (Before Furnace Efficiency)			835.00	59.0

Solar Elements - Solar gain through south facing windows or a sunspace can provide virtually all of the auxillary heating that a superinsulated house needs. But superinsulated houses do not rely on solar and can deliver 80 percent or more in energy savings with no south facing windows at all.

A sunspace kit on the initial single-family rehab in Saint Louis demonstrates the impact that a small solar contribution can have. Because of the reduced heating load, a ten foot wide sunspace provides enough heat to heat itself and pick up the auxillary heat for the rest of the house.

COSTS

According to a survey by the Minnesota Housing Development

Commission, the cost of superinsulating a typical single-family house in Minnesota is about $4,500. In Saint Louis, $3,700 was spent for energy conservation improvments above the base cost of rehabilitating a 1,500 square foot unit in the Rehab 2000 prototype unit. A breakdown is shown in Table 4.

TABLE 4 —— **INCREMENTAL COSTS FOR SUPERINSULATION**
(1500 S.F. Single Family)

	Standard Construction	Rehab 2000 Superinsulated
Wall Insulation	$1,079	$3,579
Windows (installed)	$1,972	$2,700
inside storms		950
HVAC/Air-to-Air	$3,500	$1,989
Heat Exchangers	---	700
Electrical (added)	---	200
	$6,551	$10,118
		−6,551
Total Incremental Cost		**$3,567**

Superinsulation can allow the added investment in insulation beyond what is normally economical to be partially off-set by cost savings from eliminating or downsizing the HVAC system and ductwork. In fact, computerized economic optimization studies of the insulation levels used in Rehab 2000 show that even these high-end levels of R-value and glazing are justified for a typical Saint Louis buyer staying in the house five years.

Chapter 3
The St. Louis Demonstration Program

Drawing on its experience with the initial "Rehab 2000" house, the City explored a variety of superinsulation approaches with four Saint Louis developers. The program instituted to gain developer participation and achieve implementation of a significant number of demonstration projects, is described in this chapter.

INCENTIVES FOR DEVELOPERS

The incentive package offered to the candidate developers consisted of financial, technical, and marketing assistance. Given the constraints on the available funds, the decision was made to provide only one-half of the incremental cost of the superinsulation improvements. This "shared risk" approach ensured that the developers would have a genuine committment to the energy modifications but it also required careful, detailed selling of each developer on the concept of superinsulation and its potential market value.

The technical assistance involved the following five important aspects of residential design and construction.

- o Plan review
- o Computer based energy calculations
- o Design modification:
  -Examination of insulation, window, and
  HVAC strategies

-HVAC downsizing
-Probable cost development and comparison

- Training of construction supervisors
- On-site problem solving

Thus, the developers had considerable energy expertise available to them at no cost through consulting with the Saint Louis Energy Management Program.

The participating developers also gained public relations advantages through participation in this project. City and developer cooperation by itself always generates some media interest. With the addition of the issue of an innovative construction technique featuring very low utility bills, some media coverage is virtually certain. The result is a boost for the marketing efforts of the participating developers.

After candidate developers were selected, technical assistance was given to upgrade the architectural design of the targeted projects to superinsulation standards. This involved initial meetings with the developer, architectural team and general contractor, with subsequent follow-up meetings with subcontractors involved.

In all projects but one, the transition to superinsulation involved modification of existing plans and specifications. Although this generally involved some minor changes in floor plan, the major considerations were as follows:

- Envelope modifications, including:
  -Examination of insulation strategy, type and R-value
  -Determination of air tightness strategy workable for

each project and insulation type

- o Project profile (occupants, window-to-floor area, type of construction, window strategy, etc.)
- o Sizing and placement of air-to-air heat exchanger and arrangement of ducts and control switches and location and choice of HVAC equipment.

DEVELOPER SELECTION

Because the project required a high degree of cooperation between the developers, their subcontractors, and the Energy Management Program, great care was exercised in selecting specific development companies.

Efforts were made to determine if each candidate developer had a stable operation, was flexible in construction techniques, and had residential development of one of the types necessary for this project. Informal interviews were then held with each developer. With many of the preliminary questions answered prior to the interview, it was possible to concentrate first on determining if the developer had a housing project which could be integrated into the grant schedule, and secondly on selling the developer on trying superinsulation construction methods.

The fact that the City had completed the pilot demonstration unit and had actual construction costs was of great value in securing developer participation. Securing developer participation required several months. A deliberate process of gaining participants and reaching an agreement on the housing units to be superinsulated was used, one developer at a time.

By initiating discussions with a developer only when previous commitments were locked in and there was a clear understanding of the remaining capacity for the City, it was possible to retain control over the total mix of housing types to be superinsulated. Also, this ensured that the City was not over-committed on the number of units to be done.

TABLE 5

SUPERINSULATION SYSTEMS EXAMINED

PROJECT	CONSTRUCTION TYPE	INSULATION SYSTEM	HVAC SYSTEM
1.) REHAB 2000	Rehab	Fiberglass/Vapor Barrier	ELECTRIC FURNACE
2.) Pantheon Corporation	Rehab	Fiberglass/Vapor Barrier* Foam Core Wall System Spray High Density Cellulose	ELECTRIC FURNACE
3.) MMCRC	Rehab	Fiberglass/Vapor Barrier Spray High Density Cellulose*	ELECTRIC — HEAT PUMP
4.) Munoz	Rehab	Spray High Density Cellulose Foam Core Wall System*	GAS— SEALED COMBUSTION
5.) Laclede	New	Foam Core Wall System 2 x 6 Wall With: Cellulose & Insulated Sheathing* Fiberglass & Insulated Sheathing Sheathing Explored For Interior And Exterior Use)	GAS — HYDRONIC FORCED AIR
6.) Conner	New	Spray High Density Cellulose With Phenolic Foam Interior Insulating Sheathing*	GAS — SEALED COMBUSTION

PROJECTS

After working through the process of developer selection, system analysis and cost projections we arrived at five basic projects entailing 26 units of housing, (See Table 5), with estimated energy cost reductions ranging from 71% to 80% compared to conventional construction. (See Table 6)

TABLE 6

COST ANALYSIS FOR SYSTEM OPTIONS
(THREE-UNIT TOWNHOUSE, NEW CONSTRUCTION)

	CONVENTIONAL 2X4	"SUPERSTICK" 2X6 CONSTRUCTION				DELTA INDUSTRIES STRESS-SKIN PANELS	
	3½" FIBREGLASS BATTS	5½" FIBREGLASS BATTS		SPRAYED HIGH DENSITY CELLULOSE (CELBAR)		4" FOAM CORE PANELIZED	
	R-10.4 (ADJUSTED FOR FRAMING LOSSES)	R-16.5	R-23 PLUS R-6.5 SHEATHLING (1½")	R-19.25	R-25.5[2] PLUS R-6.3 SHEATHING (1½")	R-20 4" WALL PANEL/ 8" ROOF PANEL	R-20[3] DELTA 4" CONV ROOF
CARPENTRY							
LABOR	11,373	11,373		11 373		5,049	4,249
MATERIALS	4,029	4,233		4,233		22,775 ROOF WALLS	2,334 15,133
INSULATION							
WALLS/GABLES	1,959 (R-11)	2,657 (R-19)		4,198 (R-23.1			
FLOORS/1ST		698 (R-19)		698 (R-19)		698 (R-19)	698
3RD	1,282 (R-30)	1,285 (R-30)		1,285 (R-30)			1,285
ROOF	1,106 (R-19)	1,106 (R-19)		1,106 (R-19)			1,106
AIR VAPOR BARRIER		351					
WINDOWS		2,739		2,739		2,739	2,739
DOORS		1,533		1,533		1,533	1,533
HVAC	-0-	−1,245		−1,245		−1,245	−1,245
SHEATHING	($7,740 Baseline)		4,548[1]		1,609[2] (4,540)[1]		
TOTALS	19,749	25,975	30,523	27,165	28,774 31,705	32,794	28,789
PER/UNIT	6,583	8,658	10,174	9,055	9,591 (10,568)	10,931	9,596
SQ/FT COST (@1800 SF)	$3.66	$4.81	$5.65	$5.03	$5.33 ($5.87)	$6.07	$5.33

[1] Foil-Faced Styrofoam
[2] Foil-Faced EPS "Solarshield"
[3] Cuts $7,642 From Delta Materials
Adds $3,334 Conv Roof & Labor
$4,308 Roof Savings

TYPES OF SI SYSTEMS

Several different insulation, heating and air conditioning equipment technologies were explored for use in the projects. Although building technologies that were easily adapted by the local building community were targeted, several new products were introduced into the Saint Louis market including a high-density, sprayed-in-place cellulose insulation material and several brands of air-to-air heat exchangers.

Two general questions guided our research into technologies: first, in light of practical and aesthetic considerations how can you achieve superinsulated levels of insulation with minimal wall thickness and minimal impact on interior living space? Secondly, what are the best methods to attain an air-tight envelope? Though the conventional approach of using fiberglass batting and a continuous polyethelyne vapor barrier is standard practice for energy-efficient design, it is painstaking to install and requires a thorough understanding of the end result by supervisors in the field. Another limitation is that tight-fitting insulation and continous vapor barriers are more difficult to achieve in rehab than in new construction.

Consequently, the use of panelized foam-core building systems and spray cellulose insulation were also explored. Foam-core stress skin panels speed site erection and also provide a seamless envelope and extremely tight construction. Spray cellulose prevents settling in the wall cavity over time, provides an air-tight insulation barrier and can conform to custom conditions prevelant in many rehab projects.

The program also explored state-of-the-art HVAC systems. Research into downsized equipment and sealed-combustion gas furnaces was carried out to find systems compatible with the superinsulation strategies developed in each project. Two new gas heating systems, designed for heating loads below 40,000 BTU per hour, were introduced to the Saint Louis market: the Apollo Hydra-Heat system (which uses the stand-by loss of a quick-recovery gas hot water heater) and the Suburban brand Dyna-Twin, (a sealed-combustion, 28,000 BTU/hour output furnace with integral 1-1/2 ton air conditioner).

TABLE 7

DEMONSTRATION PROJECTS SUMMARY

	PROJECT	DEVELOPER	ADDRESS	FUEL	GRANT AMOUNT
1)	Rehab 2000 1-Single-Family	Midtown Medical Center Redevelopment Corporation	3630 Blaine Tiffany	Electric	$5,000
2)	15-Rehabbed Apartments	Pantheon Corporation	615 Clara Debaliviere	Electric	$15,061
3)	3-Single-Family Rehab Houses	Midtown Medical Center Redevelopment Corporation	3662 Blaine	Heat Pump	$2,125
			3632 Blaine	Heat Pump Add-On	$2,375
			3660 Blaine	Heat Pump	$2,375
4)	6-New In-Fill Townhouses	Laclede Partnership	820 Ann Soulard	Gas/ Electric	$8,735
5)	1-In-Fill Townhouse	Mark Conner Builder	1217 McKay Lafayette Sq.	Gas	NONE
6)	Owner-Sweat Equity 1-Single-Family	Alex Munoz - Private Individual	2638 Allen Fox Park	Electric	NONE

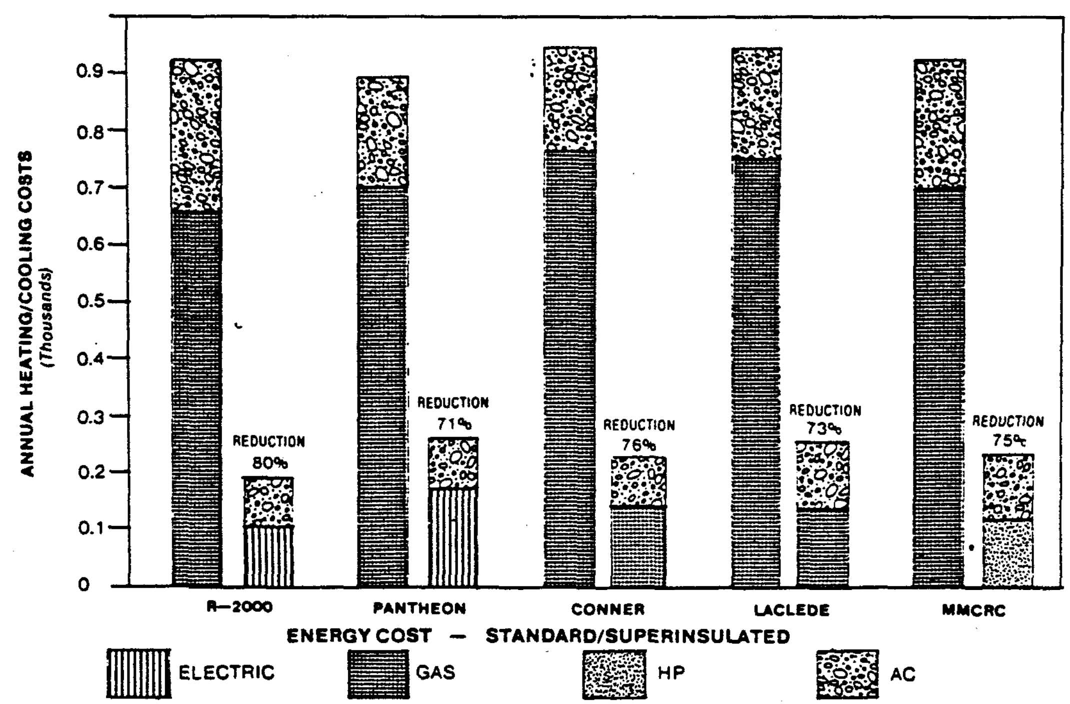
SYSTEMS COSTS

An important element in determining the cost-effectiveness of superinsulation on various housing types is the added cost of construction. This is particularly interesting when a variety of superinsulation design strategies are compared, as was the case in this project.

The added cost per unit for superinsulating rehabbed apartments was about $1,200 per unit on the Pantheon project. On the new in-fill construction carried out by the Laclede Partnership, a variety of energy efficient strategies were compared with the baseline of conventional construction. (See Table 8)

TABLE 8

COMPARATIVE SAVINGS
PRELIMINARY ESTIMATES



As Table 8 shows, the costs of "super-stick" construction (2x6 studs with insulated sheathing) on new projects is quite comparable with those for stress-skin, foam-core panels. Although the foam-core wall system costs more in materials, the labor costs on the erection of a new townhouse shell were reduced by 50 percent.

MONITORING

As part of the Rehab 2000 Agreement Form signed by each participant developer (See Appendix E), access to read or acquire utility bills is assured for one year. This applies to both for-sale and rental units.

In order to validate computer projections and estimates of utility bills for the projects, separate metering of heating and cooling equipment was provided by the utilities and the cost of installation was included in project costs (on the Pantheon project, for example, 10 selected apartments are metered). Bills may vary due to individual habits, various external influences (such as solar gain and exposure to north winds) as well as the buffering of some units by location and floor level.

Information collected from the monitoring will be sent to Lawrence Berkeley Laboratory (LBL) for analysis by their Building Energy Data Group. Under the Building Energy-Use Compilation and Analysis program (BECA), data from efficient homes across the country are being compiled to develop a further understanding of the costs and benefits of superinsulation and energy-efficient construction. Participation with LBL will help in understanding how the benefits produced by the Saint Louis project will apply to different climates throughout the United States.

MARKETING

Marketing assistance for participant developers has basically fallen into two areas: 1) utility cost projections, and 2) assistance with brochure and advertising preparation and publicity. The initial Rehab 2000 house featured an open house for the development and banking community and won a design award from the local chapter of the Home Builder's Association. Marketing materials included: 1) a fact sheet complete with projected energy bills on an annual basis, 2) presentation boards explaining energy strategies and 3) a brochure introducing superinsulation. (See Appendix B)

Laclede Partnership's new in-fill townhouses were the first demonstration projects to be marketed. The sales brochure featured "innovative energy efficient design" and mentioned annual heating and cooling costs. The project was featured at the annual Soulard House Tour and received front-page coverage in the Saint Louis Post-Dispatch real estate section. (See Appendix D)

The impact of the energy savings on overall housing affordability and an analysis of the approach developed for marketing the benefits of the superinsulation on the Pantheon project are covered in Chapter 4.

DEVELOPER SURVEY

Upon completion of the demonstration projects, a Developer Survey (See Appendix G) will be sent to determine the results of the program in transferring new technology to the building community. The survey will seek feedback on the assistance offered by the City, the effectiveness of superinsulation as a marketing mechanism and suggestions for improving program delivery. Survey results will be provided as an addendum to this report.

Chapter 4
A Case Study: The Pantheon Corporation Project

DEVELOPER PROFILE

A case study of the City's involvement with one developer in bringing a 15-unit superinsulated apartment building on-line illustrates the technical support offered as well as the working interaction required in this project.

Pantheon Corporation is the premier St. Louis rehab developer with a national reputation for "bringing back neighborhoods." Pantheon annually produces some 500 to 600 units of housing, with approximately $19 million in revenues in 1983.

The DeBalivere neighborhood just north of Forest Park in central St. Louis, is nearing the end of a five year period of intensive rehab which has created hundreds of new rental units in a 35 block area. Phase VI includes the rehabilitation of some 200 rental units in a scattered-site development encompassing more than 30 buildings. Included are two clusters that were examined for the superinsulated approach: four three-story, fifteen unit market-rate apartment buildings, to be simultaneously brought into the market in late 1985; and 12 three-family rehab apartment buildings and other scattered site projects.

Apartment construction accounts for about 89 percent of an overview of this building's apartment configuration.

TABLE 9

PANTHEON 15-UNIT APARTMENT BUILDING UNIT PROFILE

Unit Type	Number of Apartments	Number of Bedrooms	Size SF	Total SF
A	3	3	1,372	4,116
B	3	2	978	2,934
C	3	2	987	2,961
D	3	2	987	2,961
E	3	2	1,061	3,183
	15 Units			16,155 SF

TABLE 10

COST PAYBACK ANALYSIS
PANTHEON 15-UNIT APARTMENT

COST BREAKDOWN/THREE UNIT BASIS						COST PER UNIT		ECONOMIC BENEFIT		
Unit A	Square Feet	Superinsulated Strategy	Cost/ Square Feet	Total Cost	Sunspace	Total With Sunspace	Total With Sunspace Wet Blown Cellulose	Energy Savings On Heathing & AC	Simple Payback/ Sunspace	Sunspace Wet Blown Cellulose
Window	832	Triple Glazed	$3.30	$2,746	$305					
Ceilings	1372	R-40	.18	247	84					
Walls	3504	R-30	.37	1,296	354					
Sunspace	986	R-11	.20	297						
Floors	1372	R-30	.26	357	84					
A/VB			10	724						
Totals				$5.587	$1.003	$2.194	$2.245	$554	5.0 Year	4 1 Year
Unit B Totals						1.027	1.046	409	2.5 Year	2 6 Year
Unit C Totals		(AS PER ABOVE ANALYSIS)				957	922	401	2.4 Year	2.3 Year
Unit D Totals						950	1.033	400	.2 4 Year	3.0 Year
Unit E Totals						1.378	1.400	392	3.5 Year	3.6 Year
					COST 15-UNITS	$19.149	$19.938			
					AIR TO AIR HEAT EXCHANGERS	11.250	11.250			
					TOTAL COST	$30.399	$31.188			

(ALL ENERGY COSTS BASED ON 60% EFFICIENT GAS UNITS AT 60% EFFICIENCY)

Energy calculations and probable costs were then

storm windows
- Addition of doors to zone heated areas
- Thermal breaks on masonry interior firewalls
- Abandoning and blocking old chimineys
- Downsizing of furnace and air conditioning
- Addition of air-to-air heat exchangers

Since the "superinsulated" version increased exterior wall thickness from three and one-half inches to nine inches, the floor plan needed to be reworked to preserve kitchen and bathroom spaces. With the approval of the project architect, this work was handled by an in-house draftsperson on the developer's staff to minimize expense.

Switching from conventional bathroom ventilation fans to central air-to-air heat exchangers also required a revised ductwork layouts, to ventilate each bath and kitchen area. This was done by the heating and air conditioning contractor and included in the revised cost of the HVAC bid.

COST COMPARISION

Based on the revised design incorporating superinsulation, Pantheon had the project rebid. As a time-saving consideration, the initial superinsulated design was costed out using probable cost estimates on increased insulation, window treatments, vapor barriers, etc. based on earlier demonstration projects. This allowed the modified project to be rebid only one time. (See Table 11)

Bidding showed that conversion from gas to electric heating on the project allowed the inclusion of centralized air-to-air heat exchangers for the same price as windows to be attached to the inside of the standard double-glazed aluminum replacement windows. Since this had a large impact on costs, two strategies were used to evaluate this investment.

TABLE 12 — **REVISED COST ESTIMATES**
PANTHEON CORPORATION
JULY 2, 1984

TOTAL PROJECT COST (LABOR & MATERIALS)		$34,590.00
REVISED WINDOW COSTS (MAGNETIC STORMS)		
(MATERIAL	9,275.00	
WOOD STOP	630.00	
LABOR	2,360.00	
	$12,535.00	12,535.00
TOTAL IF MAGNETIC WINDOWS ARE ELIMINATED		22,055.00
10% GENERAL REQUIREMENT		2,205.00
10% OVERHEAD		2,205.00
5% ADMINISTRATIVE		1,256.00
TOTAL ADDED COST		**$30,122.00**
50/50 INCENTIVE GRANT (URBAN CONSORTIUM FUNDS)		($15,061.00)

First, a blower-door test was conducted on the completed superinsulated house using identical replacement aluminum windows and magnetic inside insulating windows to determine their effect on air tightness. Secondly, additional energy-use comparisions were modeled with and without the third glazing.

The results of the blower door test indicated that the aluminum replacement windows were far tighter than initially interior storm window. The results of the testing, modeled for both summer and winter conditions, is presented in Table 13.

The payback of the inside windows based on straight conductive heat loss going from double to triple glazing was equally unimpressive and could not justify their use, given the three to five year payback range targeted for the project. Savings for individual apartments are shown in

TABLE 14

SAVINGS BY UNIT *PRELIMARY ENERGY ANALYSIS 15 UNIT BUILDING*

Unit Type	STANDARD			SUPERINSULATED			Percent Savings	Combined Savings	Simple Payback SS	SS & WBC
	Heating	Cooling	Total	Heating	Cooling	Total				
A	$595	$255	$850	$207	$89	$296	65%	$554	3.6 Yr	4.1 Yr
B	386	178	564	79	76	155	73%	409	2.3 Yr	2.6 Yr
C	399	166	565	87	76	164	71%	401	2.5 Yr	2.6 Yr
D	398	166	564	87	76	164	71%	400	2.6 Yr	3.0 Yr
E	457	191	648	126	76	202	69%	446	3.2 Yr	3.6 Yr

*WBC Denotes "Wet-Blown Cellulose"

Another factor considered was the possibility of buffering the apartment interiors from nearly half of the windows by simply closing off the sun rooms in the winter with a door. Since this approach was favored over the third inside storm window due to costs. Other projects, such as the new in-fill townhouses with Laclede Partnership, did retain the third glazing because of the lower price obtained from a different window company and the impossibility of buffering the interior space from a large amount of window area.

the possible need to upgrade the electrical service posed a potential cost addition. Also, with a nuclear power plant coming on line in the Saint Louis region, electric rates were scheduled to increase by about 65% over a five year period, with an initial 25% to take effect almost simultaneously with completion of the superinsulated units. An analysis was run comparing the superinsulated electric units with the control units. After rebidding the HVAC system, the savings from not including gas piping and flues paid for the added costs of installing air-to-air heat exchangers for ventilation.

TABLE 15

HVAC DOWNSIZING — *PANTHEON 15-UNIT BUILDING*

Square Foot	Unit	Floor	FURNACE SIZE Standard (Gas)	FURNACE SIZE Superinsulated (Electric)	AIR CONDITIONING Standard (Tons)	AIR CONDITIONING Superinsulated (Tons)
1372	A	1, 3	61,000	10KW (34,140 BTU)	3.5	2.5
		2	57,000	10KW (34,140 BTU)	3	2.2
978	B	1, 3	45,000	10KW (34,140 BTU)	2.5	1.6
		2	38,000	10KW (34,140 BTU)	2	1.4
987	C	1	45,000	10KW (34,140 BTU)	2	1.6
		2	38,000	10KW (34,140 BTU)	2	1.6
		3	45,000	10KW (34,140 BTU)	2.5	1.6
987	D	1	45,000	10KW (34,140 BTU)	2	1.6
		2	38,000	10KW (34,140 BTU)	2	1.6
		3	45,000	10KW (34,140 BTU)	2.5	1.6
1061	E	1, 3	45,000	10KW (34,140 BTU)	2.5	1.9
		2	28,000	5KW (34,140 BTU)	2.5	1.7

Further examination of the heating and cooling requirement also showed that the reduction in furnace and air conditioning equipment size due to the superinsulation

TABLE 17

PANTHEON FIVE-YEAR ESCALATION ENERGY COSTS (HEATING & COOLING)			
	STANDARD GAS	SUPERINSULATED[1] ELECTRIC	SUPERINSULATED HEAT PUMP
YR 1	$ 850.00	$ 367.00	$ 260.00
YR 5	1,486.65	697.20	494.28
YR 10	2,990.18	1,403.33	994.18
TOTAL ENERGY (10 YEARS)	$11,527.09	$ 7,700.52	$ 5,455.40

[1]25% First Year Rate Increase Followed By 15% Annual For 4 Years.

THE CONSTRUCTION PROCESS

After the design work was finished, construction began on the three standard buildings first, so that the crews would not confuse the superinsulated design with the conventional approach.

Meetings were held with the on-site foreman before start of wall framing to orient him to changes in the layout. Appropriate sub-contractors were also contacted prior to the start of their work to review idiosycracies of the design, discuss sequencing and solicit suggestions.

Heavy involvement from both the HVAC, electrical and insulation subcontractors was necessary for a successful project. The HVAC contractor needed to redesign duct runs for the air-to-air heat exchanger, which supplements the

CONCLUSION

The Pantheon project is, clearly, the keystone in this demonstration program, not only because it involves a relatively large multi-unit building, but also because there are identical structures immediately adjacent to it which will yield highly comparable data for energy consumption. Analyzing this data over an extended period will reveal the true market value of superinsulation, both in terms of utility savings benefits to occupants and marketing factors for developers (effect on rate of lease-up, price structure, etc.). In short, the Pantheon project could eventually provide a major focus of attention on this new building technology in the Saint Louis housing industry.

Chapter 5
Energy And The Affordability Crisis In American Housing

REGIONAL AFFORDABLE HOUSING EFFORTS

In the winter of 1983, the Mayor formed an Affordable Housing Committee to explore strategies to produce new housing units that could be bought by a wider range of City residents. As a result of the Energy Management Program's superinsulated housing program, energy and operating costs became a major consideration in assessing housing affordability. An analysis of superinsulation compared to other cost reduction strategies in three Department Of Housing And Urban Development (HUD) projects showed that energy and operating costs were second only to increased land use density in lowering the costs of housing.

THE AFFORDABILITY GAP

Due to a combination of influences, housing in the United States is becoming increasingly unaffordable for the vast majority of Americans. (See Table 18) The dream of owning home is becoming an option for fewer and fewer middle-class families, much less those with more limited income. And for tenants, increasing rental and operating costs can make the accumulation of a home downpayment extremely difficult.

TABLE 18

Income and Expenses Needed to Purchase a New Single-Family Home 1970-82

	1970	1975	1978	1979	1980	1981	1982
Median sales price	$23,400	$39,300	$55,700	$62,900	$64,500	$68,900	$69,300
Contract interest rate	8.35%	8.75%	9.28%	10.43%	12.29%	14.50%	14.53%
Monthly mortgage payment (prinicipal, interest, taxes, and insurance)	$187.05	$316.63	$454.14	$551.77	$644.47	$791.59	$817.97
Median family income	$ 9,867	$13,719	$17,640	$19,684	$21,023	$22,388	$23,800
Percent of families who can afford a house assuming 33% of income for housing expenses (mortgage payments, taxes, insurance, maintenance, utilities)	61.0%	48.8%	41.3%	37.1%	33.6%	26.1%	24.0%

Source: U.S. Department of Housing and Urban Development, Federal Home Loan Bank Board, U.S. Bureau of the Census. Compilation, analysis, and estimates by National Association of Home Builders Economics Division.

The median price of a new home in the United States has, in fact, jumped from $27,000 in 1972 to $75,000 in 1983 (6). Today only 15% of all Americans can afford to buy a $60,000 house with a 13%, 30-year mortgage (7) and the situation only gets worse when rising energy costs are considered. Though income rose by 55% from 1970 to 1978, the expenses of operating a home, including heating and cooling costs, jumped 150 percent.

The statistics are particularly dramatic for low-income, subsidized housing as tenants on fixed incomes are increasingly pressed by climbing operating costs. As with most conventional housing, HUD subsidized units do not generally make use of state-of-the-art energy improvements. Instead, federal policy currently commits most energy assistance monies to utility bill subsidies rather than conservation investments.

However, as utility costs continue to increase, clearly the low-income tenant is the loser, because the limited federal subsidies will not be able to keep pace with the escalation in energy costs. At current projections, homeowners will be paying three to four times more for electric or natural gas by the year 2000. An average heating bill of $850 a year in 1984 may well be in the $2,500 to $3,400 range by the end of the century.

REASONS FOR RISING COSTS

Higher priced housing is caused by a number of factors, including increasing land, material, labor and financing costs. Over the past five years, land has increased in cost by 40% in Boston and by 200% in San Jose, California. The price of gypsum wallboard has doubled in one year in some regions of the country due to demand (8).

It is important to note, however, that higher housing prices are not primarily the result of escalating construction costs. In the last ten years, the real average hourly earnings of construction workers have declined, and the real prices of concrete and wood products have helped to lower overall construction costs. Residential construction costs rose 88 percent over the decade while prices in general increased 123 percent according to a joint study conducted by MIT and Harvard University (9).

Increased financing costs have become a major cause of housing costs. Builders at the National Association Of

Homebuilder's 1984 Conference in Houston identified interest rates as the number one cause of the higher cost of housing (10). Nationally, 15.4% of the buyers can afford a $60,000 house at an interest rate of 13%, whereas only 11.2% can afford that same house at an interest rate of fifteen percent. Ironically, this critical element in homebuilding is largely beyond the control of builders, developers or buyers and renters. (11)

Demographic trends have also contributed to the affordability crisis. Competition for housing has grown as the number of young adults has risen through the 1970's and an increasing number chose to live independently. In the decade of the 1970's, the number of persons between the ages of 20-34 increased 40 percent (12).

Another trend has been the rising costs of complying with government regulation, including building codes, land use restrictions and environmental regulations. According to one study of new developments near San Francisco in 1982, local fees primarily for utility hook-ups and "growth impact" have risen from $800 per unit in 1966 to over $7,000 per unit (13).

CONVENTIONAL AFFORDABLE HOUSING STRATEGIES

In an effort to deal with the crisis in housing affordability, HUD initiated the Joint Venture for Affordable Housing program in 1982. The Joint Venture has as its objectives development of a variety of innovations in construction, site planning and site development, building code, zoning and processing procedures to facilitate housing construction and cut costs. Working with the National Association Of Homebuilders and state and local officials, the Joint Venture has sponsored a variety of demonstration projects nationwide.

Reduction in energy and operating costs are not emphasized in these projects. Instead, the key strategies investigated are: optimal value engineering approaches to cut construction costs: increased housing density in site planning, and reductions in housing size to cut construction costs. The results of three HUD demonstration projects are considered here in comparison with the benefits of energy efficiency as an affordable housing strategy. In nearly every respect, energy efficiency is seen as an optimal strategy. (See Table 19)

TABLE 19—**COST REDUCTION STRATEGIES**

	Savings Impact
OVE—Construction Cost Savings	2.8 - 4.3%
Increased Density	12% - 13%
Downsizing	8.6%
Superinsulation—First Year Impact	6% - 8%
Superinsulation—Fifth Year Impact	11.2% - 15.6%

Optimal Value Engineering

In a demonstration program of 256 townhouses and single-family homes in Phoenix, Arizona, an average of $2,165 in construction cost savings were achieved using optimal value engineering, (14) approximately a 3.8% reduction in construction costs. Savings on an attached townhouse demonstration project in Mesa County, Colorado averaged 2.8%; a detached single-family project in Crittenden County, Arkansas averaged about 4.3% (15). Strategies included elimination of right-of-ways, elimination of kitchen soffits and roof overhangs, elimination of mechanical exhaust fans in bathrooms and utility, use of polybutylene pipe and large quantity purchasing of building materials.

Increased Land Density

The largest potential for reducing housing costs is in increasing the density of units, according to Joseph Sherman, Director of the HUD Joint Venture Program (16). This often requires a variety of zoning and planning changes to allow reduced roadway widths, zero lot lines and elimination in some cases of right-of-way set-backs. Land development savings accounted for the majority of the savings in the Phoenix demonstration, or about $3,676 per unit as compared to $2,165 for direct construction (17). Density had an even more dramatic impact on the other demonstrations, accounting for a 13.7% reduction in housing costs in the Crittenden County, Arkansas development (18) and a 12.1% reduction in the Mesa County, Colorado project (19).

Although increased housing density can offer substantial savings, it only lends itself easily to larger, planned unit developments, and is much more difficult for in-fill construction or custom homes. This is significant because 82.4% of the homebuilders in the United States build fewer than 50 houses a year (20). Though larger builders are responsible for the majority of new housing starts, density and land development cost reductions are highly dependent on local building and zoning codes, and generally do not appear as universally applicable as other strategies.

Size Reduction

A reduction in housing size has recently become a clear response to affordability. Sixty-one percent of the builders at the 1984 National Association Of Homebuilders convention said they reduced the square footage in new homes to cope with rising material and labor cost (21).

From 1950 to 1979, the size of houses in the U.S. increased from 983 square feet to 1,750 square feet. But from 1979 to 1982, average housing size dropped to 1,600 square feet in 1982, or an 8.6% reduction. The Real Estate Research Corporation says the trend is likely to continue through this decade, with new housing by 1990 expected to be around 1,200 square feet. (22) Though average house size does float up and down in response to the market, clearly it is an important tool builders use to lower costs.

Although the increase in single-person households --

predicted to be one-third of all U.S. households by 1990 -- is one reason for downsizing, the predominate reason is economic. Even though all of the HUD demonstration projects feature smaller, well designed homes and townhouses, it is difficult to break-out the savings of downsizing from the overall dollar figures cited in reports for increased density. As a result, the average reduction in housing size nationally of 8.6% from 1979 to 1983 is used for the purpose of this discussion.

ENERGY COST REDUCTION STRATEGIES

Largely ignored as a factor in housing affordability, reduced operating costs for the homebuyer through highly energy-efficient construction, offers a promising strategy for the private or public housing developer.

Superinsulation Overview

Superinsulated housing using conventional building techniques and materials can typically cut heating and cooling costs by 80 to 90 percent over their standard built counterparts. (23) According to a survey of superinsulated houses in the harsh Minnesota climate, the added costs of the energy features typically added about four percent to the cost of construction. (24) A Vermont builder using one of the latest technologies in superinsulation, structural stress-skin, foam-core panels, claims to be delivering completed superinsulated houses at the same cost as conventional housing in the area. (25)

Though interest in superinsulated housing is growing in the United States, both Canada and Sweden have already had widespread success with highly energy-efficient homes. In Sweden, which has long had one of the most efficient housing stocks in the world, electrically heated houses built under the 1984 building code will use 75 percent less energy than their 1970 counterparts. (26)

As the twenty-seven new and rehabbed superinsulated housing units in Saint Louis have shown, dramatic energy savings are feasible for both rental and for-sale units in the midwestern United States.

TRANSLATING ENERGY SAVINGS INTO AFFORDABILITY

Unlike fluctuating interest rates or changes in land development or land use strategies, the decision to build an energy-efficient house is largely up to the discretion of the developer. If the benefits of using state-of-the-art approaches become fully recognized, energy efficiency can become a high-impact strategy to provide affordable housing -- and this strategy can be married to a variety of other strategies available to builders.

Too often, improvements in energy efficiency have translated into added cost and higher risk for the homebuilder, housing authority or the U.S. Department Of

Housing And Urban Development. In order to encourage the use of energy efficiency as a strategy to enhance affordability, it is necessary to translate the operating cost savings of superinsulation into terms comparable to other affordable housing strategies.

PITI ± E

Even though the owner of an energy efficient home or apartment stands a much better chance of meeting all of the financial obligations associated with home ownership, the expense of housing discourages buyers from the added investment in energy efficiency. Typically mortgage lenders only qualify applicants for mortgages if monthly housing costs -- principal, interest, taxes and insurance (PITI) do not exceed 28 percent of the borrower's gross income.

Therefore, one approach to showing the benefits of superinsulation is to show the overall mortgage impact of the added investment in energy efficiency on a buyer's purchase and operating costs. This comparison adds the energy costs to the other monthly purchaser obligations. (PITI + E).

A comparison of a conventional and superinsulated 1,500 square foot single-family house demonstrates benefits from superinsulation. Although an added $4,000 investment in conservation adds to mortgage costs (rounding costs up from the $3,500 actually experienced on the project-See Chapter 2), the overall costs of PITI + E are $43.69 a month less than the conventional house with a lower sales price. This saving translates into a $3,300 reduction in front-end cost, in terms of avoided mortgage payments at 13% interest rate for 30 years.

The energy savings, however, are not static. The savings over the life of the mortgage increase when compared to the standard reference house - from $949 in savings in year one to $1,660 in savings in year five at a 15% annual energy inflation rate. Adjusted for the amortized costs of the investment in superinsulation, the savings are $429 the first year and $1,129 in the fifth.

Equivalent Size Reduction

On the 1,500 square foot pilot house, superinsulation has the same impact on affordability as reducing the size by 5.8% or 87 square feet, without the sacrifice in living space or resale value. This is the same as a reduction of more than $3,500 in construction costs.

Furthermore, the benefits of superinsulation continue to grow as energy costs increase, whereas the savings from reduction in size are static. For example, the superinsulated single-family house costs 10.7% less than its downsized counterpart in the first year, but it is 52.3% less expensive by year five (at a 15% annual fuel inflation rate. (See Table 20)

It is also important to note that any initial cost savings achieved through size reduction alone are eventually erased by energy cost escalation on conventional homes. With first year energy costs of $398, annual savings from a 5% size reduction are absorbed by increased heating and cooling costs by the fourth year.

TABLE 20

SAVINGS FROM
ENERGY SAVINGS US
REDUCED HOUSING SIZE

	STANDARD	REDUCED SIZE (BY 5%)	SUPERINSULATED
Year One Energy Cost	$1,088.00	$1,034.00	$139.00
		−398.00 (1)	+429.00 (2)
Adjusted Year One Energy Cost	$1,088.00	$636.00	$568.00
Adjusted Year Five Energy Cost	$1,903.00	$1,402.00	$672.00

(1) 5% Cost Reduction Over 30 Years

(2) Annual Cost of $4,000 At 13% Over 30 Years

Combination Strategies

Ideally, superinsulation could be combined with other strategies tested in the Joint Venture for Affordable Housing. Assuming a 7.5% reduction in housing costs from a combination of increased density, administrative and code savings, optimal value engineering and appropriate downsizing, then the added cost of superinsulating a 1,500 square foot house would be more than offset.

As Table 21 shows, combining affordable housing strategies with superinsulation results in lowering the annual minimum qualifying income by $3,300. <u>This has virtually the same effect as a 15% reduction in sales price.</u> If a particiular development can reap greater savings from one of the HUD strategies such as increased density, the overall impact could be proportionally greater.

TABLE 21 — **COMBINING AFFORDABLE HOUSING AND SUPERINSULATION STRATEGIES**

	Conventional	Superinsulated
Sales Price	$60,000.00	$60,000.00
Cost To Superinsulate	-0-	+3,5000.00
Cost Savings From Hud Affordable Housing Strategies (7.5% Total Savings)	-0-	−4,500.00
Net Sales Price	**$60,000.00**	**$59,000.00**
(Amount of Mortgage Based on 80% Loan/Value Ratio)	($48,000.00)	($47,200.00)
Monthly Payment - Based on 30 Year/13.5% Loan	549.81	540.65
Add Insurance and Taxes	115.00	115.00
Add Energy Costs	90.66	11.58
Total Monthly Housing Costs	**$755.47**	**$667.23**
	(Difference of $88.24)	
Qualifying Annual Income— Based on 32% Debt/Income Ratio	**$28,332.00**	**$25,020.00**

<u>Rental Property Impact</u>

For a superinsulated fifteen unit market-rate apartment building in Saint Louis, the combined costs of rent plus energy are 4.5% less for the superinsulated unit than a conventionally built unit, even after the amortized costs of the energy improvements. By year ten, the energy-efficient units are projected to be 10.6% more affordable. (See Table 22)

TABLE 22

STANDARD VS. SUPERINSULATED RENTAL COSTS (MARKET-RATE)

	MONTHLY RENT	MONTHLY ENERGY (2)	TOTAL	PERCENT SAVINGS
YEAR ONE				
Standard	$605.00	$74.34	$679.34	
Superinsulated	$619.95 (1)	$29.00	$648.95	4.5%
YEAR FIVE				
Standard	$885.78	$130.00	$1,015.78	
Superinsulated	$900.73	$50.72	$951.49	6.3%
YEAR TEN				
Standard	$1,426.56	$300.75	$1,727.31	
Superinsulated	$1,441.51	$102.01	$1,543.52	10.6%

(1) Rent Plus Amortized Cost Of Superinsulation At $14.95/Month
(2) Energy Comparison Based On Gas Furnace In Conventional Unit/Electric Resistance In SI Unit

By Year Ten, the superinsulated low-income apartment is nearly twenty percent cheaper than its counterpart. In the first year, the superinsulated unit is eight percent less expensive to rent and operate than its standard counterpart.

Superinsulation also has a dramatic benefit for low-income and subsidized rental housing. For a developer or housing authority interested in the long-term management of a housing unit with tenants on fixed incomes, energy savings can help keep housing affordable for the economically disadvantaged. Assuming the fifteen-unit apartment building above has a fifty percent rent subsidy, the impact of energy costs becomes a proportionally greater burden for the tenant and the benefits of highly energy-efficient conservation much more dramatic. (See Table 23)

TABLE 23

STANDARD VS. SUPERINSULATED RENTAL COSTS (SUBSIDIZED)	MONTHLY RENT	MONTHLY ENERGY	TOTAL	PERCENT SAVINGS
YEAR ONE				
Standard	$305.00	$74.34	$379.34	8%
Superinsulated	$319.95	$29.000	$348.95	
YEAR FIVE				
Standard	$446.55	$130.00	$516.55	11.2%
Superinsulated	$461.50	$50.72	$512.22	
YEAR TEN				
Standard	$719.17	$300.00	$1,019.17	18%
Superinsulated	$734.12	$102.01	$836.13	

Appraisal Impact

Though superinsulation has a clear benefit for the apartment dweller, these improvements cost the developer or housing authority more initially. Energy efficiency, however, can yield impressive returns for developers of multi-family rental units. This is an important perspective to explore because rental property is often the most difficult type of housing in which to encourage energy efficiency.

Based on income and expense figures derived from the Institute Of Real Estate Management's Income/Expense Analysis/Apartments (1983 Edition), an analysis was run on a

15-unit superinsulated apartment building in the Saint Louis demonstration program. This hypothetical analysis used conservative figures of 25% and 50%, though greater savings are anticipated in the demonstration projects.

TABLE 24

PROPERTY VALUE/RATE-OF-RETURN ANALYSIS*
(15 UNIT STRUCTURE)

	STANDARD	AFTER (25%) ENERGY REDUCTION	AFTER 50% ENERGY REDUCTION
Property Value	$135,000	$165,000	$195,000
Construction Cost	$460,000	$480,000	$480,000
Debt Service (15%/10 Year)	6,900	7,200	7,200
Net Operating Income	13,503	16,495	19,486
Less: Debt Service	−6,900	−7,200	−7,200
Cash Flow	6,603	9,295	12,286
Rate of Return	**13.21%**	**18.59%**	**24.57%**

*NOTE: 1) Assumes Capitalization rate of 10%.
2) Value = Net Operating Income/Capitlization Rate
3) Rate of Return = Cash Flow/Equity

As shown in Table 24, energy savings of 25% increase the property value by 22 percent, or from $135,000 to $165,000. A savings of 50% in energy costs would enhance the property value by some 44 percent.

IMPLICATIONS FOR DEVELOPERS

Investing in energy-efficiency through superinsulation is a generic, highly predictable strategy that housing developers, whether private or public, can use to increase the value of a project. An analysis of a fifteen unit apartment building in Saint Louis shows a superinsulated version yields a return on investment of 24.5 percent as compared to 13.2 percent for a conventionally built project. (See Tables 24 & 25) Clearly, the benefits of enhanced energy efficiency are available both for tenants and developers.

TABLE 25

OPERATING EXPENSE ANALYSIS FOR SUPERINSULATION

Account	Standard	After (25%)	After (50%)
Income			
Scheduled Rents	$56,005	S	S
Less: Vacanacy/Rent Loss	−2,762	A	A
Effective Rent	$53,243	M	M
Miscellaneous Income	614	E	E
Total Income	**$53,857**	**$53,857**	**$53,857**
Expenses			
Administrative		S	S
Management Fee	$ 2,608	A	A
Other	4,450	M	M
		E	E
Operating			
Supplies	307		
Heating	4,757	3,568	2,379
Electricity	7,211	5,408	3,606
Gas	5,064	S	S
Water/Sewer	1,841		
Maintenance	6,291	A	A
Real Estate Taxes	2,608	M	M
Insurance	1,534	E	E
Miscellaneous Expanses	3,683		
Total Expenses	**$40,354**	**$37,362**	**$34,371**
Net Operating Income	**$13,503**	**$16,495**	**$19,486**

(**NOTE** - Based on Low-Rise Multi-Family, 12-24 Unit, Property with 15,344 Square Feet)

IMPLICATIONS FOR FEDERAL HOUSING POLICY

In Missouri alone, $31 million went to low-income energy assistance payments in 1983 compared to $7.5 million for weatherization. These funds are a non-recoverable, recurring expense, whereas investment in weatherization and energy efficiency can reduce future housing costs. Given the cost-effectiveness and rapid payback of superinsulation and other energy improvements, fiscal prudence would suggest that federal policy should be redirected - away from simply subsidizing utility bills indefinitely and toward the financing of much higher degrees of energy efficiency, in both new and rehabilitated public housing. A housing authority, for instance, that invests in superinsulation can roll-over the savings after a three to five year payback period, to fund energy improvements on another set of apartments under construction. Dollars spent on superinsulation can therefore be used to continue dramatic savings for tenants or be tapped to expand the base of energy-efficient apartments available to a community.

Chapter 6
The Economic Ramifications Of Superinsulation As Standard Practice In The Housing Industry: A Regional Model

MARKET DIMENSIONS AND CHARACTERISTICS

Because of both.. demographic factors and housing stock characteristics, housing rehabilitation and new construction are essential for the revitalization of St. Louis. Like many older cities in the "manufacturing belt," St. Louis has suffered dramatic population loss in the past two decades. Although the regional population has remained virtually stable over the last two census surveys, the City population has declined from a high of nearly one million in the early 1950's to approximately 450,000 presently.

The housing stock in the city is predominantly brick, as a consequence of a code requirement imposed after a devastating fire in 1849 (it has since been repealed). Much of the housing stock is very old, some 60 percent having been constructed before 1940 (See Table 26), and badly in need of rehabilitation. It is, in fact being rehabbed at a substantial rate (See Table 27), but given a total stock of 201,960 units in 1980, the potential market has barely been touched, and will support a major rehab industry for the forseeable future.

Table 26

Saint Louis City Housing Characteristics (26)

Year-Round Housing Units	—Percent of Units Built Between—			
	1980-1970	1969-1960	1959-1940	1939-EARLIER
201,960	3.7	7.8	27.9	60.0

Table 27

Saint Louis City Housing Construction (27)

Year	New Units	Value (Millions)	Rehabed Units	Value (Millions)	Total Units
1980	852	$20.9	1119	$37.8	1971
1981	273	$ 7.8	616	$14.4	889
1982	1115	$32.6	1483	$21.9	2598
1983	585	$17.9	994	$23.2	1579

METHODOLOGY OF THE ECONOMIC MODEL

There are economic linkages between businesses, government, other organizations, and individuals because of the transfer of goods and services within a region. This dollar turnover generates economic activity called the indirect effect or multiplier effect. The multiplier ratios are very low generally for the purchase of heating and cooling fuels, and relatively high for investments in energy conservation. For example, when one dollar is spent on natural gas or petroleum products, about 80 percent leaves the local economy immediately -- primarily for the energy product.

According to a Minnesota study, the result is that $1.00 spent on electricity, petroleum products, or natural gas has a net local economic effect of $1.69, $0.55, or $0.59 respectively compared to the net economic effect of $2.21 from every $1.00 spent on home conservation. (See Table 28) Therefore, spending money on energy efficient construction and conservation (rather than energy imports) generates more looal economic activity.

Table 28

Energy Purchase: Net Economic Effect (28)

	Economic Multiplier	Money Leaving Locality	Net Economic Effect
Petroleum	1.35	.80	.55
Natural Gas	1.40	.81	.59
Electricity	2.02	.33	1.69
Conservation	2.55	.34	2.21
Solar	2.43	.31	2.12

Admittedly, energy production, company stock ownership and interregional and interstate trade has a mitigating effect on the economic drain caused by energy purchases. However, according to a recent Harvard study (30) which divided the country into three regions (one producing and two consuming regions) to model the effect of natural gas price decontrol, consuming regions' gross income are negatively affected by a price increase if it cannot be passed through to the consumer and if property values fall due to flight of businesses and residents to the producing region. Given the shift in business and population to the Sun Belt, that theoretical economic possibility appears to actually be occuring, probably not strictly due to natural gas decontrol but certainly heavily influenced by heating costs.

What occurs under price decontrol should mirror what happens each time a dollar is spent on natural gas. Economic multipliers often differ for different regions. However, a 1972 input-output study found St. Louis multipliers quite close to those listed in the Minnesota study. (See Table 29)

Table 29

1972 Saint Louis Multipliers (31)

Petroleum Products	1.30
Natural Gas	1.43
Electricity	1.85
Construction	2.34

MARKET PENETRATION SCENARIOS

Given a conservative market penetration scenario which projected constructing one superinsulated housing unit in 1983, 30 in 1984, 75 in 1985, and expanding to 500 units per year in 1992 (which would still be less than one-third of all the units built per year) over 2,750 units would be superinsulated during an initial ten year period. A more ambitious scenario could develop, however. With continued active promotion by the City, it should be possible to achieve superinsulation as standard construction practice within ten years. Given the favorable economics of superinsulated housing, this optimal result appears feasible.

PROJECTED ECONOMIC IMPACT

Projecting a gradual penetration of the housing market by the superinsulation construction methodology so that, by 1992, 500 units per year are superinsulated, there would be a cumulative ten year economic benefit of over $128 million in St. Louis City alone. (See Table 30)

Table 30

Saint Louis Economic Impact/Low Scenario
($2.21 Net Multiplier)

Year	# Units	Added Cost Each	Annual Savings Each	Cumulative Energy Savings*	Cumulative Economic Impact**
1983	1	$3,500	$ 950	$ 950	$ 2,100
1984	30	3,500	950	30,400	67,184
1985	75	3,675	997	137,085	302,958
1986	200	3,859	1,047	488,932	1,080,539
1987	275	4,052	1,100	1,296,318	2,864,862
1988	350	4,254	1,155	3,028,739	6,693,513
1989	425	4,467	1,212	6,626,530	14,644,631
1990	450	4,690	1,273	13,908,155	30,737,024
1991	475	4,925	1,337	28,566,225	63,131,358
1992	500	5,171	1,404	57,986,697	128,150,601

* Sum of year-to-date units times savings each in current year plus the sum of all previous cumulative totals

** Cumulative savings times the $2.21 multiplier

Given a more rapid market penetration resulting in

1,700 units per year being superinsulated by 1992, there would be a cumulative ten year economic impact of over $218 million. (See Table 31)

Table 31

Saint Louis Economic Impact/High Scenario
($2.21 Net Multiplier)

Year	# Units	Added Cost Each	Annual Savings Each	Cumulative Energy Savings*	Cumulative Economic Impact**
1983	1	$3,500	$ 950	$ 950	$ 2,100
1984	30	3,500	950	30,400	67,184
1985	125	3,675	997	186,960	413,182
1986	250	3,859	1,047	643,544	1,422,233
1987	500	4,052	1,100	1,858,222	4,106,671
1988	750	4,254	1,155	4,632,311	10,237,407
1989	1000	4,467	1,212	10,572,701	23,365,669
1990	1250	4,690	1,273	22,897,781	50,604,095
1991	1500	4,925	1,337	48,049,314	106,188,984
1992	1700	5,171	1,404	98,846,041	218,449,751

* Sum of year-to-date units times savings each in current year plus the sum of all previous cumulative totals

** Cumulative savings times the $2.21 multiplier

The high scenario is quite feasible. Presently, about 1,700 units are built or rehabbed in Saint Louis each year and that is expected to expand. More importantly, given the favorable economics of superinsulation, it is reasonable to expect this construction technique to become standard practice. No matter which project proves correct, in an economy the size of Saint Louis' either scenario represents a substantial gain.

Chapter 7
Conclusions - Project Status And Lessons Learned

This project has been a "field test" to determine the feasibility and acceptability of a new affordability strategy in the housing industry, and more specifically an experiment in the ability of the public sector to accelerate the use of new technology as standard practice. Rather than simple attempts to reach maximum "theoretical" superinsulated design, the units constructed in the demonstration program embodied an effort to arrive at the maximum cost-effective energy efficiency, using a variety of approaches.

Since the basic premise of the project was to adapt climate-appropriate superinsulation strategies from Canada and Sweden to the Midwestern climate of Saint Louis, in all cases, the demonstration units incorporated conservation measures above and beyond common practice in the industry. This meant that we were challenging "conventional practice" in almost every respect.

Consequently, the backing of the developer is critical in successfully modifying a project to the extent undertaken in this project. Unless the developer is sufficiently "sold" on the potential benefits of a high degree of energy efficiency and has enough financial assistance to buffer the added cost, true superinsulation standards will not be achieved.

It should be noted that in the Saint Louis project, the developer's willingness to participate was greatly enhanced by the fact that the City had already completed a prototype unit (See Rehab 2000, Chapter 2) and could provide detailed construction costs and energy reduction figures.

Another important factor to consider is that changing a project's specifications to superinsulation might seem to imply that the mechanical engineer, architect and subcontractors have really not been doing their jobs. If not handled diplomatically, this perceived threat could create personnel conflects to overcome, above and beyond the technical challenges.

Finally, a word of caution might be offered regarding the interface between the demonstration project and the public sector housing development bureacracy. Project managers and directors may experience a lack of responsiveness or outright resistance because of the disruption of status quo involved in this kind of innovation. To minimize the effects of such resistance, it would be prudent to solicit definitive support directly from the highest public officials of the jurisdiction. If the project is perceived as a "low priority", the bureaucratic resistance may in fact seriously hamper the project.

However, we see the Saint Louis project as a significant success in several respects. First, the analysis and preliminary monitoring have shown that superinsulation _is_ feasible and highly cost effective in a midwestern climate. Secondly, the technology _is_ attractive to those in the housing development community and we expect superinsulated units to go on being produced even without the financial incentives provided by our project grant (quantification of this trend will be provided in the Developer Survey data to follow as supplement to this report). Thirdly, the City has now incorporated language on energy performance in its guidelines for public subsidy funding for housing. Though presently still optional, energy standards may be mandatory to some degree by late 1985.

The Saint Louis Year V project is also developing a software prototype for energy optimization analysis in prospective superisulation projects.

Last but not least, of course, the project has resulted in actual construction of some 26 superinsulated units, which should sharply stimulate local interest (and competition). The real question remaining is wheather the benefits of reduced life cycle costs can be utilized by a development community traditionally concerned with only "front-end" costs, in providing affordable housing to the community. This will be explored as energy conservation becomes increasingly integrated as a marketing strategy by both the City Of Saint Louis and the development community.

SUGGESTIONS FOR FUTURE ACTION

In instituting a superinsulated housing program to either promote a local housing market or for economic development, the cooperation or active support of a municipality is key. Though homebuilder's groups have had highly successful "energy-awareness" marketing programs, a reluctance to add to front-end costs and fear of confronting building code limitations can inhibit innovation.

The strong participation of the public entity can also provide a central coordination to facilitate a dialogue between all members of the building community. It is important to note, however, that the role the municipality plays in the process will be a balancing act, considering the often adversarial roles of the building community and municipalities in the code compliance area.

One way that the Saint Louis project was able to garner developer participation was by providing a clear technological lead in exploring energy efficiency. Because builders are aften unable to explore new strategies in construction technology the opportunity to learn in a "no-risk" situation is highly appealing.

The long-term effectiveness of a superinsulated housing program is tied to the ability to produce successful projects with eye appeal, that are completed smoothly and in a timely fashion. Long delays and excessive problems, while quite educational, can unfairly label a new approach as "unworkable". Thus, pre-planning and the ability to flexibily work with problems to catch problems early is important. Having some "contingency" funds to be able to help with added costs of fixing problems is recommended, since they are bound to come up as part of the learning process.

Finally, the success of any technology transfer program is tied to long-term results. After the demonstration phase, it is important to have some on-going mechanism to encourage adaptation of the new technology. In Saint Louis this is through voluntary use of superinsulated standards as a criteria in receiving housing incentive monies, along with the carrot of no-cost technical support. Other approaches being explored are loans or grants as an incentive, adaptation of energy standards as part of the building code and the use of marketing incentives such as "certified" homes, to highlight projects utilizing superinsulation. Having an on-going mechanism to encourage the new technology will go a long way in maximizing the benefit of the initial projects.

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TABLE APPENDIX

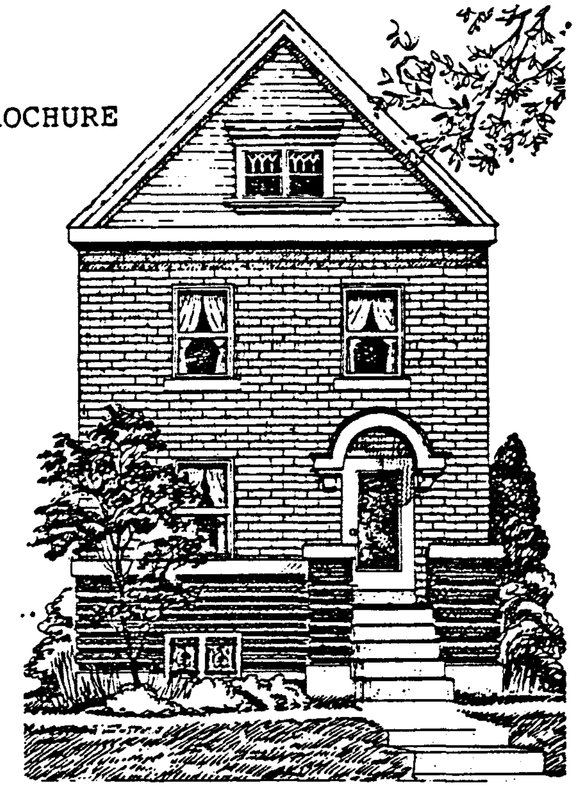
SUPERINSULATED HOUSING
ENERGY BENEFITS AND COST PER SQUARE FOOT

J.G. Sackett, January 7, 1985

Building Type	Developer	Unit Size (SF)	Furnace Type	Estimate Source	STANDARD Heating Cost	STANDARD Cooling Cost	STANDARD Total Energy	SUPERINSULATED Heating Cost	SUPERINSULATED Cooling Cost	SUPERINSULATED Total Energy	Total Savings	% Savings	Added Cost	Payback (Simple)	Five YR Net Present Value	Ten YR Net Present Value
1. Rehab Single-family (Rehab 2000)	Midtown Medical Redevelopment	1400	Electric Furnace	EMP UE	$659	$267	$926	$108	$76	$184	$742	80%	$3,560	4.8	$4,026	$9,800
2. Allen Residence (Rehab)	Midtown Medical Redevelopment	1800	Heat Pump	EMP	$774	$305	$1,079	$136	$153	$289	$790	73%	$2,700	3.4	$4,286	$10,433
				UE	$526	$208	$734	$182	$144	$326	$408	56%	$2,700	6.6	$2,214	$5,388
3. New In-Fill Townhouses	Laclede Partnership	1800	Gas-Apollo Hydra-heat	EMP	$658	$191	$849	$104	$114	$218	$631	74%	$3,797	6.0	$3,119	$6,700
				LACLEDE	$444	$138	$582	$235	$65	$300	$282	48%	$3,797	13.5	$1,394	$2,994
			Heat Pump	EMP	$658	$191	$849	$71	$114	$185	$664	78%	$4,172	6.3	$3,603	$8,769
				UE	$444	$138	$582	$95	$65	$160	$422	73%	$4,172	9.9	$2,290	$5,573
4. 15-Unit Apartment	Pantheon Corporation															
Unit "A"		1372	Electric Furnace	EMP	$569	$229	$798	$217	$76	$293	$505	63%	$1,879	3.7	$2,740	$6,670
				UE	$451	$226	$717	$250	$149	$399	$318	44%	$1,879	5.9	$1,725	$4,200
Unit "B"		987	"	EMP	$344	$191	$535	$176	$114	$290	$245	46%	$1,352	5.5	$1,329	$3,236
				UE	$325	$176	$501	$185	$96	$281	$220	44%	$1,352	6.1	$1,815	$2,746
Unit "E"		1061	"	EMP	$416	$191	$607	$202	$76	$278	$329	54%	$1,454	4.4	$2,715	$4,106
				UE	$386	$214	$600	$192	$87	$279	$321	54%	$1,454	4.5	$1,742	$4,239
5. New In-Fill Townhouses	Mark Conner Builder	1400	Gas-	EMP	767	$176	$943	$162	$76	$238	$705	75%	$2,500	3.5	$3,484	$7,485

SOURCES:
EMP - ENERGY MANAGEMENT PROGRAM
UE - UNION ELECTRIC
LACLEDE - LACLEDE GAS COMPANY

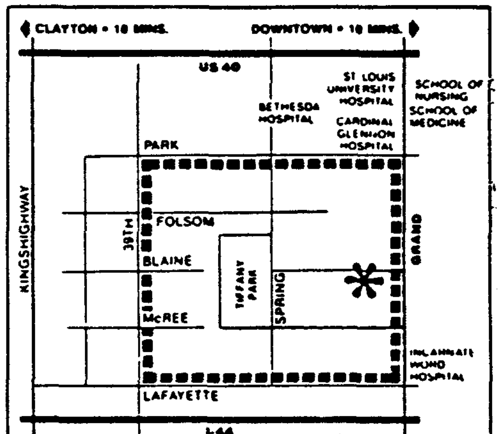
B. REHAB 2000 MARKETING BROCHURE



REHAB 2000

The Rehab 2000 Home in the Tiffany Neighborhood estimated annual heating and cooling cost—$140.

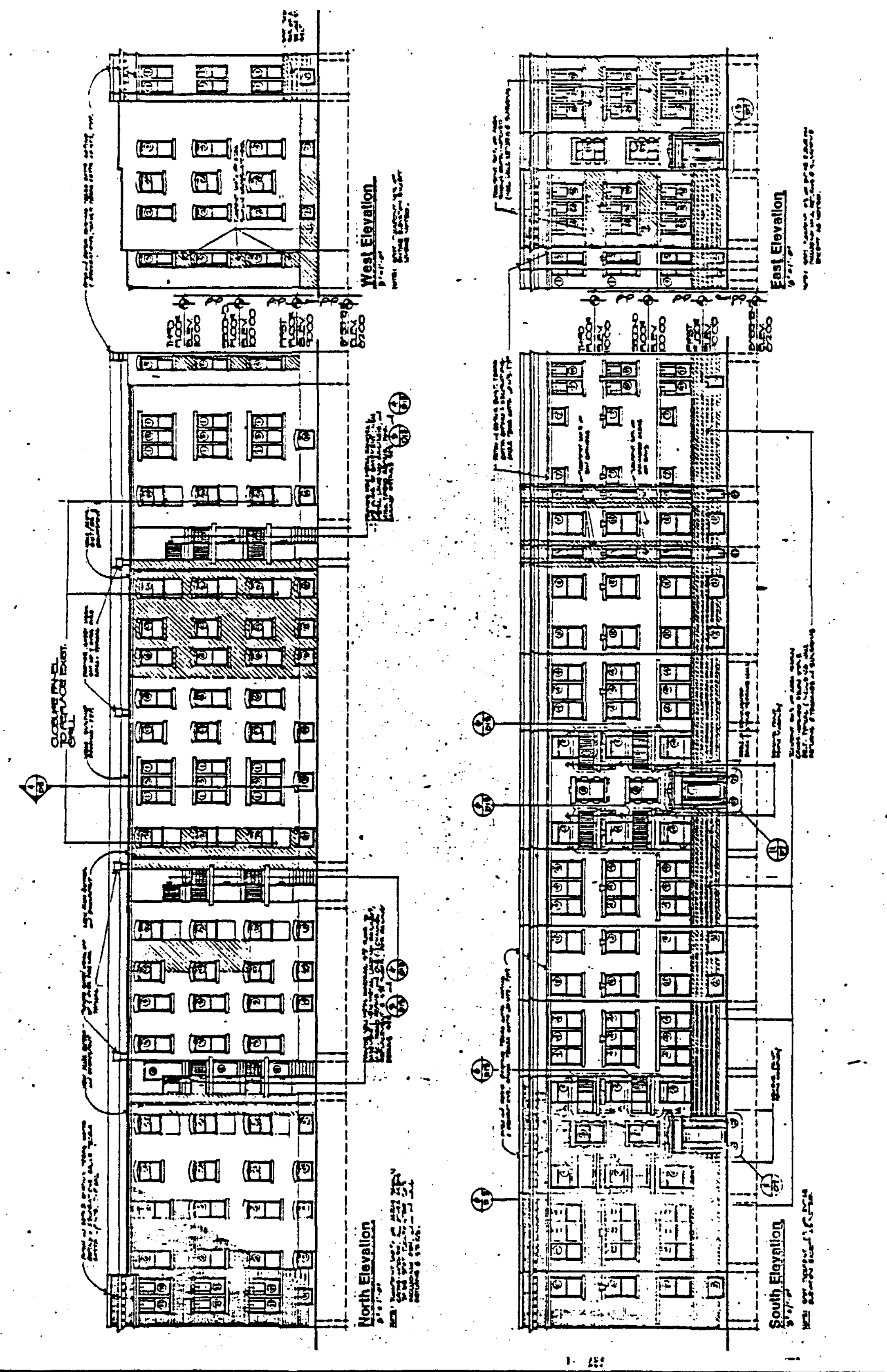
- The illustration above is of the Rehab 2000 Home in the Tiffany Neighborhood. As you can see, it does not look like an ultra-modern "solar" home that looks like it came from Mars.
- On the contrary, it's a quiet, inviting home using conventional construction features that, quite simply, can save you up to $950 a year in heating and cooling costs over a standard rehab home and can cost about half as much to heat and cool as a "solar" home.
- Utilizing a building concept perfected in Canada, this super-insulated home actually lowers your monthly housing costs, requires lower income to qualify for purchase and increases in resale value as energy costs rise.
- This Rehab 2000 Home is not all facts and figures. The Rehab 2000 Home features an open, contemporary floor plan, a dramatic 3-story lightwell, 2 master suites, 2½ baths, greenhouse/sunroom and eat-in kitchen all contained within 1500 square feet.
- The Rehab 2000 Home also features a cedar walkout deck in the rear, full basement, off-street parking, fenced yard and complete landscaping.
- The Rehab 2000 Home is offered at $95,000 and has many special financing features available.
- We invite you to come and see this extraordinary home. The Rehab 2000 Home in the Tiffany Neighborhood. Call us at **(314) 771-2800** to arrange an appointment.
- **Open Sunday 1-4 PM at 3630 Blaine.**
- Just west of Grand Boulevard between Park Avenue and Interstate 44.



TIFFANY

A neighborhood whose time has come. Again.

C. PANTHEON CORPORATION PROJECT ELEVATION



DEBALIVIERE PLACE 5 (PW VI)
PANTHEON CORPORATION
415 DEBALIVIERE AVENUE
ST LOUIS, MISSOURI 63112
DEVELOPER
(314)361-7200

MACKEY & ASSOCIATES — ARCHITECTS, PLANNERS & INTERIOR DESIGNERS
LEHMUTH & ASSOCIATES — MECHANICAL & ELECTRICAL
WEINTRAUB & ASSOCIATES — STRUCTURAL ENGINEERS
PITZMAN'S COMPANY — CIVIL ENGINEERS

D. LACLEDE PARTNERSHIP TOWNHOUSES

o Marketing Brochure

New Townhouses in Historic Soulard

810-20 Ann Avenue

Innovative Energy Saving Construction

LACLEDE PARTNERSHIP INC.

800 GEYER AVE.
SAINT LOUIS, MISSOURI 63104
314/231-6656

D. LACLEDE PARTNERSHIP TOWNHOUSES

o Elevations

ENERGY SAVERS

- *Wooden double-hung, triple-glazed "Easy Tilt" windows*
- *Rated R-30 in walls, R-49 in ceiling*
- *Air to air exchanger*
- *Projected annual utility bills: heating & cooling $450*

FEATURES

- *2 + Bedrooms*
- *1 ½ Baths*
- *1340 square feet on 2 floors, + 600 sq. ft. on third floor*
- *Full basement with 8′ ceilings*
- *Ten-foot ceiling heights*
- *Porch off Master Bedroom*
- *3rd floor includes stubbed in plumbing for future bath*
- *Private fenced yards*
- *Washer-dryer hookups*
- *2 parking places*
- *Window screens and storm doors*
- *Quality Construction — 2 × 6 on 16″ center*

APPLIANCES

- *Dishwasher*
- *Garbage disposal*
- *Frost-free refrigerator*
- *Electric range*

FINISHES

- *Ceramic tile in full bath*
- *Oak flooring on first floor*
- *Carpeted stairs and bedrooms*
- *Quality oak cabinets*
- *Recessed lighting*
- *Track lighting in kitchen*
- *Pantry closet*
- *Cast iron bathtub, china bowl*
- *Choice of many finishes. i.e., carpet, tile, paint, kitchen/bath counter tops and cabinets*

ELECTRIC

- *200 Amp service*

REHAB 2000 AGREEMENT

Developer ______________________________

Project ______________________________

Units ______________________________

Type ______________________________

Target Completion Date ________________

This Agreement made and entered into this __________ day of ______________, 1984, by and between the City of St. Louis, acting through the Energy Management Program (EMP) and ____, the Developer,

WITNESSETH, that

WHEREAS, EMP has applied for a grant for a pilot program in superinsulated housing and has received said grant, and

WHEREAS, Developer is in the business of housing construction.

NOW, THEREFORE, the parties agree as follows:

1. The conventional financing on the unit(s) described above is already in place.

2. Funds in the amount of __________ will be made available to Developer subsequent to design review and upon evidence of project inititation.

3. All work in the project, including both conventional construction and superinsulation components, will be completed in a timely fashion, not to exceed the target completion date above, unless extended by EMP. Projects substantially behind schedule at the end of this period may be required to refund grant funds to EMP, City of St. Louis, Federal Grants account 1139-1203000.

4. EMP is granted authority for design review and approval regarding the unit envelope and HVAC, and for monitoring construction activity and materials including but not limited to insulation type and levels, glazing (door and window), vapor barrier, heat exchanger and HVAC systems.

5. Access to the unit for monitoring and testing purposes will be provided to EMP on a timely basis with 24 hours notice minimum.

6. Full cooperation with EMP will be provided to develop public relations activities for the Rehab 2000 probram (e.g. scheduling tours for lenders, appraisers, etc., and print media material).

7. Energy estimates provided by the EMP are to be used in the design process and marketing program for the unit(s) and do not contribute any formal guarantee of performance.

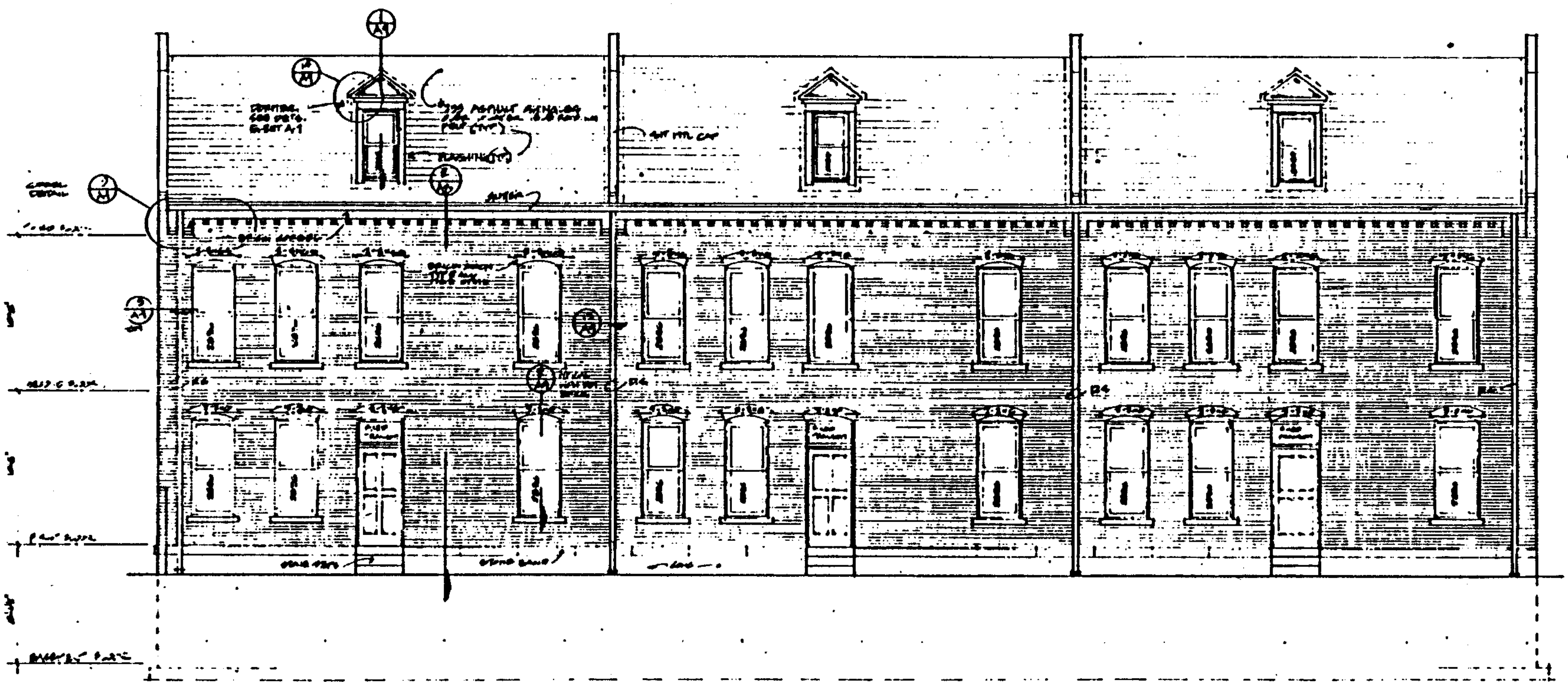
8. Some construction materials employed will be innovative uses, and in agreeing to their use the Developer does not relinquish liability in any fashion, nor hold the City of St. Louis, EMP nor any persons associated therewith liable in any fashion.

INFILL HOUSING 814-822 ANN AVE.

LACLEDE PARTNERSHIP INC.
4906 LACLEDE AVE.
ST. LOUIS, MO. 63108 · 361-6042

THOMAS HILTON COHEN—ARCHITECT
1929 S. NINTH STREET
ST. LOUIS, MO. 63104 · 721-2488

A4



EAST ELEVATION

IN WITNESS WHEROF, we set our hands the date stated above.

________________________________Development Company

________________________________Officer

____________________ Comptroller	____________________ Ken Lauter Administrative Assistant
____________________ City Counselor	____________________ Register

ADDENDUM TO SPECIFICATIONS

MARCH 1, 1984

PROJECT:	DeBaliviere Place 5 (PWVI) Building 713-North
DEVELOPER:	Pantheon Corporation 415 DeBaliviere Saint Louis, Missouri 63112 John Moore Gene Morris
ENERGY CONSULTANT:	James G. Sackett Saint Louis Energy Management Program 421 City Hall Tucker & Market Streets Saint Louis, Missouri 63103

The following changes amend the Construction Specifications for Building 713-North. These changes apply to both written specifications and drawings.

A. DIVISION 6 - WOOD AND PLASTICS

SECTION 6E - ROUGH CARPENTRY

1) Add To "DESCRIPTION OF WORK:"
"NOTE: Exterior wall framing to be held 9" from existing walls to accomodate R-30 fibreglass batt insulation."

SECTION 6F - FINISH CARPENTRY

1) Add To "DESCRIPTION OF WORK:"
"Furnish and install 3/4" x 3/4" minimum wood stop for magnetic inside insulating window (distance from prime window as per manufacturer's specs)."

2) Note-BUILDING 713 NORTH:
"Plastic laminate window sills to be of sufficient width to accomodate 9" thick exterior wall furring due to superinsulation."

B. DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 7G - THERMAL INSULATION

1) Amend "DESCRIPTION OF WORK:" AS FOLLOWS:
"For north building, 713, apply the following types and level of insulation:
Mineral fiber blanket insulation for exterior ceilings (R-40).
Loose mineral fibre or cellulose for exterior walls (R-30) full width "super-batt" 24 width batt.
Mineral fiber blanket insulation for floor joist ends below insulated wall above (R-30).
Continuous 6-mil air/vapor barrier with all joists over-lapped and continuously taped.
1/2" foil-faced, polyisocyanurate sheathing field fit between floor joists at exterior wall line and sealed four sides with "poly-

cell" sealant to form continuous vapor barrier. Mineral fibre blanket insulation for ceilings over commercial space (R-13). ."

2) "Part 2-Materials/Products" Amend As Follows:
"Continuous air-vapor barrier to be 6-mil polyethelene sheets with all joints in wall, ceiling and floor continuously sealed with tape. Vapor barrier at joist space to be polyisocyanurate foam core, foil-faced sheathing, field-fit. Seal all edges with "Polycel One" single component ureithane."

3) "Part 3-Execution Foam Sealant" Amend As Follows:
"For north building, 713, apply a single layer of insulation of the required thickness to provide the following resistance ratings or thickness."

Type II: All Exterior Walls: R-30 Minimum Batt Insulation

Type II: Exterior Ceilings: R-40 Minimum Batt Insulation
Pl 104-130, 707-713, 717

Type III: Exterior Ceilings: R-40 Minimum Blown Insulation
PL 102, 711, 806

Type II: Basement Ceilings: R-30 Minimum Batt Insulation
PL 707-713, 717

"Install continuous 6-mil polyethylene vapor barrier all exterior walls, floor above basement and ceiling of units on top floor. Continuously tape all seams. Seal vapor barrier to all electrical outlets. Lap wall vapor barrier 4" to 6" on first floor ceiling, second floor floor and ceiling and third floor floor. Tape to floor in workmanlike manner to assure good seal. Field fit polyisocyanurate sheathing (1/2") between floor joists after batt insulation is installed in joist space at wall line. Seal all edges with "polycell one". Stuff loose mineral fiber insulation into miscellaneous voids and cavity spaces."

C. SECTION 8F - ALUMINUM WINDOWS

1) "Part 2-Materials/Products" Add:
"Inside magnetic insulating windows to be installed on independent wood stop, to add third glazing to double-glazed aluminum units, building 713 north."

D. SECTION 8G - WOOD WINDOWS

1) "Part 2-Materials/Products" Add:
"Glazing: All units for building 713 north shall be furnished pre-glazed with double, sealed glazing. Inside magnetic insulating windows to be installed on independent wood stop, to add third glazing to double-glazed wood units."

E. ADD NEW SECTION:

"SECTION 8H - MAGNETIC INSIDE INSULATING WINDOWS"

PART 1 - GENERAL

RELATED DOCUMENTS:

All provisions of the General Information and General Requirements shall govern work under this Section.

DESCRIPTION OF WORK:

Furnish and deliver to the job site inside insulating magnetic acrylic windows, complete with magnetic and metal tape edge connection system, for all windows indicated on drawings, building 713, north.

Refer to: Sections 8F and 8G for installation of wood stop for mounting magnetic inside insulating windows.

QUALITY ASSURANCE:

Standards: Magnetic window manufacturers acceptable shall have code acceptance and material quality assurance equal to those of the MAGNETITE Inside Insulating Windows, 210 South Street, Boston, Massaschusetts, 02111. Local supplier: Saint Louis Thermal Products, 8255 Brentwood Industrial Drive, Brentwood, Missouri, 63144, (314)645-8558. Code recommendations for materials used in the fabrication of MAGNETITE windows include: ICBO Research, Recommendation Number 1084; BOCA Report Number 72-33 and SBCC Report Number 7246; New York City Board Of Standards And Appeals Calenders 444-60-SM, 657-63-SM: New York City Department Of Water Supply, Gas And Electricity approval for use in signs and lighting fixtures; New York City MEA 107-69-M; California Fire Marshall File Number A2560-007 UL Subject 94 Vertical (94V-1).

Glazing recommendation is the use of GM-Class Plexiglas cast sheet or sheet extruded from Plexiglas molding pellets or equal, such as "Acrylite" brand, 100 percent acrylic sheets.

Manufacturer: Provide magnetic inside insulating windows produced by a single fabricator, capable of showing prior successful production of units similar to those required.

PART 2 - MATERIALS/PRODUCTS

Two-piece, upper and lower units, with self-storing capacity on upper lite.

Provide acrylic glazing complete with edge channel.

Provide magnetic tape to be installed on wooden stop applied to window return.

Provide bracket or wall mounted tabs for lower unit to "self-store" over upper unit and remain in place.

Provide needed accessories to assure that inside insulating unit does not move or drop after installation.

Color choice of edge channel and accessories to be by Owner.

PART 3 - EXECUTION

Not Applicable

F. SECTION 15B - HVAC

Under "DESCRIPTION OF WORK:", Add:
". . . Kitchen exhaust ducts
Bathroom exhaust ducts
Air-to-air heat exchangers. . ."

Under "WORK DONE BY OTHERS:", Add:
". . . All electrical power wiring for heaters, fans, air conditioners, furnaces and air-to-air heat exchangers as required. . ."

Under "SHOP DRAWINGS:", Add:
". . . Exhaust fans
Air-to-air heat exchangers. . ."

Under "COMBINATION AIR AND EXHAUST DUCTWORK:", Add:
"Provide sheet metal ducts and exterior weather cap for bathroom exhaust fans and kitchen exhaust fans and air-to-air heat exchangers which are noted. . ."

Under "ELECTRIC HEATERS:", Add:
"Electric furnace sizes and air conditioning sizes for units in PW VI, Building 713 North to be based on the following loads:"

UNIT	AC	HEAT
A Top Floor	2.5	7.5 KWH
Mid Floor	2.2	6.8 KWH
B Top Floor	1.6	4.8 KWH
Mid Floor	1.4	4.3 KWH
C Top Floor	1.6	4.7 KWH
Mid Floor	1.6	4.7 KWH
D Top Floor	1.6	4.7 KWH
Mid Floor	1.6	4.7 KWH
E Top Floor	1.9	5.6 KWH
Mid Floor	1.7	4.9 KWH

Source: Union Electric Company — Jim Kaye - 554-3186

Under "DUCTWORK FOR EXHAUST FANS:", Add:
"Furnish and install all ductwork for the exhaust fans and air-to-air heat exchangers. . ."

Under "ROOF MOUNTED AND PROPELLOR FANS:", Add:

"Air-to-air heat exchangers for building 713 north to be either sensible or sensible/latent exchange units, with minimum 200 cfm capability. Units, to be approved by Owner, include:

1) FAN-X CHANGER - P.M. Wright, Ltd., 1300 Jules-Poitras, Montreal, Quebec H4N 1X8, Canada, (514) 337-3331

2) VAN-EE, Model R200, - CÊS Conservation Energy Systems, Inc., Box 8280 Saskatoon, Canada S7k 6c6, (306) 665-6030.

3) or Equal, approved by Owner.

G. SECTION 16A - ELECTRIC

Under "DESCRIPTION OF WORK:", Add:

". . . Apartment intercom and security systems.
Exhaust fans and air-to-air heat exchangers resistance heating. . ."

". . . Temperature control and interlock wiring for HVAC equipment (including humidistatic control for air-to-air heat exchanger). . .
Apartment intercom and security systems.
Exhaust fans and air-to-air heat exchangers. . ."

Under "SHOP DRAWINGS:", Add:

". . . Kitchen and bathroom exhaust fans and air-to-air heat exchangers. . ."

\- END -

REPORT INFORMATION AND SOURCES

Additonal copies of this Report, "Energy Conservation And Economic Development: Commercial/Industrial Land Use Applications are available from:

PUBLICATIONS AND DISTRIBUTION
PUBLIC TECHNOLOGY, INC.
1301 PENNSYLVANIA AVENUE, NW
WASHINGTON, DC 20004

For additional information on the procedures, analyses and results contained in this report or for additional information on other energy conservation and management programs in the City Of Saint Louis, please contact:

JAMES G. SACKETT
SPECIAL PROJECTS DIRECTOR
ENERGY MANAGEMENT PROGRAM
OFFICE OF THE MAYOR
200 CITY HALL
TUCKER & MARKET STREETS
SAINT LOUIS, MO 63103
(314) 622-3600

ORDER NO. DG/84-319
01/85-100

REHAB 2000 SURVEY

COMPANY ______________________________

SUPERINSULATED UNITS PRODUCED

--Rental ______
--For Sale ______
--Total ______

1) Were you aware of superinsulation before being approached by the City? YES _____ NO _____

   a) If yes, how had you learned about it?

   b) If yes, had you produced or planned to produce any superinsulated units? Why or why not?

2) As a result of participating in this project, what are your future plans for superinsulated construction? (Check one below and comment)

   _____ a) We will produce approximately _____ superinsulated units in the next year.

   _____ b) We will produce no superinsulated units next year. Why not?

3) What elements of this demonstration project were most helpful to you?

4) What elements were least helpful or negative?

5) Since other cities may use the Saint Louis project as a model, are there any things you can suggest which would make such projects more effective?

6) Can you suggest any follow-up action by the City (or other action) which would facilitate making superinsulated construction standard practice in the residential market?

7) In your opinion, should the City work toward using higher energy standards as a criteria for CDBG funding for housing? Why or why not?

8) Do you believe that a concentrated high volume production of superinsulated housing stock with appropriate marketing effort could make the City's residential market more competitive? YES _____ NO _____

Why or why not?

9) Other Comments

Thank you for your assistance in this survey.