

U.S. Department of Housing and Urban Development
Office of Policy Development and Research

**INNOVATIVE
REHABILITATION
TECHNOLOGIES**

**A STATE OF THE ART
OVERVIEW**

INNOVATIVE REHABILITATION TECHNOLOGIES

A STATE OF THE ART OVERVIEW

Prepared for

**U.S. Department of Housing and Urban
Development
Office of Policy Development and Research**

Prepared by:

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Silver Spring, Maryland

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Notice

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Foreword

In recent years, the resolution of many issues regarding housing rehabilitation has been greatly influenced by the *Rehabilitation Guidelines*, first published by the U.S. Department of Housing and Urban Development in 1980. Despite some progress since that time, user expectations, compliance requirements, and code enforcement still vary significantly from jurisdiction to jurisdiction. This situation often results in frustration over inconsistent regulations and an inability to introduce potentially cost-saving technologies.

HUD has recently taken steps to increase the opportunities for affordable rehabilitation. In May 1995, the Department sponsored the first National Symposium on the Status of Building Rehabilitation Regulations to help determine the most effective way to regulate the rehabilitation of existing buildings. The symposium established the status and trends in rehabilitation regulation and resulted in recommendations for follow-on activity by industry, the three model code organizations, and HUD. *Innovative Rehabilitation Technologies - A State of the Art Overview* represents a second major accomplishment—the identification of promising cost-saving technologies for housing rehabilitation. We believe it gives the rehabilitation industry more of the tools they need to create homeownership opportunities.

The rehabilitation needs of our cities are growing as we approach the 21st century. The comparative advantages of housing made available through the rehabilitation of existing buildings can enhance the character of our housing stock in the years to come. Through this report and other activities, HUD will continue to encourage rehabilitation as a way to increase homeownership opportunities for all Americans.

Michael A. Stegman
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EXECUTIVE SUMMARY

This Housing Rehabilitation Technologies study was conducted from February through September 1995. Its goals and objectives derive from the fact that rehabilitation of housing is essential for meeting the need for affordable housing, and that little research has been conducted on technologies to reduce the cost of rehabilitation. The rehabilitation industry is extremely fragmented and it tends to adopt new technologies slowly. A survey of new technologies could help promote more cost effective practices. This includes advances in materials, products, and systems and their applications, methods used during design and construction, and new and improved equipment used in diagnostics and construction activities.

The study is limited to the building industry. While its focus is the full range of building types and uses within the residential occupancy category, technologies applicable to other occupancy types were also investigated in the hope that housing rehabilitation could benefit. Site work technologies were not sought, but where found, they were included. Technologies limited to entire residential communities were not studied.

Inquiries were made of trade and professional associations, the National Institute of Standards and Technology, the National Institute of Building Sciences, and the testing and evaluation services of the three model code organizations. Manufacturing sources were also contacted. A questionnaire was used to assure some uniformity in information gathering. In addition, articles, advertisements, product directories, and related publications were researched; the exhibition, Restoration 95, was attended and relevant literature databases were searched.

To select candidate technologies, three categories of benefits were broadly applied: cost (lower capital costs, lower maintenance costs), time (less time to manufacture, assemble, install, and longer service life), and quality (improved appearance, greater durability, higher level of performance).

It was pointed out by respondents that a completely new technology was extremely rare and incremental improvements and adaptations of existing technologies were far more common. However, results of this study (summarized in Tables 1 and 2) indicate that many new building products and practices continue to become available, especially in the building envelope area. In addition to products and construction practices, there are many design and evaluation tool improvements that are continuing to develop. Examples of major areas where these improvements are occurring include computer software, seismic retrofit, hazardous materials abatement, accessibility, home automation, and energy efficiency labeling.

**Table 1. Materials and Products Technology
Improvements Applicable to Building
Rehabilitation**

SITE	Conductive Concrete
	Hill-Climber Lift
FOUNDATIONS	Footing Forms/Drains/Radon Vents
BUILDING ENVELOPE	Reinforced Hollow Brick Masonry
	Fireplace Construction Template
	Brick Veneer with Steel Stud
	Improved On-Site Brick Handling
	Lighter Concrete Masonry Units
	Marble and Stone Slabs as Thin as 1/2"
	Lightweight Concrete Forms
	Sprayed Polyurethane Foam Insulation
	MIRAFLEX ® Encapsulated Glass Fiber Insulation
	Housewrap
	Fiber Cement Shakes
	Improved Cedar Shakes and Shingles
	Improved Vinyl Siding
	Exterior Insulation and Finish Systems
	Improved Glazing
	Retrofit Heat Control Film
	Wood Composites for Window Frames
	Pultruded Fiberglass Window Frames
	Improved Steel Doors
	Polymer Doors and Frames
	Improved Door Hardware
	New Door Control Units
	Improved Elastomeric Caulk
Building Cleaning System - Dry Procedure	
Building Cleaning System - Wet Procedure	
ELECTRICAL	Compact Fluorescent Lamps
	Halogen Lamps
	Lighting Controls
	Baseboard Raceway

**Table 1. Materials and Products Technology
Improvements Applicable to Building
Rehabilitation (Continued)**

PLUMBING AND HVAC	Alternatives to HCFC 22
	Natural Gas Refrigeration Systems
	Better Controls
	Ductless Air Conditioners
	Corrugated Stainless Steel Gas Piping
	Plug-In Gas Outlets
	Through-the-Wall Vents
	Unvented Gas Heaters
	Improved Gas Fireplaces
	Gas-Fired Space Heaters
	Air Admittance Valve for Drainage Systems
	Corrosion-Proof Piping
	Flue Relining Systems
INTERIOR FINISHES	Flexible ("High Flex") Gypsum Wallboard
	Fiber-Reinforced Gypsum Wallboard Panels
	Increased Wood Flooring Options
	Floating Wood Floor
	Thin Wood Flooring
	Thin Stone Flooring Systems
	Improved Molded Millwork
	Polypropylene Carpet Backing
	Reusable Carpet
TOOLS AND EQUIPMENT	Heavy Duty Cordless Tools
	Laser Aligning Devices
	Construction Utility Belts
	Construction Dust Control
SEISMIC RETROFIT	Fiber/Epoxy Composites Wrap System
HAZARDOUS MATERIALS ABATEMENT	Lead Encapsulation Coating
	Lead Abatement Wall Covering
UNIVERSAL DESIGN/ ACCESSIBILITY	Kitchen Counters/Cabinets/Appliances

**Table 2. Information Technology Improvements
Applicable to Building Rehabilitation**

BUILDING ENVELOPE	Wood Protection
COMPUTER SOFTWARE	Estimating and Design Systems
	Digital Camera
HAZARDOUS MATERIALS ABATEMENT	Asbestos
	Lead-Based Paint
UNIVERSAL DESIGN/ ACCESSIBILITY	Information
	New Product Sources
PERMITTING	Reviews/Approvals/Permits at One Desk
OPEN BUILDING	Dwelling Unit Fit-Out Concept
HOME AUTOMATION	Powerline Technologies/Dedicated System Technologies
VALUE ENGINEERING	Cost and Performance Improvement from Pre-Design VE
ENERGY EFFICIENCY	Energy-efficiency Labeling of Residential Buildings
	Model Energy Code Thermal Envelope Compliance Guide
PRODUCTIVITY/ RELIABILITY/COSTS	Annotated Bibliography

INTRODUCTION

This study of Housing Rehabilitation Technologies was conducted from February through September 1995. The goals and objectives of this study are derived from the fact that rehabilitation of existing housing is an essential mechanism for meeting the need for affordable housing, and that little research has been conducted on technologies and processes to reduce the cost of rehabilitation. Because of the extremely fragmented nature of the rehabilitation industry and because the rehabilitation industry tends to be very slow in adopting new technologies, a survey of new technologies could help promote more cost effective practices. This includes advances in materials, products, and systems and their applications, methods used during the design and construction process, and new and improved equipment used in diagnostics or construction activities.

APPROACH AND METHODOLOGY

While the occupancy type which is the focus of this study is residential, inquiries about new technologies and improvements in existing technologies were not predicated on that one occupancy. The study was limited to the building industry, however, with the hope that technologies presented as applicable to any occupancy other than residential will find beneficial use in the housing industry. The full range of building types and uses within the residential occupancy category were included in the study. While site work or recreational building or community building related technologies were not excluded, they were not specifically sought. However, technologies related to entire residential communities, such as sewage treatment or power distribution, were not studied.

As a means to penetrate the construction industry nationwide, inquiries were made of trade and professional associations to identify candidate new technologies and advances in existing technologies. Where appropriate, manufacturing sources identified by associations were also contacted, and information about new technologies or advances in existing technologies was gathered. Working through associations to identify new technologies and advances in existing technologies was believed to be the most direct way to identify specific advances and the best way to insure that a cross section of a diverse rehabilitation industry was investigated. To supplement these sources, inquiries were made of the National Institute of Standards and Technology, the National Institute of Building Sciences, and the testing and evaluation services of the Building Officials and Code Administrators International, the International Conference of Building Officials, and the Southern Building Code Congress International.

To assure some uniformity in information gathering, a questionnaire entitled "Renovation and Rehabilitation New Technology Sources Questionnaire" was developed and used to structure interviews with trade and professional associations. In addition, manufacturers, government and private sector institutions were contacted. Interviews with them were structured using the "Renovation and Rehabilitation New Technology Questionnaire." (See the Appendix for a copy of both questionnaires.) Publications, articles, advertisements, and product directories of trade and professional magazines also were reviewed to identify new technologies and advances in existing technologies. New and improved technologies were first sought for this project at the international exhibition and conference, Restoration 95, at the Hynes Convention Center in Boston, MA in late

INTRODUCTION

February 1995. Some rehabilitation technologies from that conference have been included in this study. A report dated March 1987 by Building Technology Inc. entitled "Rehabilitation Technology: A State of the Art Overview" (HUD Small Grant H-5782SG) was reviewed and where appropriate, updated for inclusion in this study. Lists of Associations and manufacturers which were interviewed and publications which were reviewed are appended to this study. Lastly, a literature search of relevant databases was conducted.

For the literature search, four databases were searched: NTIS for the period 1964-1995, Compendex Plus for the period 1970-1995, Energy SciTec for the period 1974-1995, and Trade and Industry Database for the period 1976-1995. While the databases covered the periods stated, like the other inquiries in this study, the search was limited to technologies which were reported on from 1980 to the present. The search produced just over three hundred titles of which thirty- seven appeared relevant, and abstracts were produced for more detailed review. From among those abstracts a number were selected as candidates for this study.

As a means to select candidate technologies from among the many technologies identified, three categories of benefits were broadly applied: cost, time, and quality. To the extent that expectations about these benefits have been formulated or estimated, such attributes as lower capital costs; lower maintenance cost; less time to manufacture, assemble, install, or apply; longer service life; improved appearance; greater durability, and higher level of performance were used as selection criteria.

In carrying out the study, a number of issues and conditions were encountered which affected the gathering of information. For some trade associations the possibility of antitrust action appeared to act as a constraint to disseminating technical information through the association. In those instances, the association repeated the substance of our inquiry to its members asking them to respond to us directly and individually. Certain other associations appeared to have little or no interest in their members' technological knowledge. Any such information had to be identified by contacting individual members—the association's responsibilities lie in other areas such as lobbying. Some associations raised the question of what constituted a new or an improved technology. Representatives of these associations pointed out that developing a completely new technology was extremely rare, that incremental improvements in and adaptations of existing technologies were by far the more common development. Given a very fragmented industry, the definition of new or improved technologies depended less on the technologies themselves and more upon the knowledge of potential users about what technologies are available and appropriate. In discussions with some associations it was apparent that there was also considerable variation in the technological knowledge of the membership. As a result, as this study progressed, a broader definition of new technology and improved technology was used in identifying a new technology or an improved technology. Thus, more emphasis was placed on whether there was a significant number of potential users of the technology who had limited or little knowledge of it.

TECHNOLOGY DESCRIPTIONS

The results of this study are contained in this section which has two parts: materials and products technology descriptions, and information technology descriptions. In the first part, technology improvements are organized according to the phase of construction, beginning with site work and moving on through the buildings' foundation, structure and finish phases. Computer software, design information, and related items are covered in the second part. Sources used in developing information for this study are contained in the Appendix including trade and professional organizations contacted, literature sources reviewed, and manufacturers contacted. Bibliographic references and additional resources from two significant documents developed under HUD's HOME (Home Ownership Made Easy) Program are also included in the Appendix. Reference is made in the text to associations that represent a variety of products or manufacturers in a given category. In a few cases, reference is made to a specific distributor, owner, or manufacturer.

MATERIALS AND PRODUCTS TECHNOLOGY DESCRIPTIONS

SITE

Conductive Concrete

A new concrete formulation that provides high electrical conductivity promises a range of useful applications. The conductive concrete could be used along with specially configured electrodes and an electric power supply to provide de-icing on roads, driveways and walkways, and would be especially applicable for handicap ramps in icy climates. The concrete itself is the heating element.

The conductive concrete can be used as a structural material and bonds well with normal concrete so it can be applied as a retrofit on existing concrete. The conventional mixing type is lightweight, only 70 percent of normal concrete weight. Thermal stability is comparable to normal concrete. Production employs conventional mixing and casting equipment, and placing is similar to conventional concrete. For more information, contact the American Concrete Institute at (313) 532-2600.

Hill-Climber Lift

A hill-climber lift has been introduced which, while not designed to meet true handicapped wheelchair specifications, is a relatively inexpensive application that can ease ascending steep slopes. It is a basic open-air platform with two benches attached that rides up an inclined steel framework at 39 feet per minute. The cog-driven system has a 500 pound capacity, adapts to slopes up to 45 degrees, and has a maximum range of 250 feet (See Figure 1).

TECHNOLOGY DESCRIPTIONS

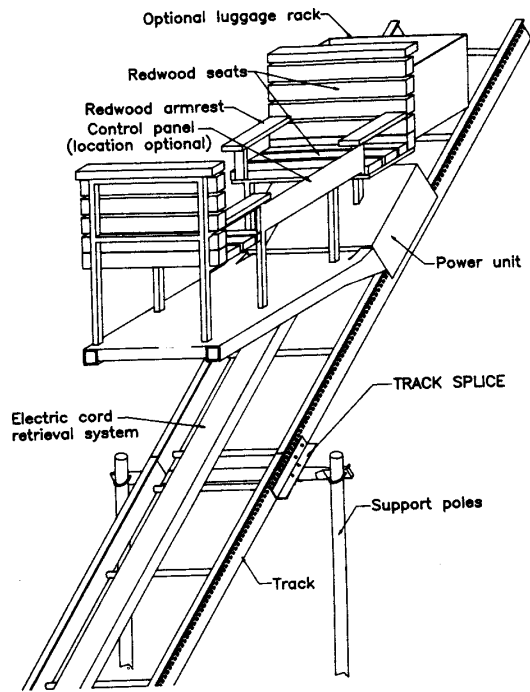


Figure 1. Hill-Climber Lift

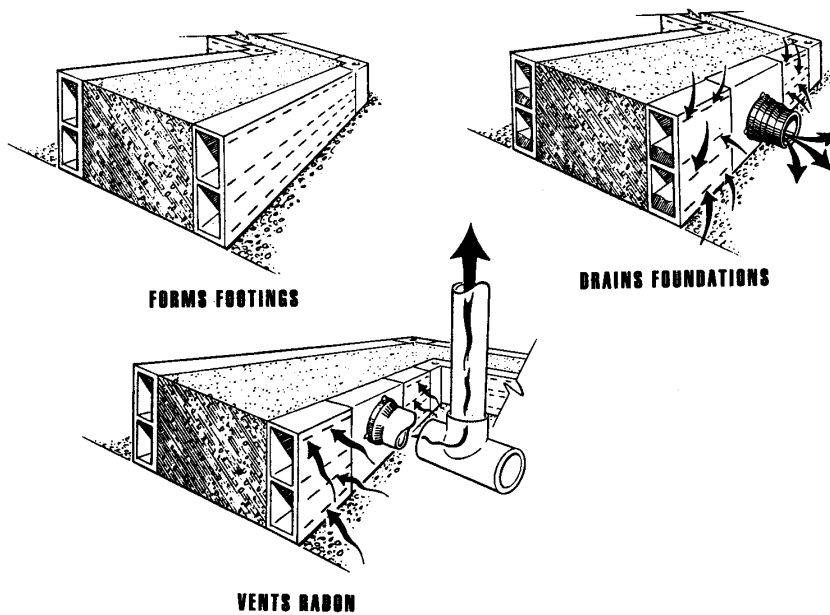


Figure 2. Footing Forms/Foundation Drains/Radon Vents

FOUNDATIONS

Footing Forms/Foundation Drains/Radon Vents

A patented system by CertainTeed called Form-A-Drain consisting of rectangular PVC tube sections serves as forms for footings as well as foundation drainage or radon venting. Available in 4-inch, 6-inch, or 8-inch heights and standard 2 1/4-inch deep x 12-inch lengths, sections are joined by interlocking couplings. The sections are staked like timber foundation forms, but the forms remain in place to serve their second function—foundation drainage or radon venting. Water, or radon, enters through slots in the outer walls of the rectangular tube sections and drain out through outlet fittings available as system accessories. Sections can be stacked to form footings deeper than the 8-inch maximum available heights (See Figure 2).

BUILDING ENVELOPE

Masonry, Brick and Concrete

Reinforced Hollow Brick Masonry. Reinforced hollow brick masonry is not new to construction, but development of a size (5-inch module) specifically for housing is new for residential construction. Hollow bricks receive reinforcing and grout to produce brick walls that are exterior finish and structure. Joist hangers and bolts for ledges are built in to receive floor framing, and plastic furring strips attached to the inside face of brick to receive interior finishes.

While this represents time savings in brick exterior wall construction, the change in construction sequence—brick masons before framing—may or may not be a benefit, but the use of this technique has significance in earthquake areas. The new building code (ACI 539-92) allows reinforced masonry in earthquake areas (See Figure 3).

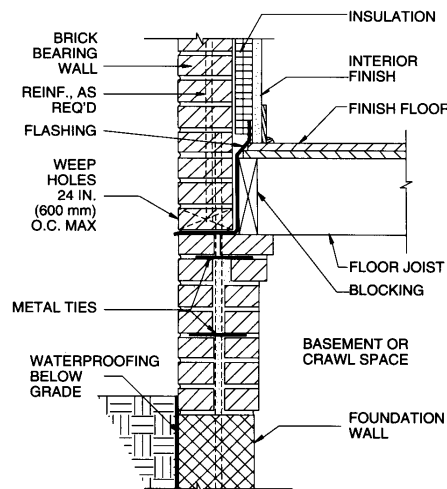


Figure 3. Reinforced Hollow Brick Masonry

TECHNOLOGY DESCRIPTIONS

Fireplace Construction. A template has been developed to cut flue tiles into slabs which can be used to form the interior firebox. Specific tile pieces are used to form the smoke chamber. Time and labor are saved compared to forming the firebox in fire brick.

Brick Veneer with Steel Stud or Masonry Backup in Residential Construction. A new chapter in the masonry code addressing ties and tie spacing specific to steel stud and masonry backing has been developed and is currently being reviewed for submission to BOCA.

On-site Brick Handling. Newly developed methods and equipment for handling brick and mortar on-site are speeding brick masonry work leading to cost and time savings. Formerly handled with brick tongs, 100-brick packages are delivered to the site in 5-pack (500 brick) "cubes". Packages are handled on-site by forklifts which can now unload to scaffolding 40 feet in height and more. Mortar is also delivered to scaffolding by forklift in tubs with wheels that can be pushed along scaffolding from mason-to-mason. New tower-type scaffolds that adjust to the precise height required by the mason are on the market (See Figure 4).

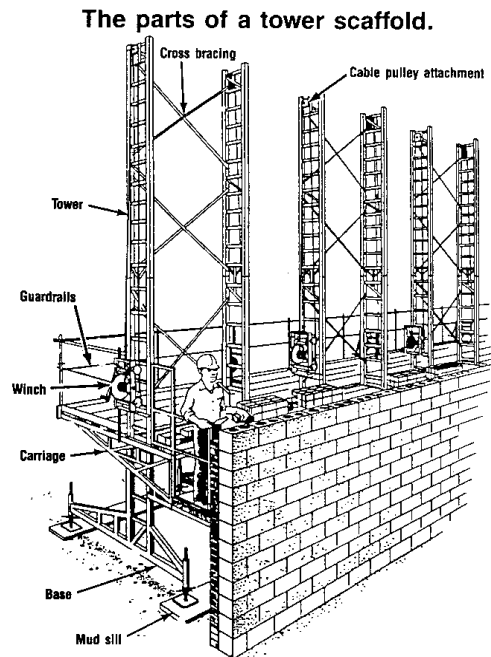


Figure 4. On-site Brick Handline

Lighter Concrete Masonry Units. New blocks weighing about 30 pounds each can be lifted and placed faster than conventional blocks weighing around 35 pounds. Fillers such as perlite and hadite added to the mix accomplish the weight reduction without loss of strength.

Marble and Stone Slabs as Thin as 1/2 inches fixed to panels provide exterior stone finish, reducing building weight and structure and eliminating conventional slots and dovetail anchors. Hung on steel grids, the panels go up expeditiously as a dry system using sealants.

Lightweight Concrete Forms. Several systems of pre-assembled, lightweight forms are said to reduce time and labor in forming concrete walls. The systems consist typically of polystyrene insulation tied together with ties, some of which are hinged to be folded flat for shipping, storage, or handling. The systems are designed as a stay-in-place insulating form system. For non-insulated structures, some of the forms can be easily stripped from formed walls and reused.

For more information on brick, masonry or concrete products, contact the Brick Institute of America, (703) 620-0010; the National Concrete Masonry Association, (703) 713-1900; or the Portland Cement Association, (708) 966-6200.

Insulation

Sprayed Polyurethane Foam Insulation has superior qualities for exterior wall and roof insulation. It swells to seal cracks against air and moisture infiltration and develops high R- values for its thickness (R of 6.2 per inch), attaining R-19 in a 2x4 exterior wall, eliminating the need for 2x6 walls using other insulation and saving valuable framing material. A seamless, closed-cell material, it protects against moisture penetration making it a good material for insulating below grade against concrete or block basement walls.

MIRAFLEX® glass fiber insulation encapsulated in a poly-wrap by Owens-Corning is a virtually itch-free, soft to the touch, and highly compressible product ideal for rehabilitation work because it is easier to transport and simpler to install than other glass fiber insulation. MIRAFLEX fibers are formed with a random twist—the first new form of glass fiber in 60 years. Four products using MIRAFLEX® are planned: PINKPLUS R-13, R-19, R-25, and R-30.

For further information on insulation contact the North American Insulation Manufacturers Association, (703) 684-0084; or the Society of Plastics Industry at (202) 371-5200.

Housewrap

Housewrap is a fabric barrier which significantly reduces air infiltration and drafts that could penetrate even well insulated walls through cracks in sheathing seams and around windows or doors. Housewrap consists of coated cross-woven fabric of polypropylene or polyethylene. It is applied around exterior walls directly to studs or over exterior sheathing where it covers window and door openings. X cuts from corner to corner of openings produce flaps which are pulled inside, folded over, and fastened. The cross woven fabric is tough and resists tears and rips during installation. The fabric is moisture vapor permeable, allowing moisture vapor inside wall cavities to pass through to the outside, eliminating the potential for condensation buildup. An easy and economical application, housewrap provides significant energy savings and improved comfort.

TECHNOLOGY DESCRIPTIONS

Roofing

Shingles are available in various materials which replicate natural materials but have greater fire resistance rating (Class A) and improved resistance to wind, hail, sun, water, rot, fungus, and termites.

Fiber Cement Shakes "have the natural texture and tones of cedar shakes" or replicate natural slate. They contain no asbestos, formaldehyde, or resins. Some manufacturers provide a 50-year warranty, transferable from the original owner.

Cedar Shakes and Shingles have improved their durability, longevity and resistivity to fire, fungal decay, high winds and freeze/thaw conditions through pressure treatment technology. Heavy cedar shakes are now available with a 50-year limited warranty; medium shakes and shingles with a 30-year limited warranty.

For more information on roofing, contact the National Roofing Contractors Association at (708) 299-9070.

Vinyl Siding

Improvements in vinyl siding have increased its acceptance in both new construction and rehabilitation. Stiffer siding has been developed providing flatter overlaps, straighter course lines, and more resistance to kinking, sagging, and flexing. One manufacturer accomplishes the stiffening by using a high density fiberglass tube that fits in a formed channel of the siding at the lap. Better flashing systems around openings, systems eliminating J-channels and corner posts, and wood-texturing more convincingly imitate traditional wood siding.

A wide variety of colors has been introduced—CertainTeed currently has 17 siding and 20 coordinating trim color choices. Improvements have also been made in reducing color fading through the use of new resins and other methods.

For more information contact the Plastics Institute of America, Inc., (201) 808-5950, or the Society of Plastics Industry at (202) 371-5200.

Exterior Insulation and Finish Systems (EIFS)

Exterior insulation and finish systems (EIFS) have come a long way since their introduction into the United States from Europe 25 years ago and are overcoming their earlier image as imitation stucco. EIFS has grown to represent an estimated 15 percent of cladding work in commercial construction but currently only about 3 to 4 percent of the residential market. In both commercial and residential construction, EIFS provide options in renovation and rehabilitation projects for attaining both energy savings and a renewed appearance. Improved chemical formulations and components, improved durability, higher energy efficiency, and the ease of architectural elaboration of surfaces have increased EIFS performance and customer acceptance.

A lack of industry standards and accepted approaches have hindered wider use of EIFS. To rectify the situation, the EIFS Industry Member Association (EIMA), representing 277 companies, established new industry standards in June 1994. These standards have been submitted to ASTM. EIMA has also revised specifications to reflect these standards and has published generic details. Further, EIMA has announced an applicator training program in conjunction with the EIFS manufacturers. All are positive steps to establish standards, consistent practices, and training to improve quality in applications.

One recent technical refinement has been the introduction of drainage and weep holes into what has been considered a surface-sealed system. In these new systems a waterproof layer is applied to the substrate before insulation is attached. If water penetrates the system, it is stopped by this layer and exits through weep holes. Other EIFS manufacturers utilize "rain screen" technology to equalize air pressure within the system so water will not be drawn in through cracks or improper seals. Because these refinements increase costs, many U.S. manufacturers are offering "performance tailoring" options from which the user can choose depending on design requirements and budget.

Newly developed finish systems are said to provide surfaces having the "look and feel" of solid stone. The deeply textured finish is attained through use of multi-colored quartz aggregate and an acrylic-based finish. Through custom blending of aggregates, the finish can be designed to match specific real stone. The finish can be applied over exterior concrete, stucco, masonry, exterior insulation and finish systems (EIFS), interior drywall, or plaster surfaces. EIMA can be reached at (202) 783-6582, for more information.

Windows

The fenestration industry has responded to the challenge of providing energy efficient and economic products to a discerning market increasingly sensitive to environmental issues at a time when there are industry concerns both with supply and price stability of traditional materials.

Glazing. In a relatively few years, research and engineering technology has produced vastly improved energy efficiency in window glazing and improved window design resulting in better performance and greater durability. Over the last ten years "super window" technology has been commercialized in North America and high-performance insulating glazing has essentially become standard for leading window manufacturers. Key components of the new technology include:

- glass tinting,
- low emissivity (low-E) glass coatings,
- coated film suspended between panes of glass,
- air spaces between panes filled with high molecular weight gas,
- vacuum glazing which approaches the R-values of conventional opaque walls,
- gas retention systems,
- non-conductive spacers separating panes, and
- foam-filled frames.

TECHNOLOGY DESCRIPTIONS

Various combinations of these technologies produce windows that reflect solar radiation to the exterior in the summer and permit its penetration to the interior in the winter, thus reducing both winter heat loss and summer heat gain by 50 percent or more; and glazing that develops high R-values, blocks out up to 99 percent of UV radiation, and reduces noise penetration 95 percent more than standard insulating glass, while allowing visible light to enter without impairing the view.

As the performance of tinted and coated glass approaches theoretical limits, attention and experimentation are turning to "switchable" glazing for the next level of evolution, such as:

- electrochromic glazing that varies heat and light transmission to control heat gain and loss, and varies translucency from transparent to opaque for privacy,
- photochromic glazing in which translucency is altered in response to solar brightness, much like some sunglasses, and
- thermochromic glazing in which solar gain characteristics respond to temperature change.

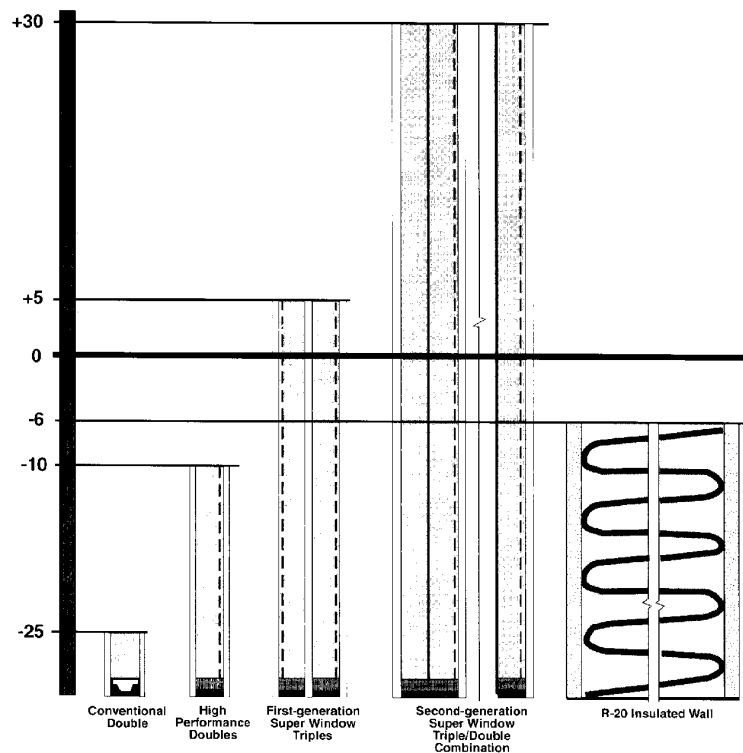


Figure 5. Canadian Energy Ratings of Glass

Figure 5 shows a comparative range of different window designs. For example, a conventional double-glazed casement window typically has a -35 ER rating, a high-performance double-glazed window has a -10 ER rating, a high performance triple-glazed window has a +5 ER rating and a high performance triple/double combination has a +30 ER rating. In contrast, a R-20 insulated wall has only a -6 ER rating.

In calculations the +30 ER rating for a second-generation super window, various simplifying assumptions were made, including overall window U-value based on center-of-glass performance; solar heat gain coefficient based on clear glass area; no window air infiltration through the combined triple/double assembly; no venetian blind system between the glazing panels and no account taken of the potential thermal benefits of PCM drywall storage.

Retrofit Heat Control Film. A transparent polyester film with a scratch-resistant coating on one side and adhesive on the other is said to offer a retrofit application to glazing which reduces heat gain by more than 50 percent, absorbs UV radiation, and does not reduce the level of daylighting or add color or reflectivity to the glass. Llumar offers a five-year warranty against peeling, cracking, demetalization, and delamination. In addition to heat and UV control, Armourcoat's "Graffiti Gard" is designed for application to the exterior of the glass to protect the glass against etching (graffiting). When the film is etched by vandalism or other occurrences, the film can be easily removed and replaced at a minimal cost. This film offers a very cost effective method for retrofitting existing windows to reduce solar heat gain. Research conducted after the Northridge (CA) earthquake indicates that the window film also provides resistance against glass fallout (See Figure 6).

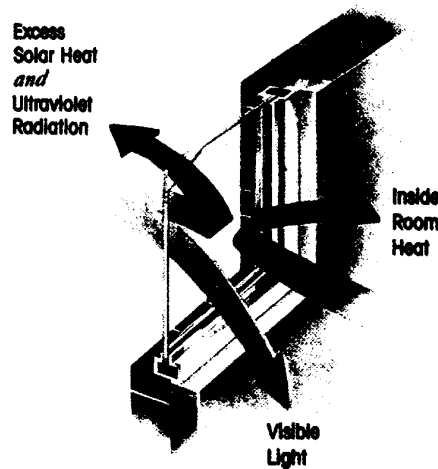


Figure 6. Glazing Retrofit Heat Control Film

Frames

Wood Composites. A number of wood composite materials (wood and resins) are being used as substitutes for standard lumber for windows. The composites are equal to standard lumber in strength, nailability, and resistance to screw withdrawal and are not affected by humidity. These materials are more dimensionally stable when water is absorbed. Greater price stability is an additional advantage for manufacturers.

Pultruded Fiberglass. Window frames of all fiberglass, or in combination with traditional materials for cladding in lieu of aluminum or vinyl, are finding increased market acceptance. Fiberglass has excellent physical properties for use in window frames such as low thermal conductivity, dimensional stability under temperature changes, resistance to moisture and corrosion, and ready acceptance of colored finishes. Its high strength makes metal reinforcement unnecessary. Bicomponent window frames of pultruded fiberglass cladding over wood cores are low-maintenance and will not rack or warp because of the rigidity and strength of the fiberglass.

TECHNOLOGY DESCRIPTIONS

Doors and Door Hardware

Steel Doors. Not a new technology, but a trend in residential construction is the increased use of steel doors for greater security. Steel doors have become more acceptable through new finishing techniques such as ornate embossed designs and techniques to give steel doors a wood door appearance. One manufacturer offers a natural oak pattern on 22 gauge steel that is said to be stainable. Insulation of steel doors has been improved by the use of foamed-in-place expanded polyurethane made by a foam injection process that causes the expansion to fill all cavities resulting in a solid core.

Polymer Doors and Frames are now being marketed which are immune to corrosion and therefore very appropriate for salt-air environments.

Door Hardware. There is also a trend to use higher quality door hardware for greater security. Since the onset of the Americans with Disabilities Act (ADA), the use of lever handles in lieu of knobs has become more common.

New Door Control Unit functions as a standard door closer, or when signaled by a remote actuator to provide opening assistance. This unit allows the door to be opened by pushing on it with a force adjustable from 1.5 to 5 pounds. Field adjustable controls allow speed and hold-open time to be set to accommodate user needs.

For more information on windows, doors, or hardware, contact the American Architectural Manufacturers Association, (708) 202-1350; the Door and Hardware Institute, (703) 222-2010; or the National Wood Window and Door Association at (708) 299-5200.

Sealants

Improved Elastomeric Caulk has been introduced by Dow Corning to address chalking and streaking problems often encountered with both organic-based and silicone-compound weatherproofing sealants. Specifically designed for use with porous stone and metal panel claddings where fluid migration, dirt runoff, and streaking are particularly noticeable, the new sealant repels dirt from the exterior and keeps plasticizers from migrating through the surface to stain adjacent porous or micro-porous surfaces. It is described as a medium modulus product that can accommodate plus or minus 50 percent movement in a properly designed joint and is said to bond well with most building materials. This sealant is compatible with several types of backer rods. It is exclusively made for exterior application and needs both atmospheric moisture and UV exposure to cure. Standard and custom colors are available. The sealant can also be painted within months of installation, if desired. More information on sealants can be obtained from the Society of the Plastics Industry at (202) 371-5200.

Building Cleaning Systems

Dry Procedure (Facade Gommage). The French term "gommage" refers to the process of gently cleaning masonry by projecting a very fine powder with low pressure compressed air to mechanically clean a surface without abrasion. No water, chemicals, or detergents are used in conjunction with the powder/air mix. This technique has been used to clean dirt deposits from both exterior and interior surfaces of limestone, sandstone, granite, marble, brick, concrete, exposed aggregate, and plaster.

Thoman-Hanry, Inc., a company with headquarters in Paris and, more recently, an office in New York, has been refining the "gommage" technique since 1965 and received a new patent in 1985. Powders and mixes are custom designed for each project. The company has also developed a movable enclosure for the application technician and the powder spray which contains and disposes of the airborne particles, dust, and dirt that are produced by the cleaning process. The company's projects include the Palace of Versailles, Place de la Concorde, Gaudi's Casa Mila in Barcelona, the Tribune Tower in Chicago, and the Hotel DuPont in Wilmington, Delaware, among others.

Wet Procedure by Germany's Hartmann Company uses low pressure compressed air, "very little water" (1.5 to 12 gallons per hour), and inert abrasive powder. The system is claimed to also clean painted wood, glass, and ceramic tile in addition to masonry materials. Hartmann's projects include Westminster Abbey and Canterbury Cathedral, among others.

ELECTRICAL

Lighting

A vast array of innovative lighting products has been introduced in response to the drive for energy efficiency and to federal energy legislation which has decreed that manufacture and importation of some incandescent lamps be eliminated to reduce energy consumption. Since electricity accounts for over 80 percent or more of the cost of light in incandescent lighting systems as compared to 7 percent for the lamp, by choosing a more efficient lamp, even one that costs more, results in significant savings.

Compact Fluorescent Lamps bring the advantages of fluorescent lighting to incandescent sockets by offering high lamp efficiencies and operating economies through long life, high light output, and a wide choice of color options, wattages, and shapes. They are appropriate for most residential applications and fixtures including recessed cans, track lighting, wall sconces, etc. Some are dimmable.

In one-piece systems the unit screws directly into incandescent sockets. In the most economical systems, lamps plug into separate adapters that screw into standard incandescent sockets. Adapters generally last 3-4 lamp lives. Plug-in compact fluorescent lamps are an economical alternative even to conventional fluorescent lighting.

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Halogen Lamps, while more expensive than incandescent, are more energy efficient, do not depreciate in lumens with age, and provide better color rendition. Some incandescent fixtures eliminated by energy legislation have been replaced by halogen fixtures.

Lighting Controls. More variety and more affordable lighting controls have appeared on the market such as dimmers, timers, and photoelectric controls which reduce energy waste in unoccupied rooms (See Photo 1).

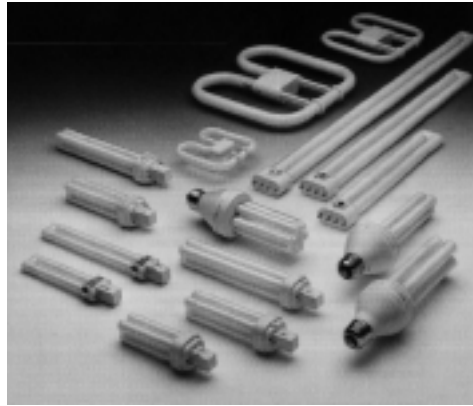


Photo 1. Lamp Varieties

For more information contact the Electronic Industries Association Consumer Electronics Group at (202) 457-8700, or the Home Automation Association at (202) 333-8579.

Baseboard Raceway

Wiremold now markets a new raceway—Access 5000—that resembles a standard 6-inch high baseboard in size, profile, and finish. The polymer molding conceals separate channels for running electric power and low voltage data wiring for computer, telecommunication, and security system wiring. This raceway greatly simplifies running both power and low voltage in renovation without demolition. Mounting plates can be added anywhere along the raceway to accommodate various duplex outlets, phone jacks, and co-axial connectors. Finish options include a variety of finishes and colors including black and white vinyl, as well as maple, cherry, oak, and mahogany veneers. The system is UL listed and CSA approved up to 300 volts (See Photo 2).

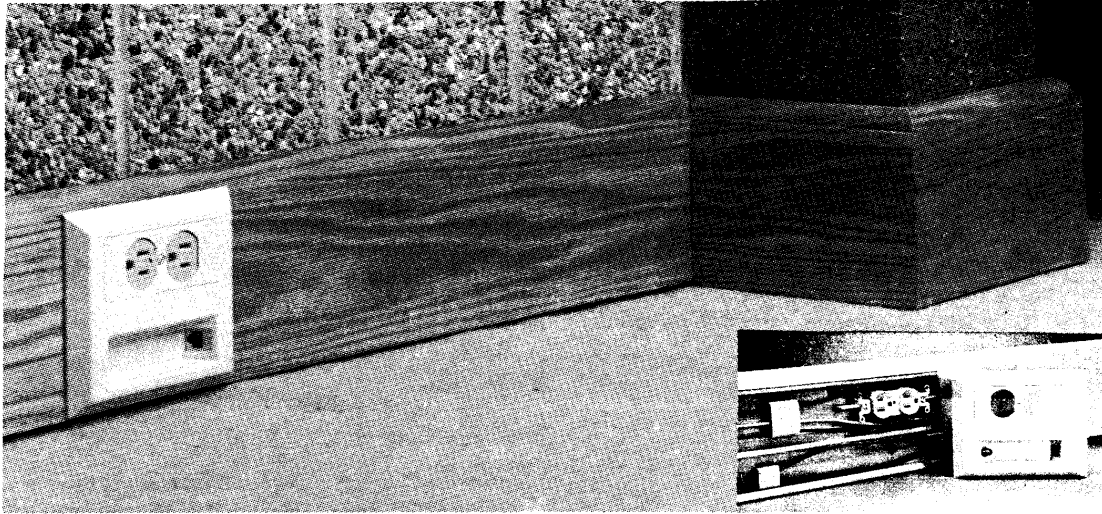


Photo 2. Baseboard Electrical Raceway

PLUMBING AND HVAC

Residential Air Conditioning

A major focus of technological research in the air conditioning industry is the development of **alternatives to HCFC 22**, the predominant refrigerant in use. Currently, most alternatives are HFC blends. In addition, pressures to improve energy efficiencies are leading to more complicated and sophisticated controls and equipment such as multi-speed motors. At the same time that first costs of equipment are rising, and will continue to rise, maintenance will become more expensive since many contractors may not be qualified to work on equipment using new blends, or to perform diagnostic work on the more sophisticated systems.

Alternative technologies in the industry customarily appear first in the commercial sector which is far less cost sensitive than the residential market. As the technology is refined and costs come down, new technologies find use in residences. An example is **natural gas refrigeration systems**. In general use in large-scale commercial applications, gas absorption equipment for residential use has become cost effective in some markets.

Other technological advances common in commercial applications but now appearing in residential use include **controls** that provide:

- Better Temperature and Humidity Control. One application uses variable dampers controlled by individual thermostats varying air flow in individual rooms or zones but with a single, central equipment.
- Improved Air Quality. Equipment senses and eradicates carbon dioxide and other contaminants.

TECHNOLOGY DESCRIPTIONS

Ductless Air Conditioners are wall, floor, or ceiling mounted (surface or recessed) units which provide heating and/or cooling without the need for ducts to distribute the conditioned air. As such they are relatively economical and ideal for housing rehabilitation in most temperature climates. Cooling and heating is accomplished by a split-system heat pump or by split-system cooling and electric resistance heating. Split-system cooling is also used for a cooling only unit. The units can be installed in almost any location, and they operate quietly. They are individually controlled and have capacities to adapt to various environmental requirements and load conditions, except those of extremely cold weather. The units are energy efficient with 12- or 24-hour programmable controls. Installation is simple and economical: an electrical connection to the interior unit and in split systems, an electrical connection to the exterior unit with refrigerant lines between the exterior and interior units.

For more information on HVAC systems, contact the Air-Conditioning and Refrigeration Institute at (703) 524-8800, or the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., at (404) 636-8400.

Gas

Recent developments in both piping and venting of gas appliances are pertinent to residential renovation.

Corrugated Stainless Steel Gas Piping. Small diameter corrugated stainless steel piping for gas, developed and in use in Japan, is now available in the United States where codes permit (BOCA currently accepts it). A separate line is pulled for each appliance. The piping can be pulled through walls and joist spaces similar to the way electric wiring is pulled. The freedom in installation makes this flexible piping particularly applicable to retrofit and rehabilitation. Since the piping is designed for 4 psi, adapting existing appliances to the service requires a regulator at each appliance (See Figure 7).

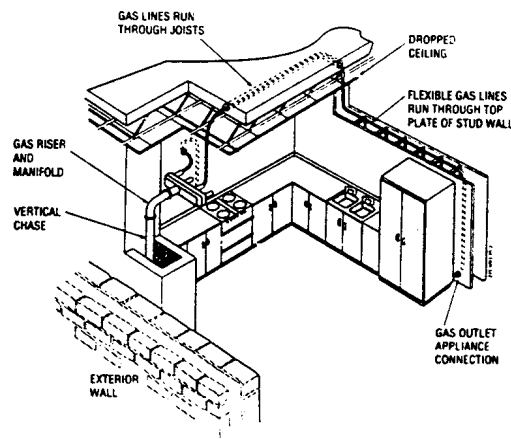


Figure 7. Small Diameter Gas Piping

Plug-in Outlets. Plug-in gas outlets allow movable appliances such as gas grilles, woks, chafing dishes, and space heaters to be stored when not in use, or moved and plugged in. Plugs lock into fail-safe receptacles.

Through-the-Wall Vents. Gas water heaters and high efficiency furnaces can be through-the-wall vented, eliminating the need for chimney or flue venting which is particularly beneficial in renovation and rehabilitation. This is particularly pertinent where federal efficiency requirements would require relining chimneys (See Figure 8).



Figure 8. Through-the-Wall Vents

Unvented Gas Heaters. The National Fuel Gas Code along with the Consumer Products Safety Commission now allows gas-fired room heaters to be unvented when they have an oxygen depletion sensor.

Gas Fireplaces. Gas fireplaces and gas logs are said to be the hottest selling gas appliances on the market thanks to their efficiency and the ability to vent gas fireplaces through the wall. They can attain a thermal efficiency up to 74 percent and an Annual Fuel Utilization Efficiency rating of 63 percent. Some gas fireplace designs are vent-free, allowing them to be installed on any wall. Some manufacturers claim 99.99 percent efficiency, and market them as a back-up for the primary heating system in case of power outages.

Gas-Fired Space Heaters. Direct-vent, gas-fired, energy efficient space heaters are now available with 22,000 to 38,000 BTU outputs and 5-year warranties. With quiet fans, electronic ignition, and built-in thermostats and humidifiers, these cleanly designed heaters are built with cool-to-the-touch cabinetry and are about the size of old fashioned radiators. Gas-Fired space heaters are particularly appropriate for additions and renovations.

For more information on gas piping and appliances, contact the American Gas Association at (703) 841-8400.

TECHNOLOGY DESCRIPTIONS

Plumbing

Air Admittance Valve for Drainage Systems. Studor Inc.'s air admittance valve, introduced into the United States in 1986, is an innovative replacement for conventional through-the-roof vent piping for plumbing drainage systems. As water falls in a drainage system which has an air admittance valve, the valve opens to admit air to relieve the negative pressure that occurs. The design utilizes a reverse lift sealing member that relies only on gravity to close the valve, thus eliminating the through-the-roof piping. The valve is installed four inches above the weir of the trap so it fits under the counter. It is an ideal way to vent sinks in kitchen islands. The valve can vent 20 drainage fixture units which, for example, could provide venting for two toilets, two lavatory bowls, and one tub/shower. Studor's air admittance valve meets ANSI and ASGE's 1050 and 1051 requirements, has been approved by SBCCI, BOCA, and CABO, and has recently been listed by IAPMO/UPC.

The cost savings realized in labor and material over conventional venting is very significant, particularly in renovation where threading conventional venting through upper floors is especially difficult. The benefits of reduced roof penetrations are also important, both aesthetically and in the reduction of potential roof leaks. Other problems inherent to conventional open stack venting, such as frost closure and trap losses due to high wind, are prevented.

Corrosion-Proof Piping. Solvent-weldable CPVC piping for hot and cold domestic water distribution is said never to corrode, pit or scale, and reduces water hammer. This piping is particularly useful in renovation since the material's flexibility permits fairly tight curves.

For more information on plumbing products, contact the National Association of Plumbing-Heating-Cooling Contractors at (703) 237-8100.

Flue Relining Systems

Cast-in-Place Cementitious System. Invented in England over 60 years ago, cast-in-place chimney relining systems were introduced in America in 1979 and have been UL listed since July 1991. Current liner mixes consist of air-entrained Portland cement, perlite, and a plasticizer to improve flowability allowing chimneys with multiple offsets to be lined. After any existing liner is removed by a device which "gently" breaks up the liner, long rubber tubes are extended into the chimney and inflated to precise dimensions. Proprietary devices space the tubes away from the chimney casing to assure proper lining thickness. The bottom of the casing is temporarily sealed to confine the mix which is

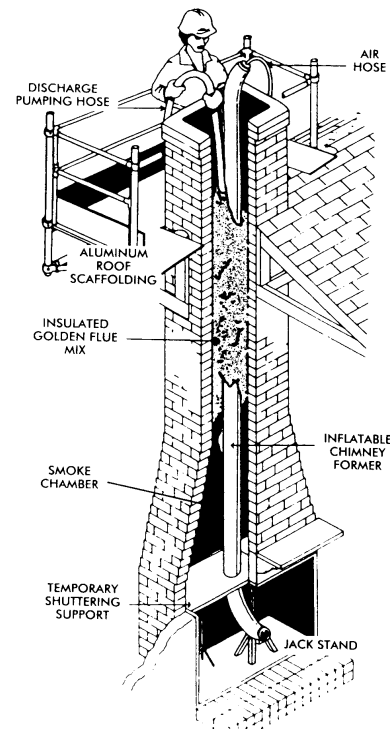


Figure 9. Cast-In-Place Flue Relining System

pumped from the roof into the gap between the chimney former and the chimney casing. The smoke chamber is also relined in the same pour. A bonding agent is used to allow the mixture to adhere to surfaces that may be covered with creosote. The insulating qualities of the liner reduce creosote and condensation formation, and the material itself withstands the attack of acids produced by gas and oil furnaces vented to chimney flues. One manufacturer claims that just one inch of lining material allows zero clearance to combustible materials. The improved flowability of the mix allows it to seal voids, cracks, and missing mortar joints, structurally strengthening the chimney. The result is a seamless, high-insulating liner installed without expensive and messy masonry demolition, and at far less cost. One manufacturer/applicator, Golden Flue, has developed a mix and casting system that produces a one-piece cast-in-place chimney and liner in one pour (See Figure 9).

Flexible Stainless Steel Chimney Liner System. This is a system of chimney lining that utilizes advanced steel alloys and has a high mechanical strength. These lining systems are resistant to acids found in solid fuel chimneys and are tolerant to thermal shock and temperature extremes. The flexible stainless steel liner is encapsulated in a foil-faced, ceramic-fiber insulation blanket protected by wire mesh, inserted into the chimney from the roof, and connected to the heating appliance with appropriate adaptors. Benefits are said to be similar to those of cementitious lining systems.

INTERIOR FINISHES

Gypsum Wallboard

Flexible ("High Flex") Gypsum Wallboard bends to form curves without the usual wetting, scoring, or plaster finishing of standard drywall, making it easy to create archways, rounded corners, and even columns. Tapered edges make finishing as easy as regular drywall.

Fiber-Reinforced Gypsum Wallboard Panels are designed for use where extra durability is required for interior walls and ceilings. Reinforcing with blended recycled cellulose fiber and gypsum results in a stronger panel that resists denting, breaking and puncturing, and provides superior nail, screw and adhesive-holding ability. Fastener pops are virtually eliminated when fiber reinforced gypsum wallboard panels are used.

For more information, contact the Gypsum Association at (202) 289-5440, or the Ceilings and Interior Systems Construction Association at (708) 833-1919.

Flooring

Wood Flooring Options. Recent advances have been made in installation systems that have resulted in improving application methods. Pre-finished wood flooring nailed or glued to substrates has greatly increased in use over conventional stain, seal, and wax methods. New and improved adhesives have been developed and tested for proper adhesion to newer less expensive substrate materials such as oriented strand boards (OSB), structure boards, flake boards, and the like. Some new adhesive systems provide their own moisture barriers. Adhesives have moved toward 100

TECHNOLOGY DESCRIPTIONS

percent urethanes, replacing solvent-based adhesives which did not meet volatile organic compounds (VOC) regulations. The choice of wood species has also greatly increased, providing more color options without requiring staining. Some manufacturers offer birch, cherry, mesquite, and southern yellow pine, in addition to the traditional oak, maple, and ash.

Floating Wood Floor. A new "floating floor" installation method is available in which flooring strips are glued at the tongues and grooves thus eliminating nailing to the subfloor. A floating wood floor is installed over 1/8-inch closed-cell foam providing sound deadening to meet apartment sound transmission requirements. Floating floors can be installed over many types of substrates and can be used in below-grade installations.

Thin Wood Flooring. A new 5/16-inch thick strip flooring, versus conventional 3/4-inch can be installed over existing synthetic flooring. The lesser thickness is particularly helpful in renovations where transitions are made to adjacent floor levels.

Thin Stone Flooring Systems. Very thin sheets (1/4-inch) of natural stone are reinforced or impregnated with high performance epoxy that bonds a mesh of fiberglass or steel to the stone, developing a thin, unusually strong, lightweight and easily handled product said to have eight times the flexural strength of unreinforced stone and more than three times the compressive strength. It is particularly useful for retrofit or renovation where thickness limitations and transition to existing floors are important.

For more information on floors, contact the National Wood Flooring Association, (314) 391-5161; the Wood & Synthetic Flooring Institute, (708) 449-2933; or the World Floor Covering Association at (714) 978-6440.

Molded Millwork

Millwork products such as door and window trim, louvers, balustrade systems, and moldings are available in a fire-rated, high density polymer. For more information, contact the Wood & Synthetic Flooring Institute at (708) 449-2933.

Carpet

Polypropylene versus Jute As Secondary Backing. Because jute, the customary secondary backing in carpeting, has become less available and more expensive to import, polypropylene has become the secondary backing of choice. Seam failure, which surfaced as a problem in the transition to polypropylene, is rapidly disappearing as installers become educated in proper seaming procedures. Done properly, seams in polypropylene are stronger than seams in jute. Installed costs are not significantly changed, but the polypropylene backing represents an improvement in carpeting quality since polypropylene will not mildew from being wetted as jute does.

Reusable Carpet. Milliken Carpet has developed a program to recycle, revitalize, and reinstall its old carpeting. The manufacturer claims that carpeting can be updated with new patterns and colors

and reinstalled for about half the cost of new carpeting. The recycled carpeting has a 7-year warranty. In addition to the environmental benefits, the potential cost savings in renovation is impressive.

TOOLS AND EQUIPMENT

Heavy Duty Cordless Tools are now available to handle virtually any small construction task including drilling, driving, screwing, fastening, boring, and cutting (See Photo 3). The technology behind this proliferation has been advances in powerful 14.4, 12.0 and 9.6 volt batteries delivering greater power and longer battery life, and high performance fan-cooled motors with lifetime or replaceable brushes. The DeWalts "system" of cordless tools features interchangeable batteries and ergonomically balanced designs.



Photo 3. Cordless Handtools

Laser Aligning Devices shorten leveling and installation time. A palm-size, battery operated version levels or performs 90 degree layout.

Construction Utility Belts. Back strain is the number one cause of sick leave and workers' compensation claims. Utility belts specifically designed for carpentry, electrical, and drywall tools distribute weight evenly, preventing fatigue, and acting as a back brace during lifting.

Construction Dust Control. A door and wall system to contain construction dust has recently been introduced to seal off a door opening or rough opening between a work area and an occupied space. Made of heavy vinyl sheet, the product is an alternative to the typical polyethylene sheeting solution.

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Use of velcro sewn into the edges of the vinyl sheet allows mounting the barrier without damage by adhesives or nails to door frames, wallpaper or paint. A zippered flap allows passage of people. Add-on panels can be used to produce a barrier to fit large openings. A recent addition to the system is a panel with a built-in nylon elastic sleeve for attaching regular, flexible, dryer vent duct and a simple fan to exhaust construction dust generated in the sealed space to the outside (See Photo 4).



Photo 4. Construction Dust Control

SEISMIC RETROFIT

Earthquake forces can severely damage concrete structures. To protect existing structures against seismic damage and to add strength to existing concrete columns, a retrofit wrap system using high strength, hybrid fiber/epoxy composites has been developed. This method is more durable and less expensive than previously used strengthening repairs.

As an alternative to reinforcing by using steel jackets which must be welded and maintained against corrosion, the glass and aramid fiber/epoxy jacket is wrapped around a column in large sections or bands of woven unifabric that cure in place. Installation requires no heavy equipment and generally takes less time or personnel as compared to steel. Containment of the concrete may be accomplished by the wrap alone or in conjunction with a post-tensioning technique utilizing grout injected under pressure between the column and the composite shell. Damaged columns can also be repaired using an epoxy grout to fill and seal the damaged parts of the column, and completing the repair by the wrapping procedures. The architectural shape of the column—rectangular, oval, square, circular—can usually be preserved. The system can be applied in confined spaces with clearances

as little as three inches. Fire retardant/resistant additives can be included in the resin systems or the finish coats.

In masonry building walls the prime concern in earthquakes is plane shear and flexural destruction. Fiber wrap systems spread the stresses over the whole wall face increasing the in-plane shear resistance. Special composites can be designed to increase the compressive strength of the wall as well. The system can be used on both reinforced and unreinforced masonry and brick walls. For previously damaged walls, a post injection of epoxy-based grout can restore the wall to high ductility levels. One-sided application can be accomplished without intrusion into opposite side interior. Reinforcement for hurricane protection is another area of application. Fiber/epoxy wrap has also been successfully used to reinforce concrete beams which did not come up to the design strength as well as timber beams and rotted utility poles. The wrap technology is particularly effective in corrosive environments to arrest corrosion or protect against it.

Surface finishes resembling concrete are available as well as a clear finish for brick walls which has promise for use in historic preservation. Hexcel-Fyfe Company is working with ASTM, ACI, and UL to develop standards and ratings (See Figure 10).

For more information on seismic retrofit, contact the American Consulting Engineers Council at (202) 347-7474, or the American Concrete Institute at (313) 532-2600.

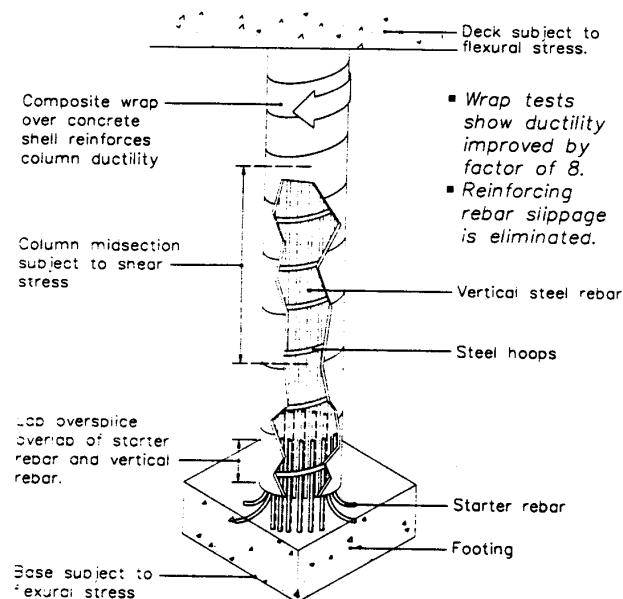


Figure 10. Seismic Retrofit Wrap System

HAZARDOUS MATERIALS ABATEMENT

Lead-Based Paint

Encapsulation Coating. It has been estimated that lead-based paint is present in approximately three-quarters of U.S. structures built before 1978, which represents a serious national health hazard. According to EPA estimates, complicated and expensive procedures would have to be performed in 57 million residential units nationwide at a cost up to \$10,000 apiece in order to abate the danger from lead. In traditional methods of lead-based paint removal, occupants must leave the unit or parts of it, containment must be installed, scraping and demolition of lead-containing surfaces must be done by workers in protective clothing, and all waste must be handled as a hazardous material.

An alternative to removal is encapsulation which involves leaving the lead-containing material in place and applying an impervious coating over it. Coating lead-containing material with a non-impervious paint such as latex or alkyd paint will not provide protection since lead molecules migrate through this type of paint within months.

One newly developed encapsulant is an elastomeric thermoplastic co-polymer that forms a flexible yet durable barrier. Water-based and non-toxic, it can be applied with brush, spray, or roller with occupants remaining in the unit, making it ideal for lead abatement in renovation work. The antique linen color and eggshell texture are said to be a satisfactory finish coat, or any latex paint can be used as a top coat. Guaranteed not to pit, peel, split, or crack, the encapsulant is offered with a 20 year warranty on interior applications, ten years on exteriors. Both warranties apply to coatings over lead-based paint on wood, concrete, cement, brick, sheet rock, wallboard, plaster, or gypsum. When the end of the effective life of the impervious coating is reached, another coating of the same material is necessary to continue the protection. The coating can withstand a direct blow of up to 160 pounds per square inch. The product meets ASTM requirements and OSHA standards and has been accepted by EPA and HUD among other federal agencies.

Lead Abatement Wall Covering. A new, woven-fiberglass wall covering can be hung over cracked and rough brick concrete, block, drywall, paneling, and plaster to perform as a reinforcement in lead paint encapsulant systems. The material is paintable, textured and air permeable, and has been approved by the New York City Housing Authority. Additional information can be obtained through NIBS at (202) 289-7800, or the National Paint and Coating Association at (202) 462-6272.

UNIVERSAL DESIGN/ACCESSIBILITY

Kitchen Counters, Cabinets, and Appliances

Recent and imminent changes in kitchen equipment and design are generally more responsive to changing demographics than to technology. In response to ADA-issues and an aging population, designers are providing adjustable counter heights and under-counter accommodations for wheelchairs, and manufacturers are offering appliances with larger, more readable numbers on controls, lever handles, and automatic shutoffs and other safety features.

A new line of energy efficient and ADA-compliant washing machines and dryers with load capacities equaling or exceeding those of conventional machines can be installed under 34-inch high counters. Both the washers and dryers are front-loading and feature front-mounted controls making them accessible to people who use wheelchairs. One model has an internal condenser which collects moisture from the dryer, eliminating the need for an outside vent.

Sub-Zero has introduced a series of built-in refrigerator/freezer modules that fit into standard 27-inch wide by 24-inch deep cabinet systems. The line consists of an 80-inch high module with a cabinet above and two drawers below and a base module with two drawers that fits under counters. Either unit can be refrigerator or freezer. Panels and handles to match the rest of the cabinetry can be mounted on the fronts. Compressors are hidden under the bottom drawers. While designed to make the refrigerator or freezer "disappear" when the doors are shut, this system offers the possibility of adding refrigerator or freezer capacity as needed in kitchen remodeling or additions.

In response to aging baby boomers, the computer is expected to be the next appliance to move to the kitchen, accomplishing such tasks as tracking inventories by monitoring bar codes and making shopping lists or linking with stores for automatic delivery of depleted items. For more information contact the Kitchen Cabinet Manufacturers Association at (703) 264-1690.

TECHNOLOGY DESCRIPTIONS

INFORMATION TECHNOLOGY DESCRIPTIONS

BUILDING ENVELOPE

Wood Protection

The Wood Protection Council of the National Institute of Building Sciences, (202) 289-7800, has completed a major revision to its previous document on wood protection. The revised publication is titled *Wood Protection Guidelines, Protecting Wood from Decay Fungi and Termites*. This latest edition expands upon cooperation between the builder and the wood protection contractor by addressing what can be expected from a wood protection treatment program and what a builder can do to facilitate protection by selecting species of wood which are naturally more resistant. In addition, there is considerable information included about borate materials—the newest and most environmentally friendly of the effective termiticides.

COMPUTER SOFTWARE

Estimating and Design

As in virtually every field of endeavor, improved computers and sophisticated software are accomplishing more and more construction planning and administrative tasks, and at affordable prices. Examples of the range of software available are:

- Professional estimating systems with fully integrated graphics digitizer that lets the user do takeoffs quickly. Some automatically generate purchase orders.
- Turtle Creek Software's Bid Magic for estimating remodeling projects, additions or new construction includes over 1,200 unit prices in a customizable price book. A material takeoff module is available. McNail includes integrated estimating, accounting, scheduling, and contract writing for Excel spreadsheet and is available for Macintosh or Windows. Craftman's new 1995 CD Estimator provides over 2,000 pages of labor and material prices.
- Computer Integrated Building's Softbuilder features 3-D design, automatic roof creation, integrated estimating, production of framing drawings with cut lists and automatic generation of plans.
- A computer disc with a compact fluorescent lighting directory contains specifications for each model featuring 8,000 products from 100 manufacturers.
- Builders Buyer's Guide is a CD-ROM covering 1,750 building product manufacturers including 32 videos.

- Lumber companies and other building materials suppliers are providing customers with discs or software to speed pricing or purchasing. One lumber company provides discs with quarterly updates for entry into the customers' programs or spreadsheets. The discs include prices for lumber, millwork, and other products the company sells. Another company developed software available to customers so they can hook up to the company's lumber-net, allowing the customer to check the company's inventory, review prices and put together a list for deliveries. Another company uses electronic scanners to track orders from purchase orders to invoice. Dispatchers can check on an order's whereabouts by calling it up on their computer.
- Concrete diagnosis software, a knowledge-based system being developed by the National Institute of Standards and Technology, diagnoses problems such as cracking or spalling. The software is now being applied to diagnosing concrete in highway pavements and to military uses. Its greatest potential for the future is its use in concrete in buildings.

At the same time that computer-aided drafting hardware and software have made great technological strides and become widely affordable and accessible, a staggering variety of software that helps designers and clients visualize designs has been developed and brought to market, such as:

- ray trace rendering software that includes viewpoint and sunlight animation, renders models in less than four minutes with reflections and shadows, and sells for about \$400 (summer 1995);
- an architectural modeler program that constructs buildings as three-dimensional objects in about 20 minutes and sells for about \$200; and,
- new computer based ergonomic design programs such as Mannequin Designer that improve on drawing board methods with more effective ways to analyze and produce scaled drawings, and better ways to provide safer, easier to use, and more handicap accessible homes and consumer products.

In the past, designs were modeled, measured, and tested against scaled anatomical templates, trials, and documented research. The new software allows the designer to manipulate objects or size of the user, show different views of the design, and compare them against each other for fit, providing a quick and accurate 3-D human factor analysis. As new information arrives or requirements change, designs can be immediately re-analyzed. The benefits are faster design time and greater understanding of how products and designs will fit the ultimate users (See Figure 11).

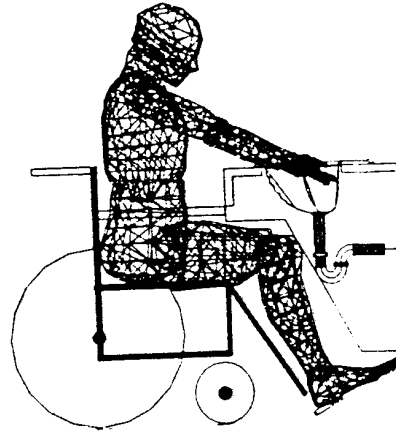


Figure 11. Mannequin Ergonomic Design

The Construction Criteria Base (CCB) CD-ROM which is offered, maintained, and up-dated by the National Institute of Building Sciences (NIBS) contains the following: guide specifications and regulations from 16 federal agencies; cost estimating systems from NAVFAC, the Corps of Engineers, and the tri-service TRACES program; private industry standards from 120 organizations; private guide specifications from AIA MASTERSPEC and CSRF SPECTEXT; NIBS Wood Protection guidelines; product information; libraries of CADD symbols; technical, engineering, and design manuals from many federal agencies; federal regulations related to construction; federal regulations related to lead-based paint; executable design, analysis and engineering programs; and more. NIBS can be contacted at (202) 289-7800.

The Digital Camera

Digital images of existing construction and construction progress can be displayed on a computer screen at a job site, or transmitted by telephone to a remote computer screen for inclusion in a report or as an aid in working out a construction problem. The digital camera, in conjunction with the computer, eliminates the delays associated with processing photographic film and provides a means to quickly print high quality images economically in unlimited quantities.

HAZARDOUS MATERIALS ABATEMENT

Asbestos

Environmental Protection Agency (EPA) publication *Managing Asbestos In-Place: A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials* provides guidance on how to organize and structure O&M programs.

National Institute of Building Sciences (NIBS) supported by the U.S. Environmental Protection Agency has published *Asbestos Abatement and Management in Building: Model Guide Specifications, and NIBS Guidance Manual: Asbestos Operations and Maintenance Work Practices*.

Lead-Based Paint

National Institute of Building Sciences (NIBS) supported by the U.S. Department of Housing and Urban Development, Office of Lead-Based Paint Abatement and Poisoning Prevention has published *Guide Specifications for Reducing Lead-Based Paint Hazards, and Lead-Based Paint Operations and Maintenance Work Practices Manual for Homes and Buildings*. The uniform criteria established in these manuals act to improve the quality and efficiency of lead-based paint abatement.

UNIVERSAL DESIGN/ACCESSIBILITY

Information

With funding from HUD, the Center for Accessible Housing answers questions about accessibility requirements (1-800-647-6777).

New Product Sources

The Association for Safe and Accessible Products (ASAP) continues to grow and play a leading role in the promotion of products that are easy and safe to use and of Universal Design concepts to increase accessibility for people with disabilities and the aging. Through the Special Interest Forum (SIF) series, conferences, research and media promotion, ASAP is reaching an ever-growing number of product manufacturers, designers, advocates and consumers with the message that products, homes and offices can be designed to include, rather than exclude users.

In 1995, ASAP conducted SIFs on *Accessible Cabinetry, Aging in Place: Home Technology Access, Accessible Telecommunications, and Thresholds and Sliding Door Tracks*. The SIF series provides a forum for manufacturers, designers, advocates, and consumers to examine specific issues and work together to develop solutions that meet the needs of a diverse population of users. Later in 1995, ASAP will conduct SIFs on *Accessible Plumbing and Intelligent Housing*.

ASAP was accepted as an accredited member of the American National Standard Committee on Accessible and Usable Facilities (CABO/ANSI A117). The CABO/ANSI A117.1 Standard plays a pivotal role in the world of accessibility regulations. Membership in CABO/ANSI provides ASAP members with a valuable opportunity to participate in the review and development of regulations. ASAP sponsored a number of proposals that were reviewed during the recent ANSI A117 committee meetings that took place in Washington, DC in May and July 1995. The ASAP proposals included automated doors, door thresholds, grab bars, plumbing fixtures and others. From the ANSI

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involvement they are obtaining a great deal of information to help their members keep on top of standard making and regulatory developments.

ASAP is also participating in research activities with the Adaptive Environments Laboratory at SUNY/Buffalo and the Center for Accessible Housing at North Carolina State University.

PERMITTING

Pasadena, California has opened a new permit center which accelerates the permitting process. A flexible software consolidates every step of the process via a user-friendly system. Customers also get a folder with material to guide them through the process. Builders can get plans, conditional permits, and fire department reviews and approvals at one desk. Staff training across departments means customers can get assistance from any employee at any step.

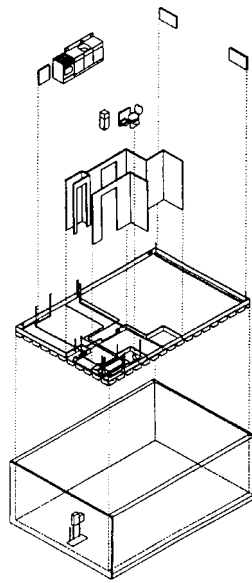


Figure 12. Open Building for Housing

OPEN BUILDING

A new approach to designing and constructing multi-family residential projects, implemented in several projects in the Netherlands, has had an airing at an exploratory workshop sponsored in May 1994 by Fannie Mae's Office of Housing Research (See Figure 12). Supporters of this approach expect reductions in project costs and risks without sacrifice of quality, with special implications for rehabilitation and renovation of future projects constructed under this approach.

In a typical new open building project a residential base building is designed and constructed to include structure, roof, facade, internal public areas, stairs, elevators if required, and base building mechanical, plumbing and electrical system risers and main feeds. A custom-designed dwelling unit fit-out is then constructed. This much of the concept is analogous to current office and shopping center development processes.

Integral to the concept is the idea of organizing fit-out packages for each dwelling offsite, and delivering the package of parts to complete the unit "just in time." Supporters believe that through carefully organizing the package, and since all work is entirely within the dwelling space, a 1,000 sq. ft. dwelling can be fitted out in five days. (This would appear to be problematic in view of the fact that 1,000 sq. ft. of office fit-out with its far simpler layouts and systems, customarily takes more than five days.) Supporters foresee residential fit-out providers producing the packages and small installation teams accompanying the containers to the site to complete the fit-out. Several such companies have appeared in the Netherlands.

Benefits are said to be:

- The developer can defer unit design and mix to meet market demand and give greater purchaser layout choices.
- The developer defers financing costs on individual units until sale or leasing.
- Construction is faster since the base building contractor has simplified site operations and approval processes.
- Future rehabilitation of any unit can be more easily accomplished since all elements of the unit—mechanical systems, drain lines, etc.—are contained within the unit and no disruption of building or adjacent units is involved.

HOME AUTOMATION

Thanks to advances in microchip technology, Home Automation (HA), after years of hoopla, has arrived in the consumer marketplace. It is now possible to program a home's operating systems "to create a silent, invisible valet," to control heating, cooling, lighting, security, entertainment systems, and more.

An HA system is generally defined as any device that controls three or more mechanical systems. According to Home Automation Associates, more than 20,000 HA system installations were performed in 1994.

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There are two broad categories of HA systems—dedicated systems and "powerline" technologies:

- Powerline technologies operate over existing electrical wiring and are usually the preference in the rehabilitation and retrofitting of existing homes since a considerable range of control options are available without the high costs of removing sections of walls or ceilings to re-wire with required loops of two-way co-axial cable (see electric wiring retrofit section).
- Dedicated systems with their own special wiring are more appropriate for "gut" rehabilitation and new construction.

Installing a powerline system involves replacing electric outlets, light switches, and selected circuit breakers or installing plug-in modules which can respond to commands from a central controller via the electric wiring. What occupants get is the ability to turn things on and off, dim lights, or control a thermostat. This system does not provide feedback or monitoring information or the ability to have two systems "talk" to each other; e.g., have a video camera at the front door send a signal to the TV screen. But the Electronic Industries Association, in alliance with consumer electronics manufacturers, plan to establish data transmission standards for "intelligent" appliances that will communicate with each other and a central control device over the home power grid, thus making similar automation features available to both new and older homes. Until then, consumers in older houses will be limited to home automation functions which can be controlled with on-off or up-down commands. However, with a computer, users can input a series of commands into a system control pack or keyboard and direct action during the day or in a vacation mode, switching on or dimming lights, turning down or up the heating system or the water heater, turning on the security system, and so forth. In addition, most systems permit modifying an established mode remotely using a touch-tone phone.

The Home Automation Association estimates the cost in 1995 of retrofitting a 2,500 square foot house with a basic powerline HA system at between \$1,000 and \$2,000. A basic powerline HA system would include lighting controls, motion detectors to turn lights on and off, dimmers, a programmable thermostat, and the capability of controlling some appliances.

Wiring a 2,500 square foot "gut" rehabilitation house or new house with dual coaxial lines and two 4-pair telephone cables plus speaker wire to every room would probably cost between \$5,000 and \$10,000 and provide the potential for a complex HA system to include interactive TV, controller units connecting appliances, and a stereo in every room controlled from anywhere in the house.

Dedicated system HA packages available from Smart House, Total Home, Unity Systems, and AMX Corporation range from \$3,000 to \$15,000. The \$15,000 package includes pre-wiring, central controller, security system, heating/cooling and lighting controls, and the ability to see who is at the front door on your TV. Other devices available include controlled sound systems, motorized drapes, touch-screen control panels, programmed lawn watering, and more.

Inexpensive ways already exist to "boost your domicile's IQ a few points," and these off-the-shelf devices have the biggest impact on energy cost savings. Examples are set-back thermostats that vary heating and cooling levels during various parts of the day and during vacation periods, available for \$20 to \$100; and motion-activated light switches that turn off lights in unoccupied rooms. The Home Automation Association can be contacted at (202) 333-8579.

VALUE ENGINEERING

When Value Engineering (VE) began during WWII it was concerned with identifying alternatives to scarce materials and products which would perform as well as the materials and products to be replaced. As the effectiveness of VE became more apparent its performance analysis approach was applied to construction—first in finding alternative products of equivalent performance and lower cost, and later to design alternatives. Now VE is sometimes applied to building programs. For the first time the State of Virginia Department of Transportation has used VE to identify where roads are to be built or expanded. This analysis of need is done in public hearings as the first step in a building program. The earlier in the building process VE is employed, the greater are the potential savings. The use of VE in programming renovation, rehabilitation, and repair projects could lead to economies without sacrificing performance quality. Information on value-engineered home construction can be obtained from the NAHB Research Center, (301) 249-4000.

ENERGY EFFICIENCY LABELING

Energy Efficiency Labeling of Residential Buildings

The increase in the residential remodeling market includes both single-family and multi-family dwellings, the growing public demand for environmentally sound products such as those that save energy, and the acceleration of the development of equipment with higher energy efficiency have brought new opportunities for electric utilities to implement demand side management. To help coordinate the utility industry role with the needs and perceptions of customers, the Edison Electric Institute and the USA electric industry has developed the E Seal Certification System.

The E Seal Certification System was developed as a means to express and categorize the various energy efficiency and environmental criteria and to measure a utility's residential program's compliance with the E Seal guidelines. This system provides participating utilities with the flexibility to structure their residential programs in the most effective manner to meet their customers' needs while ensuring a reasonable balance between energy efficiency and environmental features.

Energy efficiency and environmental features have been organized into modules and are divided into required features (which must be included) and optional features (which may be chosen at a utility's discretion). They are:

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Required Modules

- Energy Efficiency
- Renewable Energy
- Indoor Air Quality
- Home Waste Management
- Water Quality and Conservation
- Comfort, Safety, and Convenience
- Information

Optional Modules

- Energy and Load Management
- Construction Practices
- Transportation
- Home Site Evaluation
- Environmental Testing
- Home Operations
- Electric Service
- Custom Environmental
- Financing/Incentives



Figure 13. Energy Efficiency Label

E Seal has earned the support and praise of the U.S. Environmental Protection Agency, the U.S. Department of Energy, and other major industry, energy, and environmental allies. At present 30 utilities representing over 22 million customers are participating in the E Seal initiative. E Seal has established energy efficiency and environmental parameters at a higher level than any other national activity while still meeting workable realities in the marketplace.

E Seal objectives are to combine energy efficiency and environmental criteria into a system that allows qualifying utility home programs to:

- Provide homeowners and prospective homebuyers with packaged options for:
 - Improving efficiency and reducing operating costs,
 - Enhancing the internal environment of their new or existing home,
 - Contributing to the improvement of the global environment.
- Advance current residential building practices related to efficiency and environmental sensitivity.
- Provide utility residential trade allies (i.e., developers, builders, contractors, realtors, lenders) with added environmental value for the sale of homes to a growing customer base concerned about the environment.
- Demonstrate the connection between energy efficiency and environmental benefits.

- Demonstrate the environmental benefits of electric technologies and link the benefits of non-fuel related environmental measures with efficient energy use at the individual home level.
- Allow participating utilities to offer value-added customer services such as enhancing housing affordability through energy efficiency financing, and strengthen the environmental position of the electric industry.

The E Seal certification system (E Seal) demonstrates an industry-wide commitment among electric utilities in addressing energy efficient and environmental needs and opportunities. E Seal provides residential customers across the United States with a nationally credible initiative that offers the first real understanding of how to contribute significantly to a cleaner, more efficient environment based on housing choices.

E Seal is the first national industry consensus initiative that merges energy efficiency and environmental criteria into a certification process for both utility new home construction and retrofit programs.

E Seal utilities can now offer the benefits of electric energy efficiency to owners of existing homes, as well as buyers of new homes. With a new E Seal Loan Program, qualifying homeowners can obtain long-term loans at competitive fixed interest rates to finance the cost of new, highly efficient HVAC Equipment. Edison Electric Institute has signed an agreement with Environmental Financial Services of Richmond, VA to implement the E Seal Loan Program. E Seal participants will be able to save money by forming "pools" to meet the program's minimum loan commitment and to take advantage of slightly lower interest rates. For more information, contact the Edison Electric Institute at (202) 508-5000.

Model Energy Code Thermal Envelope Compliance Guide. The National Building Code published by the Building Officials and Code Administrators (BOCA) International, Inc. includes in Section 1305.0 a specific reference to the 1993 CABO Model Energy Code (MEC) as an alternative means for establishing the thermal performance of the exterior envelope. Through this action, states that adopt this code will be in compliance with the requirements of the Energy Policy Act of 1992 and will also assure that homeowners in the state seeking financing for housing through mortgages insured, guaranteed, or made by Federal Government programs meet the energy requirements of the CABO MEC referenced by those programs.

The 1993 CABO MEC allows flexibility and encourages innovation by stating requirements in terms of envelope component performance and by allowing trade-offs between components (ceilings, walls, and floors). Since an infinite number of designs and construction strategies could be employed to satisfy the code, many in the building community want specific guidance in identifying some of those strategies.

The state-specific compliance guide presents an easy-to-use trade-off worksheet to be submitted to code enforcement authorities to demonstrate compliance with the MEC. The worksheet is applicable

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to both detached one- and two-family dwellings and multi-family buildings three stories or less in height. Tables that provide pre-calculated thermal performance of common building assemblies expressed in R-values assist users in completing the worksheet. The worksheet is intended to be completed for each design and submitted as evidence of compliance with the MEC. The MEC is available directly from CABO at (703) 931-4533.

PRODUCTIVITY/REHABILITATION/COSTS

Productivity in Residential Construction: An Annotated Bibliography, is a 1981 publication of the National Institute of Standards and Technology which is available from the Department of Commerce National Technical Information Service. For housing it presents a state-of-the-art review of the technical literature related to productivity concepts and measurement, construction productivity, residential rehabilitation/renovation, construction/housing costs, construction cost estimating and control, the economics of construction, and building codes and regulation. Abstracts of 93 articles and papers are included with source information about where the articles and papers may be obtained in full.

The single topic of greatest interest was concerned with how one can identify the factors affecting productivity and measure their differential impact. Such issues as building regulations, management expertise, job size, training, crew composition, method of financing, quality of materials, equipment, and the work environment all exert some influence on the productivity of the factor inputs.

APPENDIX

TRADE AND PROFESSIONAL ORGANIZATIONS RESEARCHED

American Architectural
Manufacturers Association
(708) 202-1350

American Consulting
Engineers Council
(202) 347-7474

American Concrete Institute
(313) 532-2600

American Gas Association
(703) 841-8400

American Institute of Architects
(202) 626-7300

American Institute of
Steel Construction
(312) 670-2400

Air-Conditioning and
Refrigeration Institute
(703) 524-8800

American Solar Energy Society
(303) 443-3130

American Society of Heating,
Refrigerating and Air
Conditioning Engineers, Inc.
(404) 636-8400

Brick Institute of America
(703) 620-0010

Ceilings and Interior Systems
Construction Association
(708) 833-1919

Door and Hardware Institute
(703) 222-2010

Edison Electric Institute
(202) 508-5000

Electronic Industries Association
Consumer Electronics Group
(202) 457-8700

Exterior Insulation
Manufacturers Association
(202) 783-6582

Home Automation Association
(202) 333-8579

Illuminating Engineering Society
of North America
(212) 705-7926

International Masonry Institute
(202) 783-3908

Kitchen Cabinet Manufacturers
Association
(703) 264-1690

Mason Contractors Association
(708) 782-6767

National Association of Plumbing-
Heating-Cooling Contractors
(703) 237-8100

National Concrete Masonry
Association
(703) 713-1900

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National Forest Products Association
(202) 463-2700

National Glass Association
(703) 442-4890

National Insulation and Abatement
Contractors Association
(703) 683-6422

National Paint and Coating
Association
(202) 462-6272

National Roofing Contractors
Association
(708) 299-9070

National Stone Association
(202) 342-1100

National Wood Flooring
Association
(314) 391-5161

National Wood Window and Door
Association
(708) 299-5200

North American Insulation
Manufacturers Association
(703) 684-0084

Plastics Institute of America, Inc.
(201) 808-5950

Society of American Value Engineers
(202) 347-8998

Society of the Plastics Industry
(202) 371-5200

Wood & Synthetic Flooring
Institute
(708) 449-2933

World Floor Covering Association
(714) 978-6440

PERIODICALS RESEARCHED

A/E/C Systems, Computer Solutions: July/August 1995

Architectural Record: December 1994, January - August 1995

Architectural Specifier: July/August 1995

Better Roads: May 1993

Builder: April 1995 - August 1995

CNA/Schinnerer Liability Update: June 1995

Construction Innovations: National Research Council, Canada: July 1995

ENR: August 1995

Glass Magazine (National Glass Association): August 1995

High Performance Composites: September/October 1993

Masonry Construction: August 1995

NIST Building and Fire Research Laboratory Research Update, Spring 1995

Progressive Architecture: January - May 1995

The Military Engineer: August-September 1995

Universal Design: July 1995

Walls and Ceilings: May - July 1995

Washington Post, Fast Forward: June 1995

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PUBLICATIONS, GENERAL

An Exploratory Discussion on Open Building, Background Papers, May 3, 1994, Fannie Mae, Office of Housing Research

CEBUS Backgrounder Document
Electronics Industry Association, Consumer Electronics Group

GE Lighting
General Electric Company

Model Energy Code, 1993 Edition, June 1995 Ohio Version
North American Insulation Manufacturers Association

Sweet's Engineering & Retrofit Mechanical, Electrical, Civil/Structural Catalogue File, 1995,
Volumes 1, 2, and 3

Window Innovations '95, Conference Proceedings, World Conference on State-of-the-Art Window
Technology, Toronto, Canada, June 1995

MANUFACTURERS AND FABRICATORS

Dryvit Systems, Inc.
West Warwick, RI

Fibertock Technologies, Inc.
Cambridge, MA

General Electric Company
Cleveland, OH

Golden Flue
Ruther Glen, VA

Hartman Company
Ansbach, Germany

Hexcel Fyfe Company
Del Mar, CA

Smart House
Upper Marlboro, MD

Solid Flue
Grand Rapids, MI

Studor, Inc.
Dunedin, FL

Thoman-Hanry, Inc.
New York, NY

Owens-Corning, Inc.
Toledo, OH

**RENOVATION AND REHABILITATION NEW TECHNOLOGY
SOURCES QUESTIONNAIRE**

INTERVIEWEE

Organization

Phone _____

Person Interviewed

Date

SUBJECT(S)

- 1.0 Processes
- 1.1 Condition Surveying,
Testing & Diagnosing
- 1.2 Programming &
Planning
- 1.3 Designing
- 1.4 Engineering
- 1.5 Specifying
- 1.6 Contract Conditions
- 1.7 Cost Estimating
- 1.8 Bidding/Contracting
- 1.9 Administering
Contracts and
Observing Work
- 1.10 Demolishing
- 1.11 Manufacturing and
Fabricating
- 1.12 Transporting

APPENDIX

- 1.13 Storing_____
- 1.14 Laying Out_____
- 1.15 Installing & Erecting_____
- 1.16 Applying & Finishing_____
- 1.17 Maintaining_____
- 2.0 Materials & Products
- 2.1 Exterior
 - Foundation_____
 - Structure_____
 - Exterior Wall_____
 - Roofing_____
 - Windows_____
 - Doors_____
 - Insulation_____
 - Vapor Barriers_____
 - Flashing_____
 - Sealants_____
- 2.2 Interior
 - Walls_____
 - Floors_____
 - Ceilings_____
 - Doors_____
 - Cabinetry_____
 - Stairs_____
 - Coatings_____
- 2.3 Elevators_____
- 2.4 Mechanical
 - HVAC
 - Heating_____
 - Cooling_____
 - Ventilating_____
 - Domestic Hot Water_____
 - Plumbing
 - Drain Waste
 - Vent _____
 - Water Supply_____
 - Fixtures/
Appliances_____
 - Gas Distribution_____
- 2.5 Electrical
 - Distribution_____
 - Devices_____

- Luminaires _____
- 2.6 Fire Protection
 - Detection _____
 - Suppression _____
- 2.7 Safety - Security _____
- 2.8 Hazard Abatement _____
- 3.0 Construction
Equipment _____

BENEFITS

- 1.0 Cost _____

- 2.0 Time _____

- 3.0 Quality _____

INFORMATION SOURCE(S)

**RENOVATION AND REHABILITATION
NEW TECHNOLOGY QUESTIONNAIRE**

INTERVIEWEE

Organization

Person Interviewed

Phone

Date

SUBJECT(S)

USE(S)

DESCRIPTION

APPENDIX

APPLICABILITY

1.0 Geographic

2.0 Building Type(s)

3.0 Market Sector(s)

4.0 Environmental
Condition(s)

5.0 Scale/Quantity

AVAILABILITY

COST

PARTICIPANT(S)/SKILL(S)

1.0 Architects

2.0 Engineers

3.0 General Contractors/
Builders

4.0 Specialty Contractors

5.0 Manufacturers/
Fabricators

BENEFITS

1.0 Cost

2.0 Time

3.0 Quality

**ANNOTATED BIBLIOGRAPHY FROM COST-SAVING
CONSTRUCTION OPPORTUNITIES AND THE HOME PROGRAM*****Affordable Housing Challenge and Response:***

Volume 1: Affordable Residential Land Development, HUD #5039 \$4.00

Volume 2: Affordable Residential Construction, HUD #5051 \$4.00

Presents findings of HUD-sponsored Joint Venture for Affordable Housing (JVAH), a program designed to demonstrate cost-saving techniques in actual subdivisions nationwide. The publication includes all phases of housing production: land planning, site layout, land development, on-site infrastructure installation, and house construction. Illustrations and documented cost-savings accompany the text.

Affordable Housing: Development Guidelines for State and Local Government, HUD #5940 \$4.00

Presents technical guidance and information to State and local governments to reform their regulatory systems to encourage provision of affordable housing. Focuses on land development techniques, construction practices and building codes, zoning provisions, and subdivision requirements and offers suggested ordinances and code language.

Alternatives to Lumber and Plywood in Home Construction, HUD #6135 \$4.00

Identifies several alternative materials or building systems that can be used in residential construction under most current building codes, as well as emerging technologies that will be commercially available in the near future.

Applying Cost Effective Energy Conservation Standards (CEECS) in Rehabilitation Projects, HUD #2778 \$10.00 (reproduction copy)

Energy conservation measures that may/must be undertaken during residential rehabilitation. Describes standards and discusses their use in single and multifamily buildings.

Energy Conservation for Housing, HUD #2651 \$25.00

A workbook designed to assess existing energy consumption and energy conservation potential in public housing. Applicable to all multifamily housing. Useful for energy audits.

Energy Conservation and Housing Rehabilitation Under the HOME Program,

The American Communities Information Center, P.O. Box 7189, Gaithersburg, MD 20898-7189, 1-800-998-9999.

Frost-Protected Shallow Foundations in Residential Construction—Phase I, HUD #6143 (unpublished report) \$15.00

Presents an investigation and demonstration of frost-protected shallow foundations in homes, including cost-effectiveness of the technology and design and construction guidance for builders, designers, and code officials.

Home Building Cost Cuts: Construction Methods and Materials for Affordable Housing, HUD #2930 \$4.00

Loose-leaf bulletins documenting cost-effective techniques in residential design, materials research and usage, and construction methods.

Housing Quality Standards (HQS) (two video tapes), HUD #5353 \$60.00

Provides training for public housing agency staff, housing managers, and inspectors in Housing Quality Standards (HQS) of the Section 8 Existing Housing Program to provide affordable housing for low-income families. (All units, new or rehabilitated, must meet the HQS before occupancy.)

Innovative Site Utilities, HUD #3159 (reproduction copy) \$10.00

Identifies and describes both practical and innovative cost-saving methods and materials that are being used across the country to reduce site utility costs for residential development.

Making Rental Housing Energy Efficient: Guide to Performing Energy Retrofit During Multifamily Property Rehabilitation, HUD #5650 \$4.00

Model Energy Code Compliance Procedures (MECCP) Version 1.0, HUD #5904 \$20.00

Computer software package and accompanying user guide automates procedures for determining if a building design meets the provisions of the model energy code (MEC).

Proposed Model Land Development Standards and Accompanying Model State Enabling Legislation, HUD #6212 \$4.00

Presents detailed minimum standards and specifications that can be incorporated into local development ordinances. Includes streets, stormwater management, sediment and erosion control, site utilities, sanitary sewage, water supply standards, and model enabling legislation. Illustrated.

Recirculating Sand Filter Septic Systems, Report to HUD available Fall 1994.

Presents design, performance, and results of three sand filter demonstration sites.

Rehabilitation Guidelines

An 11-volume set addressing upgrade and conservation of nation's building stock. The following volumes include cost-saving techniques that can be applied during rehabilitation.

Volume 6: Electrical Guidelines for Residential Rehabilitation, HUD #50788
\$4.00

Chicago, IL 60637-2891
312-955-9100

Volume 7: Plumbing DWV Guideline for Residential Rehabilitation, HUD #50789
\$4.00

Volume 9: Guideline for Structural Assessment, HUD #2958 \$4.00

Volume 10: Guideline for Rehabilitation of Walls, Windows, and Roofs.
HUD #2959 \$4.00

Automated Builder Dictionary/Encyclopedia of Industrialized Housing,

Don O. Olson, editor, 1991, \$15.00

Provides a comprehensive introduction to industrialized housing (panelized, modular, and HUD-Code units). Includes definitions, materials, tools, engineering principles, unit designs and components, and production processes. Available from:

Automated Builder Magazine
Publications Division
P.O. Box 120
Carpinteris, CA 93014
805-684-7659

Stemwall Foundations for Residential Construction, HUD #6134 (unpublished report) \$10.00

Addresses design and demonstration of monolithic stemwall foundations for basement, split-level, and crawlspace homes. The following publications provide additional information on cost-saving technologies for affordable housing that have been discussed in this HOME model program. They are readily available from the noted sources.

Affordable Single-Family Housing—A Review of Development Standards, American Planning Association (APA), 1984, #PAS 385, \$30.00

Discusses land-use strategies for affordable housing and their effectiveness in 13 communities. Includes parking, outdoor space, and privacy issues. Available from:

American Planning Association
Planners Bookstore
1313 E. 60th Street

Model Energy Code: Thermal Envelope Compliance Guide for One and Two Family Dwellings, North American Insulation Manufacturers' Association, November 1993, #B1407 \$10.00

Presents easy-to-use energy application and trade-off worksheets, with expected performance of numerous component constructions to enable users to determine MEC compliance. Includes discussions of energy use, materials selection, and building design. Available from:

North American Insulation Manufacturers Association
44 Canal Center Plaza Suite 310
Alexandria, VA 22314
703-684-0084

APPENDIX

The Cost Cuts Manual: Nailing Down Savings for Least-Cost Housing—164 Ideas for Saving Money in Rehabilitation,

Enterprise Foundation Rehab Work Group, 1987 \$25.00

Presents resourceful, effective approaches to low-cost rehabilitation that can be used by public and private sectors. Includes acquiring property cheaply, designing-out unneeded rehab, construction methods and materials, efficient management, and labor-saving methods. The Enterprise Foundation also produces loose-leaf style *Cost Cuts* tips several times annually to provide additional information on reducing construction costs in low-income housing and rehabilitation. Available from:

The Enterprise Foundation Rehab Work Group
500 American City Building
Columbia, MD 21044
301-964-1230

Cost-Effective Home Building: A Design and Construction Handbook, NAHB Research Center, 1994 \$10.00

Presents Optimum Value Engineering (OVE) approach to design and construction. Includes revised strength and span lumber tables, metric conversions, and new technologies. Available from:

NAHB Research Center
400 Prince Georges Blvd.
Upper Marlboro, MD 20772
301-249-4000

Cost-Effective Site Planning, National Association of Home Builders (NAHB), 1986, #ISBN O-86718-270-9 \$23.50

Discusses making higher density housing fit any community. Includes sample site plans and solutions for problems caused by increased density. Available from:

Home Builders Bookstore
National Association of Home Builders
1201 15th Street, NW
Washington, DC 20005
1-800-223-2665 or 202-822-0463

Design Manual, On-site Wastewater Treatment and Disposal Systems, U.S. Environmental Protection Agency (EPA), 1980

Provides technical information on on-site waste-water treatment and disposal systems. It does not include standards, rules, or regulations regarding the systems. Available from:

National Small Flows Clearinghouse
(pub. #WWBKDM35 \$31.30)
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
1-800-624-8301

National Technical Information Service
(#PB83219907 \$52.00)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Energy Conservation Technical Information Guide, vol. 3: Residential Buildings, Department of Energy, 1989.

Focuses on structural elements and mechanical elements that conserve energy. Topics range from energy-efficient walls and windows, to high performance heating systems and energy-conserving appliances. Available from:

National Technical Information Service
(DE89009468 \$27.00)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Land-Use Regulations Handbook, National Institute of Building Sciences, 1990, #5063-4, \$10.00

Presents land-use guidelines for affordable housing including strategies for zoning, density, and land development. Includes appendix of basic terminology and processes used in land development regulation. Available from:

National Institute of Building Sciences
(NIBS)
1201 L Street, NW
Washington, DC 20005

PUDs in Practice, Urban Land Institute (ULI), 1985, #P36 \$36.00

Discusses design and regulatory elements of planned unit developments (PUDs), including PUD ordinance language, development process, and review and approval process. Illustrated by five case studies. Available from:

Urban Land Institute
Publication Orders
625 Indiana Avenue, NW
Washington, DC 20004-2930
1-800-321-5011 or 202-624-7142

Residential Streets, 2nd edition, American Society of Civil Engineers (ASCE), Urban Land Institute (ULI), and National Association of Home Builders (NAHB), 1990 Differentiates street types by function and recommends design and construction guidelines. Available from:

Urban Land Institute #R07 \$23.00
625 Indiana Avenue, NW
Washington, DC 20004-2930
or

National Association of Home Builders
#ISBN O-86718-341-1 \$23.00
1201 15th Street, NW
Washington, DC 20005

Small Wastewater Systems—Alternative Systems for Small Communities and Rural Areas, EPA. (pamphlet) Available from:

Small Flows Clearinghouse
(#WWBLPE02 Free)

or
National Center for Environmental Publications and Information (NCEPI)
Free
11029 Kenwood Road
Cincinnati, OH 45242
513-891-6561

APPENDIX

Truss-Framed Construction, NAHB Research Center and U.S. Forest Products Laboratory, 1982 \$5.00

Covers essentials of technique that integrates roof trusses, floor trusses, and wall studs into unified frames. Includes design, fabrication, and erection. Available from NAHB Research Center.

Publications and other documents produced by various U.S. government departments/agencies can be located through the following sources:

National Center for Environmental Publications and Information (NCEPI)

Dissemination center for all EPA publications. Call 513-569-6685

National Technical Information Service (NTIS)

Dissemination of government technical publications. Provides subject bibliography and price list, fills publications orders:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

FED WORLD

On-line publication service for NTIS
Call 703-321-8020
Via internet telenet Fedworld.Gov

Government Printing Office (GPO)

Call 202-783-3238 to locate library in your area that is a full depository of GPO documents. Orders can be placed through:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9325
202-783-3238

**ENERGY CONSERVATION PROGRAM RESOURCES
FROM ENERGY CONSERVATION AND HOUSING REHABILITATION
UNDER THE HOME PROGRAM****Alliance to Save Energy****1725 K Street, NW, Suite 509, Washington, DC 20006**

The Alliance to Save Energy is a nonprofit coalition of business, government, environmental, and consumer leaders dedicated to increasing the efficiency of energy use. It conducts research, pilot projects, and education programs, and produces a number of guidebooks on energy efficiency programs.

American Council for an Energy-Efficient Economy (ACEEE)**2140 Shattuck Avenue, Suite 202, Berkeley, CA 94604****1001 Connecticut Avenue, NW, Suite 801, Washington, DC 20036**

ACEEE is a nonprofit organization that gathers, evaluates, and disseminates information to stimulate greater energy efficiency. It conducts studies, publishes books and reports, provides expert testimony, organizes conferences to facilitate the exchange of information, and produces an annual publications catalogue.

Association of Home Appliance Manufacturers**20 North Wacker Drive, Chicago, IL 60606**

The Association produces the *Consumers Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment*, a directory of certified unitary air-conditioners, unitary air-source heat pumps, and sound-rated unitary equipment, a consumer selection guide for refrigerators and freezers, and a directory of certified refrigerators and freezers.

Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS)**P.O. Box 3048, Merrifield, VA 22116**

CAREIRS provides information fact sheets on appliance labeling, windows, insulation, energy-efficient lighting, heat pumps, and other heating equipment such as automatic and programmable thermostats. It also produces other fact sheets, bibliographies, and contacts for conservation and renewable energy measures and products.

Local Electric and Gas Utility Companies

Public utility companies can assist with utility bill interpretation and analysis. They sponsor rebate and other incentive programs, provide technical assistance and guides on energy conservation, and maintain lists of qualified heating contractors.

APPENDIX

State and Local Government Energy Offices, Housing Finance Agencies, Weatherization Agencies, and Code Officials

These agencies generally offer weatherization, home energy assistance, and energy-efficiency programs, including energy-efficient mortgage lending. They can also provide local/State energy conservation with advise and guides. Code officials have information on building codes as they relate to energy conservation measures.

U.S. Department of Energy

Energy Conservation Program Division

State Energy Conservation Program

Weatherization Assistance Program Division

Forrestal Building, 1000 Independence Avenue, SW, Washington, DC 20585

The Energy Conservation Program performs activities to stimulate the development of energy-efficient technology through support of research, exploratory development, engineering feasibility studies, and pilot-scale evaluations. It also conducts data analysis, technology assessments, model development, and consumer information dissemination. The State Energy Conservation Program provides funding and technical assistance to States in support of State and local energy conservation programs. The Weatherization Assistance Program Division provides funding for weatherization activities. The DOE can provide the following resources:

- **DOE Insulation Fact Sheet.** This publication gives detailed information on the uses of insulation in the home, and includes a chart to determine insulation recommendations based on postal ZIP code.
- **Reports on the ZIP computer program.** The ZIP program allows for a more in-depth analysis of a particular building and includes options for entering local fuel costs. The two reports are:

ZIP - The ZIP-Code Insulation Program, Version 1.0: Economic Insulation Levels for New and Existing Houses by Three-Digit ZIP Code: Users' Guide and Reference Manual, by Stephen R. Petersen, ORNL/TM- 1009, NISTIR 88-3801, Oak Ridge National Laboratory, Oak Ridge, Tennessee (January 1989).

Contact: (615) 576-5454

ZIP - The ZIP-Code Insulation Program, Version 2.0: Economic Insulation Levels for New and Existing Houses by Three-Digit Zip Code: Users' Guide and Reference Manual (Revised edition), by Stephen R. Petersen, NISTIR 88-3801-1, U.S. Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD (January 1991). Contract: (301) 975-2000

- **DOE Attic Radiant Barrier Fact Sheet.** This fact sheet explains radiant barriers and how they work. The series of tables provided in this publication are designed to help readers determine whether adding a radiant barrier is cost-effective. The tables are based on national average fuel costs and average heating and cooling equipment efficiencies; a worksheet is provided so that readers can use their own fuel costs and efficiencies if they differ from the values assumed in the tables.
- **DOE Weatherization Installation Standards.** This booklet provides detailed information on insulation materials and methods of installation in ceilings, walls, and floors, and includes many sketches to help readers specify and inspect insulation jobs.
- **DOE Computerized Energy Audit.** DOE has developed a national energy audit for the Weatherization Assistance Program that is extremely useful in planning energy upgrades. The audit may be used on a portable computer that can be taken along during an inspection of a housing project and used later at the office. The audit's user-friendly screens let users enter much of the information discussed above concerning building envelope areas and existing levels of insulation. The computer program performs a series of calculations to make recommendations on what levels (if any) of insulation should be added to each of the envelope components. In addition to insulation, the program also includes recommendations on heating systems. The final output of the program is a prioritized list of energy improvements and a list of materials needed. Using this program eliminates the need for many calculations of the energy savings due to adding insulation and calculating payback periods.

The program can be obtained by contacting:

Ms. Veronica Johnson
EE-532
U.S. Department of Energy
Weatherization Assistance Program

The source of some of these citations is *Eye on Energy: Rehab for All Seasons*, U.S. Department of Energy and U.S. Department of Housing and Urban Development, 1992. An *Eye on Energy* video and companion guide will be completed and made available through HUD's Office of Environment and Energy in spring 1994.