

The reHABITAT Guide: For Energy- and Resource-Efficient Retrofit Strategies

February 2003–February 2004



Consortium for Advanced Residential Buildings
Norwalk, Connecticut

Prepared under Subcontract No. KAAX-3-33411-00



The reHABITAT Guide: For Energy- and Resource-Efficient Retrofit Strategies

Consortium for Advanced Residential Buildings
Norwalk, Connecticut

NREL Technical Monitor: M. Eastment

Prepared under Subcontract No. KAAX-3-33411-00



NREL

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: <mailto:reports@adonis.osti.gov>

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/ordering.htm>



The reHABITAT Guide For Energy- and Resource-Efficient Retrofit Strategies

Prepared for:

Habitat for Humanity International

Prepared by:

Steven Winter Associates, Inc.

Building Systems Consultants

Norwalk, Connecticut

and

The Consortium for Advanced Residential Buildings (CARB)

A Building America team member

Funding Provided by:

The U.S. Department of Energy's Building America Existing Homes Program

Terry Logee

Project Manager

CREDITS

STEVEN WINTER ASSOCIATES, INC. STAFF MEMBERS WHO WERE INSTRUMENTAL IN THE DEVELOPMENT AND PRODUCTION OF THIS GUIDEBOOK INCLUDE:

Steven Winter

Principal-in-charge

Ric Guilbert

Project Manager

Dianne Griffiths

Amanda Magee

Peter A. Stratton

Bambi Tran

Project Team

Harold Bravo

Jack Heaney

Graphics

Michael J. Crosbie

Editor-in-chief

Steven Winter Associates, Inc. would like to thank Chesapeake Habitat for Humanity and Habitat for Humanity Philadelphia for their contribution to this guide. A special thank you is extended to Habitat for Humanity of Greater Newburgh (HFGN), Deirdre Glenn, Executive Director, for their contribution to this publication.

TABLE OF CONTENTS

INTRODUCTION	1
INCENTIVE PROGRAMS.....	1
HABITAT FOR HUMANITY INTERNATIONAL NATIONAL PARTNERS	2
"WHOLE BUILDING" APPROACH.....	2
CHAPTER ONE: THE ENERGY- AND RESOURCE-EFFICIENT RETROFIT	
PROCESS	3
PROJECT DEVELOPMENT (PLANNING/PROGRAMMING).....	3
SITE SELECTION.....	4
DESIGN DEVELOPMENT	4
CONSTRUCTION & INSPECTIONS	6
CLOSING.....	7
CHAPTER TWO: HEALTH CONCERNS, HISTORIC CONSIDERATIONS, AND	
ACCESSIBILITY	8
HEALTH CONCERNS.....	8
Lead-Based Paint.....	8
Asbestos.....	8
Radon	9
Mold and Moisture.....	9
Carbon Monoxide	9
HISTORIC CONSIDERATIONS.....	10
ACCESSIBILITY	10
CHAPTER THREE: DURABILITY	12
SITE	12
Evaluate Site Grades, Soil Condition, and Adjacent Sites.....	12
Modify Site Grades and Soil Condition and Address Other Site-	
Related Conditions.....	12
OTHER SITE-RELATED CONDITIONS	13
Site Drains	13
Adjacent Patios and Walks.....	13
Porches.....	13
Debris and Other Material.....	13
FOUNDATION.....	14
Evaluate Foundation Walls and Address Potential Damage Appropriately.....	14
Remove Overgrown Vegetation.....	15
FINISHES (EXTERIOR & INTERIOR).....	16
Exterior Finishes	16
Interior Finishes.....	16

TABLE OF CONTENTS (continued)

CHAPTER FOUR: ENERGY- AND RESOURCE-EFFICIENT RETROFIT STRATEGIES	19
FRAMING (EXTERIOR AND INTERIOR) AND ROOFING.....	19
Evaluate Framing.....	19
Evaluate Roofing.....	20
Energy- and Resource-Efficient Strategies	20
WINDOWS.....	24
Energy- and Resource-Efficient Strategies	25
INSULATION & AIR SEALING	26
Energy- and Resource-Efficient Strategies	27
SPACE AND WATER HEATING	30
Energy- and Resource-Efficient Strategies	31
MECHANICAL VENTILATION.....	32
Local Exhaust.....	32
Clothes Dryers	32
Whole-Building Ventilation	33
LIGHTING AND APPLIANCES.....	34
Energy- and Resource-Efficient Strategies	34
PLUMBING & PLUMBING FIXTURES	35
Energy- and Resource-Efficient Strategies	37
RESOURCES.....	39
APPENDICES	
APPENDIX A: Habitat for Humanity National Partners	
APPENDIX B: Rehab Workshop Handout	
APPENDIX C: Rehab Inspection Report	

Introduction

The reHABITAT Guide for Energy- and Resource-Efficient Retrofit Strategies seeks to advance the goal of the U.S. Department of Energy's Existing Residential Buildings Program (ERBP): to develop approaches that will enable the housing retrofit industry to deliver energy-efficient housing improvements and to ensure that energy-efficient retrofit technologies incorporated into projects are viable over conventional approaches. This guide was developed for Habitat for Humanity International and is the result of lessons learned from demonstration retrofit projects undertaken by Habitat for Humanity affiliates in Newburgh, New York; Baltimore, Maryland; and Philadelphia, Pennsylvania; with building systems consulting and technical assistance provided by Steven Winter Associates, Inc. (SWA).

The demonstration projects used as a model for this guide were brick infill homes located in historic districts in urban areas. The model homes were attached or semi-attached brick rowhouses with low-sloping roofs. In each case, the homes had hydronic heating systems and did not require cooling. Since the demonstration projects are examples of housing typically found in the Northeast and Middle Atlantic region of the country, lessons learned and retrofit strategies indicated may not be appropriate for housing in other parts of the country. The guide is the first step toward a dialogue on the benefits and importance of energy and resource efficiency in rehab projects and serves as a tool to educate Habitat construction managers and subcontractors.

While the focus of this guide is on energy- and resource-efficient retrofit strategies, other issues related to rehab work are also discussed, including health concerns, historic requirements, accessibility for people with disabilities, and durability.

Retrofit strategies suggested by SWA and implemented by Habitat for Humanity affiliates have demonstrated an increase in overall value and quality, while significantly reducing energy consumption and raw materials. This translates into significant savings on energy for homeowners, providing more funds to dedicate toward other living expenses. This guide recommends retrofit strategies to help achieve energy efficiency at a low first-cost, while reducing maintenance and other life-cycle costs.

INCENTIVE PROGRAMS

Since Habitat for Humanity is a non-profit organization developing affordable housing, keeping the first-cost low for rehab and new construction projects is critical. To help offset the cost of upgrading certain systems and features, federal, state, and utility programs are available that offer incentives, rebates, or tax credits for energy-efficient retrofit and new construction. For example, for the Newburgh demonstration project, New York State ENERGYSTAR Certification (NYES) was pursued, which provides incentives for incorporating higher standards of building performance into new construction and gut rehab projects (Fig. 1). The NYES program, like other incentive programs, requires third-party testing at the completion of each home to ensure that performance goals are met. Based on the NYES performance requirements, the overall goal of the Newburgh demonstration



Fig.1: ENERGYSTAR Logo

retrofit projects was to achieve a 30% reduction in energy use compared to a retrofit project of the same type built to the requirements of the 1995 Model Energy Code. Other states provide incentive programs similar to the NYES program. State energy offices are the best source of information for federal, state, and utility incentive programs. Consult the Resources section of this guide for a link to a list of state energy offices.

HABITAT FOR HUMANITY INTERNATIONAL NATIONAL PARTNERS

Habitat for Humanity International has developed national teaming relationships with a number of product manufacturers and suppliers. These partnerships provide Habitat for Humanity with free or discounted materials to keep first-cost low. The demonstration projects used as a model for this guide incorporate products and materials from those national partners. Whenever a strategy, technique, or material is recommended in this guide, consult Appendix A for a listing of national partners to contact for product availability. When products are not available from the national partners, local businesses are typically the most affordable source for products. Consult the local Habitat office for a list of locally available products.

A “one-stop shop for Habitat information” is available at www.partneret.habitat.org. Among other information, this Web site contains links to helpful information related to Habitat rehab projects, including the listing of national partners, which can also be found in Appendix A. It is recommended that, in addition to consulting Appendix A, users of this guide consult the national partners list provided on the Web site for the most up-to-date information. Consult the Resources section of this guide for instructions on how to obtain the rehab resources available on PartnerNet.

“WHOLE BUILDING” APPROACH

This guide features affordable, innovative, and “volunteer friendly” strategies and technologies. Whenever possible, these strategies should be used with a “whole building” approach. This approach is based on the principle that the components and systems of a house are interdependent – one component or system positively (or adversely) affects another. For example, sealing gaps in the home to prevent uncontrolled air infiltration is a necessary part of retrofitting for energy efficiency. Air infiltration cannot be relied upon for fresh air ventilation because it is highly variable and unpredictable. In fact, infiltration rates are highest when it is cold and windy, causing a significant energy penalty. To help ensure good indoor air quality with the introduction of fresh outside air, it is important to complement air sealing measures with a controlled mechanical ventilation system. The interdependence between air-sealing and mechanical ventilation is one example of the “whole building” approach and is an important part of energy efficiency. Consult the Resources section of this guide for links to information about the “whole building” approach.

CHAPTER ONE: The Energy- And Resource-Efficient Retrofit Process

Rehab housing projects differ from new construction in small but significant ways. For rehab projects, the design and construction team must deal with fixed constraints, such as the home's site, orientation, massing, and basic structural systems. Older homes in particular make excellent candidates for energy-efficient upgrades. Far less energy and fewer resources are needed to rehab a home whose shell is being reused. Also, by taking advantage of their older construction, higher ceilings, and narrower width, these buildings can be transformed into comfortable, healthy, affordable, energy-efficient, durable homes using basic guidelines and innovative technologies.

To begin the energy- and resource-efficient retrofit process, the application of integrated design— or “whole building” design—is needed in order to produce a solution that is greater than the sum of its parts.

The list below includes recommended practices to optimize an energy- and resource-efficient retrofit project. The “whole building” energy- and resource-efficient retrofit process begins long before any demolition or re-construction work takes place. Careful planning, which involves inspecting and evaluating existing conditions, affects the ultimate quality of the project.

PROJECT DEVELOPMENT (PLANNING/PROGRAMMING)

- Clarify goals for the Habitat home.
- Develop Habitat affiliate's standards for decent, affordable, and low-maintenance homes, including energy- and resource-efficiency. Use the standards when evaluating potential project costs (refer to the Rehab Workshop Handout provided in Appendix B. This handout is also available on www.partnet.net.habitat.org. Consult the Resources section of this guide for instructions on how to obtain the handout from PartnerNet).
- Review local building codes, zoning ordinances, and other applicable federal, state, and local regulations that may affect the project, such as historic considerations and accessibility (refer to Chapter Two: Health Concerns, Historic Considerations, and Accessibility for information on historic considerations and accessibility). Local building departments are the best resource for applicable codes and laws.
- Develop a project schedule and budget. Secure financing as soon as possible.
- Take advantage of federal, state (such as the New York State ENERGYSTAR program), and local programs, which could provide incentives, rebates, or tax credits for energy upgrades. State energy offices are the best resource for federal, state, and utility programs. Consult the Resources section for a link to a list of state energy offices.
- Conduct frequent marketing and outreach efforts during the project. This will help to raise awareness among community members, officials, future homeowners, and other organizations that might be a potential funding source.
- Assess the availability, skill, and limitations of volunteer labor.

SITE SELECTION

- Conduct a preliminary site inspection and evaluation based on your affiliate’s standards. Use Habitat for Humanity International’s Rehab Inspection Report (provided in Appendix C and also available on www.partnernet.habitat.org) as a guide for inspections. Consult the Resources section of this guide for instructions on how to obtain the inspection report from PartnerNet. Local Habitat affiliates may have their own inspection reports.
- Develop potential rehab costs for comparison with other homes under consideration to determine project feasibility.
- If the home is being donated, compare the rehab cost versus the cost of new construction to ensure that the project is viable and cost-effective.
- Take into account the special needs and resources of the selected family whenever possible. Addressing specific needs, such as constructing a ramp to allow wheelchair access, will have an affect on rehab costs.
- Carefully evaluate homes with potential health and safety hazards, such as asbestos insulation and adhesive, lead paint, mold, and major structural failures. Mitigating such hazards will greatly increase the cost of rehabilitation (refer to Chapter Two: Health Concerns, Historic Considerations, and Accessibility for more information on health concerns).
- Consider the benefits of existing site features, such as a property with positive drainage – slopes that direct storm water away from the home.

DESIGN DEVELOPMENT

- Keep the “whole building” approach in mind when developing the rehab plan.
- Take advantage of existing home and site features that help make the house energy-efficient and comfortable, such as high ceilings and prevailing winds for natural ventilation, or trees for shading.
- Develop a plan that will support the home’s durability over time.
- Reduce the energy load of the home by insulating and tightening the building envelope first and then incorporating more efficient equipment (refer to Chapter Four: Energy- and Resource-Efficient Retrofit Strategies for recommendations). If possible, conduct an energy analysis to inform the design. Local utility companies are the best source for information on professionals who conduct home energy analyses.
- Where possible, use as much of the existing layout and components (e.g., interior doors, detailed plasterwork, original woodwork) as possible in the new layout and design (Fig. 2). This will minimize demolition time, construction waste, and time and materials for rebuilding, and will help preserve the character of the original house.



Fig. 2: To save on costs, the original stairway was maintained.

- If a new layout is needed, design spaces that serve more than one function, such as including laundry areas in bathrooms or a combined living/dining area. Creating new layouts is an opportunity to create more efficient spaces (Fig. 3).



Fig. 3: A better layout is created (right) by revising the original layout (left) and creating a more efficient unit.

- Where possible, plan to rebuild on a 24" module to maximize framing material cost savings (refer to Chapter Four: Energy- and Resource-Efficient Retrofit Strategies; Advanced Framing Techniques for more information).
- Consider the future needs of the family. For example, if there are elderly family members, plan for the future addition of ramps and other features that support “aging-in-place,” etc.

- Use donated or discounted materials available to Habitat affiliates through national partnerships or local businesses.
- Make sure that plans meet:
 - Local building codes, including historic district requirements
 - Zoning ordinances
 - Other applicable codes (such as energy codes) and federal, state, and local regulations
 - Incentive program requirements
 - Habitat standards for decent, affordable, and maintainable homes (refer to the Rehab Workshop handout provided in Appendix B).
- Develop specifications that emphasize overall performance of the house.

CONSTRUCTION & INSPECTIONS

- Whenever possible, reuse components removed during demolition, such as interior doors and wall studs (Fig. 4). Note that the actual dimensions of older lumber are usually larger than that of contemporary materials. If use on a current project is not possible, consider storing components for a future project or selling them in the salvaged materials market.



Fig. 4: The demolition of the interior spaces of this home has provided construction materials that can be reused in the rehab project, thereby saving on material costs.

- After demolition, conduct a comprehensive inspection and evaluation to finalize designs and budget.
- Develop a detailed “scope of work” for subcontractors hired to work on the project.
- Hold a pre-construction workshop with all subcontractors so that they understand the project goals, including energy efficiency.
- Early in the construction process, let the building inspector know about any special technologies that are planned for the project. This will mitigate concerns on the part of the inspector later on.
- Focus on overall house performance. Ensure subcontractors and volunteers are complying with your affiliate’s standards and the home’s design and specifications.
- Depending on the strategies and technologies incorporated, consider on-site volunteer training.
- Make sure that subcontractors are licensed and bonded.
- Limit cost overruns through good planning and execution.

- If possible, hold a pre-construction workshop with the future homeowners to inform them about the construction process and schedule. At this time, consider discussing options that can be included in the home (such as floor covering), if any.
- Encourage subcontractors to suggest ways to produce a more affordable, energy-efficient home without sacrificing quality.

CLOSING

- Hold a post-construction workshop with the homeowners to inform them about the features of their house, the required maintenance, warranties, and where to go for help if something malfunctions.
- Provide a homeowner maintenance manual that includes information about special energy-efficient features of the house, such as programmable thermostats.
- Celebrate successes—give credit and appreciation to everyone involved in the project (Fig. 5). This will foster partnerships and community pride, and get the message out about energy- and resource-efficient retrofits.
- After each project, conduct a thorough review of the site inspection and evaluation results, designs and specifications, budget, and the outcome to determine if the rehab met project goals.



Fig. 5: Celebrating success during a Habitat house dedication

CHAPTER TWO: HEALTH CONCERNS, HISTORIC CONSIDERATIONS AND ACCESSIBILITY

HEALTH CONCERNS

There are several health and safety issues associated with rehabbing older buildings. Construction methods and materials used when the homes were originally built may no longer be permitted because of their adverse health effects. For example, many homes built before the 1970s have lead-based paint and asbestos, which are hazardous materials. In addition, because many rehab candidate homes are in disrepair, mold might be present as a result of water infiltration over time. Remediation of conditions that threaten the health of workers or residents must be addressed by the overall rehab plan. Some potential hazards that should be remedied are outlined in this section.

Lead-Based Paint

Lead-based paint is most likely present in homes built before 1978. Left undisturbed and in good condition, lead-based painted surfaces are usually not harmful. However, chipping or peeling paint is a common health risk (Fig. 6). Deteriorated painted surfaces that are disturbed during rehab work can result in airborne lead dust. Although gut rehabs will remove potential sources of lead contamination, proper handling of painted surfaces during demolition and restoration of features such as window and door casings, stairs, and banisters is required to eliminate potential health risks. Consult the Resources section of this guide for a link to information on lead abatement.



Fig. 6: Deteriorated painted surfaces might pose a health risk during rehab.

Asbestos

Several building products and insulation materials in older homes contain asbestos. When materials containing asbestos are disturbed during demolition, asbestos particulates become airborne and pose health risks. It is not always easy to identify the presence of asbestos. It might be present in many materials including vinyl floor tile, insulation, ceiling tiles, textured paints, shingles, and siding. As a result, it might be appropriate to consult a certified asbestos contractor to examine the home before determining the feasibility of a rehab project since abatement will have an affect on the rehab budget. Asbestos should always be handled by a licensed professional. Consult the Resources section of this guide for a link to information on asbestos and its abatement.

Radon

Radon is a naturally occurring radioactive gas. It comes from the decay of uranium that is found in nearly all soils. Radon gas is colorless, odorless, and tasteless and cannot be detected by human senses. Indoors, radon can accumulate in the lower levels of homes where it can adversely affect human health. The only way to know if a home contains radon gas is to test for it. Consult the Resources section of this guide for a link to information on radon.

Mold and Moisture

There are several health risks related to mold, including allergic reactions; asthmatic episodes; eye, skin, nose, and throat irritation. For mold to grow, it needs warmth, food (such as wood, carpet, drywall, or even dust), and moisture. Moisture control is the first step in controlling mold and preventing its growth and resulting damage (Fig. 7). Many rehab candidate homes have leaky roofs, damaged or broken windows, poor site drainage, and cracked foundations, all of which are sources of moisture infiltration and mold growth. **If mold is present in the rehab-candidate home, it is a sign of the presence of moisture.** Search for and eliminate the source of moisture, such as a plumbing leak or improper flashing. Consult the Resources section of this guide for a link to information on mold and moisture.



Fig. 7: Mold is a sign that moisture is present.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas which at high levels can cause serious illness and death. These higher levels of CO may occur from improperly maintained, installed, or used fuel-burning appliances. CO alarms (Fig. 8) are widely available and should be considered a back-up to, but not a replacement for, proper installation, use, and maintenance of fuel-burning appliances. CO alarms are designed to warn of any unusual build-up of CO in the home. If a CO alarm is installed, the device should be certified to the most current Underwriters Laboratory (UL) standard 2034 or the International Approval Services (IAS) 6-96 standard. Consider installing a CO alarm outside each bedroom.



Fig. 8: CO alarm

HISTORIC CONSIDERATIONS

Many Habitat rehab projects fall within historic districts. As a result, typically the rehab project must comply with guidelines established to preserve the historic character of the buildings and communities. Usually, guidelines are established, reviewed, and enforced by a historic committee. The committee reviews applications for building permits that request a modification to any part of the home required to comply with historic guidelines.

Sometimes, historic guidelines conflict with energy-efficiency goals for the project. In such cases, explore options that can fulfill energy-efficiency goals and historic requirements. For example, new insulated, low-e, wood windows with grilles to simulate historic windows satisfy energy efficiency and historic design goals. Although coordination with historic commissions on items such as windows and doors requires additional planning and effort, the energy savings provide a large benefit to the future homeowner. Before beginning a rehab project, consult with the local building department to determine whether historic requirements apply. The State Historic Preservation Officer (SHPO) can also provide guidance. Consult the Resources section of this guide for links to information about historic preservation.



Fig. 9: Historic window and door

ACCESSIBILITY

Many existing homes are not designed to allow access for people with certain types of disabilities. For example, the typical stepped entry is a common barrier that prevents wheelchair access. Even though potential occupants may not have disabilities, removing barriers allows the creation of supportive living environments for occupants who may become disabled, for future residents with disabilities, and for visitors with disabilities. Incorporating the highest level of accessibility in a rehab of an older or historic home may not be possible because of structural and budgetary constraints. However, incorporating accessibility whenever possible is a good idea (Fig. 10).



Fig. 10: Installing blocking in walls around tubs and toilets provides the structural support for the installation of grab bars.

Most building codes require that newly constructed multifamily housing be accessible to people with disabilities, with some limitations. There are also federal, state, and local accessibility laws that require that certain types of housing provide some level of accessibility. For example, Section 504 of the Rehabilitation Act of 1973 (Section 504) requires that accessibility be incorporated into newly constructed and rehab projects if there

is any amount of federal financial assistance, regardless of whether that assistance is handed directly to the developer or funneled through other sources. In addition, local- and state-funded housing is required to be accessible according to Title II of the Americans with Disabilities Act. Consult the local U.S. Department of Housing and Urban Development (HUD) office to identify which federal access law might apply to your project. Consult the local building department to determine whether building code and state and local requirements for access apply.

In addition to federal, state, and local access laws and building code requirements for access, designing homes to be “visitable” is quickly becoming a requirement in some jurisdictions across the country (Fig. 11). Homes that are “visitable” incorporate minimal levels of access so that they can be visited by a person with a disability. Consult the Resources section of this guide for links to information on accessibility and “visitability.”



Fig. 11: An accessible entrance makes this home “visitable.”

CHAPTER THREE: DURABILITY

In addition to implementing energy- and resource-efficient retrofit strategies, which will be discussed in the following chapter, a plan to ensure that the building remains durable by protecting and preventing damage to its structural integrity is a necessary component to any rehab project. Before addressing energy- and resource-efficiency, the building's site and foundation must be evaluated and a plan developed that will support the building's durability over time. Additionally, finish selections will play a key role in maintaining a structure's durability. Consult the Resources section of this guide for links to information about the topics included in this chapter.

SITE

Because water infiltration can compromise the structural integrity of a building over time, it is important to develop a plan to prevent water from penetrating the building. The evaluation of site grades and soil conditions is the first step toward developing an effective plan.

Evaluate Site Grades, Soil Condition, and Adjacent Sites

Improper site grades and impermeable soil can lead to water infiltration and potential damage to foundations (Fig. 12). Grades sloped toward the home might direct runoff to the foundation and non-porous soil at the foundation might cause water to pond or pool, which may eventually make its way through the foundation. Both of these conditions should be mitigated.

It is also important to evaluate adjacent sites to determine their affect on managing storm water. Typically, there is no control over neighboring sites. Improper grading of an adjacent site or rowhouses with connected roofs might be sources of water infiltration, and the inability to fix them might render a retrofit project infeasible.



Fig. 12: Improper site grading directed water toward this home.

Modify Site Grades and Soil Condition and Address Other Site-Related Conditions

Site Grades and Soil Condition

Identify all areas of the site that appear to direct water toward the home or cause water to pond at the foundation. Depressed sections of the site and concentrated areas of vegetation are typical clues for non-porous soil. Keep in mind that impermeable soil conditions might require extensive grading and soil modification, and an architect or engineer might need to be consulted. Improving site grading might be all that is needed to correct the problem.

Consider using soil from other parts of the site to build up low-lying areas at the foundation, thereby creating positive drainage away from the house. It might be necessary to bring in soil to remedy improper grading, which will have an impact on project costs. Runoff cannot be

directed onto neighboring sites or into storm sewers. Check local requirements for recommended or required grades.

OTHER SITE-RELATED CONDITIONS

Site Drains

Some homes have site drains installed either in an adjacent walkway (usually leading to the basement) or somewhere on the site. Clogged drains can lead to flooding and water leakage into the home. Test the drains to ensure proper drainage and take care to keep them clean of debris.

Adjacent Patios and Walks

Over time, patios and other paved areas adjacent to the home tend to settle toward the foundation since the soil below these paved areas was newly compacted at the time of construction. Removing the patios and other paved areas that have settled should be considered in order to prevent water damage to the foundation. Removing settled concrete patios and replacing them with wood or plastic-wood decks with proper flashing might be an affordable option. These decks are porous and allow water to penetrate; thereby preventing ponding at the foundation.

Porches

Porches are common to older homes slated for rehab. Over time, it is typical for the porch to “pull away” from the home due to undersized footings. The separation of the porch from the house creates a route through which water can penetrate the home and its foundation. Once a porch has separated, rebuilding it is the only option for effective water management (Fig. 13). Proper flashing at the connection of the porch to the house is an important detail to prevent water penetration.



Fig. 13: Rebuilding the porch prevents further water damage to the foundation of this home.

Debris and Other Material

A site inspection should also identify debris, accessory structures (such as dilapidated sheds), and other materials that should be removed as part of the rehab project. Although they do not have an affect on the energy efficiency of the building, hazardous materials such as oil tanks and buried fuel tanks should be removed. Air vents or oil lines that originate in the basement and pass through the foundation wall may be evidence of a buried oil tank. Active and abandoned drywells should be identified and evaluated, but not removed. Leaders buried below grade might be a clue to an underground drywell.

Below-grade conditions might be difficult to assess without excavation. However, property records and site plans, which are usually maintained by the city, can help determine conditions below grade. Excavating and removing below-grade tanks and other hazardous materials or objects will add cost to the project.

FOUNDATION

The homes used as a model for this guide had fieldstone rubble foundations with no footings, which is typical in many older homes throughout the Northeast and Middle-Atlantic U.S. The foundations of the homes were not reinforced and are held together with mortar. Wood posts supporting wood girders can be found in basements. These wood members are commonly a solid piece of sawn timber.

Concrete block foundations are also common in older homes. In some sections of the foundation wall, the original rubble foundation has been replaced with concrete blocks. Basements typically have dirt floors and lack insulation between the unconditioned basement space and the conditioned floor above.

This section will help contractors to identify potential problems common to older foundations. Energy- and resource-efficient retrofit strategies appropriate for foundations and basements typically center on proper insulation techniques. Once all of the following problems associated with durability have been addressed, energy- and resource-efficient insulation strategies can be used (refer to Chapter Four: Energy- and Resource-Efficient Retrofit Strategies; Insulation).

Evaluate Foundation Walls and Address Potential Damage Appropriately

Identify areas on the interior of the foundation wall that appear damaged to determine the corrective work required and its associated cost. Large damaged areas should be inspected by an architect or engineer, who can determine whether the structural integrity of the building has been compromised.

A common condition of old rubble foundations is missing or damaged mortar. This is typically the result of water that has penetrated the foundation wall over time. Missing or damaged gutters and downspouts (Fig. 14) can lead to water damage to foundations, which is usually apparent in large sections of wall or concentrated in a small area if the problem is more localized (a missing downspout, for example). Cracks caused by settling provide a route for water penetration, which eventually wears away the mortar.



Fig. 14: Damaged downspouts are a source of water penetration through the foundation wall.

The easiest fix for missing or damaged wall mortar may entail cleaning out the old mortar and patching the rubble with new mortar. However, if an architect or engineer determines that the structural integrity is compromised, the fix might be more extensive and costly.

In conjunction with replacing missing mortar, missing or damaged gutters, downspouts, and leaders must be replaced to direct runoff away from the foundation to prevent further damage (Fig. 15). Adding leaders to the ends of downspouts at grade to direct water away from the foundation is a common fix. Do not direct runoff onto a neighbor's property or

into public sewers. It is important to make sure the source of the problem has been eliminated before any repair work is undertaken.

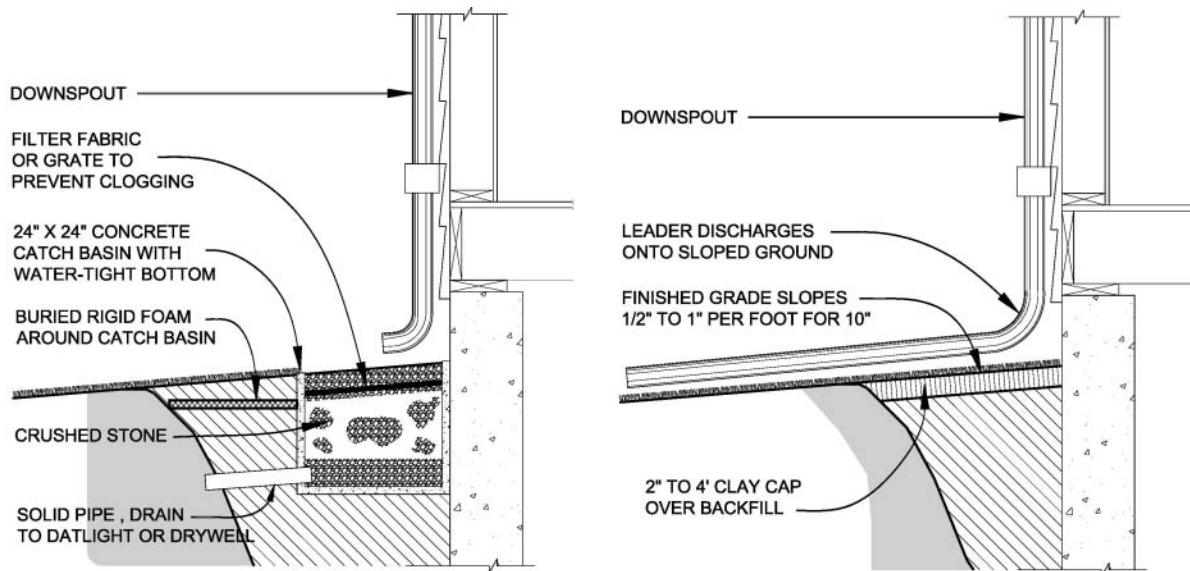


Fig. 15: Two methods of directing water runoff away from foundations

Spray-on materials that seal the rubble to reduce water infiltration are available, but they add cost to the project.

Remove Overgrown Vegetation

Overgrown vegetation is common on older sites. Trees originally planted too close to the home can become a source of damage to foundations and a threat to the home’s structure (Fig. 16). Their roots can penetrate the rubble foundation wall and cause cracks, which can lead to water infiltration. Removing overgrown trees and vegetation should prevent further damage to foundations.



Fig. 16: Trees planted too close to the home can be a source of structural damage. Root systems might crack foundation walls, creating a path for water infiltration.

FINISHES (EXTERIOR & INTERIOR)

While most historic homes have wood or masonry (brick) exterior walls, there are instances where they have been painted or sided with aluminum, vinyl, or wood. Interior wall finishes of lath and plaster are common. Any recently remodeled areas within the home would likely be covered with gypsum drywall. The plastered or wallboard walls are usually painted or wall papered. Some walls are covered with wood paneling. Detailed ornate plaster work and woodwork (for trim, molding, and baseboards) are also common in homes that still have original details.

Floor coverings vary between rooms: wood flooring and carpet in the living areas and bedrooms; vinyl, resilient, or ceramic tiles in the kitchens, bathrooms, and utility areas; and dirt floors in the basements.

Most Habitat rehab projects involve removing the interior coverings and finishes to assess the condition of the structure. If a room is being considered for minor repairs, note the following typical problems that may be encountered with existing finishes:

- Lead paint
- Peeling, stained, and/or blistered paint
- Mold and mildew or water-damaged materials
- Deteriorated, worn, or warped materials
- Improper flashing and joints
- Asbestos adhesives

Inspect exterior finishes carefully. In most cases, removing existing siding materials that cover brick exterior walls is cost-effective and preferred over repairing/replacing the siding material.

Exterior Finishes

To keep rehab costs down, Habitat for Humanity will typically choose a masonry/brick home over a wood-sided home since replacing or repairing damaged siding is more costly than repointing and repainting brick. With this in mind, replacing or repairing a home's exterior siding is usually not an option. Additionally, much less preparation is needed to paint a brick-sided home as opposed to a wood-side one. As a result, costs are kept at a minimum. Masonry or siding materials must be restored to good condition as part of the rehab plan. To achieve maximum durability, use caulk or foam sealant in penetrations through the exterior finish.

If siding the home is the only option, consider using vinyl siding, which is a durable, low-cost, low-maintenance cladding alternative. Installing siding on top of masonry walls provides an opportunity to install insulation under the siding if it is not possible to install it on the interior side of the exterior walls.

Interior Finishes

Interior finishes, including paints, sealants, and floor coverings, significantly affect the quality of the indoor environment within the house. There are many products that help ensure a healthy, environmentally friendly home, including low- or no-volatile organic compound

(VOC), natural, and/or recycled-content products. Consider the following in selecting interior finish materials:

Low- or No-VOC Interior Latex Paint

Many latex paints are available with low amounts of organic solvent. Select latex paints that also have low or no VOCs. These paints have less odor and emissions when wet or newly dried. Latex paint is generally nonflammable, has lower toxicity than oil-based paints, and can be cleaned up with water.

Low-VOC, Water-Based Wood Finishes

Water-based, formaldehyde-free, nonflammable, low-odor, and low-VOC content wood finishes are available in gloss, semi-gloss, satin, and solid finishes for interior applications. These products are easy to clean up and fast drying, which reduces downtime between coats.

Natural Paint

Natural paints, made from milk protein, plant, or mineral-based compounds, can be a viable alternative to conventional paints. Natural paints are not necessarily low-VOC, as some types are organic and solvent-based, and contain isosaliphatic hydrocarbons. Some paints use citrus oil solvents that dry quickly; however, they may cause allergies or irritation in environmentally sensitive individuals.

Synthetic Drywall

Where available, install drywall that contains up to 100% synthetic gypsum, which replaces virgin gypsum content. Most conventional drywall already contains 100% recycled, unbleached paper facing.

Recycled-Content or Formaldehyde-Free Interior Panels

Choose from a variety of recycled-content and/or formaldehyde-free panel materials for millwork, cabinets, and paneling. These include formaldehyde-free medium density fiberboard (MDF); panels made from post-consumer and post-industrial corrugated boxes and newspapers; and panels made from agricultural waste such as wheat, straw, and soy. Some panels are available in sizes up to 5' x 18' with thicknesses of 1/4" to 1 1/4".

Finger-Jointed Trim

Finger-jointed trim is made from short lengths of lumber formerly scrapped or burned for fuel. Finger-jointed trim is good for painting, and some products have a hardwood veneer well suited for stain or other finishes.

Environmental Considerations for Selecting Flooring

Environmentally preferable flooring materials have one or more of the following characteristics: they produce low emissions, are made from rapidly renewable and/or natural

resources, contain recycled content, are recyclable, and require little maintenance and/or do not require toxic cleaners to maintain.

General Carpet Information

Carpet systems, including carpets, carpet cushions, and carpet adhesives, can emit significant levels of VOCs, particularly during installation and immediately afterward. The Carpet and Rug Institute in Dalton, Georgia, has established a Green Label testing program that sets emission thresholds for VOCs, formaldehyde, and other compounds found in carpets, cushions, and adhesives. Carpet selections should meet or exceed these standards. Carpet must also be properly maintained to control dust, antigens from dust mites, and potential microbial growth (often the result of excessive moisture from leaks, spills, etc.). Carpet cleaners should also use low-emission formulations where available.

Recycled-Content Carpet

Post-consumer products (such as plastic soda bottles) containing polyethylene terephthalate (PET) are recycled into polyester carpet face fiber, thereby minimizing landfill waste, air pollution, and the fuel required for producing virgin fiber. PET is inherently stain-resistant and is more hydrophobic than nylon. Where additional durability is required, a growing number of nylon carpets are available that incorporate recycled content into their face fibers or backings.

For padding, consider synthetic felted pad made from carpet manufacturing waste, natural fiber wool or jute, foamed pads made from true natural rubber, or foamed pads manufactured without the use of ozone-depleting chemicals.

Flooring From Rapidly Renewable Materials

Bamboo and cork flooring are long lasting, sustainable flooring alternatives. Controlled bamboo forests mature in three years and typically produce as much flooring as a hardwood forest does after 40 years. Installing bamboo is similar to installing hardwood floors. Cork flooring is harvested from the bark of the cork tree, which grows back completely in 9 to 14 years. Cork has natural fire resistance, is resilient, will not rot, is hypoallergenic, and provides insulation and cushioning. Cork can be waxed, varnished, and polyurethane or acrylic coated.

Recycled-Content Ceramic Tile

Recycled content ceramic tiles are available in a wide variety of styles, colors, and finishes. Installation and cost are often similar to those of non-recycled tiles. Some contain as much as 85% post-consumer recycled glass.

Natural Linoleum

Natural linoleum is made primarily of natural raw materials: linseed oil, resins, and wood flour combined with a natural jute backing. Linoleum is highly resistant and, over time, becomes harder and more durable, while remaining quiet and comfortable underfoot.

CHAPTER FOUR: ENERGY- AND RESOURCE-EFFICIENT RETROFIT STRATEGIES

This chapter presents a number of proven, cost-, energy-, and resource-efficient strategies and techniques for rehab projects that might be undertaken in the Northeast and Middle-Atlantic region of the U.S. Consult the Resources section of this guide for links to information on the topics included in this chapter. The strategies and techniques included in this chapter are presented under the following subject headings:

- Framing (exterior and interior) and Roofing
- Windows
- Insulation & Air Sealing
- Space and Water Heating
- Mechanical Ventilation
- Lighting and Appliances
- Plumbing and Plumbing Fixtures

FRAMING (EXTERIOR AND INTERIOR) AND ROOFING

The homes used to compile this guide had similar wall/roof framing systems. They typically consisted of structural masonry walls with a plaster coat over the brick. This is common practice for older rowhouses with shared party walls. Door and window headers are built with 3x or 4x lumber embedded in the masonry. Alternatively, the masonry around openings may be arched to carry the loads to the sides of the opening. Interior walls are almost always wood framed.

In cases where the home is 18' wide or less, floors are typically framed with 2x8s, which bear directly on exterior brick walls or on a mid-span beam. Subfloors are usually pine planks, sometimes tongue-and-groove, and range from 2" to 6" wide or more.

Roofs are flat or pitched. Pitched roof framing usually bears on the front and back exterior walls and consists of 2x6 rafters. Flat roofs are slightly pitched front to back, and they are usually framed with 2x8s running from front to back, bearing on several beams anchored in side exterior walls. Roof decking usually consist of 4" to 6" pine planks or boards.

Evaluate Framing

Prior to any rehab work, inspect and evaluate the structural integrity of the framing system: exterior and interior walls, floors, and roofs. If a thorough evaluation is not possible due to coverings, perform an initial evaluation prior to demolition and a more comprehensive one post-demolition. Typical problems in existing framing include:

- Deteriorated brick and mortar
- Water damaged, rotted, or decayed wood members
- Termite damaged wood members
- Notches or cuts in wood members
- Missing wood or masonry members

- Under-sized members, particularly beams and joists, which cause sagging
- Fire-damaged wood members

Structural problems with the framing system (as well as the foundation system) must be stabilized prior to demolition. Repairs to these defects should be made before any construction takes place.

Evaluate Roofing

Problems that typically lead to roofing failure include:

- Deteriorated roofing materials
- Improper flashing
- Water ponding due to insufficient slope
- Improper installation
- Insufficient roof framing

Inspect the roofing carefully to determine if a repair or replacement is needed. For replacements, it might be possible to re-roof directly over the existing roofing. However, in some cases damaged sections of roofing must be removed and the roof framing repaired before the new roofing is installed. Be sure to consult an architect or engineer who can calculate the additional weight of the new roof to determine if the structural framing system can bear the extra load.

Energy- and Resource-Efficient Strategies

Exterior Walls and Interior Partitions

Concrete Masonry Units (CMU)

CMU, also known as concrete blocks or cinderblocks, is a resource-efficient material for re-bricking exterior walls. Re-brick the visible side with old bricks to match the originals and use CMU on the interior course to save cost, time, and materials.

Advanced Framing Techniques

Advanced Framing Techniques or Optimum Value Engineering (OVE) reduces the lumber or metal required to build a house without sacrificing structural integrity. OVE techniques can lower material and labor costs and improve energy performance. While the system can be applied as a whole package, many of techniques can be used independently in a rehab project. For example:

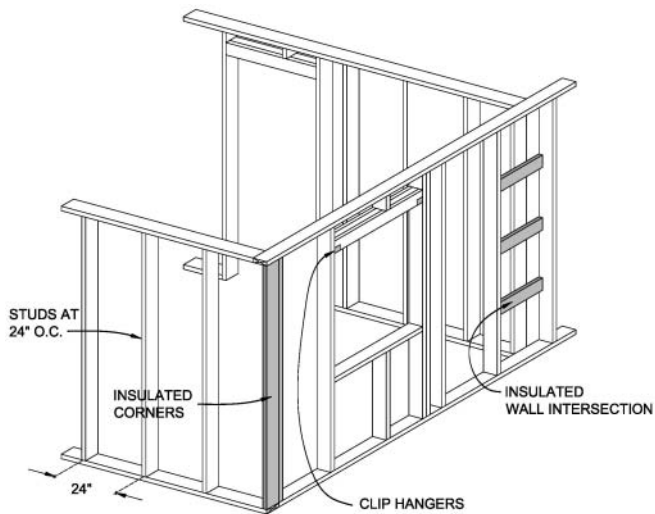
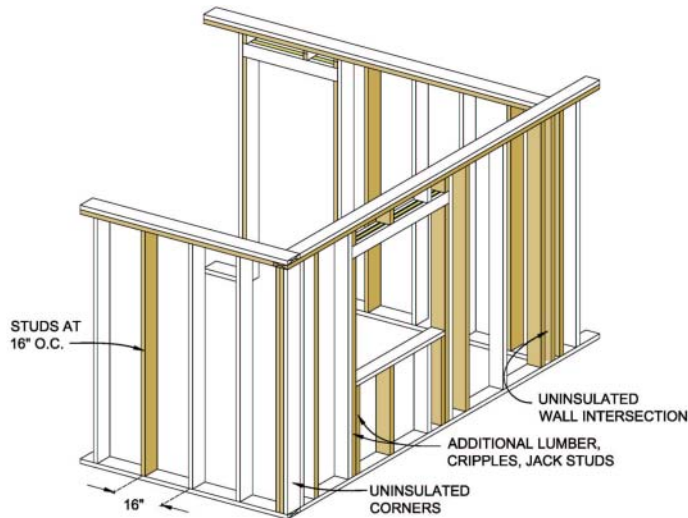
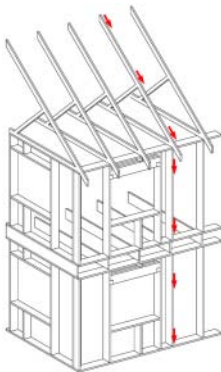


Fig. 17: Advanced Framing (top) compared to traditional framing (bottom) reduces the amount of material used for construction, thereby reducing costs while maintaining structural integrity.



- Modular layout and increased spacing of framing members (designing and building to a 24" module and using 24"-on-center wall and floor framing, as opposed to the 16"-on-center method) can reduce framing material cost (Fig. 17);
- In-line framing, where floor, wall, and roof framing members vertically align, allow loads to be transferred directly downward (Fig. 18).

Fig. 18: In-line framing



- Appropriately sized headers, sized for the particular load and span, will save labor and material;
- T-intersection details eliminate extra studs and provide additional space for increased insulation;
- Two-stud or “California corners” use only two studs at an outside building corner (Fig. 19).

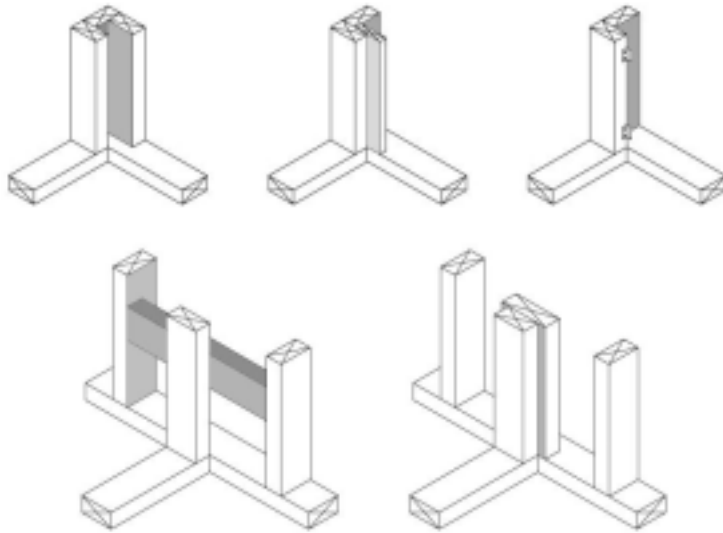


Fig. 19: Two-stud corners (top) and T-intersection (bottom)

Salvaged Lumber

Reuse lumber removed during the demolition for replacement or new framing. Avoid mixing and matching salvaged and new lumber (because they are different dimensions). Denailing activities are volunteer friendly.

Steel/Metal Framing

Depending on the extent of replacement framing, steel framing members can be used as one-for-one substitutes for wood framing members (Fig. 20). Steel framing is not only more cost-effective, but also contains up to 28% recycled material, and construction waste generated during framing is 100% recyclable. However, there is a learning curve with steel framing, as well as a change of tools and materials (i.e., use snips, screw guns, and screws instead of saws, hammers, and nails).

Use 25-gauge 2-1/2" metal studs at 24"-on-center for non-structural walls. Make sure to install a thermal break—in the form of an air gap, rigid insulation, or exterior insulating sheathing—when used on exterior walls to prevent thermal bridging.



Fig. 20: Metal framing used for the interior partitions of this home

For structural applications, be aware that the top track is not capable of transferring vertical loads. Therefore, studs, joists, and rafters must be aligned vertically to transfer vertical loads.

Finger-Jointed Studs

Finger-jointed studs are alternatives to solid sawn-wood studs.

Floors and Roofs

Oriented Strand Board (OSB)

Use OSB to replace subflooring or roofing. OSB is as strong as and uses less formaldehyde than plywood and is structurally nondirectional. OSB should not have prolonged exposure to moisture.

Engineered Lumber

Engineered lumber in the form of manufactured laminated veneer lumber, laminated strand lumber, glue-laminated lumber, truss-joist I-beam, etc. offers consistent performance, predictable quality, and superior structural characteristics, while reducing construction waste.

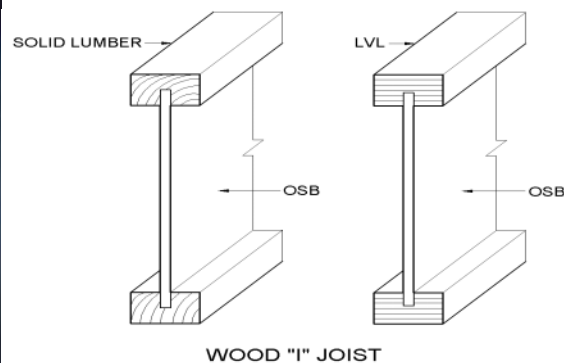
Engineered lumber consists of small pieces of wood combined with adhesives under heat and pressure to produce practical and economical alternatives to solid wood framing in headers, beams, joists, and studs.

Substitute engineered lumber for 2x10s or larger. Use engineered wood products such as trusses or I-joists for greater uniformity and strength. Avoid using 2x10s and 2x12s, as they often come from old growth forests. Materials from old growth forests are not resource efficient.

Use engineered lumber for headers and beams. Manufactured laminated veneer lumber and laminated strand lumber are stronger than dimensional lumber of the same size, and they are well-suited to replace solid or built-up headers.

Use wood I-joists for floors and ceilings (Fig. 21). I-joists have a very high strength-to-weight ratio and provide structural support for floors and roofs, while only using a third of the material required for traditional solid joist systems.

Fig. 21:
Engineered
lumber



Roofing Membrane

Cool Roofs

In general, light-colored roofing is recommended for Habitat rehab projects because it absorbs less heat than darker roofing materials. Most traditional dark-colored roofs absorb 70% or more of the solar energy striking them—resulting in peak roof temperatures of 150° to 190°F. By comparison, white, reflective roofs are 50° to 60°F cooler on hot days and can decrease cooling costs by 20% on average. In addition to reducing energy consumption, cool roofs offer many other benefits, including decreased roofing maintenance and replacement costs; improved home comfort; and reduced impact on surrounding air temperatures (heat island effect).

Replace or Repair Roofs

Replace pitched roofs

Install 30-lb. roofing felt underlayment under light-colored, 40- to 45-year, three-tab asphalt shingles, which have thicker fiberglass mats for higher durability. Be aware that historic district requirements might limit roofing material and color options.

Replace flat/ low-slope roofs

Install ½" fiberboard underlayment under white, granular modified bitumen (MB) roofing membrane. Alternatively, install ½" fiberboard underlayment under smooth modified bitumen membrane with a white/silver fibrous aluminum coating or elastomeric coating over the membrane.

Repair flat/ low-slope roofs

Install a white/silver fibrous aluminum coating or elastomeric coating over the repaired roofing membrane in good condition. Note that the coatings cannot plug leaks or fix an unsound roof. Repairs must be made prior to coating a roof. Check the cool roof coating's installation instructions for surface preparation and application details.

Flashing

Proper flashing is an important element of the roofing system. Be sure to flash and seal properly around skylights, chimneys, vent pipes, etc., to prevent water intrusion. Aluminum flashing is preferred because it is easy to work with, and preformed aluminum drip edges and other related components speed installation and assure effective results.

WINDOWS

Windows in older and historic homes typically have painted wood frames, are double-hung, and have single-pane glass. Sash weights, which are an integral part of historic window frames, help with the

The image shows a certification label from the National Fenestration Rating Council (NFRC). It features the NFRC logo on the left, which includes a sunburst design and the text 'National Fenestration Rating Council' and 'CERTIFIED'. To the right, the text reads 'World's Best Window Co.', 'Millennium 2000+ Casement', 'CPD#0098-xyz-001', and 'Vinyl-Clad Wood Frame • Double Glaze Argon Fill • Low E+ Solar Control Coatings'. Below this is a table of technical information:

Technical Information				
Res	U-Factor	.32	Solar Heat Gain Coefficient .45	Visible Light Transmittance .58
Non-Res		.31	.45	.60

Below the table, a small disclaimer states: 'Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product energy performance. NFRC ratings are determined for a fixed set of environmental conditions and specific product sizes.'

Fig. 22: This label affixed to the window contains the NFRC ratings information.

movement of the sashes. Uninsulated single-pane windows are a major source of heat gain in the summer and heat loss in the winter. These older windows should be replaced with more energy-efficient models to increase the home's energy performance and improve thermal comfort. New window technology offers dramatic savings on annual utility costs and increased comfort for the homeowner.

Energy- and Resource-Efficient Strategies

Multiple glazing layers and new technical advances have significantly increased the performance of windows. Insulating glass includes an air space between the glass panes to reduce the transmission of heat, cold, and sound through the window.

Energy performance criteria have been standardized with the establishment of uniform rating procedures by the National Fenestration Rating Council (NFRC). Through the NFRC Certification Program, participating manufacturers obtain certification for total product energy ratings such as the measure of the rate of heat transfer (U-value) and the measure of solar energy penetrating the window (solar heat gain coefficient or SHGC). The ratings for windows can be found on the NFRC label affixed to the product (Fig. 22). For northern U.S. climate zones, low-e windows should have U-values that are less than or equal to 0.35; the lower the U-value, the slower the rate of heat flow and the better the insulating quality (Fig 23). The SHGC is more important in climates where cooling of the home is required.

The selection of a suitable window does not ensure performance. A unit is only as good as its installation. Improper or inadequate anchoring of the unit will defeat the wind and weather resistance of the best-performing window.

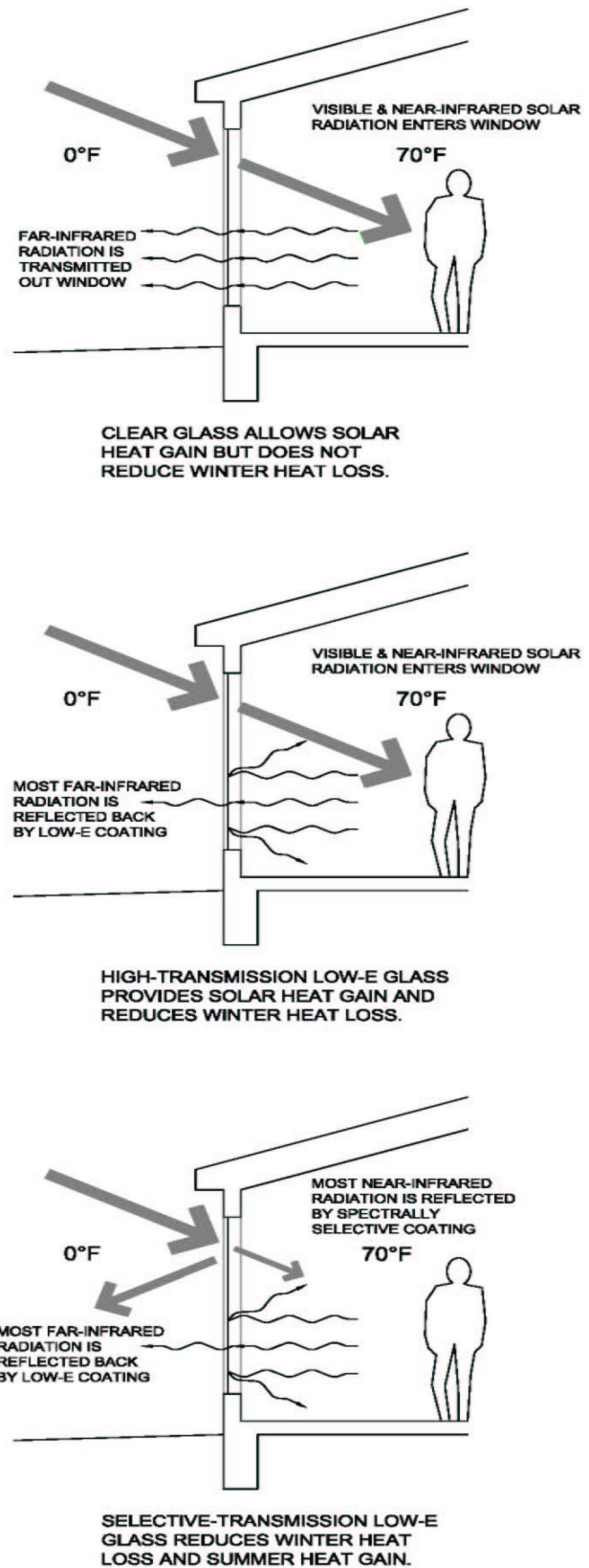


Fig. 23: Energy-efficient glazing

When replacing older wood windows, the original upper and lower sashes (the portions that move and hold the glass in place) are removed and the original frame is retained (installing new vinyl windows does not require the original wood frame to be retained. In this case, the original frame is removed and a new vinyl window, including a new frame, is installed). Retaining the original frame requires that it be in good condition and relatively square. If either of these conditions is not met, the new sashes will not operate properly. As a result, the existing frame must be modified so that it is square.

If the original frame is retained, the opening created by removing the original sashes provides the space into which the sash replacements are installed. Before installing the new sashes, it is important to insulate the original housing that contained the old sash weights. This housing is located inside the wall to the left and right of the original frame. These areas should be injected with insulating, low-expanding foam sealant before installing the new sashes. Original casings, whenever possible, should be refinished and reinstalled.

Often in rehab projects, rough openings are not large enough to allow for the expansion of the window unit and general structural movement. Out-of-square installation will also impair the proper functioning of the unit and result in a poor weather seal around its perimeter. Use injectable non-expansive foam to air seal the gap between the window unit and the rough opening (Fig. 24).



Fig. 24: Air sealing reduces air infiltration around the window.

INSULATION & AIR SEALING

Particularly in cold climate zones, inadequate insulation and high air leakage can account for over 50% of a home's heating costs and contribute to problems with moisture, noise, dust, and entry of pollutants, insects, and rodents. Implementing insulation and air sealing strategies can reduce energy use as well as improve comfort, health, and building durability. The main idea is to insulate the walls, floors, and attic/ceilings and to seal all holes and seams between sheet materials such as drywall, sheathing, and decking, and between conditioned and unconditioned spaces. Be sure to coordinate insulation and air-sealing activities with framing.

Most older and historic homes are drafty and have very little insulation. However, some homes may have been retrofitted with fiberglass batt insulation in the floors and attic, and caulking and/or weather-stripping around doors, windows, and major penetrations. Occasionally, there might be batt insulation in exterior walls. The insulation should be inspected to determine its condition and to check for any moisture problems.

If exposed to moisture for long periods of time, batt and loose-fill insulation may harbor mold and mildew. Batt insulation that is saturated with moisture or has been improperly installed, such as overly compressed, will have a decreased insulating value (R-value) and will not achieve the rated performance values. If moisture problems are encountered, the problems should be mitigated immediately and the insulation replaced with new. This also provides an opportunity for air sealing, as discussed below.

Energy- and Resource-Efficient Strategies

Particularly in cold climate zones, inadequate insulation and high air leakage can account for over 50% of a home's heating costs and contribute to problems with moisture, noise, dust, and entry of pollutants, insects, and rodents. Implementing insulation and air sealing strategies can reduce energy use as well as improve comfort, health, and building durability.

Insulation

Per inch of thickness, rigid insulation (e.g., extruded polystyrene [XPS], expanded polystyrene [EPS], polyurethane, and polyisocyanurate) has a higher R-value than batt or blown-in fiberglass, cellulose, and cotton insulation. Rigid insulation is also more impervious to water and has higher bearing strength. However, fiberglass and cellulose insulation can also be used to increase the performance of the envelope.

Insulation Checklist for Rigid Insulation

Note: XPS insulation is available free of charge for HFH affiliates. Refer to the listing of National Partners provided in Appendix A or available on PartnerNet.

Above-Grade Walls:

Install up to 3" XPS rigid insulation (R-15) against exposed exterior walls with caulk or appropriate construction adhesive.

- Install 1" XPS insulation (R-5) against any party walls with caulk or appropriate construction adhesive.
- Caulk joints between XPS insulation sheets with acrylic-latex caulk (Fig. 25). Larger gaps can be filled with foam sealant.
- Frame with metal studs (Fig. 26).
- Finish with gypsum wallboard.
- Note: When using XPS, gypsum wall board is required to provide a fire-rated assembly. If foil-faced polyisocyanurate rigid insulation is used instead of XPS, gypsum is not required to provide a fire-rated assembly.



Fig. 25: Sealing joints between rigid insulation boards



Fig. 26: Metal studs are installed over rigid insulation.



Fig. 27: 4 layers of 2" rigid insulation (Total R=40) installed on the attic floor. Joints between insulation boards should be staggered.

Attic:

- Install up to 8" of XPS insulation (R-40) on the attic floor. Because multiple layers are used, the joints of each layer should be staggered and offset from the layer below (Fig. 27).
- Caulk joints between XPS insulation sheets with appropriate caulk. Larger gaps can be filled with foam sealant.

Basement:

There are two different strategies for preventing heat loss through the basement. The first approach involves applying insulation to the basement walls. Alternatively, insulation can be installed in the basement ceiling. The selected approach will strongly depend on site conditions. It is important to note that either approach will first require proper air sealing and a full evaluation of the foundation, as outlined in Chapter Three: Durability. If mold and moisture problems are not properly mitigated first, adding insulation will compound the problem.

Since the mechanical equipment is typically located in the basement of the home, it is ideal to insulate the basement walls with rigid insulation to increase the usable floor space of the home. Once the walls are well-sealed and insulated, the waste heat from the boiler should be adequate to semi-condition the basement space. However, this strategy is only feasible for homes with poured concrete or concrete block walls that can be well sealed and to which rigid insulation can be easily applied. As discussed above, rigid insulation is preferred for this application because it is more impervious to water and has higher bearing strength than fiberglass batt or cellulose insulations.

Basement Walls:

- Install one or two layers of 1" XPS insulation (R-5/inch) against any exterior poured concrete or concrete block walls. Use caulk or appropriate construction adhesive.
- Caulk joints between XPS insulation sheets with acrylic-latex caulk. Larger gaps can be filled with foam sealant.
- Frame with metal studs.
- Finish with gypsum wall board.
 - Note: When using XPS, gypsum wall board is required to provide a fire-rated assembly. If foil-faced polyisocyanurate rigid insulation is used instead of XPS, the gypsum is not required to provide a fire-rated assembly.

Many of the homes used as a model for this guide had fieldstone rubble foundations, typical throughout the Northeast and Middle-Atlantic U.S. This type of foundation is difficult to seal and creates problems with the proper installation of rigid XPS insulation. An alternative insulation strategy was developed to address this scenario, using insulation installed in the basement ceiling. After sealing all floor and band joist penetrations, fiberglass batt insulation can be installed between the first floor joists.

As previously discussed, moisture will degrade the performance of batt insulation and can result in mold and moisture problems. To prevent moisture problems associated with condensation on the interior side of the cold exterior walls, rigid insulation should be cut to fit in the band joist. The rigid insulation will create a thermal break between the cold wall and the batt insulation.

Pipes:

- Wherever feasible, install pipe insulation on exposed water pipes, especially in basements.
- Seal around all pipe penetrations with caulk or foam.

Air Sealing

Air sealing must be done throughout the rehab process: during framing, prior to insulating and installation of interior finish materials, after installation of fixtures, and as a part of final punch-out (Fig. 28). Air sealing does not require expensive materials or special construction skills and is extremely volunteer friendly. Materials that can be used include: adhesive, caulk, spray-foam sealant, mastic, sill seal, backer rod, and foam gaskets. Do not use batt or loose-fill insulation for air sealing, as these materials merely delay air infiltration and do not seal against air leakage.

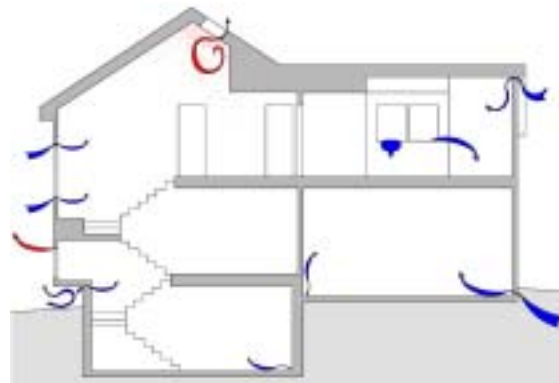


Fig. 28: Gaps in the home should be sealed throughout the rehab process to prevent air leakage and infiltration.

Air Sealing Checklist

- Bottom wall plate (exterior walls only): Apply two beads of caulk/sealant on the subfloor before erecting the wall.
- Window and door openings: Seal with correctly sized backer rod, or use low-expansion urethane foam to avoid bending frame.
- Drywall: Seal drywall to wall studs by applying a bead of adhesive on the studs prior to installation of drywall.
- Electrical wiring: Use wire-compatible caulk or expanding foam to seal penetrations through the bottom and top wall plates.
- Electrical boxes on exterior walls: Use wire-compatible caulk to seal around wiring on the outside of electrical boxes. Seal between the interior finish material and boxes.

- Recessed light fixtures: Consider using surface-mounted light fixtures rather than recessed lights. When recessed fixtures are used, specify airtight models rated for insulation coverage (IC).
- Exhaust fans: Seal between the fan housing and the interior finish material. Choose products with tight-fitting backdraft dampers.
- Plumbing: To the maximum extent possible, locate plumbing in interior walls and minimize penetrations through exterior wall plates. Where penetrations are necessary, seal them with expanding foam sealant or caulk.
- Attic access: Weatherstrip attic access openings. For pull-down stairs, use latches to hold the door panel tightly against the weatherstripping. Cover the attic access opening with an insulated box.
- Flue stacks: Install a code-approved flue collar and seal with fire-rated caulk. Closely follow local codes for firestopping measures, which reduce air leakage as well as increase the safety of the appliance.
- Dropped soffits at ceilings below attic or roof: Install sheet material such as fiberboard sheathing or drywall to create a continuous ceiling plane. Build all dropped soffits inside this continuous envelope. Caulk or foam-seal any penetrations through the sheet material such as ductwork or wiring.
- Chases (for flues, etc.): Prevent air leakage through these bypasses with sheet materials and sealants. Use fire-rated caulk around flues.

SPACE AND WATER HEATING

Typically, older homes in many urban areas throughout the Northeast and Mid-Atlantic U.S. have hydronic baseboard heating (Fig. 29) and no air conditioning. The space and water heating equipment, often located in the unconditioned basement, typically complies with only the minimum energy efficiency standards and is atmospherically vented. This guide does not address those homes that have forced air systems that utilize ductwork for heating and/or cooling. The mechanical equipment selected will affect both the energy efficiency and indoor air quality of the home.

Traditionally, atmospheric combustion equipment relied on the natural movement of warm air up a chimney (Fig. 30). Because more efficient equipment conserves energy, it does not send as much heat up the chimney; thereby weakening the natural exhaust process. Rehab projects will likely include the installation of new space and water heating equipment and other appliances that burn fuel as a power source, such as clothes dryers. If not properly vented, combustion products (e.g., carbon monoxide gases) might be drawn back into the home. This process is called backdrafting, and it can be hazardous to the health of the

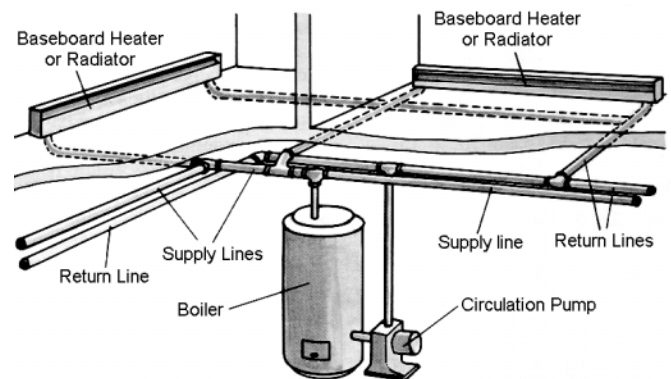


Fig. 29: Hydronic system



Fig. 30: Atmospheric boiler typically found in older homes

occupants. Backdrafting is easily avoided by the proper selection, installation, inspection, and maintenance of combustion equipment and appliances (Fig. 31).

Note: Mechanical ventilation systems must be properly designed to prevent backdrafting, as discussed in the following section.

Energy- and Resource-Efficient Strategies

To provide higher energy efficiency and help avoid problems that might result from the process of combustion, including backdrafting or faulty equipment, specify power- or direct-vented combustion equipment. Like atmospheric equipment, power-vented appliances draw their combustion air from the living space. However, a fan is used to assist with the venting of combustion gases, minimizing the potential for backdrafting while the burner is firing. Direct-vent or closed-combustion units bring combustion air directly into the burner via a sealed inlet connected to the outside and use a fan to vent the exhaust gases through a sealed outlet directly to the outside. Power- and direct-vented space and water heating equipment are more energy efficient, cost less to operate, and have a higher assurance of safety than non-direct vent appliances.

Combination appliances are available that provide both space conditioning and hot water heating using one piece of equipment (Fig. 32). A boiler with an indirect tank for domestic hot water storage can also be used. These options reduce the number of combustion appliances that must be purchased, installed, and vented. This may help offset the higher first cost of the more efficient equipment.

Proper Ventilation of Combustion Equipment and Appliances

As discussed, sealed combustion equipment draws its combustion air directly from the outside. Combustion products are also exhausted directly to the outside. The air intakes and exhaust are sealed off from the inside of the home. This significantly reduces the chance for any spillage of combustion products into the home. Induced draft or power-vented appliances rely on air in the home for combustion but use a fan to force pollutants out of the home.

If atmospheric combustion equipment is used, it should be tested to be sure that it functions properly. A Worst-Case Depressurization Test can be conducted. This combustion safety test determines if any non-sealed combustion appliances will backdraft or spill combustion products into the living space. This test should use an established procedure such as Appendix D of the International Fuel and Gas Code or ASTM E1998 “Guide for Assessing Backdrafting and Spillage from Vented Combustion Appliances.”

Existing fireplaces and wood stoves should be carefully assessed as part of the rehab plan. Chimneys and flues must be in good condition in order to safely vent products of

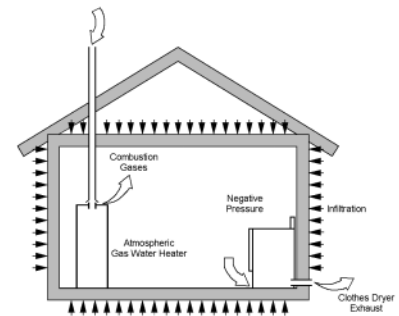


Fig. 31: Negative pressure created in the home can lead to backdrafting.



Fig. 32: An example of a combination appliance

combustion. Careful assessment will allow contractors to determine whether flue cleaning or replacement is necessary. Since fireplaces are a source of air infiltration, ensure that the damper is working properly.

MECHANICAL VENTILATION

Mechanical ventilation is commonly used for local control of moisture and odor, including exhaust fans in kitchens and baths. More recently, studies have shown the impact of poor indoor air quality on health, comfort, and durability. The desire for increased energy efficiency has led to improvements in the envelope of the home and a corresponding decrease in the amount of fresh air infiltrating into the home. This creates the need for a mechanical ventilation system to ensure adequate indoor air quality.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recently released a standard governing residential ventilation. For further information on residential ventilation system design, refer to *ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*. The following information is taken from *ASHRAE Standard 62.2* and is intended to provide a brief summary of the major recommendations in the standard.

Local Exhaust

Install a local mechanical exhaust system (Fig. 33) in each kitchen and bathroom. This system can be designed to run continuously or intermittently. A continuously operating mechanical exhaust system is installed to operate without occupant intervention, with a readily accessible occupant override control. An intermittently operating local mechanical exhaust system is designed to be operated as needed by the occupant.

Kitchen exhaust ventilation is used to remove odors and excess moisture associated with cooking. While there are various ventilation strategies for kitchens, a range hood is the most common. The range hood should be vented directly to the outside and sized correctly. For a typical kitchen range, *ASHRAE Standard 62.2* and the Home Ventilation Institute (HVI) recommend a design airflow of 100 cubic feet per minute (cfm).



Fig. 33: Local exhaust system

Similarly, each bathroom requires exhaust ventilation to remove moisture and odors. The simplest and least expensive option is to install an exhaust fan with a crank timer. When designed for intermittent operation, each bathroom should have a ventilation system capable of exhausting a minimum of 50 cfm.

Clothes Dryers

Clothes dryers should always be vented to the outside. In addition to combustion products produced by gas dryers, all dryers generate large amounts of moisture and particulates, which should be vented out of the house.

Whole-Building Ventilation

Older homes have hundreds of penetrations through their exterior. These gaps are often created during framing and from penetrations for wiring, plumbing, and ducts. Outdoor air that leaks indoors makes it difficult to maintain comfort and energy efficiency. In a typical home, air leakage accounts for 25-40% of the energy used for heating and cooling. Sealing a home to reduce air infiltration, combined with proper ventilation, not only reduces energy costs but also improves the quality of indoor air.

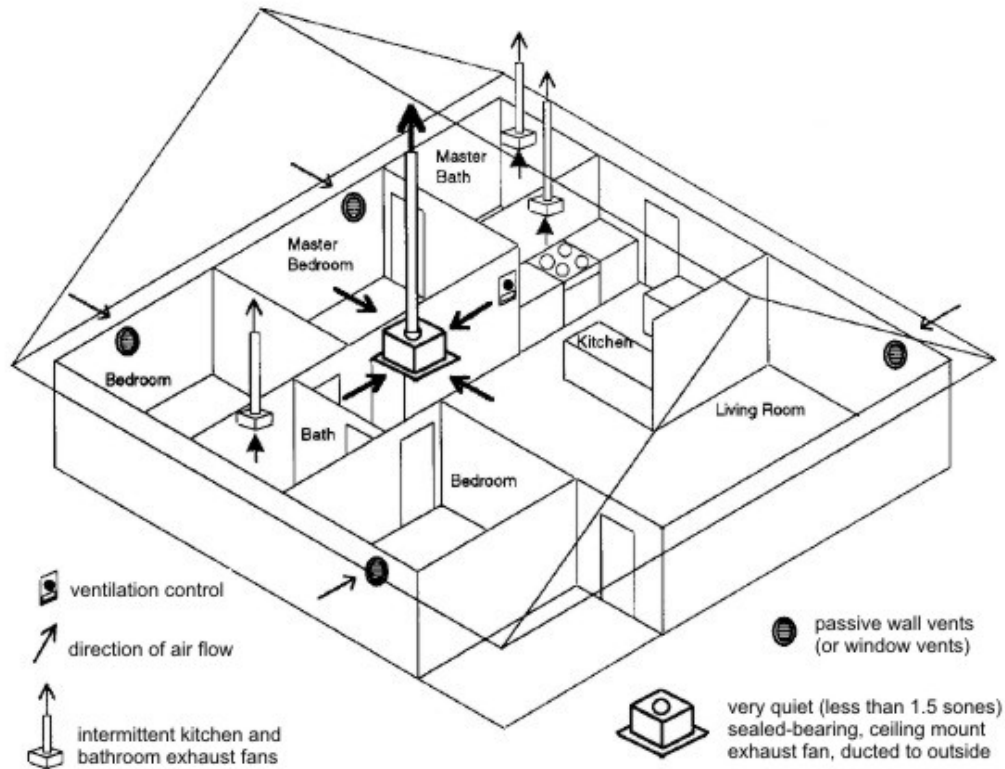


Fig. 34: Exhaust only mechanical ventilation

Where tighter construction reduces air leakage, active mechanical ventilation systems must be incorporated to provide fresh air. An “exhaust only” ventilation system is the simplest and most affordable ventilation system and is recommended for Habitat rehab projects (Fig. 34). In this system, indoor air is removed from the home by a high-efficiency fan, typically located in the bathroom. This fan may run continuously or according to a controlled schedule. As air is exhausted by the ventilation fan, a negative pressure is created in the home. As a result of this pressure differential, fresh outdoor air is drawn into the home through any remaining gaps.

Typically, builders upgrade the main bath fan in the home to provide the “exhaust only” ventilation system. A standard bath fan is replaced by a fan designed to run quietly, operate more efficiently, and exhaust a larger amount of air. Select a fan that has a low sone rating, which is a measure of the noise level generated by the fan. If the fan is noisy, the

homeowner is likely to avoid operating it frequently enough to provide adequate fresh air. Choosing an energy-efficient fan is also important. Homeowners will be less willing to run the fan if it results in a large increase in the electric bill. In addition to this fan, manually operated fans should be located in the kitchen and any additional bathrooms to provide local exhaust, as discussed above.

Care must be taken to prevent backdrafting. Combustion appliances must be provided with adequate combustion air. To ensure safety, this guide recommends the use of power- or direct-vented combustion appliances. If atmospherically vented combustion appliances are installed, a Worst-Case Depressurization Test should be conducted as discussed in the previous section on Proper Ventilation of Combustion Equipment and Appliances.

When installing a ventilation system, attention must also be paid to garages that adjoin the occupied space. Doors should be gasketed with weather stripping or similar materials to prevent contaminants from being drawn into the home. Any other penetrations should also be tightly sealed.

LIGHTING AND APPLIANCES

Lighting and appliances can account for 20% to 40% of a home's energy use. After heating, cooling, and hot water heating equipment, refrigerators are among the largest energy consumers, accounting for approximately 5% of total energy consumption in U.S. households. Dishwashers can also consume a great deal of energy, mostly in heating water. Other energy-demanding appliances include, but are not limited to, ovens, clothes washers, room air conditioners, and dehumidifiers.

Energy- and Resource-Efficient Strategies

Improvements in appliances and lighting have resulted in models that are more energy efficient and cost competitive compared to conventional models. For example, most energy-efficient models use 10% to 50% less energy and/or water than standard models. ENERGYSTAR-labeled lighting and appliances help consumers shop for more efficient products. It is recommended that the purchase and installation of ENERGYSTAR appliances be part of every rehab project.

Lighting

Nearly 90% of the energy used for incandescent lights (the type normally used in homes) is converted to heat, adding to the air-conditioning load. Recessed lights that are not air-tight can increase heating and cooling costs due to increased air leakage. Energy-efficient alternatives include air-tight recessed light fixtures (which can reduce air leakage and reduce moisture problems associated with air leakage) and fluorescent lamps and fixtures (which will reduce internal heat gain and cut the cooling load). Fluorescent lamps are about three to five times as efficient as standard incandescent lamps and last about 10 to 20 times longer. Technological advances, especially in electronic ballasts, have eliminated the flicker and hum often associated with fluorescents. Also, improved fluorescent lamps produce light qualities very similar to that of incandescent lights.

Installation of fluorescent and energy-efficient light fixtures and ceiling fans is similar to that of conventional models. Screw-base compact fluorescent lamps (CFLs) can be used in retrofits to replace incandescent lamps in conventional fixtures (Fig. 35). Note that CFLs emit electromagnetic frequency wavelengths, which can interfere with signals to television and radio. For this reason, manufacturers recommend positioning these lamps at least 8' away from such devices. There has been concern that the disposal of fluorescent components may allow toxic chemicals into our environment. Polychlorinated biphenyls are associated primarily with magnetic ballasts, but all fluorescent lamps contain mercury. Alternatives include low-mercury lamps and lamp recycling.



Fig. 35: Compact fluorescent light bulb (left) replaces a standard incandescent bulb (right)

One should also design to maximize natural lighting while giving proper consideration to heat loss or gain that might result from using windows or skylights.

Appliances

ENERGYSTAR appliances are recommended for all rehab projects. To maximize energy-efficiency, consider installing models with the following features:

- Refrigerator: Top freezer model, 18.5 cu.ft. or smaller, with manual defrost.
- Dishwasher: Model with booster heater (allows the homeowners to lower their water heater temperature) and air-drying option.
- Clothes Washer: Front loading, horizontal axis model (uses less water and electricity).
- Clothes Dryer: Natural gas model with automatic shut-off (shuts off once the dryer detects that the clothes are dry) and moisture sensor.
- Range/Oven: Natural gas model with an electronic pilotless ignition.

Installation of energy-efficient appliances is similar to that of conventional appliances. If possible, do not locate refrigerators near stoves, ovens, or dishwashers, or in direct sunlight.

PLUMBING & PLUMBING FIXTURES

Most water supply and distribution systems in older and historic homes are galvanized or lead pipes. If copper pipes are present, most likely there is lead in the solder. Drain, waste, and vent (DWV) pipes are typically cast iron with lead and oakum joints. In addition, the existing plumbing fixtures are usually pre-1992, when the Energy Policy Act (EPACT) was enacted. EPACT defines the maximum water usage requirements in commercial, institutional, and residential facilities, including fixture performance requirements: toilets (gallons per flush) = 1.6; showerheads (gallons per minute) = 2.5; faucets (gallons per minute) = 2.5; replacement aerators (gallons per minute) = 2.5. Refer to the Resources section of this guide for a link to EPACT.

Fixture/Fitting/Appliance Water Use

Fixture/Fitting/Appliance	Water Use (gallons per)
Vintage Toilet*	4-6 flush
Conventional Toilet**	3.5 flush
Low Consumption Toilet***	1.6 flush
Conventional Showerhead*	3-10 min
Low-Flow Showerhead	2-2.5 min
Faucet Aerator*	3-6 min
Flow Regulating Aerator	0.5-2.5 min
Top-Loading Washer	40-55 load
Front-Loading Washer	22-25 load
Dishwasher	8-12 load

*Manufactured before 1978

** Manufactured from 1978 to 1993

*** Manufactured since January 1, 1994

Common plumbing and fixture problems and symptoms include:

- Failed joints
- Low water pressure
- Corroded or broken pipes
- Condensation on cold-water pipes
- Leaks and slow drainage
- Nonworking drains
- Dry traps
- Non-existent vent system
- Odors

Lead contamination of the water supply is a major problem with older systems. In most cases, it is more cost-effective and safer to replace the entire water system and bring it up to code. DWV systems, if functioning properly, could be kept or repaired. The nature of plumbing problems is complex, so a thorough inspection and evaluation is advised.

Energy- and Resource-Efficient Strategies

Water Supply and Distribution Systems

Plumbing Manifold System and Cross-Linked Polyethylene (PEX)

While copper piping is popular and relatively easy to use, PEX piping, used in conjunction with a manifold water distribution system, is cost effective and volunteer friendly. Manifold plumbing systems use control centers for hot and cold water that feed the PEX supply lines to individual fixtures (Fig. 36). Plastic manifolds with PEX piping can be installed more quickly (and by volunteers) than rigid plumbing systems with fewer fittings and without the need for piping tees and elbows. By downsizing supply piping, water velocity is increased and delivery of hot water to fixtures is faster. Heat loss in the piping may be less than that in a copper system because plastic has better thermal insulating properties. Also, maintenance is relatively simple with plastic manifolds because valves at the manifold for each fixture line permit individual fixture control, shutoff, and maintenance.



Fig. 36: Manifold water distribution system

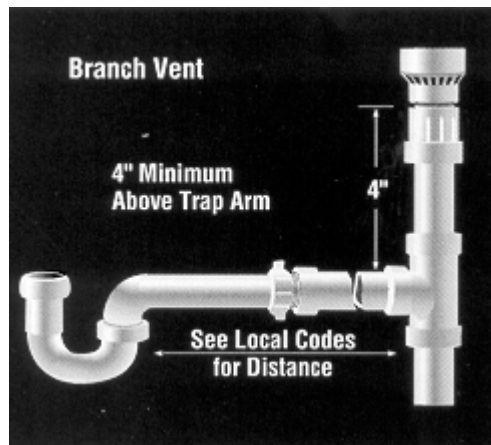
Drain, Waste, and Vent Systems

Air Admittance Valves (AAVs)

AAVs are pressure-activated, one-way mechanical venting ports used in a plumbing system to eliminate the need for conventional pipe venting and roof penetrations (Fig. 37). They should be considered if a vent stack has to be relocated or repaired, or if a new one has to be installed due to a change in existing layout.



Fig. 37: Air Admittance Valve



Wastewater discharges cause the AAV to open, allowing air to circulate for proper drainage. When not in operation, the valve remains closed, preventing the escape of sewer gas and maintaining the trap seal. Using AAVs can significantly reduce the venting materials needed for a plumbing system, increase plumbing labor efficiency, allow greater flexibility in the layout of fixtures, and reduce long-term maintenance problems where conventional vents break the roof surface.

Plumbers commonly install AAVs using conventional tools. The larger units can serve multiple fixtures. They are attached to 2" or 4" vertical lines in place of a vent stack in the attic or in a wall accessed by a recessed plastic box. Some manufacturers make units for interior use only; others offer insulating collars for exterior use. The smaller single-drain vents come with tapered threaded connectors that allow chemical welding to 1½" or 2" pipe. Adapters are available for 1¼" pipe diameter. Single AAVs are often placed on drain lines inside cabinets below sinks, between the trap and the wall. The location must be accessible, and in a space where air can move freely. Devices are compatible with both PVC and ABS piping.

Although air admittance valves can eliminate the need for multiple roof vents, one fresh air vent per structure is usually required, especially when used with a septic system.

Manufacturers supply exact installation guidelines and sometimes offer software and/or design assistance for laying out the system.

Plumbing Fixtures

Unless existing plumbing fixtures are in excellent condition and post-1992, replace them with new plumbing fixtures that meet or exceed EPACT requirements.

- Toilet: Install low-flow toilet, air induced (1.6 gallons per flush or less)
- Faucet: Install faucets with low-flow faucet aerators (2.5 gallons per minute or less)
- Showerhead: Install low-flow showerhead (2.5 gallons per minute or less)

Note that water distribution systems have historically been used for grounding electrical systems. Please keep this in mind during rehab work, and restore or provide for this important safety requirement.

Resources

The Web site addresses provided below are hyperlinked. You can visit each Web site by clicking on the underlined Web site address highlighted below.

CHAPTER ONE: THE ENERGY- AND RESOURCE-EFFICIENT RETROFIT PROCESS

State Energy Offices

<http://www.builtgreen.org/sites/state.asp>

CHAPTER TWO: HEALTH CONCERNS, HISTORIC CONSIDERATIONS, AND ACCESSIBILITY

HEALTH CONCERNS

Lead-based Paint

www.epa.gov/opptintr/lead/leadsafetybk.pdf

Asbestos

www.epa.gov/asbestos/

Radon

www.epa.gov/iaq/radon/

Mold and Moisture

www.epa.gov/iaq/molds/moldresources.html

HISTORIC CONSIDERATIONS

Advisory Council on Historic Preservation (ACHP)

www.achp.gov

National Conference of State Historic Preservation Officers (NCSHPO)

www.ncshpo.org

National Trust for Historic Preservation

www.nationaltrust.org

ACCESSIBILITY

Fair Housing Laws and Presidential Executive Orders

www.hud.gov/offices/fheo/FHLaws/index.cfm

Concrete Change – Making All Homes Visitable
www.concretechange.org

CHAPTER THREE: DURABILITY

Site

Low Impact Development Center
www.lowimpactdevelopment.org

PATH Technology Inventory
www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1291&Type=

Foundation

PATH Technology Inventory
www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1286&Type=

Finishes

Evaluating and Selecting Green Products by John Amatruda
Whole-Building Design Guide, January 2004.
www.wbdg.org.

Guide to Resource Efficient Building Elements by Tracy Mumma. National Center for Appropriate Technology's Center for Resourceful Building Technology, Missoula, Montana. Extensive listings of environmentally preferable products and manufacturers, primarily for residential construction.
<http://www.crbt.org/>

Oikos® Green Building Source - Green Product Information
<http://www.oikos.com/products/>

GreenSpec™ - The Environmental Building News Product Directory
<http://www.greenspec.com/>

PATH Technology Inventory
www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1312

CHAPTER FOUR: ENERGY- AND RESOURCE-EFFICIENT RETROFIT STRATEGIES

Framing and Roofing

DOE Advanced Framing Fact Sheet
www.eere.energy.gov/buildings/documents/pdfs/26449.pdf

Residential Construction Waste Management: A Builder's Field Guide by Peter Yost and Eric Lund. National Association of Home Builders Research Center, January 1997.
<http://www.nahbrc.org/>

PATH Technology Inventory -- Framing

www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1284&Type=

PATH Technology Inventory - Interior Partitions

www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1313

PATH Technology Inventory - Roofing

www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1290&Type=

Cool Roof Rating Council

www.coolroofs.org

Cool Roofing Materials Database

<http://eetd.lbl.gov/coolroof/>

Windows

Windows & Glazing by Gregg Ander

Whole-Building Design Guide, June 2003

www.wbdg.org

Department of Energy's Efficient Windows Collaborative

www.efficientwindows.org

PATH Technology Inventory

www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1282&Type=

Insulation and Air Sealing

ZIP-Code Program for Insulation

www.ornl.gov/roofs+walls/insulation/ins_05.html

Buildings for the 21st Century Fact Sheet: Air Sealing

[http://eber.ed.ornl.gov/DOE air sealing%20GO-10099-767.pdf](http://eber.ed.ornl.gov/DOE_air_sealing%20GO-10099-767.pdf)

Energy Checklist prepared by Southface Institute for U.S. Department of Energy.

www.southface.org/home/sfpubs/techshs/cheklist.pdf

Energy Efficiency in Remodeling: House Air Leakage.

Prepared by NAHB Research Center with support from the U.S. Department of Energy and the National Renewable Energy Laboratory.

www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1528&DocumentID=2299

Space and Water Heating

PATH Technology Inventory

www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1318

Mechanical Ventilation

PATH Technology Inventory

www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1311

Lighting and Appliances

Energy Efficient Lighting by David Nelson
Whole-Building Design Guide, October 2003
www.wbdg.org

American Council for an Energy-Efficient Economy (ACEEE)
www.aceee.org

PATH Technology Inventory
www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1280&Type=

Plumbing and Plumbing Fixtures

PATH Technology Inventory
www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1289&Type=

GENERAL RESOURCES

“Whole Building” Design Approach
www.sbicouncil.org/about/wholeBld.html

Habitat for Humanity International - PartnerNet
Rehab resources, including the National Partners listing, the Rehab Workshop Handout, and the Inspection Report, can be found by clicking “Jump To Construction/Environment” under “HFHI Department Info,” then “Construction Resources” listed under “Resources,” and then “Rehab Resources” in the table.
www.partnernet.habitat.org

Habitat for Humanity International, Construction and Environmental Resources
Department
<http://www.habitat.org/env>

PATH (Partnership for Advancing Technology in Housing)
www.pathnet.org

TOOLBASE
www.toolbase.org

GreenHOME
www.greenhome.org

Home Remodeling Green Building Guidelines
www.globalgreen.org/pdf/remodeler.pdf

Green Building Guidelines: Meeting the Demand for Low-Energy, Resource-Efficient
Homes www.sbicouncil.org

Home Rehab Handbook: Techniques for Home Renovations
www.swinter.com

Green & Lean—Design and Building an Affordable, Resource-efficient Home.
GreenHOME, 2000.
www.greenhome.org

Whole-Building Design Guide (WBDG)
www.wbdg.org

Energy Codes and Standards by Martha VanGeem. Whole-Building Design Guide, June 2003.
www.wbdg.org

Energy Policy Act of 1992
http://energy.navy.mil/publications/law_us/92epact/hr776toc.htm

American Society of Heating, Refrigerating and Air-Conditioning Engineers
www.ashrae.org

Building America's Top 25 Web Sites for Home Builders and Home Buyers of Energy-Efficient Homes

Advanced Energy Corporation: www.advancedenergy.org/buildings/ - Great publications, particularly "Building Solutions On-line" and "High Performance Homes."

Building Science Corporation: www.buildingscience.com - Building America (BA) team leader with a newly revised Web site. Lots of practical text and graphic resources on energy-efficient design and construction, particularly under "Houses That Work" and "Case Studies."

DOE's Building America: www.buildingamerica.gov - Lots of good information, particularly under "Additional Resources."

Canada Mortgage and Housing Corporation: www.cmhc-schl.gc.ca/en/index.cfm? - Lots of quality information and technical resources for cold climates for both builders and home buyers/owners.

Consortium for Advanced Residential Buildings (CARB): www.carb-swa.com/ - BA team leader, Steven Winter Associates. Check out their "Projects" and "CARB-News."

Energy & Environmental Building Association: www.eeba.org - This is the trade organization for energy-efficient builders. Especially go to "Building Info Central" and "Communications."

Environmental Building News: www.buildinggreen.com/ - Lots of news stories and feature articles offered on-line that deal with energy efficiency in design and construction.

DOE's Efficient Windows Collaborative: www.efficientwindows.org/ - Great resources on why and how to select high performance, climate-tuning glazing.

DOE's Energy Efficiency and Renewable Energy Network Building Technologies: www.eren.doe.gov/EE/buildings.html - Lots of highly technical resources for both commercial and residential building, but also some energy basics for consumers.

EPA's ENERGYSTAR: www.energystar.gov/ - Really good product-specific information on high performance appliances and lighting for the home.

Hickory Consortium: www.hickoryconsortium.org/ - Has web resources currently under development representing their work under the Building America program.

Home Energy magazine (on-line resources): www.homeenergy.org/ - All past issues of this great publication are on-line. Good technical information for both builders and consumers.

Integrated Building and Construction Solutions (IBACOS): www.ibacos-ba.com/index.html - BA team leader, IBACOS, posts their builder case studies under "Publications."

Industrialized Housing Partnership: www.fsec.ucf.edu/ - BA team leader, Florida Solar Energy Center, has excellent technical resources, particularly on energy efficiency for hot, humid climates.

Iris Communications, Inc.: www.oikos.com/ - One of the oldest and best commercial sources of publications, products, and news on resource and energy efficiency.

HUD's Partnership for Advancing Housing Technology: www.pathnet.org/ - Great resource for builders on technology and building components/systems. Go to "Inventory."

NAHB Research Center: www.nahbrc.org/ - Key programs with builder resources include: ToolBase, Energy Value in Housing Award, and "Research."

Southface Institute: www.southface.org/ - Southface Institute is a BA partner, posting great resources under "Journal" and "Fact Sheets."

National Renewable Energy Lab: www.nrel.gov/buildings_thermal/buildings.html#residential - NREL does a wide range of work on energy efficiency, but this section of their Web site is dedicated to excellent technical resources for builders, particularly on renewable energy systems and energy analysis and building evaluation.

Sustainable Buildings Industry Council (SBIC): www.sbicouncil.org/home/index.html - National resource clearinghouse for whole-building design, product information, professional training, consumer education, and analytic tools.

ACEEE: www.aceee.org - The American Council for an Energy-Efficient Economy is a non-profit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection.

Incentive Insulation Database: www.simplyinsulate.com - An on-line searchable database for access to local information on incentive programs for making energy-efficient improvements. This Web site was created and is maintained by North American Insulation Manufacturers Association (NAIMA).

Building Energy Codes: www.energycodes.gov/ - Your resource for tools to facilitate energy code compliance, development, adoption, implementation, and enforcement.

ZIP-Code Program for Insulation: www.ornl.gov/roofs+walls/insulation/ins_05.html - A computer program is available to help you calculate the amount of insulation appropriate for your house. The program is called the ZIP-Code because it includes weather and cost information for local regions defined by the first three digits of each postal service zip code.

Appendix A

Habitat / National Partnerships and Free & Discounted Product Information

Habitat / National Partnerships and Free & Discounted Product Information

Revised November 11, 2003

The following are partnerships that have been solicited by the Corporate Programs department at HFHI on behalf of the affiliates to assist you in your building programs.

Please be aware that these companies are a valuable resource for Habitat affiliates by providing free and deep discounted products and services. In addition, these companies provide a greater awareness of Habitat and its mission through their marketing and advertising efforts. Your *'Thank You'* messages to these corporations and recognition of their national partnership support in your local publications and house signage will help to ensure that these companies continue their support.

National Partnerships is an avenue for companies to serve many more affiliates with products and services, not just a few within their immediate area of operation. The partnerships are set up through the Corporate Programs office and individual staff members maintain the corporate accounts. For information on any of the partnerships call Rindall Dunston at 1-800-422-4828 ext. 2851 for the appropriate corporate representative.

PartnerNet will play a significant role in providing affiliates with information about existing and new partnership. Please consult PartnerNet for the latest information on the programs that are available.

Thank you for your cooperation.

NATIONAL PARTNERSHIP-PRODUCT AVAILABILITY

Please follow the contact procedures listed below to obtain these products.

FREE PRODUCTS

The Dow Chemical Company

Dow has been a partner since 1987 and will provide FREE Dow Styrofoam Brand Insulation products
Affiliate Access: Call the Dow Chemical Customer Information Group at 1-800-441-4369 and request information on Element # 408.

Hunter Douglas, Inc.

Hunter Douglas has been a partner since 1992 and through their generosity has provided thousands of sets of custom aluminum mini blinds across the US. They have renewed their partnership and will be provide free blinds for bedrooms and bathrooms only for all new and rehab home construction. No orders for existing homes will be filled. Blinds will be available for purchase for other areas of the house at cost. Hunter Douglas now offers customer service to our affiliates for status inquiries on all over due orders. Please call Kimberly Cooley at 1-800-333-2458 ext. 3043 to make inquiries. **Affiliate Access** Affiliates can download the order forms from partnetnet, questions should be directed to Rindall Dunston at 1-800-422-4828 ext. 2851.

Larson Manufacturing Company

Larson has been a valued partner of Habitat since 1992 providing storm/screen doors for affiliates in the US. Larson also offers doors for existing homes for a modest price. Please follow all ordering instructions carefully and please do not ask for product other than that offered in the partnership. Larson now offers customer service to our affiliates for inquiries of past due orders. Please call Todd Schultz at 1-800-334-1328 ext. 6028 to make inquiries. **Affiliate Access:** Affiliates can download the order forms from partnetnet, questions should be directed to Rindall Dunston 1-800-422-4828 ext. 2851

Whirlpool Corporation (UPDATED INFORMATION)

Starting July 1st, 2001, Whirlpool is donating an 18 cu ft Energy Star® refrigerator and a 30" gas or electric freestanding standard-clean range (color: white only) for all new and rehabed Habitat homes in the continental U.S. and Canada. **New! ADA provision:** Whirlpool is pleased to announce a provision for Americans with Disabilities. When a family has special needs, Whirlpool will apply the value of the donated Refrigerator and/or Range to the cost of ADA compliant products. The ADA compliant appliances are indicated on your newest model/price sheet. Your Affiliate will be invoiced for the difference in cost.

Special Habitat pricing for any additional appliances that a homeowner may wish to purchase is available from Whirlpool. All purchases from Whirlpool are Net 30 and no terms are extended to affiliates or homeowners.

Requesting a new account: If your Affiliate has not applied for an account, please contact Whirlpool at 800-634-9621, and choose option 2 then option 5. If you have internet access our web-site www.whirlpool.com provides general product information, and the [Habitat for Humanity](#) link provides additional details about the Whirlpool/Habitat partnership. **Please Note: This updated information was mailed to all affiliates and regional offices in July, 2001 and is also posted on PartnerNet.**

Square D Company

Square D is a market-leading supplier of electrical distribution, industrial control and automation products, systems and services. Square D has partnered with Habitat for Humanity International to provide load centers and circuit breakers for all homes built in US, Canada and Mexico through 2004. Square D is providing 100, 125, 150 and 200 amp service load centers with appropriate breakers. **Affiliate Access:** Affiliates should have received a packet in the mail containing an order form and instruction sheet. Affiliates can also download the order forms from Partnernet.

Yale Residential Security Products, Inc. An ASSA ABLOY Group Company

ASSA ABLOY, the world's leading lock company, has committed to a five-year partnership with Habitat for Humanity. Yale Residential Division of ASSA ABLOY will provide the interior and exterior locksets for all Habitat homes built in the US and Canada. **Affiliate Access:** Affiliates should have received a packet in the mail containing an order form and instruction sheet. Affiliates can also download the order forms from Partnernet.

Lafarge Corporation

Lafarge Corporation, and its wholly owned subsidiary Lafarge Canada Inc., have entered into a partnership with Habitat for Humanity International to provide the following materials: cement, concrete, aggregates, gypsum wallboard and/or asphalt to selected affiliates in their service area.

Affiliate Access: GYPSUM WALLBOARD: Gypsum Wallboard is available for all affiliates within the Lafarge Gypsum division's service area. For specific areas of availability by state, please see order instruction form below. Please note that delivery within the service area is free of charge to an HFH warehouse. Distribution through local re-sellers may be at a nominal charge to the affiliate. See instruction form for other specific products and ordering information. **Concrete, cement, and other materials.** Due to transportation limitations Lafarge is being matched up with affiliates in their service area. Lafarge facilities will contact affiliates directly.

Valspar

The Valspar Corporation, building on its long-time support of local Habitat for Humanity affiliates, has made a multi-year commitment to donate paint for all Habitat for Humanity affiliates across the US. Affiliate access: Affiliates may download order forms and product information from PartnerNet. Please note minimum order quantities apply and affiliates are encouraged to cooperate in aggregating orders where possible.

LIMITED PRODUCT AVAILABILITY

OSI Sealants, Incorporated

Affiliates may contact distribution centers and regional warehouses to find out if product is available. OSI provides caulk and adhesive for Habitat building and have been a partner since 1994. **Affiliate Access:** Americus Warehouse and various affiliate warehouse distribution locations. No direct access. Product is dropped shipped to select distribution warehouses.

Eaton Corporation

Eaton Corporation provides load centers and circuit breakers to affiliates located in cities in the United States where they have a corporate presence, i.e. Eaton or Cutler-Hammer facilities. Load centers are available in 100, 150, & 200 amp models with appropriate breakers, including ground fault and arc fault. Allow at least 30 days for delivery. **Affiliate Access:** For a listing of corporate locations and the new 2001 Order Form, please contact Rindall Dunston via email at rdunston@hfhi.org or call 229-924-6935 ext. 2851, fax: 229-928-2697.

DISCOUNTED PRODUCTS and SERVICES

The following companies have agreed to provide their products or services to Habitat affiliates at special discounted prices. Products are available based on the companies areas of distribution and may not be available to all affiliates.

ICI Paints – manufacturers of such brands as Glidden, Dulux, and Ralph Lauren provides donations of paints in certain metropolitan markets, with a discount program on paint and other products available to all affiliates. **Affiliate Access:** Affiliates in the donation programs will be notified directly – all affiliates may contact their local ICI Paints store for access to discounted paint. Affiliates may download complete descriptions from partnernet; questions should be directed to Derrick Morris at 1-800-422-4828 ext. 2721.

EFI – Energy Federation, Inc.

EFI has provided special Habitat pricing for Panasonic exhaust fans in three configurations – fan only, fan/light unit, and through wall fan. Information on the products can be found on Partnernet. To place an order or for more information, please call: 800-876-0660 or if you are in Wisconsin, call 920-757-6793.

Ferguson Enterprises

Ferguson Enterprises, Inc. is one of the leading distribution companies serving a variety of markets and product lines. Ferguson offers building products in plumbing, lighting fixtures (indoor/outdoor), ceiling fans, bath and shower fixtures, HVAC, pipe, valve, and fitting materials. Ferguson has established a competitive national pricing structure for Habitat affiliates and can work with almost any location on a local basis. To find the nearest Ferguson branch simply log on to: www.ferguson.com and click on the Locations icon and enter your zip code and select Search feature. Ferguson has over 500+ locations operating in 42 states, Puerto Rico and Mexico, with over 8000 associates. **Affiliate Access:** Affiliates must contact local Ferguson branch office to set up their account. If you have questions on the program, please contact Rindall Dunston at 1-800-422-4828 ext 2851

S & S Carpet

Offering carpet and padding and Tarkett-sheet vinyl at reduced prices.

Affiliate Access: Call S & S Carpet at 800-403-9885 and ask for Contract 7177

Shelter Supply, Inc. <http://www.sheltersupply.com>

Shelter Supply has been involved in the evolution of housing since 1980. Shelter Supply has been providing the products, technology and training to build energy efficient, healthier homes. They provide sustainable housing options that provide a safe and healthy living environment while, reducing the impact on the environment through less consumption of energy and natural resources. For special Habitat discounts, additional product information, or to receive a catalog, call Dietz Engler, Account Representative at Shelter Supply - 800-762-8399.

Telpro, Inc

Provides a deep discount on returns and demo units of their Panellift Brand Wallboard Lift Model 138-2 suitable for walls and ceilings up to 15 feet high. All units are fully warranted and are sold "like new." The special Habitat price is \$500.00 per unit including Fed-Ex ground shipping anywhere in the USA (price subject to change). Availability may be limited at certain times due to fluctuations in stock. **Affiliate Access:** Contact Telpro directly. Payment must be by affiliate check. Contact Dewey Lindgren, Customer Service Coordinator, Telpro, Inc., 7241 South 42nd Street, Grand Forks, NC 58201, Phone 1-800-448-0822, Fax: 800-474-9993. www.telproinc.com

CompuMentor

(<http://www.compumentor.org>)

CompuMentor is a San Francisco based nonprofit organization whose services include matching IT volunteers with Bay Area nonprofits, technology consulting, and distributing deeply discounted Microsoft software nationally. Visit the Web site for software listing and instructions on how to order. To receive free updates to software listings as well as CompuMentor's other services, subscribe to Connect & By the Cup at <http://www.compumentor.org/about/publications.html>.

CONTROLLED ENERGY CORPORATION

www.controlledenergy.com

340 Mad River Park
Waitsfield, Vermont 05673
USA

866-330-2725

Fax: **802-496-6924**

Controlled Energy Corporation is the nation's leading distributor of energy efficient tankless hot water heating technology. CEC has established a significant national discount purchase program for Habitat affiliates.

Shown below are specifications, prices, and shipping information for many of the tankless water heaters supplied by Controlled Energy Corporation. For more information from CEC directly, please contact Kyle Murray, Vice President of Marketing, 802 496 4436, ext. 1022, or by email: kylem@controlledenergy.com.

For information from Habitat for Humanity, for ordering information please contact Rindall Dunston at x2851, for technical information please contact Jennifer Langton at x2333

Special Affiliate Request

If you know of any companies that are offering special pricing to Habitat affiliates in your region, or nationally, please e-mail the information to: Derrick Morris, Director, Product Partners: dmorris@hfhi.org or fax the information to 229-928-2697.

Confidential Information: *Please remember that special pricing is provided solely for Habitat for Humanity International affiliate projects and not intended for any other use. Please do not share any special Habitat pricing with any vendor, distributor, or re-seller of the donated or discounted products.*

(end of listing)

Appendix B

REHAB WORKSHOP HANDOUT

REHAB WORKSHOP HANDOUT

Drew Cathell

Often our experiences, or those of others, have biased us against rehab as a viable part of Habitat. It would appear that one of our goals has become "eliminate poverty shelter without doing rehab". There is no doubt that rehab is more demanding than building new. But building new houses was more demanding than just talking about the problem of shelter. If rehab is actually the path to achieve our goals we must discover that and learn to do it well.

Our stated goal of eliminating poverty shelter becomes more complex as we begin to apply it to the community in which we work. We begin to add concerns like being stewards of the current housing stock, getting the most out of donated funds, finding homes suitable for larger families, maintaining the architectural style of the neighborhood without spending funds for "unnecessary" details, setting an example for other individuals and organizations to follow and keeping our efforts in a focused area. All of these things become part of our goals and rehab can help us accomplish them, in many cases better than new.

For this reason it is important to clarify your affiliate's goals. If your goals lead to rehab as a viable option, it is important to learn to do it well.

WHAT ARE OUR GOALS FOR A HABITAT HOME?

- Decent shelter
- Affordable payments
- Manageable future costs
- Training for future care
- Worthwhile use of volunteers

DECENT SHELTER

Defining Decent

We list every aspect of a home and define what condition they must be in to achieve our goals for decent, affordable and maintainable housing. They are typically written by the building committee and submitted to the board for review, refinement and acceptance. These standards can be tailored to meet varying needs and should be refined as they are used to increase clarity.

It really isn't as hard as it seems. Simply state what you feel is a critical aspect of a decent home and keep writing those things down until someone disagrees with you. When people disagree with you, be sure to ask and answer why you feel as you do. Understanding why someone feels the way they do provides more opportunity for creating consensus than simply knowing what they think. An example of such a description is below. However, it is very important that the local affiliate leadership

develops their own standards, and modifies them based on local conditions and experiences.

Windows

- Double pane or storm windows
- Aluminum, vinyl or newly caulked and painted
- No cracked or broken panes
- Screens for all active windows
- All windows will have working locks
- Windows or storms will be tight and resist infiltration

Standards provide the basis for the building committee to evaluate and complete the home. They focus the evaluation process on the completed home instead of the current condition and force the board of directors and building committee to deal with tough questions about how far is far enough at the most effective time. When properly applied they enable you to choose the least expensive "free" house.

ADDRESSING THE SPECIFIC NEEDS OF A FAMILY

The evaluation process should take the special needs and resources of the family into account whenever possible. Families needing ramps, larger doorways, etc., will affect the cost of rehab. Future sources of income or the ability to handle home repairs will change the parameters under which the home is rehabbed. A family with greater earnings can potentially handle a furnace replacement 5 or 10 years down the road. A family with a very limited or fixed income may need a furnace that will give them a longer service.

APPLY STANDARDS TO A HOME

The standards become a checklist for the person evaluating potential costs. They will not replace the need for a knowledgeable person to make the evaluation but it will enable them to do it accurately and will allow you to compare evaluations done by various people. In addition they may aid you in soliciting assistance from skilled professionals. Many knowledgeable people will shy away from a request as vague as "what will it cost to fix this house up?" but will help when presented with clear standards. These evaluators do not need to be professionals. Except for the structural evaluation, which should be done by an engineer, the balance of the review can be done by volunteers trained to do the task. Family specific needs and resources should be added to the standards before review.

Windows

- Double pane or storm windows
Storms needed - \$600.00
- Aluminum, vinyl or newly caulked and painted
Minor caulk/paint - \$50 materials
- No cracked or broken panes

- 1 broken pane - \$4 materials
- Screens for all active windows
Included in storm costs
- All windows will have working locks
Included in storm costs
- Windows or storms will be tight
Two north facing windows need repair \$10 materials - skilled carpenter

These costs will vary from affiliate to affiliate based on the types of resources available. From these estimates a detailed budget can be written to compare with other homes (new or rehab) under consideration.

Affordable Payments

1. Careful Assessment of Value
2. Careful Application of Standards
3. Control of Construction Costs

HOW DO WE KNOW IF A HOME IS WORTH BUYING OR RECEIVING AS A GIFT?

If you have gone through the steps of creating a set of standards, modifying them to a particular family's needs and evaluating the various homes available -- you can simply compare the total completed costs (purchase price plus rehab budget). This is as true for a home being donated as it is for one being purchased. In fact, many times a purchased home will prove to be a better value.

This process will help you get beyond the personal or organizational goals of those offering homes. Many individuals, organizations and government agencies have their own goals and will make homes available at reduced costs or even free. For an affiliate the most important piece of information is what will this house cost completed to Habitat's goals.

Although you may involve a number of people in the evaluation process, it is critical that the person who will oversee the rehab reviews and accepts the budget before a home is bought.

Maintain Construction Costs

Cost overruns result from three areas: unexpected costs, inaccurate estimates and changes to the original plan.

Unexpected costs and inaccurate estimates can be reduced by keeping accurate records of estimated and actual costs. These can provide valuable insight into the evaluation of the next home(s). The best remodeler has learned to accurately predict and control costs by establishing an estimate of costs and comparing the work to the estimate as it progresses.

Few are able to successfully estimate and control costs on the first project. Each completed home provides valuable information for future estimating. This is particularly important because Habitat has resources and needs very different from the average remodeler. Even a skilled contractor will need to adjust to the unique savings and expenses Habitat incurs.

Changes to the original plan often result from a set of standards that looked good on paper but fell short in use. Acceptability standards should be reviewed and refined following the completion of any home where the original plan was not followed.

Once a house is completed a thorough review of the original evaluation, the plan, the budget and the outcome are critical to success in the homes that follow.

MANAGEABLE FUTURE COSTS

Universal Considerations

One step in the original evaluation must be to consider the short term costs incurred during rehab and the long term costs to the family. Selecting items like amounts of insulation, types of heat and appliances, etc., must consider the family's long term expenses.

Family Specific Considerations

In addition, not all families can respond to future needs the same. One family may possess the physical resources to re-roof their own home in 5 years. Another may be able to save enough to have someone else do it. A third may have neither resource and require a roof that will last 25 years.

Our Warranty

There are three types of warranty issues. All of them are critical to discover and address. The most basic tool we have to improve the program is the feedback from the homeowners. If we shrink from this interaction or wish it would simply go away we miss the importance of the information being shared.

The first is typified by the request "my window doesn't work properly". It is a result of bad work and calls for a change in the construction process.

The second is typified by the request "my sink drain leaks". The cause of the leaky drain may be poor workmanship but the cause of the request is bad homeowner training. We are not interested in shedding the responsibility. We are interested in making sure the homeowners can address their own basic needs.

The third is typified by the request "you didn't finish painting the back of one of my closet doors". Again the lack of paint may have you review the punch out process but the

request shows a clear lack in developing partnership. If the relationship has been built as it should the request would never had been made and the painting done by the homeowner upon discovery.

TRAINING FOR FUTURE CARE

How Do We Prepare Families For Maintenance?

The rehab process represents a great opportunity for the family to accomplish their sweat equity and develop much needed skills for the future. Painting, wall repair, roof repair, window and door adjustments, etc., all can be achieved while educating the homeowner. However, this is a good example of how our goals must direct our decisions. If the home is painted by a group of volunteers because it is well suited to the size and skills of the group of volunteers, we risk the task being done without the family being trained. Goals must be prioritized. Both are important -- but one is more important.

Any aspect of the home that may require homeowners to provide maintenance should be taught during the rehab process. This would include but not be limited to:

- Painting interior and exterior
- Exterior caulking for water protection
- Interior caulking to stop air infiltration
- Linoleum repairs
- Carpet cleaning
- Landscaping & care of lawns and shrubs
- Shingle repair
- Gutter cleaning
- Siding repair
- Sheet rock repair
- Repairing window screens and glass
- Adjusting door and window fit or operation
- Minor plumbing repairs - washers, cartridges, drainage system cleanouts
- Septic systems cleanout
- Familiarity with electric systems - circuit breaker and fuse boxes
- Furnace filter changes

How Do We Prepare Families For Major Repairs?

Some materials will be in acceptable shape and will not need immediate replacement. However, the homeowner must be prepared for the expenses in the future. This potential can be managed by establishing an escrow fund that the family can pay into along with their mortgage. This is then available for major expenses when they arise instead of replacing everything in the house during rehab and increasing both the mortgage and the expenses for the affiliate. It also begins to establish in the homeowner a habit of saving ahead for future needs when the financial relationship with Habitat is finished.

WORTHWHILE USE OF VOLUNTEERS

How Do We Plan The Work/Organize The Volunteers?

Rehab requires special leadership. Its constant surprises demand a higher level of planning and flexibility. Don't make the mistake of assuming that because you must remain flexible you can work effectively without a plan.

There are three distinct stages in every rehab task:

- Removal
- Preparation
- Replacement.

The skills, tools and size of workforce vary with each of these.

- Removal (lower skill - high safety concerns)
Removing shingles, plaster, siding
Good family and large group involvement
Part of every group moves debris out of the house
- Preparation (higher skill - small numbers)
Straightening walls for rock
Preparing subfloor for floor covering
Minimal family involvement
- Replacement (varying skills more like new)
Most like new if prep was done right
Varying family involvement

HOW DO WE KEEP THINGS MOVING and MOTIVATE VOLUNTEERS?

Evaluate what slowed you down in the past and make changes. This seems obvious but often we don't take the time to analyze past experience and make an educated guess about what to do better. This is particularly important because what slowed you down is unique to your operation and will not necessarily show up on a general list of problems.

Don't work randomly on the different tasks within the home. A home that always appears to be under construction in every way becomes discouraging. Don't store old materials in the midst of the work. Clean materials and stack them for use or throw them away.

Keep it clean. A clean work site is more effective, creates a sense of accomplishment and creates a more enjoyable work site that encourages people to stay involved. A broom swept house even in the middle of reconstruction takes on the feeling of building something new.

Provide skilled workers with laborers to keep debris under control and only as many helpers as they feel comfortable leading. It stretches valuable skilled help and keeps them coming back.

Simply stated -- folks working on rehab need more encouragement. When you're a volunteer yourself it is often hard to remember those who are looking to you for a simple "job well done".

Appendix C
Rehab Inspection Report

Home Address:			Construction Style:		
Number of bedrooms		Square footage:			
Value of offer:		Estimated rehab cost:		Value of resale:	
Orientation of house: N S E W		Note: orientation indicates which exposure of the home gets mostly sun and mostly shade			
Health and safety Does this house pose any health hazards to the future occupants or the workers?					Estimate cost
Radon	Test results	Mitigation required yes no		Action required	
Lead		Mitigate Encapsulate			
Asbestos		Mitigate Encapsulate			
Health and safety factors are within our criteria for potential rehabbing					GO
Health and safety factors are outside our criteria for potential rehabbing					NO GO
As you proceed with the exterior inspection, you are looking for missing or damaged components that would permit water infiltration. Also look for signs of infestation. (rot, droppings, boring, termite tubes, etc.)					
Exterior Inspection:	Front	Left	Right	Rear	Recommendation
Siding warpage					
Siding leakage					
Paint condition					
Window flashing					
Window condition					
Gutters and downspout					
Soffits & fascia					
Site considerations that may require extensive excavation or drainage work					
Exterior appearances of home pass inspection. Nothing seen here eliminates this home from potential rehabbing.					GO
Exterior appearances of home indicate that there are repairs required beyond our criteria for rehabbing.					NO GO
As you are considering the condition of the components of the home. Keep in mind that many items that you may want to replace could be sent to a restore for reuse. For that matter, the whole house may be considered a deconstruction project.					Totals:

Exposed foundation:	Front	Left	Right	Rear	Recomondation	Estimate cost
Cracking						
Leakage						
Positive drainage						
Window condition						
Foundation is in adequate condition to be considered for rehabbing					GO	
Foundation is in need of repairs beyond our criteria for rehabbing.					NO GO	
Notes on foundation (Also see basement notes)						
<hr/>						
Roof:						
Shingle condition						
Flashing						
Penetrations						
Chimney Condition						
Roof notes:						
<hr/>						
Attic:	Descriptions:				Recomondations:	
Signs of water damage or significant air paths to the interior						
Engineering of roof system (adequate/inadequate)						
Insulation levels						
The condition of the roof system is within our criteria for rehabbing					GO	
The condition of the roof system is beyond our criteria for rehabbing					NO GO	
					Totals	

Basement / Crawlspace (indicate)		Descriptions:	Estimate cost
Heaving walls			
Sagging of 1st floor			
Insufficient structural support			
Significant cracking			
The condition of the foundation is within our criteria for rehabbing		GO	
The condition of the foundation is beyond our criteria for rehabbing		NO GO	
Mechanical systems:	boiler	approx. age	
	Forced air gas	Usable	
	converted coal or oil	Replace	
	Other		
Ducts:	fiberglass	Usable	
	Metal	OK but more required	
	Other	Must replace all	
Electrical:	Peg & Tube	Complete rewire	
	Metal sheathed	Partial rewire	
	Romex	Panel upgrade	
	Other		
Hook up	two wire 60 amp	Upgrade hook up required	
	three wire 100 amp +	Hook up adequate	
Plumbing:	Galvanized supply	Drain is good	
	Copper	Supply is good	
	Steel drain	Drain replace	
	Clay drain	Supply replace	
	Other		
As you consider the combustion appliances required, note that it is best to place naturally asperated equipment in isolated space. Combustion air should be brought in from an outside source and the appliance should be placed in a sealed closet.			
Notes:			
Totals			

Windows: Windows should be adequately sized for egress on bedrooms. In many cases, replacement of the windows will be the best investment on a rehab.	Wood w/counterweights	Refit with inserts, weights removed and cavities insulated		Estimate cost
	Other	Storm windows to be added		
		To be completely replace with new		
	Storm windows	Combination of strategies:		
Doors: Exterior	Solid wood	Good condition		
	hollow steel	Replace		
	Other			
Doors: Interior	Solid wood	Good condition		
	hollow core	Replace		
	Other			
Kitchen	Cabinets	Replace	Reface Repaint	
	Counter tops	Replace	Resurface	
	flooring	Replace	keep	
	sink	Replace	Resurface	
	Notes:			
Bath (Main)	Tub/Shower	Replace	Resurface	
	Sink	Replace	Resurface	
	Stool	Replace	Keep	
	flooring	Replace	Keep	
	ventilation	Needed		
	Notes:			
Bath (secondary)	Tub/Shower	Replace	Resurface	
	Sink	Replace	Resurface	
	Stool	Replace	Keep	
	ventilation	Needed		
	flooring	Replace	Keep	
	Notes:			
Totals:				

Walls	Gut to studs & fiberglass batt	Cover with dry wall	Skim coat	blow insulation	Details:	Estimate cost
Match with print						
Exterior 1st floor (location)						
Interior 1st floor (location)						
Exterior 2nd floor (location)						
Interior 2nd floor (location)						
					Totals:	

Additional notes:

Room additions: In some cases, added rooms may degrade the quality of the home. Removal of such additions is best in such cases.

Porches: Often, porches pull away due to lack of adequate footing or structure. In such cases, you may need to shore up the roof with temporary bracing while you rebuild the foundation and deck.

Safety: It is important to consider the existing fire hazards on older homes. Usually, fire blocking was not used. Be sure to isolate each level of a home by blocking air paths between them. This also adds to the energy efficiency of the home.

Lead: This subject is not to be taken lightly. Lead abatement guidelines have been provided by the EPA. In many cases, encapsulation by painting over lead contaminated surfaces is all that needs to be done. The danger is greatest when you are sanding finishes containing lead paints. Get a copy of the lead abatement fact sheets available from HFHI's Department of Construction and Environmental Resources.

Asbestos: This product was not used a great deal for interior applications in residential construction. When it was used, it was in composition flooring or for pipe and duct insulation. Again, encapsulation may be your best strategy, however, if asbestos is present in large quantities, you may need to hire professional mitigation or reject the home as an HFH project.

Existing Vegetation: Though vines growing on walls and trees resting on the roof may look quaint, be aware that these can lead to moisture damage and provide access for rodents and carpenter ants. Vegetation should be kept clear of the structure. Bushes near the foundation require water. This is not good for foundation drainage. Vegetation should be maintained at least 3' from the foundation and the ground should drain away.

Windows: As mentioned, new windows will often be your best investment in a rehab project. However, other options that you may consider are replacement sashes. This allows you to use insulated glazing and new jamb inserts while not disturbing the original design of the window frame. If you intend to use the existing windows and sashes, consider the thought of adding storm windows to the home. This is not, however, the best way to go.

Walls: Do not be bound by the idea that all plaster and lathe must be removed before you can rehab. In many cases, you can skim coat it or add a layer of new 1/4" drywall over it. If you use this strategy, you can make the necessary holes to run replacement electrical, plumbing and blown insulation, then cover them with the drywall. This reduces the amount of labor and landfill as well.

Fireplaces: Do not trust the condition of an existing chimney. It should be inspected by a professional. Old fireplaces are not an energy saving device. The only thing they provide is atmosphere, other than that, they are a huge penalty in the performance of a home. If you leave an existing fireplace, consider a sealed combustion, gas insert, or at least an efficient wood burning stove insert.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Executive Services and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE (DD-MM-YYYY) July 2004		2. REPORT TYPE Subcontractor Report		3. DATES COVERED (From - To) February 2003 - February 2004	
4. TITLE AND SUBTITLE The reHABITAT Guide: For Energy- and Resource-Efficient Retrofit Strategies				5a. CONTRACT NUMBER DE-AC36-99-GO10337	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Consortium for Advanced Residential Buildings				5d. PROJECT NUMBER NREL/SR-550-36057	
				5e. TASK NUMBER BET4.8004	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Consortium for Advanced Residential Buildings Norwalk, Connecticut				8. PERFORMING ORGANIZATION REPORT NUMBER KAAX-3-33411-00	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393				10. SPONSOR/MONITOR'S ACRONYM(S) NREL	
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER NREL/SR-550-36057	
12. DISTRIBUTION AVAILABILITY STATEMENT National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161					
13. SUPPLEMENTARY NOTES NREL Technical Monitor: M. Eastment					
14. ABSTRACT (Maximum 200 Words) The reHABITAT Guide for Energy- and Resource-Efficient Retrofit Strategies seeks to advance the goal of the U.S. Department of Energy's Existing Residential Buildings Program (ERBP): to develop approaches that will enable the housing retrofit industry to deliver energy-efficient housing improvements and to ensure that energy-efficient retrofit technologies incorporated into projects are viable over conventional approaches. This guide was developed for Habitat for Humanity International and is the result of lessons learned from demonstration retrofit projects undertaken by Habitat for Humanity affiliates in Newburgh, New York; Baltimore, Maryland; and Philadelphia, Pennsylvania; with building systems consulting and technical assistance provided by Steven Winter Associates, Inc. (SWA).					
15. SUBJECT TERMS Energy efficient homes; U.S. Department of Energy; Building America; retrofit houses					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UL	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code)

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

Research and Development of Buildings

Our nation's buildings consume more energy than any other sector of the U.S. economy, including transportation and industry. Fortunately, the opportunities to reduce building energy use—and the associated environmental impacts—are significant.

DOE's Building Technologies Program works to improve the energy efficiency of our nation's buildings through innovative new technologies and better building practices. The program focuses on two key areas:

• Emerging Technologies

Research and development of the next generation of energy-efficient components, materials, and equipment

• Technology Integration

Integration of new technologies with innovative building methods to optimize building performance and savings

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

An electronic copy of this factsheet is available on the Building America Web site at www.buildingamerica.gov

Visit our Web sites at:

www.buildingamerica.gov

www.pathnet.org

www.energystar.gov



Building America Program

George S. James • New Construction • 202-586-9472 • fax: 202-586-8134 • e-mail: George.James@ee.doe.gov

Terry Logee • Existing Homes • 202-586-1689 • fax: 202-586-4617 • e-mail: terry.logee@ee.doe.gov

Lew Pratsch • Integrated Onsite Power • 202-586-1512 • fax: 202-586-8185 • e-mail: Lew.Pratsch@hq.doe.gov

Building America Program • Office of Building Technologies, EE-2J • U.S. Department of Energy • 1000 Independence Avenue, S.W. • Washington, D.C. 20585-0121 • www.buildingamerica.gov

Building Industry Research Alliance (BIRA)

Robert Hammon • ConSol • 7407 Tam O'Shanter Drive #200 • Stockton, CA 95210-3370 • 209-473-5000 • fax: 209-474-0817 • e-mail: Rob@consol.ws • www.bira.ws

Building Science Consortium (BSC)

Betsy Pettit • Building Science Consortium (BSC) • 70 Main Street • Westford, MA 01886 • 978-589-5100 • fax: 978-589-5103 • e-mail: Betsy@building-science.com • www.buildingscience.com

Consortium for Advanced Residential Buildings (CARB)

Steven Winter • Steven Winter Associates, Inc. • 50 Washington Street • Norwalk, CT 06854 • 203-857-0200 • fax: 203-852-0741 • e-mail: swinter@swinter.com • www.carb-swa.com

Davis Energy Group

David Springer • Davis Energy Group • 123 C Street • Davis, CA 95616 • 530-753-1100 • fax: 530-753-4125 • e-mail: springer@davisenergy.com • deg@davisenergy.com • www.davisenergy.com/index.html

IBACOS Consortium

Brad Oberg • IBACOS Consortium • 2214 Liberty Avenue • Pittsburgh, PA 15222 • 412-765-3664 • fax: 412-765-3738 • e-mail: boberg@ibacos.com • www.ibacos.com

Industrialized Housing Partnership (IHP)

Subrato Chandra • Florida Solar Energy Center • 1679 Clearlake Road • Cocoa, FL 32922 • 321-638-1412 • fax: 321-638-1439 • e-mail: subrato@fsec.ucf.edu • www.baihp.org

National Association of Home Builders (NAHB) Research Center

Tom Kenney • National Association of Home Builders (NAHB) Research Center • 400 Prince George's Boulevard • Upper Marlboro, MD 20774 • 301-430-6246 • fax: 301-430-6180 • toll-free: 800-638-8556 • www.nahbrc.org/

National Renewable Energy Laboratory

Ren Anderson • 1617 Cole Boulevard, MS-2722 • Golden, CO 80401 • 303-384-7433 • fax: 303-384-7540 • e-mail: ren_anderson@nrel.gov • www.nrel.gov

Tim Merrigan • 1617 Cole Boulevard, MS-2722 • Golden, CO 80401 • 303-384-7349 • fax: 303-384-7540 • e-mail: tim_merrigan@nrel.gov • www.nrel.gov

Oak Ridge National Laboratory

Pat M. Love • P.O. Box 2008 • One Bethel Valley Road • Oak Ridge, TN 37831 • 865-574-4346 • fax: 865-574-9331 • e-mail: lovepm@ornl.gov • www.ornl.gov

Produced for the U.S. Department of Energy (DOE) by the National Renewable Energy Laboratory, a DOE national laboratory. July 2004 • NREL/SR-550-36057

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste.