



U.S. sustainable construction standards

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Construction Technologies

U.S. sustainable construction standards

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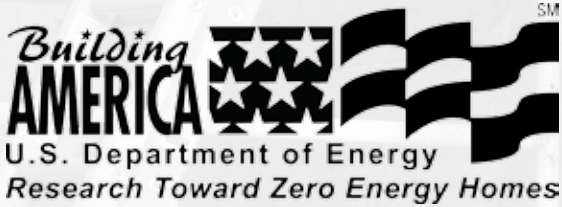


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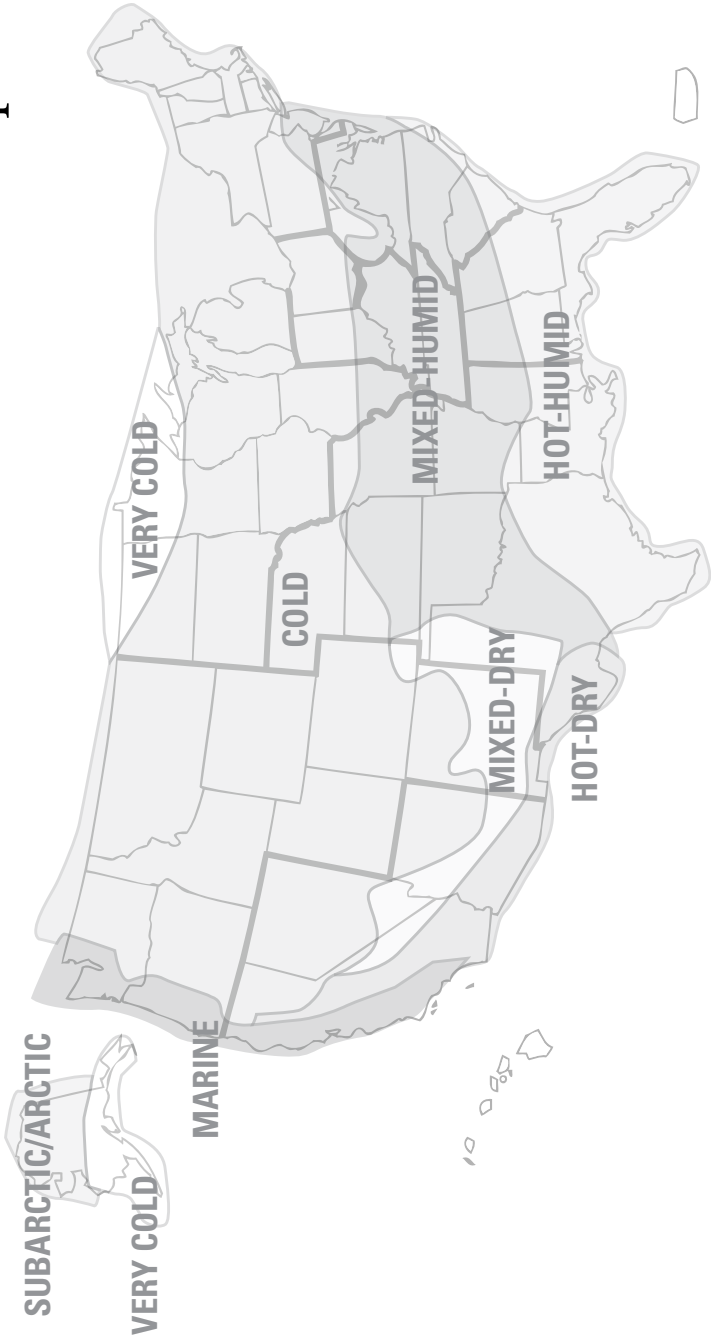
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Construction Technologies thanks Building America, one of our longtime funding partners, for providing support in helping to achieve Habitat's mission.



Climate Map



Introduction

CONSTRUCTION STANDARDS

Rationale

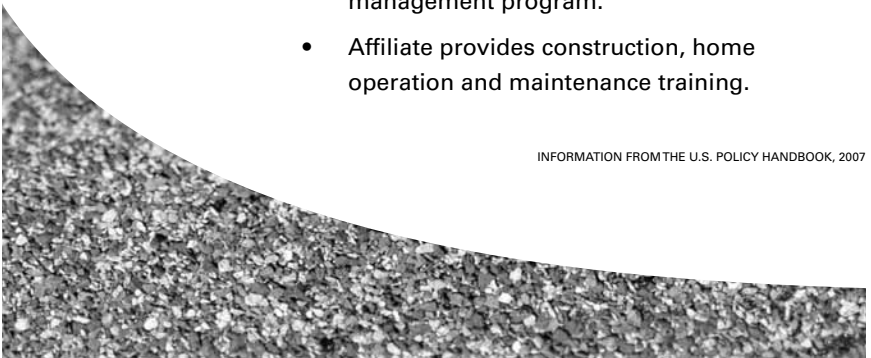
As stated in the Covenant, construction practices should reflect the Habitat philosophy of building simple and decent houses. Affiliate construction practices and procedures should follow the examples and processes described in the Affiliate Operations Manual: Construction.

Purpose

To set the basic requirements for sustainable construction practices for Habitat for Humanity affiliates.

Policy

- Affiliate builds to HFHI house design criteria, with exceptions for local and community requirements and ordinances.
- Affiliate builds to a minimum Energy Star[®], water, materials and healthy indoor air quality standard.
- Affiliate builds to minimum durability standards that address local geographic, climatic and disaster issues.
- Affiliate adopts and implements a written safety policy.
- Affiliate utilizes a written construction management program.
- Affiliate provides construction, home operation and maintenance training.



Habitat defines sustainable building or Green building as providing housing for people with methods, products and processes that create healthy homes and communities that are less expensive to operate, more durable, and that conserve resources throughout construction and after. Sustainable Building supports the development of families and communities while respecting our natural environment.

- Habitat Mission Principles: Promote transformational and sustainable community development
- Reduces the home's monthly & life cycle costs while increasing the efficiency and durability.
- Transforming the family's future by lowering utilities and maintenance costs while providing healthy environments.

Full "gut" rehabs and new construction, will refer to these sustainable building standards and achieve the same level of performance. While smaller remodel projects and energy retrofits should follow these standards and when necessary replace older obsolete items with ENERGY STAR rated appliances and products.

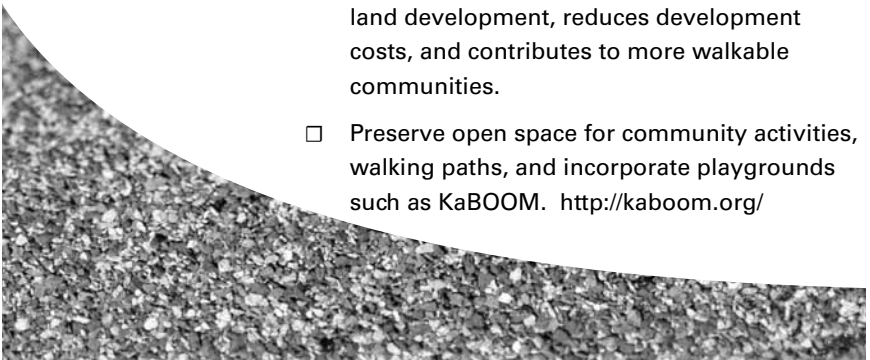
<http://my.hfhi.habitat.org/BusinessOperations/USConstruction/Template%20and%20Downloads/Rehab/ReHABITAT%20Guide.pdf>

1.0 Sustainable community development

Community design and planning

Community design and planning are a vital part of a healthy neighborhood. Thoughtful design, such as open green spaces and sidewalk integration, can foster community interaction which lowers crime. Projects located near public facilities can lower homeowner transportation costs and take advantage of infill lot possibilities. While it is understood that not all practices are ideal or in the affiliates' control special consideration should be given to attempt to incorporate one of all of the items below.

- Infill development helps to conserve land, reduce storm water runoff, and reduces travel distances.
- Neighborhood layout and orientation that considers passive solar heating and cooling during planning.
- Compact development encourages efficient land development, reduces development costs, and contributes to more walkable communities.
- Preserve open space for community activities, walking paths, and incorporate playgrounds such as KaBOOM. <http://kaboom.org/>



Habitat design criteria

Habitat for Humanity International house design criteria are defined by the following points.

- The living space provided—excluding stairwells (except to a basement) and exterior storage—should not exceed:
 - 900 square feet for a two-bedroom house.
 - 1,070 square feet for a three-bedroom house.
 - 1,230 square feet for a four-bedroom house.
- A two-bedroom house should have only one bathroom, which is to be accessible to people with disabilities. The bathroom may be compartmentalized (i.e., sink separated from toilet and shower) for increased usefulness. Three-bedroom houses may have an additional half-bath. Four-bedroom houses and/or houses with five or more people may have an additional full bathroom.
- Families should have the opportunity to choose decorative finishes for the house whenever possible.
- A budget may be established with a predetermined limit (e.g., \$1,000) to allow the family to personalize their home with features such as appliances, fencing, a shed, etc.
- Each house should have a covered primary entrance.



- ❑ When feasible, at least one entrance to the house should be accessible to people with limited mobility.
- ❑ All passage doors, including bathroom doors, should be at least three feet (3') wide. Hallways should be at least three feet, four inches (3' 4") wide from rough frame to rough frame. If there is a door at the end of the hallway, the minimum width increases to three feet, seven inches (3' 7"). These standards allow for access to people with disabilities. Further adaptations may be needed if a family member is disabled.
- ❑ Houses should not have garages or carports.

Adhering to these design criteria supports Habitat for Humanity's mission to build simple, decent, affordable houses in partnership with families in need of shelter. Adhering to these criteria also guards against inconsistency in construction, budget overruns and "creeping affluence."

Site Development

Site Development includes site selection and planning, building orientation, landscaping, storm water management to preserve natural resources.

- ❑ Protect topsoil and minimize disruption of existing trees and plants.
- ❑ Orient the home on site to capture the benefits of passive solar heating and cooling to take advantage of the natural ventilation.
- ❑ Take advantage of the local USDA to help protect and plant vegetation that is native and drought-tolerant, called xeriscaping. Make an intentional effort to save green space and trees

on the site. Practice proper fencing of tree root zones to lessen construction damage.

- Follow Low Impact Development (LID) practices, www.toolbase.org. Create and follow a site management plan that outlines proper erosion control, conservation, and storm water management procedures. Following such a plan is critical for good neighbor relations, reducing silt into water ways (streams, creeks, lakes, rivers).
- Develop landscapes that are resource efficient and require less maintenance, minimizing turf.
- Plant shade trees to help cool the home during summer months and allow for natural heat gain in the winter thereby lowering costs and improving comfort while providing an attractive valuable landscape.

2.0 Resource stewardship

AS PART OF THE U.S. CONSTRUCTION
STANDARDS FOR AFFILIATES

Building to minimum Energy Star® and healthy indoor air quality standards saves partner families at least \$300 per year in utilities bills (based on 2007 energy prices).

Sustainable building promotes the conservation and efficiency of resources through a whole systems approach that works together to develop higher performing homes cost effectively. Sustainable components are based on building science fundamentals that are measurable performance metrics.

Energy–ENERGY STAR™

What is the new Energy Star® home?

- ENERGY STAR qualified homes are at least 15 percent more energy efficient than homes built to the 2004 international residential code (IRC) with energy-saving features that typically make them 20–30% more efficient than standard homes.
- ENERGY STAR qualified homes can include a variety of energy-efficient features, such as effective insulation, high performance windows, tight construction and ducts, efficient heating and cooling equipment, and ENERGY STAR qualified lighting and appliances.



- Homebuyers across the country are increasingly interested in green building. When looking to build or buy a green home, energy efficiency is the place to start. That's because the energy used in homes often comes from the burning of fossil fuels at power plants, which contributes to smog, acid rain and risks of global climate change. So, the less energy used, the less air pollution generated.

How does my affiliate benefit from building Energy Star® homes?

- Knowledge that Habitat homes become much more affordable to partner families with every monthly utility bill and over the life of the home
- Pride in knowing that homes will be more durable, healthier and of greater quality
- Public and donor recognition that affiliates are building efficiently, saving money and energy, and conserving resources for the long term
- Energy-efficiency is a critical component of green/sustainable building





Proper window insulation provides energy efficiency, comfort and durability. More efficient windows provide a greater barrier against cold and hot temperatures outdoors, thereby reducing energy bills. Better windows also decrease condensation indoors, reducing moisture and mold problems.

How do our homeowners benefit from building Energy Star® homes?

- Lower ownership and maintenance cost per month and over the long term
- Improved comfort and quiet
- Safer, healthier homes that are more durable

Getting started:

Assistance from a partnership between Building America, U.S. Department of Energy, RESNET and Habitat for Humanity

1. Energy Star standard

In the summer of 2006, the U.S. EPA revised its Energy Star standard. Habitat for Humanity continues to recommend that ALL affiliates in the United States meet or exceed this standard. Doing so ensures a truly affordable home for our partner families as energy prices continue to rise. Following this standard also improves the durability of each home so that we can take comfort in knowing that each Habitat home built will last well beyond the lifetime of the mortgage.

- Fact Sheets of ENERGY STAR
http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_factsheets
- Technical resources of Energy Star™
http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.homes_guidelns

Your affiliate can choose between the performance path or the prescriptive path, depending on what suits your needs best.

Verification of a home's energy efficiency by a third-party organization is mandatory for earning the ENERGY STAR label. There are two paths to verify that a home meets the ENERGY STAR guidelines¹:

- **Performance path: A home energy rating,** where a HERS rater will use software to model the home's energy use to verify that it meets a target score. You will follow the performance path document and the thermal bypass document.
- **Prescriptive path: A builder option package,** where builders construct the home using a prescribed set of construction specifications that meet program requirements—called the national builder option package (or you can access this package at the county level). You still will need an energy rater to verify that you meet the Energy Star standard. You will follow the prescriptive path document and the thermal bypass document.

2. Healthy indoor air quality (IAQ) standard

Habitat for Humanity continues to recommend sensible basic strategies for building healthy indoor air quality into homes. These recommendations now form the new U.S. construction standard for healthy indoor air quality. Following this standard will not only provide for a healthier living environment for homeowner families, but will help increase the durability of each house built.

Healthy indoor air quality fact sheet
(My.Habitat)



MICHAEL A. SCHWARZ

Radon Risk Reduction Systems also help reduce moisture intrusion from the ground into the foundation and home.

Steps to building ENERGY STAR™

<http://my.hfhi.habitat.org/BusinessOperations/USConstruction/Template%20and%20Downloads/Green%20Building%20Information/Affiliate%20Steps%20to%20ENERGY%20STAR.pdf>

3. Begin the process:

Change is not always easy.

Affiliate leadership and decision-makers need to know the reasons why building a house properly is important and what this process requires. The following steps may help your affiliate adapt to such changes more smoothly:

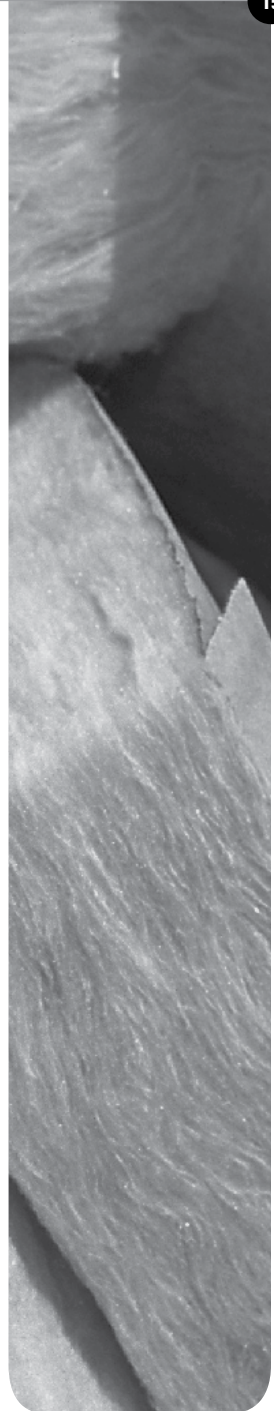
- A. Invite the construction leadership, executive director or president, the construction committee, and others who have a stake in affiliate operations to review and discuss the Energy Star paths outlined on the EPA Web site and also HFHI documents on energy-efficient and healthy building practices.
- B. Connect with an energy or HERS rater to get an existing house tested to see how energy efficient your houses are. The cost for testing can be as high as \$400 but many Habitat affiliates receive a discount or sometimes a free rating when a relationship is first established. A rater will discuss what upgrades you may need in order to meet the Energy Star standard and will include a test of any ductwork.
 - i. Check the listing of raters by state at: <http://www.resnet.us/directory/raters.aspx>
 - ii. For assistance in finding a rater, contact Kevin Gobble of the Construction Technologies Department (HFHI) at number below or e-mail at ConsEnv@habitat.org.

For further assistance contact:

Kevin Gobble	Janet McIvaine
kgobble@habitat.org	Janet@sec.ucf.edu
(800) 422-4828, Ext. 6795	Office: (321) 638-1434
Construction Technologies	Reserch scientist with Building America program
HFHI	U.S. Department of Energy

- iii. The rater will test an existing house and suggest improvements. Incorporate these improvements into your future houses. A rater will test new houses completed to confirm that you are now building at or above the Energy Star standard.
- iv. The affiliate has identified a rater that will test an existing Habitat house to identify any needed improvements.
- v. Name of rater:
- vi. Phone number of rater:
- vii. Date of initial testing: __/__/__
- viii. Score of initial testing: __/__/__
- ix. Date of testing after upgrades: __/__/__
- x. Score of testing after upgrades:
- xi. Did your rater list your affiliate name with the EPA?

(http://www.energystar.gov/index.cfm?fuseaction=new_homes_partners.showHomesSearch)



While ribbed, flexible ducts are acceptable in most areas, air flow meets least resistance in metal ducts, properly sealed, and are resistant to rodent invasions.

- C.** Schedule a session to discuss the building science issues covered by Energy Star and HFHI. Discuss at what level the affiliate is currently building, and how staff would like to proceed in the future. Develop a plan with deadlines to accomplish each step that the affiliate follows.
 - i.** Check with local distributors to see if the affiliate can receive any discounts on building products.
 - ii.** Check with corporate partnerships at HFHI to see what national product partnerships may benefit your affiliate as well (the Resource Development department on MyHabitat is a starting point).
- D.** After these new building practices become standardized, test your new Habitat houses to confirm that they meet or exceed the Energy Star standard.
- E.** Document in writing and put in a file all final decisions on current building practices and any adopted changes to these practices. The affiliate leadership should sign these documents.
- F.** Once these documents are complete, inform the rest of the staff about these changes through informational sessions and training.
- G.** Change all related documents at the affiliate to reflect these new construction changes—including the homeowner house option package, walk-through outline, and purchasing spreadsheets—to provide consistency.
- H.** Advertise your changes to donors and let your homeowners know about the quality features of their new home.



Water Conservation

Water is a vital resource and should be conserved both outside and inside the home. Water needs to be managed in all forms (solid, liquid, and vapor) in order to construct a home that is durable and be easy to maintain. Significant water savings can be achieved by installing water efficient fixtures and appliances greatly reducing utility bills and making homes more affordable.

- Proper flashing and attention to details needs to be addressed at the roof assembly, doors, windows, any penetration in the building shell.
- A drainage plane is essential to reducing moisture problems in the home and should allow exterior to shed water out and away from the home. For more information, EEBA water management guide.
- Reduce the demand of exterior water by using native and drought tolerant landscapes, and reducing the amount of turf. Outdoor water use is about 35% of residential water use.
- Water conserving plumbing fixtures with the following minimum specifications: toilets - 1.3 GPF (gallons per flush) or high efficiency, showerheads – 2.0 GPM (gallons per minute), faucets – 2.0 GPM. Fixtures should meet the WaterSense label. The costs are typically about the same for higher efficient fixtures. (<http://www.epa.gov/watersense/>)
- Water efficient appliances should be installed to reduce water and energy costs.
- Efficient plumbing design and efficient hot water system reduces heat loss, reduces water wasted waiting for hot water, by locating the heater near fixtures.

Materials and Resources

Material selection can have multiple benefits by reducing, reusing, and recycling materials will conserve natural resources and reduce costs. Many building products and techniques in the market today are more resource efficient, healthy, and durable. Using resources well has always been a part of Habitat's stewardship.

- Chose building materials that are local, saves in transportation costs and support the local community.
- Utilize a construction waste management plan to reduce the amount of waste sent to the landfill.
- Use materials with recycled content and reclaimed materials that may otherwise be deposited in landfills.
- Apply advanced framing methods to reduce the amount of lumber needed in each home while maintaining structural integrity and meeting the building code. Advanced framing saves wood and costs while allowing for more space in the wall to install insulation and improve the building shell.
- Select certified wood that ensures wood is harvesting is managed in an environmentally, economically, and socially responsible manner that protects the health of the forest ecosystem and local economies.
- Use low or zero VOC (volatile organic compounds), when selecting paint, finishes, caulk, and construction adhesives thus reducing toxic gasses. Non-flat paints – less than 150 (GPL) grams per liter of VOCs, and flat finishes – less than 50 (GPL), caulks and adhesives – less than 70 (GPL) of VOCs.

- Choose reclaimed flooring materials, recycled content, that is durable for the area it is being installed, carpet that exceeds the CRI Green Label Plus requirements. (www.carpet-rug.org)
- Minimizing products that contain VOC's and formaldehyde greatly improves indoor air quality by removing pollutants instead of diluting them.
- Deconstruction of homes can save salvageable materials and products from landfills and contribute to ReStores.

Resources:

- My.Habitat

The 2006 IECC requires the following insulation values (chart on next page)



CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR (2)	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE (3)	SLAB R-VALUE, DEPTH (4)	CRAWLSPACE WALL R-VALUE (3)
1	1.20	0.75	0.40	R-30	R-13	R-3	R-13	R-0	R-0	R-0
2	0.75	0.75	0.40	R-30	R-13	R-4	R-13	R-0	R-0	R-0
3	0.65	0.65	0.40 (5)	R-30	R-13	R-5	R-19	R-0	R-0	R-5/13
4 EXCEPT MARINE	0.40	0.60	NR	R-38	R-13	R-5	R-19	R-10/13	R-10, 2 FT	R-10/13
5 AND MARINE	0.35	0.60	NR	R-38	R-19 OR 13+5 (7)	R-13	R-30 (6)	R-10/13	R-10, 2 FT	R-10/13
6	0.35	0.60	NR	R-49	R-19 OR 13+5 (7)	R-15	R-30 (6)	R-10/13	R-10, 4 FT	R-10/13
7 AND 8	0.35	0.60	NR	R-49	R-21	R-19	R-30 (6)	R-10/13	R-10, 4 FT	R-10/13

IECC 2006 Table 402.1.1 Insulation and Fenestration Requirements by Component (1)

1. R-values are minimums. U-factors and SHGC are maximums. R-19 shall be permitted to be compressed into a 2x6 cavity.
2. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
3. The first R-value applies to continuous insulation, the second to framing cavity insulation; either insulation meets the requirement.
4. R-5 shall be added to the required slab edge R-values for heated slabs.
5. There are no SHGC requirements in the Marine zone.
6. Or insulation sufficient to fill the framing cavity, R-19 minimum.
7. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

3.0 Building

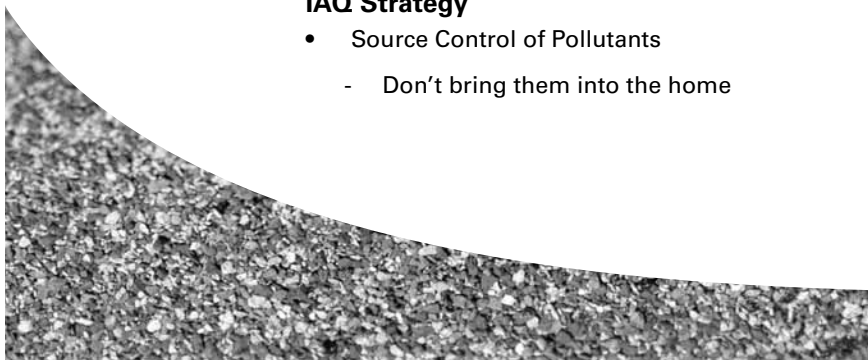
HEALTHY INDOOR AIR QUALITY INTO HABITAT HOMES

IAQ tips for affiliates

Building a new home provides the opportunity for preventing indoor air problems. However, it can result in exposure to higher levels of indoor air contaminants if careful attention is not given to potential pollution sources in the home and the proper ventilation to vent pollution outside the home. The prevention of unhealthy situations in a Habitat house is part of the affiliate's responsibility in providing a healthy, well-built home for partner families. It is therefore important to take measures to provide good indoor air quality to homeowners. Build a tightly sealed house, purchase interior building products that are less toxic, and provide an adequate amount of intentional ventilation within the house.

IAQ Strategy

- Source Control of Pollutants
 - Don't bring them into the home



- * Eliminate Pollutants - Ventilate
 - Spot Ventilation at the source
 - Kitchen - minimum 100 CFM directly to the outside
 - Bath - minimum 50 CFM directly to the outside
 - Whole House Ventilation
 - Ventilation equivalent to 10 CFM per bedroom plus 10 CFM continuous and filtered, with the master bedroom counting as two

- * Dilute pollutants - Filter
 - MERV 8 rated filter or greater filter

- Combustion Safety
 - Test combustion equipment for leaks and home pressure to safeguard against back drafting

Install carbon monoxide (CO) detectors in homes with attached garages or with any combustion appliance.

Key actions for building a good, healthy house are listed below:

Moisture

Eliminating or reducing moisture problems requires the following general strategies in building a house:

- (1) Proper sloping drainage from well-sealed foundation perimeter;

Find healthy building, IAQ information, and building fact sheets through the Energy and Healthy Building link on the Construction Technologies department site on MyHabitat.

- (2) Successful drainage plane around the exterior of the house (under siding);
- (3) Construction of a tight house with an intentional interior ventilation strategy;
- (4) Wall sections that allow trapped moisture to dry out;
- (5) Vent pipes from the interior exhaust away from the house into open air;
- (6) Homeowners understand how to keep moisture levels low inside the house.

Building out moisture concepts can be complicated at first to understand. Once understood, it requires planning before you start building and educating your construction crew about moisture strategies. Available on MyHabitat's Construction Technologies department page, read the following documents for technical advice:

- Habitat's "Building Better Houses IAQ" as an introduction
- "Build a Better House" technical series on moisture
- Construction bulletins that address technical aspects of air leakage and moisture paths

For tailored moisture suggestions according to your local climate from a real person, consult with HFHI's Construction Technologies department at ConsEnv@habitat.org or by calling (800) 422-4828, Ext. 2333 or Ext. 6795.

Posting a question on the construction roundtable is also an excellent way to receive technical feedback from fellow affiliate construction staff. Don't miss one of our regional workshops on

building out moisture, available through your regional support centers!

Healthy ventilation strategies

An intentional and well-planned ventilation plan is critical in reducing moisture problems in houses.

Habitat for Humanity follows the building science industry motto “build tight, ventilate right.”

Components of a ventilation plan include:

- A:** Proper air-sealing protocols;
 - B:** Well-placed, efficient exhaust fans;
 - C:** Properly sized heating and cooling systems.
- 1) Build a tight house.** Seal up holes—small and big—within the building envelope. Even little holes add up in a house, resulting in one big hole of total air leakage. Accidental air paths reduce the success of your ventilation strategy and invite moisture and pests into unwanted places in the house. Your homeowners will be thankful when you reduce their worry about insects, rodents, mold and higher monthly energy bills. Download the energy bulletins on My.Habitat, including the air-sealing checklist, for technical details. The technical bulletins that address air-sealing and proper window installation are helpful to review.

2) Ventilation

- a. Heating and cooling systems:* If you use a centralized system, consider placing this system within the conditioned space of the house (using a drop-down hall ceiling). As a result, costly duct leakage will occur within the



KIMI MACDONALD

conditioned space and reduce energy loads, utility bills and moisture problems. Ducts must be sealed well at the seams with mastic and insulated. Placing heating and cooling units within the attic is not advisable, as extreme hot or cold temperatures reduce the efficiency of the unit and any leaks leading to and from the unit invite undesirable air into the living space. The shorter the length of a duct, the more effective the heating and cooling system will be in removing moisture and providing proper ventilation. Work with your contractor on this issue and inspect for crimps and angles that reduce duct air flow. Turns in ducts should be large so that they do not reduce air flow.

The use of gas furnace combustion closets can create problems in Habitat houses, as this particular system is hard to seal completely with volunteers. If using a self-aspirating system (80 percent AFUE), make sure that it includes a fan-assisted vent for safe ventilation. Those rated at 90 percent AFUE are directly vented. Gas hot water heaters that are not direct-vented or fan-assisted to the outside air can also create problems, contributing to air pressure differences that result in the back drafting of carbon monoxide into the living space.

Properly sized heating and cooling units last longer and provide more comfort for homeowners. Air conditioners will not dry indoor air properly if sized too large. However, finding a unit small enough to fit a Habitat house can be challenging. Use a contractor who is willing to size each house individually, with a manual-J calculation. The following construction bulletins provide good technical details:

- i. Energy checklist overview
 - ii. Sizing HVAC
 - iii. HVAC selection
 - iv. Duct installation and sealing
 - v. Duct systems
 - vi. Spot ventilation
- b. *Exhaust fans:* Exhaust bath and kitchen fans that are quiet and efficient are used more often by occupants and exhaust moisture to the outside more effectively than cheap, loud fans that do not work as well. A good strategy is to hard-wire quality bath fans to the breaker for continuous operation but provide a shut-off switch in the bathroom for cold winter moments. Recirculating kitchen or range hood fans does not exhaust vapors, moisture and other gases from the cooking area.

For discounted high-efficiency, quiet ventilation fans (with or without a light) contact Energy Federation Incorporated (EFI). These fans are rated for continuous operation. Check the affiliate national partnership list on My.Habitat for pricing and details.

- i. **Fan specifications**—The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends a ventilation rate of 0.35 ach (air changes per hour) for new homes, and some new homes are built to even tighter specifications. This translates into 15 cfm to 20 cfm per occupant. Habitat houses typically require a 70 cfm fan. A fan rated 1.0 sone or less is very quiet. Many fans do not perform at the rate for which they are labeled. Because of this, install a fan with a higher cfm than what you actually need.

- ii. **Fan ducts**—The shorter the length of a fan duct, the more effective that fan will be in exhausting unwanted moisture and other indoor pollutants. The run of ductwork should be less than 8 feet. Work with your contractor on this issue and inspect for crimps and angles that reduce duct air flow. Ducts should exhaust to the outside air and not to the attic or crawlspace.

- c. *Ventilation and humidity*: By controlling the relative humidity level in a home, the growth of mold, mildew, bacteria and insects can be minimized. A relative humidity of 35 percent to 50 percent is generally recommended for homes. House dust mites, the source of one of the most powerful biological allergens, grow in damp, warm environments.

Some biological contaminants (certain molds) can be fatal, while others can trigger allergic reactions, including hypersensitivity pneumonitis, allergic rhinitis and some types of asthma. Diseases can be traced to microorganisms that grow in home heating and cooling systems and humidifiers. Children, elderly people, and people with breathing problems, allergies, and lung diseases are particularly susceptible to disease-causing biological agents in the indoor air.

Questions? Need help? Contact Construction Technologies at ConsEnv@habitat.org.

Carbon monoxide

- 1) The ugly facts about carbon monoxide from heating systems, clothes dryers and stoves:

- a. *What is carbon monoxide:* Carbon monoxide (CO) is a colorless, odorless gas that interferes with the delivery of oxygen throughout the body.
- b. *Effects of CO poisoning:* At high concentrations it can cause unconsciousness and death. Lower concentrations can cause a range of symptoms from headaches, dizziness, weakness, nausea, confusion, and disorientation, to fatigue in healthy people and episodes of increased chest pain in people with chronic heart disease. The symptoms of carbon monoxide poisoning are sometimes confused with the flu or food poisoning.
- c. *Sensitive individuals:* Fetuses, infants, elderly people, and people with anemia or with a history of heart or respiratory disease can be especially sensitive to carbon monoxide exposure.

2) Buy and install sealed, direct-vent or fan-assisted systems.

To avoid creating CO problems, a sealed combustion system is the best and is directly vented to the outside (90 percent AFUE). While these cost more initially, there are fewer problems with these models. The next best is an 80 percent AFUE rated system, but with fan or power assistance. Ensure that all combustion appliances, including stoves and dryers, are properly vented to the outside. Gas water tanks and heating systems should be completely sealed from air leaks. Combustion gases can be back drafted into the living space



if the combustion appliance is not properly vented or does not receive enough supply air. Installing a direct outdoor air supply for the combustion appliance can help prevent back drafting. If the house envelope is well-insulated and sealed, a more affordable and smaller gas heating system can be used.

3) Help with sealing combustion closets

Placing gas equipment that is not power-vented in combustion closets as part of the HVAC system is not the best practice. However, if you install a gas heating system and/or a gas water tank in a combustion closet, it is critical that a knowledgeable staff person create a complete and healthy seal between the living space and closet air. The combustion closet must receive enough supply air for it to work properly. Very dangerous conditions can occur when proper ventilation details are not followed with combustion systems in the home. Install a CO detector in every home to check on CO levels (a \$20 purchase, approximately).

Any time you install a gas or propane system/appliance inside a home, you should provide a hard-wired carbon monoxide detector. Otherwise you cannot guarantee a safe, healthy living environment for family members inside that home.

If you have any concerns about proper air-sealing, please call Construction Technologies at (800) 422-4828, Ext. 6795 or contact us by e-mail at ConsEnv@habitat.org.

Radon-resistant construction techniques

(Reduce moisture, radon and other soil gases from entering the house.)

- 1) Radon risk for your county
 - a. *Quick check for risk:* Are your homeowners at risk for radon exposure? Check out the radon zones in your state at <http://www.epa.gov/iaq/radon/zonemap.html>.
 - b. *Warning! Radon levels vary:* Averages are only averages and nothing more. High radon levels have been found in low-risk areas. The level of radon in a home is dependent on the type of bedrock below. As we know, bedrock does not form in straight lines. From house to house, from neighborhood to neighborhood, radon levels will always vary. Unfortunately, there is no way to predict what the levels will be after a house is built. Unless you have a generous geologist as a personal friend, and he/she will analyze and map out every build site for you beforehand, it is safest to use a radon-reduction system.
 - c. *What to do? Passive and active systems:* Habitat recommends that all new homes have at least a passive radon mitigation system in place, especially for those homes built in zones 1 and 2 (high- and medium-risk zones). Homeowners should test their homes after moving inside to make sure that radon levels are healthy. If levels are too high, then a fan should be installed to make the existing “passive” system “active.” Follow these guidelines unless you know for sure that your area has very low radon. The following documents are helpful:

- i. "Quick facts about radon" spells out the facts on one page.
- ii. "Radon guide for HFH staff" discusses testing and other details.
- iii. "Building radon out technical details" is a step-by-step guide for construction staff.
- iv. "Radon-reduction bulletin DOE" is a technical bulletin by the U.S. Department of Energy.

Choose healthy interior products

Choose building materials and furnishings that will keep indoor air pollution to a minimum for your homeowners.

- 1) Urea formaldehyde (UF) in cabinets and drawers and on floors. Use exterior-grade pressed wood products made with phenol-formaldehyde (PF) resin in floors, cabinetry and wall surfaces. Formaldehyde in PF products has much lower gas emissions than in UF products. Ask about the formaldehyde content of pressed wood products, including building materials and cabinetry, before you purchase them.
 - a. *Where UF is found:* In homes, the most significant sources of formaldehyde are likely to be pressed wood products made using adhesives that contain urea-formaldehyde (UF) resins. Pressed wood products made for indoor use include particleboard (used as sub flooring and shelving and in cabinetry and furniture); hardwood plywood paneling (used for decorative wall covering and in cabinets and furniture); and medium-density fiberboard (used for drawer fronts, cabinets and furniture tops). Medium-density fiberboard contains a higher resin-to-wood



ratio than any other UF pressed wood product and generally has the highest formaldehyde-emitting pressed wood product.

- b. *UF alternatives:* If homeowners experience adverse reactions to formaldehyde, you may want to avoid the use of pressed wood products and other formaldehyde-emitting goods. Even if you do not experience such reactions, you may wish to reduce your exposure as much as possible by purchasing exterior-grade products, which emit less formaldehyde. Other pressed wood products—such as softwood plywood and oriented strand board/OSB—are produced for exterior construction use and contain the dark- or red/black-colored phenol-formaldehyde (PF) resin.

For further information on formaldehyde and consumer products, call the EPA Toxic Substance Control Act (TSCA) assistance line at (202) 554-1404.

- c. *Sealing in UF, if used:* If you purchase cabinets that are made from pressed board and they are not solid wood, seal cabinet counters with a water-based sealant to keep in formaldehyde. Some studies suggest that coating pressed wood products with polyurethane may reduce formaldehyde emissions for some period of time. To be effective, the coating must cover all surfaces and edges and remain intact. Increase the ventilation and carefully follow the manufacturer's instructions while applying these coatings. Increasing the rate of intentional ventilation in the home will

also help in reducing formaldehyde levels.

- 2) Dust mites, mold, VOCs and other allergens in carpet products. Wall-to-wall carpet contributes to poor indoor air quality, especially if outdoor shoes come into contact with the carpet. Carpet is excellent at trapping dust, dirt, allergens, moisture, etc. It is best to avoid wall-to-wall carpet if the homeowner agrees with this decision. Children and asthmatic persons are most susceptible to problems associated with wall-to-wall carpet.
 - a. *Carpet alternatives:* Several Habitat affiliates use painted and stamped concrete floors, wood parquet squares, ceramic tile and linoleum (in some cases solid wood or cork, but it is costly) instead of large amounts of carpet. As an alternative flooring, wood parquet is found at Home Depot and installed easily by volunteers. Homeowners can use smaller throw rugs in areas where they deem appropriate as an added warmth and a nice interior touch.
 - b. *Note on carpet and concrete:* Wall-to-wall carpet on concrete, such as in basements, is not a good idea. Too many moisture problems have occurred with carpet next to concrete.
- 3) Volatile organic compounds (VOCs) in carpet and paint products. VOCs are gases found in several home interior products. Amounts are by far the highest in standard wall-to-wall carpet, the underlying pad, and the adhesive used for the installation. Although today's interior paint generally contains lower VOCs, check to make sure that you are using low-VOC or no-VOC paint for interior paint jobs.

a. Alternative carpet and paint products:

Eliminate wall-to-wall carpet. Homeowners can add a personal touch by using smaller throw rugs instead. Some carpet is especially designed without VOCs, such as some recycled-content carpet, but can be costly if a low-cost partnership is not established. Standard carpet contains much more VOCs than paint. If you use other flooring products, use water-based adhesive for easier breathing. Use low- or no-VOC paint inside and ventilate well during and after painting.

b. Installation tips for carpet: A number of consumers have associated a variety of negative symptoms with the installation of new carpet. If homeowners really desire wall-to-wall carpet, make the problem of high VOC gases less significant by following these installation tips:

- Unroll and air out the carpet in a well-ventilated area before installation.
- Use low-emitting or water-based adhesives if used for installation.
- Consider leaving the premises immediately after carpet installation.
- Follow the Carpet and Rug Institute's installation guidelines.
- Open doors and windows during and after installation. Increasing the amount of fresh air in the home will reduce exposure to most chemicals released from carpet. During and after installation, use window fans, room air conditioners, or other mechanical ventilation equipment you may have installed in your house to exhaust fumes to the outdoors. Keep them running for 48 to 72 hours after the new carpet is installed.



KIM MACDONALD

Questions? Need help? Contact Construction Technologies at ConsEnv@habitat.org.

4.0 Durability

MINIMUM STANDARDS

Addressing local geographic, climatic and potential disaster issues.

- Each affiliate should take into consideration additional minimum durability standards that help reduce hazards from floods, earthquakes, drought, insect invasions, soil movement, tornadoes, hurricanes, ice dams and any other potentially relevant issues that could negatively impact housing in your area.
- Each affiliate should develop a Durability Plan that identify and incorporate best practice approach for managing these construction measures.

General Hazards Mitigation Information:

1. FEMA has updated information on many of these issues, including design resources for residential building: <http://www.fema.gov/>
2. The Disaster Center's Resistant Building links: <http://www.disastercenter.com/build.htm>



3. The Federal Alliance For Safe Homes:
<http://www.flash.org/>
4. HFHI's Disaster Response Office on BetaPartnerNet.<http://partnernet.habitat.org/intradoc/groups/hfhi/documents/general/disastermitigation.hcsp> Site includes the Hazard Identification Checklist and Risk and Hazard Assessment Guidelines.

Soil Settlement, Drainage and Erosion

It is best to locate housing in areas not prone to major soil settlement, flooding or erosion. In addition, water drainage should move in the direction away from housing and not towards housing. It is important to understand the drainage pattern, slope and the soil type found in your project site and in the area just outside the site.

Soil type will impact how much a foundation settles and whether the settlement is total or differential. Gaining more information about soils and drainage before you buy land and break ground is very important. Issues such as problem soils and high groundwater can be identified using specific tools near to you. In some extreme cases, soil slump and large-scale erosion can occur, impacting not only

A structure located within a 100-year floodplain has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage"—FEMA

your own housing project, but adjacent housing in the area as well.

1. The United States Department of Agriculture (USDA) has soil maps for most of the U.S. at: www.usda.gov. Local USDA offices also have these maps for free.
2. The United States Geological Survey (USGS) has topographic maps at: www.usgs.gov. These maps show additional features that are not visible from the ground, including slope and drainage. These maps can be downloaded for free at: www.topozone.com or can be purchased at local outdoor and sports stores.

Consult with the local building and engineering department if there is any doubt about potential drainage, soil, slope or erosion issues. An independent soils engineer will also confirm whether you might have any potential problems if you are still unclear about conditions on your site. It is always cheaper and more efficient to prevent problems initially rather than to deal with them as they occur.

Floods

A quick check on flooding potential for project sites is a critical step before buying or accepting land for building. The following resources below are helpful tools:

1. Check floodplain hazards with the Community Map Repository, which is typically located at your local Planning and Zoning office.

2. FEMA provides information on Flood Hazards at: <http://www.fema.gov/hazard/flood/index.shtm>
3. FEMA Flood Maps are available at: <http://msc.fema.gov/>

Water Management

In most climates, water management from the foundation to the roof, and moisture within the housing envelope and inside the home, is a concern and must be addressed adequately. Proper planning and design concerning water and moisture will extend the life of housing greatly and reduce potential callbacks. Refer to the Water Management section of HFHI's Healthy Indoor Air Quality standard for best practices. Go to the new My.Habitat Construction Site and click on Templates and Downloads: <http://beta.partnernetad.habitat.org/BusinessOperations/USConstruction/>

Drought

While specific regions of the U.S. have always endured low rainfall, it is important to realize future trends of drought conditions and to be conscious of how an affiliate's landscaping plan can impact a homeowner's future with regards to the cost of maintenance and water usage.

1. Drought Conditions and Trends: <http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html>
<http://www.drought.noaa.gov/>

One of the easiest ways to reduce water use and time spent in landscaping for homeowners is to Building to durability standards restrict turf grass

to a small area of the yard or to eliminate it. Too many times turf grass performs poorly because of the constant upkeep in water, mowing and fertilizer needed to make it survive. Compensate by planting drought-tolerant plants and trees native to your area, surrounded by mulch that retains moisture in the ground and makes the yard look more attractive. Consult with the local USDA county extension office.

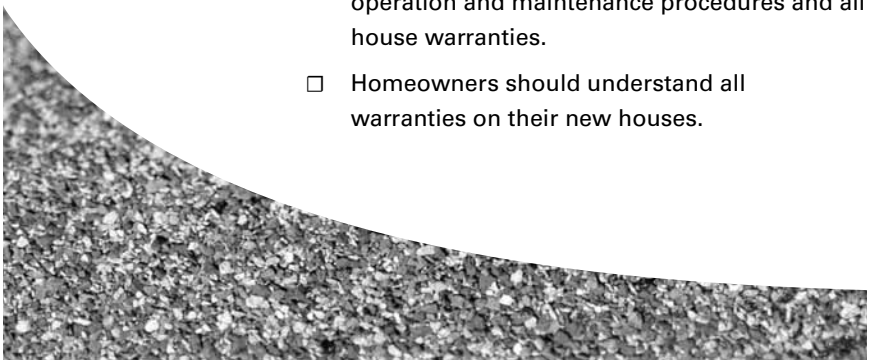
Resources:

- [My.Habitat](#)



5.0 Operations and Maintenance

- Affiliates should adopt a written procedure for offering training to homeowners about home operations and maintenance.
- The affiliate should provide every homeowner with a “walk-through,” warranty document and checklist with features of the new house before the move-in date.
- Homeowners and volunteers receive basic training in the operation and maintenance of each house, including:
 - Efficient functioning and maintenance of household energy systems (heating and cooling, water heating, ventilation, etc.).
 - Appliances (plumbing, water mains, circuit breakers, etc.).
- Homeowners should receive a written house manual that documents house features, operation and maintenance procedures and all house warranties.
- Homeowners should understand all warranties on their new houses.



Safety Policy

The following points define criteria affiliates should use when adopting and implementing a safety policy: A comprehensive written safety manual is available at all times.

- Liability waivers are signed by all volunteers on the work site.
- For liability reasons, daily safety training is scheduled and required for all staff and volunteers who will be on the site. The affiliate should have a plan for those who arrive late and miss the training. Training should include:
 - Emergency procedures.
 - Tool and equipment safety.
 - Poisons and toxic substances.
 - Clean work site plan.
 - Fall-prevention training, including ladder and scaffold safety.
- Schedule regular testing and maintenance of tools and equipment.
- Adopt a daily log for recording crew and volunteer safety meetings.
- Adopt an injury report.

Resources are available at my.habitat

- A written safety policy ensures that Habitat for Humanity is properly communicating and

training for a safe work site. This reduces the number of safety incidents and provides legal protection for affiliates.

Construction Management Plan

Proper construction management procedures encompass quality project management practices and ensure seamless collaboration between construction operations and other essential functions within the affiliate. Affiliates should adopt a complete construction management program that includes the following:

- A written schedule for each project – Affiliates should commit to creating a written schedule for each project.
- A written strategic plan and goal-setting – Construction management begins with strategic planning and a statement of long-term goals of an affiliate’s construction operations. A detailed plan should be discussed, written and adopted by construction and other affiliate leadership that maps out construction efforts to meet the goals of the strategic plan.
- Identification of resources to meet construction goals –The affiliate must identify all resources necessary to achieve construction goals. These resources include but are not limited to:
 - Human resources (paid and volunteer)
 - Volunteer recruitment and training
 - Funding
 - Land acquisition and development
 - Family services and support
 - Community relations and collaboration
 - Governmental support

- Essentials of basic project management procedures – Successful construction management includes project management procedures which incorporate the following essentials:
 - Meeting HFHI design criteria;
 - A written house description package that explains standard features including house design, finish materials, colors, fixtures, energy-efficient features, and all specific homeowner options selected;
 - A budget and materials list for each house;
 - A committee that reviews construction operations, costs, and construction quality and safety on a quarterly basis;
 - Homeowner maintenance manual;
 - Walk-through and warranty document;
 - Annual construction schedule;
 - Daily and weekly schedules of anticipated construction tasks (used to inform and 36 U.S. construction Standards communicate progress to all interested parties such as subcontractors, supervisors, staff, volunteers, donors, committees and directors);
 - Land acquisition and development plan and schedule;
 - A construction schedule that drives the volunteer schedule; and
 - Standardized tracking and training of construction volunteers.

General Resources

- Construction manuals from HFH of Charlotte in N.C., Cobb County HFH in Smyrna, Ga., and HFH Valley of the Sun in Phoenix, Ariz. (Please contact the affiliates to receive a copy of their manual.)

- Denver HFH Safety Manual (Contact HFH of Denver to receive a copy of this manual.)

Book and CD Resources

- “Habitat for Humanity—How to Build a House” by Larry Haun
- “Basic Construction Management: The Superintendent’s Job” by Leon Rogers
- “Building Better Homes” by Building Knowledge Products Group Inc. www.buildingknowledgeproducts.com

Resource:

- Habitat for Humanity Construction Technologies’ Web site at <http://my.hfhi.habitat.org/BusinessOperations/USConstruction/default.aspx>



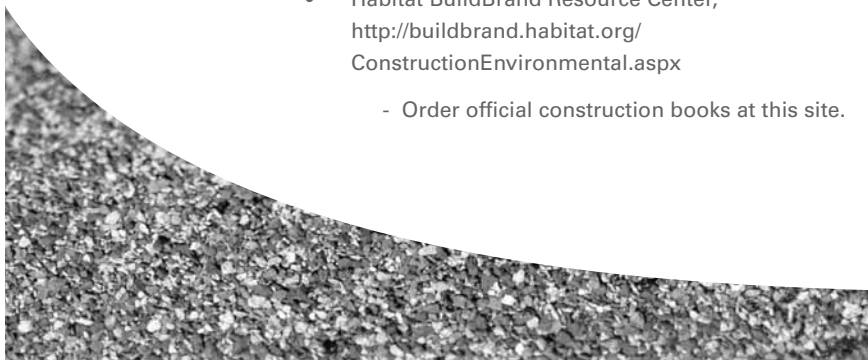


Resources

ADDITIONAL INTERNET RESOURCES YOU CAN USE

Habitat for Humanity

- My.Habitat
 - Check the Construction Roundtable Discussion and announcements regarding product partnerships.
 - Resources and materials are available for download at the Construction Technologies department site.
- Habitat for Humanity, www.habitat.org
 - Downloadable information on safety, green and healthy building, energy-efficiency, rehabbing, and lead-safe practices, and checklists.
- Construction and Environmental Resources, ConsEnv@habitat.org
 - Contact us with any questions, and to let us know how you are doing.
- Habitat BuildBrand Resource Center, <http://buildbrand.habitat.org/ConstructionEnvironmental.aspx>
 - Order official construction books at this site.



Habitat for Humanity Partner Sites

- Building America, http://www.eere.energy.gov/buildings/building_america/affordable_housing.html
 - *Access recent findings on affordable and energy-efficiency building strategies.*
- U.S. Environmental Protection Agency, <http://www.epa.gov/iaq>
 - *Download and order free brochures on healthy indoor air quality issues.*
- Energy Star, <http://www.energystar.gov/>
 - Download information on the EnergyStar® program.
- RESNET, <http://www.natresnet.org/builder/>
- Smart Growth, <http://www.smartgrowth.org/>
- U.S. Department of Housing and Urban Development, <http://www.hud.gov/offices/cpd/affordablehousing/training/web/energy/help/green.cfm>

Building Science and Affordable Housing Sites

- The Design Advisor, <http://www.designadvisor.org/>
 - Provides information on affordable green housing.
- American Lung Association Health House, <http://www.healthhouse.org>
 - Provides information and tips to improve

indoor air quality for homes and avoid toxic materials, particularly indoors.

- Energy-efficient Rehab Advisor, <http://rehabadvisor.pathnet.org/>
- The Rehab Guide (U.S. Department of Housing and Urban Development (HUD)), <http://www.huduser.org/publications/destech/rehabgds.html>
 - *The guide can be downloaded for free at this site, or order for a nominal fee by phone at (800) 245-2691 (Option 1).*
- Toolbase, <http://www.toolbase.org/>
 - The National Home Building Association's (NAHB) technical information resource site provides details on materials and techniques.
- Building Green, Inc., <http://www.buildinggreen.com/>
 - *Provides information on environmentally sensitive design and construction issues.*

Training Resource Sites

- My.Habitat
 - Habitat for Humanity training events are listed under the U.S. Training Events.
- Affordable Comfort, Inc., <http://www.affordablecomfort.org/>
 - Provides professional regional trainings and an annual conference on building science in North America.
- The Energy and Environmental Building Association, <http://www.eeba.org/>
 - Provides professional regional training and an annual conference on building science and green issues.



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