



# **EarthCraft House Technical Guidelines**

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## Introduction

The EarthCraft House Technical Guidelines apply to all new construction and gut rehab projects in the EarthCraft House program, including single-family homes, duplexes, and townhomes. When verifying items for an EarthCraft project, EarthCraft Builders and EarthCraft Technical Advisors shall reference these Guidelines to ensure all requirements have been met.

If local building codes conflict with or are more stringent than the EarthCraft Technical Guidelines, the local code shall be followed. The Builder must notify the Technical Advisor of any changes required for the home to meet local codes.

Materials and methods described are representative of typical strategies that meet the intent of the criteria, but do not represent all strategies that may be used. The project team may request permission from EarthCraft to meet the intent of the credit using a different approach. Approval from EarthCraft must be obtained prior to implementation.

## The EarthCraft House Program

The EarthCraft House program prioritizes resource efficiency and smart construction practices. It is organized into primary categories, each of which details specific criteria. The primary categories are:

SITE PLANNING	SP
RESOURCE EFFICIENCY	RE
DURABILITY & MOISTURE MANAGEMENT	DU
HIGH-PERFORMANCE BUILDING ENVELOPE	BE
ENERGY-EFFICIENT HVAC SYSTEMS	ES
INDOOR AIR QUALITY	IAQ
PLUMBING & IRRIGATION	PI
EFFICIENT LIGHTING & APPLIANCES	LA

EarthCraft's base level certification is called EarthCraft certified. An EarthCraft certified home is an energy efficient home that meets code requirements for envelope specifications and is above code on envelope performance and indoor air quality (IAQ).

Projects seeking to further distinguish themselves for building performance, environmental awareness, and/or occupant health and safety may seek additional certification packages. These packages, or certification badges, fall into four (4) categories:

COMFORT	CMFT
ENVIRONMENT	ENV
HEALTH	HLTH
PERFORMANCE	PERF

Badges are optional add-ons for any EarthCraft certified project. Each has its own requirements that projects must meet in order to obtain the badge. Since these badges serve to enhance different areas of the EarthCraft House program, their specific requirements may be distributed within multiple sections of the EarthCraft House worksheet. The table below highlights the areas each badge enhances:

	<p>The Comfort badge includes advanced heating and cooling systems, including high efficient equipment, advanced distribution design and commissioning of systems. All items covered by the Comfort badge are located within the Energy Efficient Systems section of the EarthCraft House worksheet.</p>
	<p>The Health badge includes high performance outdoor air ventilation systems and increased attention to finish materials. All of the items covered by the Health badge are located within the Indoor Air Quality section of the EarthCraft House worksheet.</p>
	<p>The Environment badge includes site design and material selection items that support environmentally preferred construction practices. This badge covers the following areas of the EarthCraft House worksheet: Site Planning, Resource Efficiency, and Plumbing &amp; Irrigation.</p>
	<p>The Performance badge supports building construction practices and materials supporting a residential structure exceeding the IECC 2015 energy code for energy and water efficiency. This badge requires that projects complete an energy model to aid the design team as they plan a high performance home. The Performance badge covers the following areas of the EarthCraft House worksheet: High Performance Building Envelope and Plumbing &amp; Irrigation.</p>

# Certification Process

## 1. Project Eligibility

Projects that meet the below criteria are eligible for EarthCraft House certification:

- A. Single-Family detached
  - New construction, built upon a new or existing foundation
  - Ancillary structures that are intended to be habitable and share the same address as the primary house, such as a guest house or a suite above a garage, will be subject to the same criteria as the primary house
- B. Townhome, row home or duplex
  - Each dwelling unit must have its own unique postal address
  - Each dwelling unit will be registered as an individual project

### *Builder Responsibilities*

Determine project eligibility

- Contact EarthCraft if you are uncertain which EarthCraft program your project qualifies for.

## 2. Registration

Projects that meet the above criteria are eligible for EarthCraft House certification. To initiate a new EarthCraft project, a project registration form must be completed. A project may be registered by any individual involved with the project. The registration fee must be paid in full before certification will be awarded.

### *Builder Responsibilities*

Select a Technical Advisor (TA)

- The TA will track the project throughout the certification process and provide all EarthCraft verification, diagnostic testing, and energy modeling services as they apply to the certification path selected by the builder.

If assigning registration responsibility to the Technical Advisor or another representative from the builder company, provide registrant with all of the information needed to complete the registration form:

- Building type
- Conditioned square footage
- Number of stories
- Number of bedrooms
- Project address
- Billing contact
- Permit date

### *Technical Advisor Responsibilities*

Ensure the project has been registered with EarthCraft

- A project must be registered with EarthCraft prior to the completion of the mid-construction review

## **3. Design Review**

The Design Review is an opportunity to identify project goals and ensure measures are in place to meet all of the criteria set by EarthCraft. If applicable, the preliminary energy model will be used to estimate performance and determine if any improvements are needed to achieve the performance badge.

### *Builder Responsibilities*

Send the following documents to the Technical Advisor for review:

- Completed construction specification sheet demonstrating how the project will meet EarthCraft requirements
- Project worksheet that lists which requirements will be applicable and which optional badges will be pursued, if any
- Manual J load calculations and Manual S equipment selection
- Drawings and specifications
- Note any questions about program technical requirements so that potential issues may be resolved during the design phase of the project

### *Technical Advisor Responsibilities*

Review all materials provided by the Builder

- Determine the project's ability to achieve certification
  - If necessary, develop options to meet program criteria
- Address all questions and concerns presented by the Builder
  - Contact EarthCraft if further clarification is needed
- Identify effective cost trade-offs for improving building performance
- Identify areas of potential confusion or failure
- If applicable, complete preliminary energy model

## 4. Mid-Construction Review

During the mid-construction review, the TA will begin to gather verification documentation and conduct the mid-construction inspection(s).

### *Builder Responsibilities*

Schedule the initial mid-construction inspection with your TA

- At least one (1) inspection must occur after insulation installation, but prior to the hanging of drywall
- Ensure the project is ready for inspection
  - Framing, rough-in, air sealing, and insulation installation must be complete and ready for visual inspection
  - The TA must be able to visually verify that framing, air sealing and insulation requirements have been met

Note: The minimum insulation installation that should be installed during the mid-construction review is for exterior wall insulation. If necessary, the TA may visually inspect attic and floor insulation during a final inspection. Builders shall discuss when all areas of insulation will be inspected with their TA during the design review, or prior to completing all inspections during the mid-construction review.

### *Technical Advisor Responsibilities*

Follow up with Builder to ensure the inspection is scheduled during the appropriate time of construction

Perform the inspection

- Verify applicable worksheet items
- Confirm the Manual J reflects the home as constructed
- If applicable, confirm the energy model represents the home as constructed

Inform the Builder whether or not the project passed inspection

- If necessary, outline items that need correction or further attention

## 5. Final Review

As construction activities near completion, the Technical Advisor will verify all remaining worksheet items and conduct final diagnostic testing.

### *Builder Responsibilities*

Schedule the final inspection with your TA

- Inspection shall occur after all interior finishing work has been completed, but prior to occupancy

Ensure the project is ready for inspection

- All unverified worksheet items must be completed and accessible

### *Technical Advisor Responsibilities*

Follow up with Builder to ensure the inspection is scheduled during the appropriate time of construction

Perform the inspection

- Conduct diagnostic testing
- Verify applicable worksheet items
- If applicable, confirm the energy model represents the home as constructed

Inform the Builder whether or not the project passed inspection

- If necessary, outline items that need correction or further attention

## 6. Certification

At certification the TA will provide EarthCraft with all documentation necessary for review. After EarthCraft has reviewed and accepted all documentation, the certificate will be awarded.

### *Technical Advisor Responsibilities*

Complete the inspection report and submit to EarthCraft for review

- This must be completed no later than forty-five (45) days after the first final inspection

Assemble the certification submittal package

- Final worksheet
- Worksheet cover, signed by builder and TA
- Projects showing compliance through an energy model\* must submit:
  - Home Energy Rating Certificate (HERS Certificate)
  - 2009 IECC Fuel Summary Report

\*Energy models must be confirmed by the provider prior to submitting to EarthCraft.

\*Reports without print permission or not listed as confirmed will not be accepted

Submit all submittal documents to EarthCraft

- This must be completed no later than forty-five (45) days after the first final inspection

## Site Planning (SP)

The location of a home and the plan for the area around that home can have a significant impact on both a resident's quality of life and on the environment. Selecting an appropriate site for a home is essential to creating more walkable, livable communities. One can also improve the air quality in a neighborhood, help manage storm water, lower energy bills, and increase property values simply by protecting and restoring trees on a site. Planning for construction on a site can prevent soil loss and water pollution by reducing erosion and properly controlling for storm water.

The Site Planning category of the EarthCraft program focuses on actions that a builder can take to minimize the direct impact of a building site on the environment. These actions range from protecting excavated topsoil from erosion to reducing lot size.

## SP 1: Do not install invasive plant species

### Purpose

Invasive species are region-specific, non-native plants that tend to spread aggressively and decrease native biodiversity.

### Criteria

Invasive species are region-specific, non-native plants that tend to spread aggressively and decrease native biodiversity. Do not include plants on the landscape plan that have been identified as non-native, invasive Category 1-2 species (also may be called Severe Threat or Significant Threat), with the exception of Bermuda grass (*Cynodon dactylon*).

### Additional Resources

For an up-to-date list of invasive species and associated categories for projects located in the Southeast please refer to the resources below:

- Alabama:
  - Alabama Invasive Plant Council: <https://www.invasive.org/species/list.cfm?id=71>
- Georgia:
  - Georgia Exotic Pest Plant Council: <https://www.gaepcc.org/list/>
- North Carolina:
  - North Carolina Native Plant Society  
[https://www.ncwildflower.org/plant\\_galleries/invasives\\_list](https://www.ncwildflower.org/plant_galleries/invasives_list)
- South Carolina:
  - South Carolina Exotic Pest Plant Council: <https://www.se-epcc.org/southcarolina/invasivePlants.cfm>
- Tennessee:
  - Tennessee Invasive Plant Council: <http://tnipc.org/invasive-plants/>
- Virginia:
  - Virginia Department of Conservation and Recreation:  
<http://www.dcr.virginia.gov/natural-heritage/invspdflist>

### Confirmation

The EarthCraft Technical Advisor will confirm compliance based on plant list provided by the builder prior to submitting project for certification.

**Example**

Miscanthus Sinensis is a Category 2 invasive species in Georgia and is not allowed to be planted on an EarthCraft House project built in Georgia.

SHRUBS				
KEY	BOTANICAL NAME / COMMON NAME	SIZE	SPACING	QTY.
⊗	BUXUS MICROPHYLLA VAR. KOREANA 'WINTERGREEN' / KOREAN BOXWOOD	3 GAL.	30" O.C.	170
⊙	BUXUS MICROPHYLLA VAR. KOREANA 'WINTERGREEN' / KOREAN BOXWOOD	5 GAL.	AS INDICATED	3
⊗	GARDENIA JASMINOIDES 'AUGUST BEAUTY' / AUGUST BEAUTY GARDENIA	3 GAL.	5' O.C.	72
⊗	GARDENIA JASMINOIDES 'RADICANS' / DWARF GARDENIAS	3 GAL.	30" O.C.	128
⊗	HYDRANGEA MACROPHYLLA 'BAILMER P.P. #15,298' / ENDLESS SUMMER HYDRANGEA	3 GAL.	30" O.C.	38
⊗	HYDRANGEA QUERCIFOLIA 'PEEWEE' / OAKLEAF HYDRANGEA	3 GAL.	3' O.C.	81
⊗	ILLICIUM PARVIFLORUM / ANISE	3 GAL.	4' O.C.	179
⊗	ITEA VIRGINICA 'HENRY'S GARNET' / VIRGINIA SWEETSPIRE	3 GAL.	3' O.C.	184
<del>⊗</del>	<del>MISCANTHUS SINENSIS 'MORNING LIGHT' / MAIDEN GRASS</del>	<del>3 GAL.</del>	<del>3' O.C.</del>	<del>54</del>
⊗	PRUNUS LAUROCERASUS 'OTTO LUYKEN' / OTTO LUYKEN LAUREL	3 GAL.	3' O.C.	16
⊗	ROSA 'RADAZZ' / KNOCKOUT ROSE	3 GAL.	3' O.C.	66
⊗	ROSMARINUS OFFICINALIS / ROSEMARY	3 GAL.	18" O.C.	5

## SP 2: Design and Implement Tree Protection Plan

### Purpose

Any activity that changes the soil conditions, or disturbs branches, trunks, or root systems, is extremely detrimental to a tree's health. A tree protection plan outlines the steps that will be taken to preserve trees and critical root zones.

### Criteria

A professional landscape architect or certified arborist shall develop a tree preservation site plan prior to clearing, grading, or commencement of construction activities that identifies existing trees with diameter at breast height (DBH) dimensions exceeding 3" and designates  $\geq 20\%$  of those trees to be protected during all construction activities.

Tree root zones (area extending in all directions from the trunk) must be protected with a physical barrier to minimize all disturbances, including those from parked vehicles and construction material storage. Set fences firmly; if wood fences are used, they must be a minimum of 2x2 lumber. Do not place any soil from clearing, grading, or construction activity on top of any root zone for trees designated on a site plan to be preserved. Trees that are marked to be preserved on a site plan and for which utilities must pass through the root zones must not have surface dug trenches. Dig tunnels through the root zone in order to minimize root damage.

The builder must review tree preservation plan with subcontractors and post plan on job site.

### Confirmation

The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor during the design review process.

The EarthCraft Technical Advisor will review documentation provided by the builder and will visually confirm compliance during the mid-construction and final inspections.

### Examples:

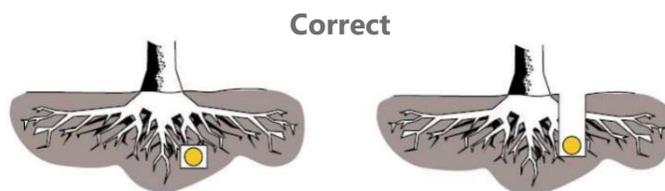


Figure 1: Tunnel to minimize root damage (left) as opposed to surface-dug trenches in root zone (right)

### Incorrect



Storage or staging of materials on tree root zones is not permitted

## ENV 1: Remove 100% of invasive plants from 100% of site

### Purpose

Invasive plant species spread quickly and displace native plants, which may cause economic or environmental harm, or harm to human health.

### Criteria

All existing plants that are listed in Category 1 or 2, Severe Threat or Significant Threat, or High or Medium (with the exception of Bermuda grass) must be removed and properly disposed of.

### Additional Resources

For an up-to-date list of invasive species and associated categories for projects located in the Southeast please refer to the resources below:

- Alabama:
  - Alabama Invasive Plant Council: <https://www.invasive.org/species/list.cfm?id=71>
- Georgia:
  - Georgia Exotic Pest Plant Council: <https://www.gaeppc.org/list/>
- North Carolina:
  - North Carolina Native Plant Society  
[https://www.ncwildflower.org/plant\\_galleries/invasives\\_list](https://www.ncwildflower.org/plant_galleries/invasives_list)
- South Carolina:
  - South Carolina Exotic Pest Plant Council: <https://www.se-eppc.org/southcarolina/invasivePlants.cfm>
- Tennessee:
  - Tennessee Invasive Plant Council: <http://tnipc.org/invasive-plants/>
- Virginia:
  - Virginia Department of Conservation and Recreation:  
<http://www.dcr.virginia.gov/natural-heritage/invspdflist>

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the TA prior to submitting project for certification.
- The Technical Advisor will review documentation provided by the builder for compliance.

## ENV 2: Permanent stormwater control $\geq 50\%$ of onsite impervious surface areas

### Purpose

Impervious surface runoff should be properly located to drain away from building foundation in order to protect the home from moisture damage.

### Criteria

Control disturbed site area by integrating Low Impact Development Best Management Practices (LID BMP) into the project. All BMPs shall be properly located to drain away from building foundation to protect home from moisture damage.

Projects must disconnect at least 50% of onsite impervious surface areas from storm drains by implementing some or all of the LID BMPs from the list below:

1. Direct impervious surface runoff to appropriately sized rain gardens, swales, drywells or bio-retention areas. Receiving area soils shall be amended to increase infiltration to the level required for maintaining storm water. Keep area protected from heavy machinery and parking during construction or mitigate soil compaction post construction.
2. Design and install rooftop gardens and/or green roofs.
3. Direct roof or site runoff into rain barrels and/or cisterns. Size barrels and cisterns appropriately and enable use of water for building reuse or landscape irrigation.

### Additional Resources

- Low Impact Development (LID) Urban Design Tools Website
- Local jurisdiction's Stormwater Management Manual
- National Resource Defense Council Water Smart Cities

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

### ENV 3: Reduce irrigated area and install drought tolerant landscaping (both, details below):

- Turf  $\leq$  40% of landscape area
- Drought-tolerant and/or native landscaping turf and plants

#### Purpose

Minimizing or eliminating lawns and integrating drought tolerant landscaping saves water and energy and reduces the amount of fertilizers that pollute waterways.

#### Criteria

When irrigation is installed, design the irrigated area with  $\leq$ 40% turf. For all landscaped areas, whether or not irrigation is present, use drought-tolerant and/or native species for at least 75% of the plantings.

#### Additional Resources

Information regarding native and/or non-invasive plant species for projects located in the Southeast may be found from the resources below:

- Alabama:
  - Alabama Cooperative Extension System: <http://www.aces.edu/home-garden/lawn-garden/>
- Georgia:
  - Georgia Native Plant Society: <https://gnps.org/>
- North Carolina:
  - North Carolina Native Plant Society  
[https://ncwildflower.org/native\\_plants/recommendations](https://ncwildflower.org/native_plants/recommendations)
- South Carolina:
  - South Carolina Native Plant Society: <http://scnps.org/>
- Tennessee:
  - Tennessee Native Plant Society: <http://tnps.org/resources.html>
- Virginia:
  - Virginia Department of Conservation and Recreation:  
<http://www.dcr.virginia.gov/natural-heritage/nativeplants>

#### Confirmation

- The builder must provide a plant list with the types of plants installed, quantity of each, water needs of each, and which are native species.
- The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## Resource Efficiency (RE)

Forests provide habitats to diverse animal species, offer watershed protection, prevent soil erosion and help maintain the water cycle. EarthCraft House encourages the protection of forests through resource efficient design. By taking the time to design a home to use less wood and by practicing simple measures to ensure that wood on site is used properly, a new home can reduce its impact the environment as well as cost less money to build.

EarthCraft projects can meet the requirements of the Resource Efficiency category through methods such as employing advanced framing techniques and providing clear framing plans and cut lists to contractors. These methods not only reduce the amount of lumber used on site, but also save money through reduced material costs, reduced tipping fees, and increased customer satisfaction including improving the home's energy efficiency.

Building materials come from a variety of sources, not all of which are environmentally friendly. The EarthCraft program strives to reduce the impact homes have on the environment, including the impacts that result from the extraction and manufacture of materials used in home construction. By choosing certain building materials, an EarthCraft Builder can conserve natural resources, prevent unnecessary waste and reduce pollution associated with manufacturing and transporting of materials.

## RE 1: Minimum stud spacing: 16" centers for 2x4 walls and 2x6 walls

- 16" centers for 2x4 walls and 2x6 walls
- Wall spacing at 24" centers for non-load bearing walls

### Purpose

Using the minimum amount of wall studs (and eliminating studs that lack a structural purpose) reduces thermal bridging and allows more space for insulation in addition to conserving lumber.

### Criteria

*Exterior and load-bearing walls:* Minimum stud spacing at 16" centers for 2x4 and 2x6 walls, unless construction documents specify that alternate spacing is structurally required. No more than 5% of studs may lack a structural purpose.

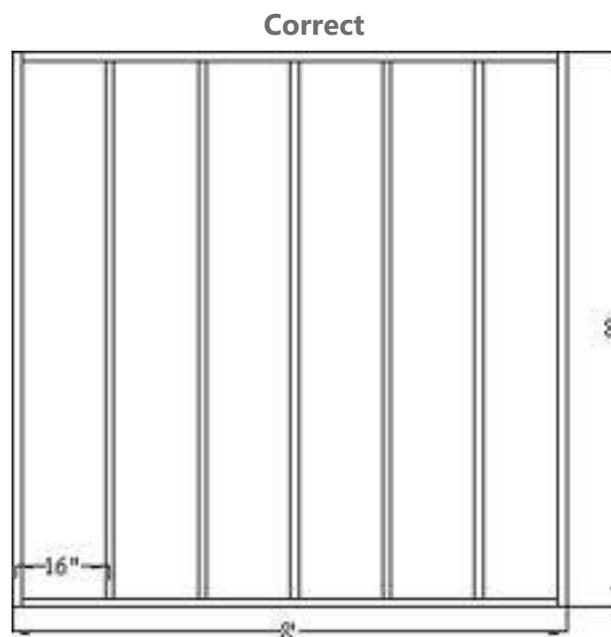
*Non-load-bearing walls:* minimum stud spacing at 24" centers for 2x4 and 2x6 walls, unless construction documents specify that alternate spacing is structurally required.

The builder must present construction documents demonstrating structural requirements for excess framing greater than 5%.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction inspection.

### Example



Construct load-bearing walls with 16 inch on center (OC) stud spacing for 2x4 and 2x6 framing.

## RE 2: Size headers for loads (non-structural headers in non-load bearing walls)

### **Purpose**

Minimize waste by designing and installing appropriately sized headers in all walls. Headers should be sized to accommodate the correct load.

### **Criteria**

Design and install appropriately sized headers in all walls. Eliminate load bearing headers in all non-load bearing walls and do not size all headers in load bearing walls to accommodate the greatest load case.

### **Clarification**

Consult local building codes in areas susceptible to high wind or seismic regions.

### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction inspection and collect supporting documentation, if necessary.

### RE 3: Energy heel truss system or raised top-plates for all vented, unconditioned attics

#### **Purpose**

Raised heel, energy trusses extend further past the wall and are deeper at the wall, thus allowing room for full insulation coverage over the top plate of the exterior walls.

#### **Criteria**

Install energy heel trusses or raised top plates to ensure full depth of attic insulation above exterior wall top plates. Depth of insulation above top plate may be traded to R-21 when allowed by code.

#### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction inspection.

## RE 4: If HVAC ductwork is in conditioned attic, attic side radiant barrier

### Purpose

Unconditioned attics are significantly hotter in the summer than the air being carried in the HVAC ductwork. Radiant barriers reduce the temperature of the attic by reflecting radiant heat instead of absorbing it.

### Criteria

If more than 10 linear feet of ductwork are located in an unconditioned attic, install a radiant barrier with a minimum initial reflectance of 0.90 and maximum initial emittance of 0.10 on all sloped roofs above vented attics. Install radiant barrier so that foil is facing down and not in direct contact with any building materials other than roof rafters. Any uninsulated attic surfaces must have a radiant barrier installed. This includes sloped roof decks as well as gable end walls.

### Confirmation

- Builder shall provide documentation of materials selected to TA prior to submitting project for certification.
- The EarthCraft Technical Advisor will visually confirm compliance of criteria at pre-drywall and final inspections

## RE 5: Engineered trim

- Interior and exterior  $\geq 75\%$

### **Purpose**

Engineered products offer both resource and durability benefits when compared to traditional wood products by resisting rot when exposed to elements (exterior) and are a more effective use of resources.

### **Criteria**

Install a minimum of 75% of total exterior and interior trim from non-solid sawn wood (e.g., finger-jointed wood, medium or high-density fiber board (MDF or HDF), etc.), or non-wood material, such as PVC. All non-solid sawn wood. Products selected must have low or no added urea-formaldehyde.

### **Clarification**

Stain grade trim does not count towards percentage of trim material covered by this criteria.

### **Confirmation**

- Builder shall provide documentation of materials selected to TA prior to submitting project for certification.
- The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction and final inspections

## ENV 4: Advanced framing package (choose one, details below):

- Deliver panelized construction or SIPS to the site pre-framed
- Site framing plan with precut framing package

### Purpose

Advanced framing results in savings on materials costs to builders, reduces the amount of labor needed for installation, and reduces environmental impact due to more strategic cutting of material and reduces thermal bridging.

### Criteria

Review complete framing plan and framing package with framing contractor to reduce unnecessary framing. The framing plan must illustrate the location and size of every stud, cripple, plate, header, and other framing members in the roof, walls, and floors. The precut framing package must correspond directly with framing plan.

#### 1. Floors

Construct a minimum of 90% of the floor area using a panelized floor system (e.g., structurally insulated panels) delivered to the jobsite pre-framed and precut. In all cases, install panelized floor according to manufacturer specifications.

#### 2. Exterior walls

Construct a minimum of 90% of all walls separating conditioned space from unconditioned space using panelized wall systems (e.g., structurally insulated panels) delivered to the jobsite pre-framed and precut. In all cases, install panelized walls according to manufacturer specifications.

#### 3. Roof

Construct a minimum of 90% of the roof area using a panelized roof system (e.g., structurally insulated panels) delivered to the jobsite pre-framed and precut. In all cases, install panelized roof according to manufacturer specifications.

### Clarifications

- Thermal mass and infiltration effects may not be included in R-value.
- Floor area must be calculated using RESNET standards for conditioned floor area.

### Confirmation

- The builder shall provide all necessary framing documentation to the TA prior to the mid-construction inspection
- The EarthCraft Technical Advisor will visually confirm compliance during the mid-construction inspection

## ENV 5: Recycled content materials (choose two, details below):

- Replace > 25% of cement in slab and/or foundation wall concrete with fly ash or slag
- Install >50% recycled content insulation
- Install >50% recycled content carpet on >50% of all carpeted floor

### Purpose

Recycled content materials lower the overall embodied energy of a project. For example, some recycled materials, such as concrete, require less energy to make than their "virgin" counterparts. Fly ash and slag are also byproducts of coal production/energy use. By removing them from the waste stream and finding a way to repurpose these byproducts, the environmental impact of the concrete is reduced.

Selecting insulation that contains a significant percentage of recycled content allows for material reuse and recovery while diverting materials that would otherwise be destined for landfills.

Selecting flooring with recycled content achieves this goal in a similar manner.

### Criteria

- Replace  $\geq 25\%$  of the cement with fly ash or slag in all concrete used for footings, foundation and basement walls and slabs.
- Install 100% of insulation with  $\geq 50\%$  recycled material (pre or post-consumer) content by weight or volume in all walls, floors and ceilings.
- Install carpet with  $\geq 50\%$  recycled content (pre or post-consumer) on 50% of carpet floor area.

### Clarifications

Floor area must be calculated using RESNET standards for conditioned floor area.

### Confirmation

- The builder shall provide documentation demonstrating compliance of criteria for cement and/or insulation (as applicable to project) to the TA prior to the mid-construction inspection. Builder shall provide documentation demonstrating compliance of criteria for carpet to the TA prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria.

## ENV 6: Responsible waste disposal

- **Develop and post waste management plan and divert >75% from landfill (details below):**
  - **Wood**
  - **Drywall**
  - **Mill cleared logs**

### **Purpose**

Responsible waste management is an essential component to reducing job-site waste. By posting it on the job site, a project may ensure that the plan will be followed throughout the entire construction process by all on-site staff and trade contractors.

### **Criteria**

Post a construction waste management plan onsite, educate each subcontractor on the aspects of the plan that pertains to their work, and enforce these measures. The waste management plan must either provide for onsite separation of materials to be recycled or provide for separation of recyclable materials by clean-up or waste hauling firms. Maintain documentation on diversion rate for each material.

#### 1. Wood

Avoid disposal of a minimum of 75% (by weight or volume) of solid sawn wood by recycling through a state or county approved program or by on-site grinding and application of wood chips as mulch. Pressure treated wood is exempt from this requirement and may not be milled or applied as mulch.

#### 2. Drywall

Avoid disposal of a minimum of 75% (by weight or volume) of drywall generated from construction through an approved recycling program, or by onsite grinding and application of drywall as a soil amendment.

#### 3. Mill cleared logs

Commercially process 100% of logs that meet sawmill standards into lumber, pulp, or other use. Logs cannot be buried in a landfill or chipped.

### **Additional Resources**

For the NAHB Research Center's "Builder's Field Guide to Residential Construction Waste Management" publication see [here](#).

## **Confirmation**

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance and will visually confirm compliance during the mid-construction inspection.

## **Durability and Moisture Management (DU)**

An important aspect of building a sustainable home is ensuring durability throughout its life cycle. EarthCraft House recognizes that proper design and installation are integral to building a durable home with minimal moisture management issues. Reducing the life cycle costs due to maintenance, repair, and replacement decreases the impact that home construction, and reconstruction, have on the environment. The durability and moisture management section includes items that improve long-term durability and occupant health and comfort.

## DU 1: Do not install wet or water-damaged building materials

### Purpose

Moisture can cause long term damage to building materials. In particular, wood products swell when they take on moisture and this change in dimension can create problems during installation. Additionally, water may weaken adhesive bonds.

High moisture content can also promote the growth of mold. Installing moldy materials in a building, or failing to properly treat building components that become wet, can expose buildings to potential structural weakness and/or poor indoor air quality when the structure is occupied.

### Criteria

Do not install building materials that have visible signs of water damage or mold.

### Clarifications

Do not enclose walls if the framing members or the insulation has high moisture content (framing members shall be dried to at least 18% moisture content). Follow the manufacturer's drying recommendations for wet-applied insulation and test framing members for moisture prior to enclosing wall cavities.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction inspection.

If high moisture or mold is found during the mid-construction inspection, the builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor. Documentation may include moisture content test results, mold remediation invoices/reports or the equivalent.

### Example

#### Incorrect



Do not install wet building materials. If materials are exposed to moisture after installation, drain/dry area and treat for mold as necessary.

## DU 2: Crawlspace, if designed (choose one, details below):

- Vented crawlspace with spray foam insulation covering 100% of framed floor and 100% coverage of sealed  $\geq 6$  mil vapor barrier over exposed earth. Vapor barrier shall extend  $\geq 6$ " up the stem wall and shall be attached and sealed to the stem wall.

OR

- Unvented crawlspace meeting IRC 2012 (Details below):
  - I. Exposed earth is covered with a continuous  $\geq 6$  mil vapor barrier. Joints of the vapor barrier shall overlap by 6" and shall be sealed. The edges of the vapor retarder shall extend  $\geq 6$ " up the stem wall and shall be attached and sealed to the stem wall or insulation; and
  - II. One of the following is provided for under the under-floor space:
    - a. Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute for each 50 square feet of crawlspace floor area, including an air pathway to the common area (such as a duct or transfer grill) and perimeter walls insulated in accordance with EarthCraft criteria or local code, whichever is more stringent
    - b. Conditioned air supply sized to deliver at a rate equal to 1 cubic foot per minute for each 50 square feet of under-floor area, including a return air pathway to the common area (such as a duct or transfer grill) and perimeter walls insulated in accordance with EarthCraft criteria or local code, whichever is more stringent

### Purpose

Traditional vented crawlspaces are known sources of moisture that can result in damage to framing members and introduce pollutants to living spaces. If a crawlspace is included in the design of a home it should be designed in a way that separates the area from moisture sources and provides for treatment of the area for moisture and humidity.

Properly unvented crawlspaces keep out unwanted moisture better than conventional, wall-vented crawlspaces in temperate-humid climates. Homes with closed crawlspaces (aka "sealed," "unvented," or "conditioned") also can save significantly on energy when compared to homes with wall-vented crawlspaces because they reduce energy loss through the floor of a building.

Properly installed crawlspace ground vapor barriers in all crawlspace areas will prevent the accumulation of ground moisture and soil gases in the crawl space.

## Criteria

See above crawlspace design and construction requirements language and reference the IRC 2012 for additional information.

## Clarifications

- Not required if project is located in 100 year flood plain.
- Drainage, pests and combustion safety issues are important considerations when sealing a crawlspace.

## Additional Resources

For more information about sealed crawlspaces, refer to the Advanced Energy's research on crawlspaces: [http://www.advancedenergy.org/portal/crawl\\_spaces/](http://www.advancedenergy.org/portal/crawl_spaces/).

## Confirmation

- The EarthCraft Technical Advisor will review plans with builder, and if necessary the HVAC contractor, during design review to confirm foundation design.
- TA will verify compliance of foundation space during the mid-construction and final inspections.

## Examples

**Correct**



Follow IRC 2012 for strategies on designing and constructing a closed crawlspace. Closed crawlspaces should have a properly installed vapor barrier, insulation on the crawlspace wall, and a method for providing dehumidification to the space.

**Correct**



Floor insulation of SPF that covers 100% of framed floor, with a properly installed vapor barrier covering 100% of exposed dirt floor is permitted.

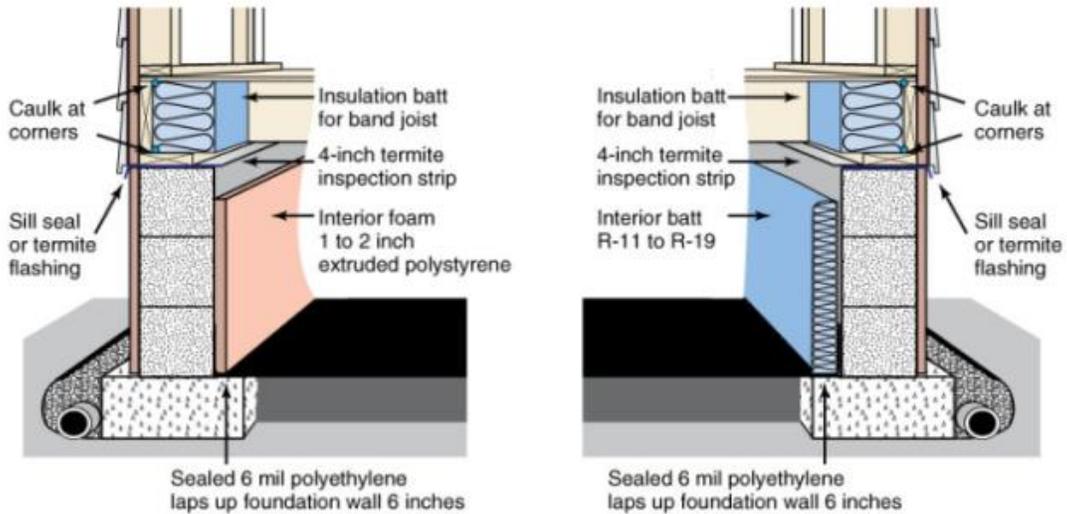


Diagram demonstrating options for creating a sealed, conditioned crawlspace. The image on the left shows foam board attached to the foundation wall, with additional insulation material in the band joist. The image on the right shows batt insulation material attached to the foundation wall, with additional insulation material in the band joist.

In both images the soil in the foundation space is covered with a continuous  $\geq 6$  mil vapor barrier that is 100% sealed at extends vertically on the foundation wall to a minimum of 6" above grade.

### DU 3: Slabs, if designed (both, details below):

- 100% coverage of  $\geq 6$  mil vapor barrier beneath all slab
- Gravel bed beneath all slabs (exception: Climate Zone 2)

#### Purpose

A vapor barrier serves to prevent water vapor and soil gases from coming into contact with the concrete slab. Gravel beds allow for groundwater drainage and can act as a capillary break and prevent groundwater from coming in contact with the slab.

#### Criteria

Install a  $\geq 6$  mil vapor barrier beneath all slabs to prevent soil moisture and gases from entering the home. Provide 100% coverage. Overlap and seal all vapor barrier joints a minimum of 6".

Install a  $\geq 4$ " deep gravel bed (consisting of  $\geq 0.5$ " clean aggregate with no fines beneath on-grade or raised concrete floor slabs (not required if project is located in Climate Zone 2).

#### Clarifications

Gravel bed must be installed beneath vapor barrier. If gravel is not available, install a  $\geq 4$ " of uniform layer of sand with geotextile drainage matting.

#### Confirmation

- The builder will illustrate compliance of criteria through photo documentation submitted to the EarthCraft Technical Advisor prior to mid-construction inspection.
- The EarthCraft Technical Advisor will review photo documentation provided by the builder for compliance of criteria.

#### Examples

Correct



Install a continuous vapor barrier of  $\geq 6$  mil plastic prior to pouring slab.

Correct



## DU 4: Bottom of foundation drain no higher than top of subgrade footing

### Purpose

Foundation drains capture and direct water away from the foundation walls and footings and help to ensure low levels of soil saturation. Increased hydrostatic pressure on the footing/foundation can cause excess stress on the joints of the foundation.

### Criteria

Install a protected foundation drain tile outside of the footing or, at the highest point, directly on top of the footing. Use appropriate drain elbows for bends to prevent drainage constriction around corners. Surround each pipe with  $\geq 6$ " of 1/2" - 3/4" gravel and wrap gravel layer fully with fabric cloth. Discharge all drain lines either away and downhill from the foundation to outside grade/daylight, drywell or to a sump pump.

### Clarifications

- Place the drainage pipe with the perforations facing down.
- A filter fabric sock for the drainage pipe may be used instead of wrapping the pipe and gravel in filter fabric.

### Confirmation

- The builder will illustrate compliance of criteria through photo documentation submitted to the EarthCraft Technical Advisor prior to the mid-construction project review.
- The EarthCraft Technical Advisor will review photo documentation provided by the builder or visually confirm for compliance of criteria.

## DU 5: Damp proof below-grade walls

### Purpose

Damp proofing prevents moisture and water passing through walls to interior spaces, preventing timber decay and structural damage.

### Criteria

Apply damp proofing for all below-grade walls. Damp proofing materials are typically roller- or spray-applied asphalt coatings and/or bituminous felt.

### Clarifications

- Wood-framed below-grade walls are not permitted along the exterior of the home.
- Do not install Class 1 vapor retarders on the interior side of air permeable insulation in exterior below-grade walls, except for tile at showers and tub walls.

### Confirmation

- The builder will illustrate compliance of criteria through photo documentation submitted to the EarthCraft Technical Advisor prior to the mid-construction project review.
- The EarthCraft Technical Advisor will review photo documentation provided by the builder or visually confirm for compliance of criteria.

### Examples

#### Correct



Damp proofing of below grade wall with a bituminous felt material.

**DU 6: Install drainage plane per manufacturer's specifications (both, details below):**

- Single lapped housewrap or taped, vapor permeable water-resistant barrier integrated with sheathing AND/OR
- Double layer of either building paper or housewrap behind cementitious stucco, stone veneer or synthetic stone veneer on framed walls

**Purpose**

A majority of all exterior wall claddings will allow water to pass through them. Therefore, a drainage plane is required to keep rainwater from entering the wall cavity and allow the water to drain down the wall. Drainage planes provide this rainwater control, but must be installed and sealed as instructed by the manufacturer on the entire building assembly exposed to the exterior to be effective.

**Criteria**

See above language and reference manufacturer's instructions for installation.

**Clarifications**

- A drainage plane must be installed and sealed as instructed by the manufacturer on the entire building assembly exposed to the exterior.
- Brick veneer requires a single layer of housewrap or taped, vapor permeable water-resistant barrier integrated with sheathing.
- The International Residential Code requires that "exterior plaster" (stucco) be installed over "a water-resistive vapor-permeable barrier with a performance at least equivalent to two layers of Grade D paper." All unvented, exterior cladding in contact with the substrate must meet the criteria.
- A single layer of building paper coupled with a single layer of housewrap meets the intent of the criteria.
- For stucco cladding systems, include weep screed per manufacturer's specifications.

**Confirmation**

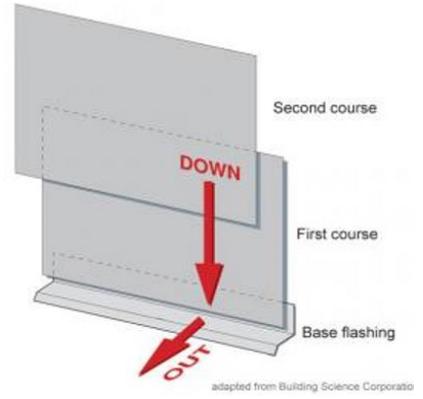
- The builder will illustrate compliance of criteria through photo documentation submitted to the EarthCraft Technical Advisor for the mid-construction review.
- The EarthCraft Technical Advisor will review photo documentation provided by the builder or visually confirm for compliance of criteria.

Examples

Correct



Correct



## DU 7: Flashing complies with 2012 IRC and/or manufacturer specifications

All of the following must be met:

- All exterior penetrations flashed and sealed to the weather barrier prior to cladding
- Window and door pan flashing installed per manufacturer specifications
- Window and door side and head flashing installed per manufacturer specifications
- Step and kick-out flashing at wall/roof intersections
- Step flashing to 4" on wall surface and integrated with wall and roof drainage plane

### Purpose

Windows and doors are an interruption in the wall's house wrap and therefore a vulnerable spot for water leakage. Properly installed flashing that is integrated with the other elements of the wall can help prevent water damage by directing water out rather than into the wall cavity.

### Criteria

See above language and reference manufacturer's instructions for installation.

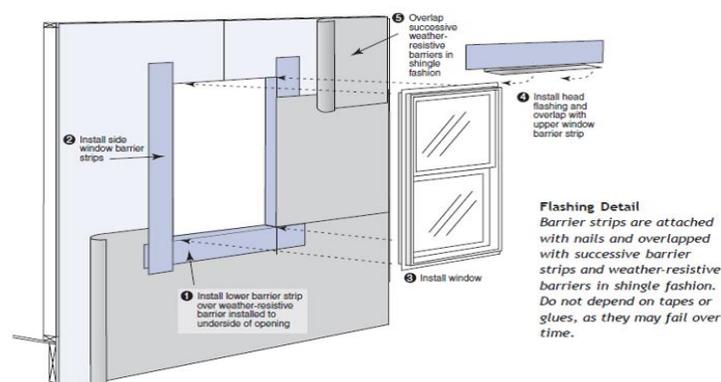
### Clarifications

- For metal and rubber membrane roofs, install continuous flashing in place of step flashing.
- For porches, install L-shaped flashing to the top of the ledger board and integrate with drainage plane (vertical leg of the flashing must extend along the wall above the ledger and the horizontal leg extends over the top of the ledger).

### Confirmation

The EarthCraft Technical Advisor will confirm installation of flashing during mid-construction review. Confirmation may occur during a field inspection or by a review of photo documentation provided by the builder.

### Example



## DU 8: Install siding per manufacturer and industry recommendations (details below):

- Maintain 2" clearance between wall siding and roof surface for wood siding, manufacturers' recommendation for composite products

### Purpose

Correctly installed siding reduces risk of improper water drainage or intrusion of water between siding and sheathing, which could result in structural damage.

### Criteria

Terminate wall siding a minimum of a 2" above roof surface unless otherwise directed by product manufacturer installation specifications.

### Verification

The EarthCraft Technical Advisor will visually confirm compliance of criteria during mid-construction inspection.

### Example

#### Correct



Flashing installed properly between roof and exterior wall.

## DU 9: Rigid, moisture-resistant backing material behind tubs and showers

### Purpose

Moisture-resistant protection is needed behind showers and tubs to prevent moisture from seeping into the wall structure.

### Criteria

Install cement board, fiberglass enhanced sheathing or equivalent moisture-resistant backing material directly behind tub and shower tile and panel assemblies with caulked joints. Install moisture-resistant backing material in accordance with manufacturer specifications.

### Clarifications

Do not use paper-faced board as a backing material for tile. Moisture-resistant gypsum board may be used behind tile-backing material, e.g., green board.

### Verification

The EarthCraft Technical Advisor will visually confirm compliance of criteria during the mid-construction inspection.

### Example

#### Correct



Install a moisture resistant backing material behind all bathtubs and showers

## DU 10: Wall cavity insulation without a vapor retarder or kraft paper

### Purpose

Installing a vapor retarder over vapor-permeable insulation on the interior of a wall does not ensure that moisture vapor in walls will be adequately controlled, regardless of which direction the paper is installed to face. Faced batts have the additional drawback of being difficult to install to RESNET Grade I or II quality and difficult to inspect for proper installation around framing, plumbing, and electrical components.

### Criteria

Install 100% of wall cavity batt insulation without a vapor retarder or kraft paper.

### Clarifications

Blown applications of fiberglass/cellulose material that requires netting is allowed provided the netting material is  $\geq 1.0$  perm.

### Verification

The EarthCraft Technical Advisor will visually confirm compliance of criteria during the mid-construction inspection.

### Example

#### Correct



Unfaced fiberglass batts allow for more effective installation around framing, electrical and plumbing components

## High Performance Building Envelope (BE)

Buildings account for about 40% of all energy use in the United States. EarthCraft encourages an energy efficient building envelope to reduce this impact. One of the key elements to any energy efficient home is constructing a proper building envelope by sealing for air leaks, properly installing insulation and using high-quality windows. The building envelope is the barrier that separates the home's conditioned space from unconditioned space or the outside. The building envelope consists of two parts – an air barrier and a thermal barrier (insulation) that must be both continuous and contiguous (touching each other). In a typical residence, the building envelope consists of the roof or ceiling, walls, windows, doors, and floor or foundation.

## BE 1: Envelope leakage testing: $\leq 5$ Air Changes per Hour at 50 pascals (ACH50) or an Envelope Leakage Ratio (ELR) of $\leq 0.30$

### Purpose

Envelope leakage is a measure of the air tightness quality of the building envelope, an assessment of how much natural ventilation is supplied by air leakage and results may be used to assess energy losses resulting from uncontrolled air leakage. Envelope leakage allows air to enter the home from unknown sources that may contain air contaminants (e.g., moisture, pests, soil gases, dust and other particles). It is preferred to build a tight home and bring in fresh air from known sources via mechanical ventilation.

### Criteria

Envelope leakage testing results must be less than or equal to 5 ACH50 or 0.30 ELR

### Definitions

- CFM50: The volume of air in cubic feet per minute moved through the fan to maintain a 50 Pa pressure difference between the house and outside.
- ACH50 = ACH50 is the number of times the air volume in a building changes per hour at 50 pascals of pressure.
  - $ACH50 = (CFM50 * 60) / \text{conditioned volume}$
- Envelope Leakage Ratio (ELR): The quotient of the CFM50 measurement divided by the square footage of the building envelope, or SFBE.
  - Square footage of the building envelope (SFBE): Sum of the foundation/floor, exterior walls, ceiling areas
  - $ELR = CFM50 / SFBE$

### Clarification

Floor area and volume must be calculated using RESNET standards for conditioned floor area and conditioned volume.

### Verification

The EarthCraft Technical Advisor will diagnostically test compliance of criteria at the final inspection.

## BE 2: Air seal where required by EarthCraft

All are required, as applicable to design:

- All gaps in exterior sheathing  $\geq 1/4"$ , including rim and band areas
- Cantilevered floors blocked at exterior wall
- All chases blocked and sealed: Fireplace, tubs, under stairs
- All plumbing and electrical penetrations
- Sill and sole plates sealed to subfloor and foundation
- All penetrations through subfloor/slab, framing and drywall
- Rough openings around exterior doors and windows
- HVAC Boots and mechanical ventilation fan penetrations through drywall and subfloor

### Purpose

Air sealing is the process of reducing air infiltration and exfiltration of a home. Air leaks are a major cause of discomfort, moisture problems, energy losses and poor indoor air quality.

### Criteria

Gaps and holes should be sealed using the appropriate sealing material, e.g., caulk (fire-rated, silicon, etc.), spray foam, foam inserts. If gaps/holes are too large to seal with caulk or spray foam alone, a rigid backing material (e.g., wood, drywall) should be used to cover the hole, with the edges of the backing material sealed with an appropriate air sealing material.

When sealing window/door rough openings with a spray foam product, selection of a low-expanding spray foam approved for use around windows and doors is preferred.

### Verification

The EarthCraft Technical Advisor will visually confirm compliance of criteria during the mid-construction and final inspections.

### Examples

Correct



Air seal all penetrations through the exterior wall (including band area in multi-story buildings) and in top plates and bottom plates

Examples continued on following page

## BE 2: Air seal where required by EarthCraft (continued)

**Correct**



Air seal wall framing to subfloor and foundation wall

**Correct**



Caulk around all penetrations in drywall at attic, including lighting and ductwork

### BE 3: All recessed can lights must be airtight, gasketed, and Insulation Contact (IC) rated in insulated ceilings

#### Purpose

If recessed lighting is installed incorrectly they may contribute significantly to air leakage and compromise building integrity. If a light fixture will be in contact with insulation, the fixture must be IC-rated to prevent any the possibility of flame ignition.

#### Criteria

See above language and reference manufacturer's instructions for installation.

#### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria during the mid-construction inspection.

#### Example

##### Correct



Can lights shall be sealed, insulation contact (IC)-rated

## BE 4: Insulated corners at all exterior locations

### Purpose

Insulated corners reduce thermal bridging by allowing more space for insulation.

### Criteria

Insulate the intersecting corner of two exterior walls to  $\geq R-6$ . EarthCraft will accept two-stud ("California corner") and two-stud corners with an offset stud to meet the intent of this criteria.

### Clarifications

- Load-bearing corners in multi-story buildings or where porches/porch roofs are designed may request a waiver for this requirement
- The corner must be fully insulated to achieve the intent of this criteria; therefore corners with more than three studs are not permitted.

### Confirmation

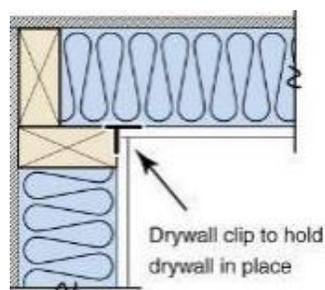
The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction inspection.

### Examples

Correct



Incorrect



Non-load bearing exterior corners framed with more than three studs are not permitted

## BE 5: Ladder T-walls at all exterior locations

### Purpose

This method reduces the amount of framing members at the exterior wall and allows space for insulation, therefore reducing framing costs and thermal bridging.

### Criteria

At interior-exterior wall intersections, the exterior wall should feature a ladder t-wall. Insulation should be installed at the exterior ladder t-wall to fill the cavity to full R-value.

### Clarifications

- Consult local building codes in areas susceptible to high wind or seismic regions.
- If installing a ladder T-wall, begin first ladder 2' above the subfloor to aid in the installation of drywall.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria during the mid-construction inspection.

### Examples

#### Correct



Install ladder t-walls where interior and exterior walls intersect to allow for maximum insulation coverage

#### Incorrect



Improper framing of intersection of exterior and interior wall. This method does not allow for insulating behind framing.

## BE 6: Insulate building components to meet EarthCraft requirements

- Insulation R-value requirements are based on Climate Zone project is located in:

Climate Zone	Ceiling-Flat	Ceiling-Sloped	Wood Framed Wall	Attic Kneewall	Mass Wall	Basement Wall	Crawlspace Wall	Framed Floor	Slab	Cantilevered Floor
2	49	38	15	18	4/6	NA	NA	13	10	30
3	49	38	15	18	8/13	5/13	5/13	19	10	30
4	49	38	15	18	8/13	10/13	10/13	19	10	30

\* A minimum of R-20, spray applied insulation is acceptable

### Purpose

Insulating homes to EarthCraft standards will ensure that each home features a well performing thermal envelope.

### Criteria

See above language for minimum cavity and continuous insulation values

### Clarifications

- Attic kneewalls require minimum R-18 plus sealed attic-side air barrier (e.g., R-13 +R-5 rigid insulation, R-15 + R-3 rigid insulation, R-19 batt in 2x6 cavity with air barrier material).
- Roofline insulation may not be used in a vented attic.
- Framed floors over basement/crawlspace only require insulation if basement/crawlspace is outside of building envelope.
- If insulating a steel joist floor, R-6 continuous insulation must be installed in addition to floor insulation listed above.
- If insulating a steel studded wall or steel header, R-5 continuous insulation must be installed in addition to wall insulation listed above.
- Garage walls are considered exterior walls.
- Foundation walls require insulation if inside building thermal envelope.
- Slabs greater than 12" below grade as measured from the top of the slab are not required to have insulation.
- Permanently install insulation to crawlspace walls and extend downward from the termite inspection strip to within 9" of the finished interior grade adjacent to the foundation wall.
- Provide a 3" inspection strip immediately below the floor joists to allow inspection for termites. (The inspection strip may be insulated with a removable section of insulation, but is not required to be insulated.)
- Paper-faced batts may not be used (see DU 10)

**Verification**

The EarthCraft Technical Advisor will visually confirm compliance of criteria during mid-construction and final inspections.

## BE 7: RESNET Grade II insulation or better installation quality (floors, walls, and ceilings)

### Purpose

The efficiency of a building's thermal envelope is highly dependent on the quality of the installation of the insulation. A low quality insulation installation can lead to a degradation of the assembly R-value, leading to hidden costs for homeowners through excessive heat gains and losses.

### Criteria

Install all insulation per manufacturer's recommendations to achieve a minimum quality Grade II or better as specified by criteria set forth by RESNET. Ensure that all insulation is in substantial contact with the building's air barrier and that batt insulation, if used, is cut to fit around electrical wiring/receptacles and plumbing.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction and final inspections.

### Examples

Correct



Incorrect



## BE 8: Unconditioned attics (All are required, as applicable to project design):

- Insulation baffles at all soffit vents, trays and attic access
- Loose-fill insulation R-value certificate, and depth rulers installed 1 per 300 ft<sup>2</sup>
- Platforms allow for full-depth insulation below
- Attic access within conditioned space  $\geq R-49$
- Kneewalls  $\geq 1\text{ft}$  tall insulated to R-18 with sealed attic side air barrier
- Kneewalls  $< 1\text{ft}$  tall fully covered to achieve same R-value as surrounding attic

### Purpose

It is important to Insulate unconditioned attic spaces correctly because they are a potential source of significant heat loss and gain. This item focuses on installing attic insulation to the correct depth (R-value) at differing attic locations and ensuring the insulation is not susceptible to wind-washing or convective losses.

### Criteria

See above requirements for reference.

### Confirmation

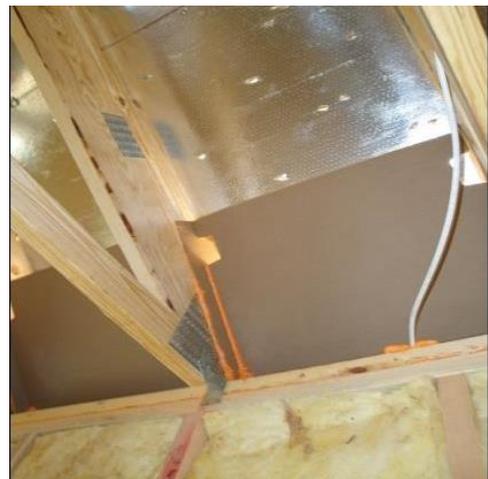
The Technical Advisor will visually verify compliance during the mid-construction and final inspections.

### Examples

Correct



Correct



## BE 9: Window and skylight U-factor and Solar Heat Gain Coefficient (SHGC) meets IECC 2012

Requirements are based on Climate Zone of project location:

Climate Zone	Window U-factor	Skylight U-factor	Glazed Window SHGC
2	0.32	0.75	0.27
3	0.32	0.65	0.27
4	0.32	0.60	0.27

### Purpose

The U-Factor determines how well your windows insulate your home and the Solar Heat Gain Coefficient (SHGC) is a measure of how much solar-radiated heat energy can transfer through a window. To maximize energy efficiency, window and skylights must be carefully selected to comply with the IECC U-factor and SHGC specifications.

### Criteria

See above language and reference the IECC 2012 for further specification details.

### Clarifications

- Up to 15 square feet of glazing or decorative glass may be exempt from this requirement.

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to the mid-construction inspection.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and verify installation during the mid-construction inspection.

## PERF 1: Confirmed HERS Index $\leq$ 55

### Purpose

Home energy modeling provides many benefits to the builder and homeowner. For example, energy models provide annual energy usage estimates, assigns the home a HERS Index Score that can be compared with other homes and can determine the home's compliance with a host of programs, standards and codes. Home energy modeling also allows the builder and homeowner to pick and choose which appliances, lighting, HVAC equipment, insulation values, etc. to install in the home instead of following a prescriptive building envelope and HVAC systems list. Energy modeling affords this flexibility while ensuring the home meets the Performance Badge's energy efficiency goal of a HERS Index  $\leq$  55.

### Criteria

Home energy model based on actual construction must demonstrate a confirmed HERS Rating Index that is equal to or less than 55

### Clarifications

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor at mid-construction.
- The EarthCraft Technical Advisor will develop an energy model in accordance with RESNET modeling criteria and confirm compliance of criteria at mid-construction and final inspections.
- If a project chooses to pursue the Performance Badge the building insulation, mechanical equipment, envelope infiltration, and duct leakage requirements will be as follows:
  - Minimum insulation and window values must be equal to or more efficient than local code requirements
  - Building heating and cooling equipment must meet minimum efficiency requirements set by local code. If a gas system is installed it must be sealed combustion.
  - Domestic water heating equipment must meet minimum efficiency requirement set by local code. If a gas system is installed it must be direct vent.
  - Building infiltration must be equal to or tighter than local code requirement
  - HVAC duct leakage testing results must be equal to or tighter than local code requirements

## Energy Efficient HVAC Systems (ES)

Buildings account for about 40% of all energy use in the United States. Constructing an energy-efficient home provides variety of benefits to both a home's occupants and to the environment. Once the building envelope has been designed, evaluating heating and cooling systems, ventilation, and domestic water heating using the house-as-a-system approach are critical to achieving a high performance home.

An energy efficient home not only provides savings on utility bills to residents but also improves their comfort and health. Comfort is a function of air temperature, relative humidity and radiant heating and cooling, all of which are impacted by the energy systems used in a home. In addition, using less energy reduces the need to extract natural resources, reduces air pollution and eases the strain on our water resources. EarthCraft encourages the use of energy efficient HVAC systems to reduce this impact.

## ES 1: Size and select all HVAC equipment in accordance with ACCA Manuals J and S

### Purpose

Properly sizing and selecting HVAC equipment account for heat loss/gain throughout the year based on factors such as a building's geographic location, orientation of windows and doors, envelope tightness, outdoor air ventilation, duct leakage, and insulation levels allow an HVAC contractor to provide a system that can properly meet design and efficiency goals.

### Criteria

Size and select all HVAC equipment in accordance with the Air Conditioning Contractors of America (ACCA) Manuals J and S. Load calculation must coordinate with accurate construction specifications and plans for the project as well as as-built conditions.

Complete load calculation with accredited ACCA Manual J 8th Edition Full Residential Load Calculation software. [Reference ACCA for a list of approved software.](#)

### OR

Load calculation must be stamped by a Professional Engineer along with a signed "Professional Engineer Load Calculation Affidavit".

The following criteria should be met for all equipment sizing:

- Load calculation must be based on actual home orientation as constructed
- Use most current ASHRAE Handbook of Fundamentals Climate Design Information for outdoor design temperatures
- Design heating and cooling systems using the annual outdoor design conditions as defined in the most current ASHRAE Handbook of Fundamentals
- The 99% design conditions must be used to size heating equipment
- The 1% design conditions must be used to size cooling equipment
- Perform room by room load calculations
- Base infiltration on semi-tight (average) or tighter
- Base duct tightness on notably sealed or tighter
- Include ventilation based on designed values
- Equipment sizing falls within the Manual S oversizing limits

## Clarifications

The abridged edition of ACCA Manual J is not an acceptable methodology within the EarthCraft program.

Multispeed or multistage equipment may have OEM nominal size increments of one ton. Therefore, the use of multispeed or multistage equipment can provide extra flexibility to meet the equipment sizing requirements. The equipment oversizing limit shall be based on the largest capacity of the unit.

Floor area must be calculated using RESNET standards for conditioned floor area

## Example #1

Equipment sizing selection:

If the load calculation specifies a total sensible load of 36,000 Btuh, the 115% oversizing limit allows for using up to 41,400 Btuh:

$$36,000 \times 1.15 = 41,400 \text{ Btuh}$$

If Manufacturer X makes a nominal 3 ton AC unit and a nominal 4 ton AC unit, but no sizes in between, then Builder Y may install the 4 ton unit made by Manufacturer X as long the nominal 3 ton unit has insufficient capacity (i.e. total capacity of  $36,000 \times 0.95 = 34,200$  Btuh).

Alternately, if Builder Y wanted to use a heat pump from Manufacturer Z and Manufacturer Z offers nominal 3 ton (33,000 Btuh), 3.5 ton (39,400 Btuh) and 4 ton heat pump (45,800 Btuh), then Builder Y must install the nominal 3.5 ton unit by Manufacturer Z because the unit is between the Manual J specification and the climate zone 3, 115% oversizing limit set Manual S.

## Additional Resources

- Air Conditioning Contractors of America, see [here](#).

## Confirmation

The EarthCraft Builder shall notify their HVAC contractor of the requirements for meeting Manual J and S requirements. The Technical Advisor will review the load calculations for accuracy and completeness at mid-construction review.

## ES 2: Heating equipment efficiency (Details below):

- Ducted furnace(s) and/or boiler(s) >90% AFUE, sealed combustion
- Ducted heat pump(s) >8.2 HSPF and within 0.5 ton of load calculation, Climate Zone 4 >8.5 HSPF and within 0.5 ton load calculation

### Purpose

Furnaces with a rated Annual Fuel Utilization Efficiency (AFUE) of  $\geq 90\%$  are equipped with a sealed combustion chamber that prevents provides combustion air from a known location. Sealed combustion chambers have the added safety benefit of being sealed from external conditions, thus reducing the risk of flame roll out and backdrafting of combustion products.

A properly sized heating system is designed to adequately condition a space according to the summer and winter loads placed on it. Using oversized equipment results in higher purchase prices and increased day-to-day charges for use.

### Criteria

Furnace(s)  $\geq 90\%$  AFUE and within 40% of load calculation

- All heating equipment must be  $\geq 90\%$  AFUE for gas combustion furnaces. All furnaces must be sized within 40% of the heating load as determined by the load calculation. If the required fan speed cannot be provided by a smaller unit, a furnace may be more than 40% oversized.

Heat pump(s) Climate Zone 2/3  $\geq 8.2$  HSPF and within 0.5 ton of load calculation, Climate Zone 4  $\geq 8.5$  and within 25% of load calculation

- All heating equipment must be rated at  $\geq 8.2$  Heating Seasonal Performance Factor (HSPF) for heat pumps in Climate Zones 2 and 3 or  $\geq 8.5$  HSPF in Climate Zone 4.
- Heat pumps in Climate Zones 2 and 3 must be within 0.5 ton of the load calculation or the next available size. Heat pumps in Climate Zone 4 must be within 0.5 of the load calculation or the next available size.

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor at the mid-construction inspection
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and will visually confirm compliance of criteria at final inspection.

### ES 3: Cooling equipment efficiency (Details below):

- Ducted split system  $\geq 14.5$  SEER
- Ducted package unit  $\geq 12$  EER
- Ducted ground-source heat pump(s):  $\geq 15$  EER

#### Purpose

A high-efficiency system will deliver more comfort, better moisture control, improved air quality, and quiet operation, while using less energy than a less efficient system.

#### Criteria

If installing a split system HVAC unit(s), the cooling equipment must have a seasonal energy efficiency ratio (SEER) of 14.5 or greater. If installing a packaged HVAC unit(s), the cooling equipment must have an energy efficiency ratio (EER) of 12 or greater. If installing a groundsource heat pump(s), the energy efficiency ratio (EER) must be 15 or greater.

SEER and EER must be determined by the Air Conditioning, Heating and Refrigeration Institute (AHRI).

#### Additional Resources

A list of qualified products can be found [here](#).

#### Confirmation

- The builder must submit documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor at the mid-construction review.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and will visually confirm compliance of criteria at mid-construction and final inspections.

## ES 4: Programmable thermostat with adaptive recovery capability

### **Purpose**

Programmable thermostats can be used to suit the needs of the occupants in the cooling or heating seasons during periods when a building is occupied and when it is not. Proper use of programmable thermostats can assist occupants with reducing energy consumption by allowing them to program a schedule that reduces runtime.

### **Criteria**

All heating and cooling equipment must have a programmable indoor thermostat or thermostat installed according to the manufacturer's specifications. Building occupants should be provided the user manual as education for proper use and maintenance of thermostats. Heat pumps must have a programmable thermostat installed that includes adaptive recovery capability.

### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## ES 5: No HVAC equipment or ductwork located in garage, and no conditioned air supplied to garage

### Purpose

Garages, including attached and carports, are known sources of indoor air contaminants and must be fully separated from conditioned space. To ensure that HVAC systems for the living space, including equipment and ductwork, are fully separated from garages they cannot be installed these spaces and cannot provide conditioned air to them.

### Criteria

Do not located HVAC equipment or ductwork inside garage spaces. Do not design distribution equipment to supply conditioned air to garage spaces.

### Clarification

HVAC equipment and ductwork are considered separate from garage spaces if they are separated from the garage by  $\geq 1/4$ " drywall that has been air sealed at all penetrations and connections. If equipment and/or ductwork is located in a closet that is accessible from the garage, the closet must be air sealed to separate the closet from the garage and the door should be gasketed on all sides.

### Confirmation

Technical Advisor will visually confirm that HVAC equipment and ductwork is separated from garage spaces during mid-construction inspection(s). If necessary, Technical Advisor shall complete verification that the entire system is separated at the final inspection.

### Examples

**Incorrect**



Do not install HVAC equipment or ductwork that serves the living space within garage.

## ES 6: If designed, HVAC ductwork meets EarthCraft requirements for installation, insulation and air sealing (details below):

- Air seal ductwork using mastic/mastic tape:
  - Plenum seals
  - Collars to plenum
  - Collars and boots to flex liner
  - Seams in boots and wyes
  - All flex liner to wye connections
  - Air handler unit seams
- Insulate ductwork to standards set by EarthCraft:
  - Unconditioned attic: R-8
  - All other spaces: R-6
- HVAC ductwork installation meets EarthCraft standards (Details below):
  - Fully duct all supply and return ducts
  - No ducts in exterior walls or vaulted ceilings
  - Install rigid ducts, or pull all flex ducts with no pinches and support at intervals  $\leq 5'$
  - Ducts suspended above attic floor trusses to allow for full depth of attic floor insulation
- HVAC system and ductwork is protected during construction (Details below):
  - Protect all ceiling/floor registers until construction is complete
  - Protect HVAC fan until construction is completed
  - Pleated filter installed during construction

### Purpose

Poorly sealed ductwork allows conditioned air to leak both inside and outside the building envelope, reducing system efficiency. Ductwork insulation controls heat transfer and reduces the risk of condensation on ductwork by reducing the temperature difference between air within the ductwork and air surrounding the exterior.

By keeping construction dust and debris out of ductwork and the HVAC equipment throughout the duration of construction IAQ goals and system integrity are maintained.

### Criteria

Seal all seams, joints and connections in forced-air delivery systems using mastic paste or Butyl rubber backed foil tape (mastic tape), including but not limited to:

- Supply and return ducts
- Supply and return plenums
- Duct-to-plenum connection
- Y-splits, butt joints and boot connections
- Outdoor air intakes
- Air handler condensate and refrigerant line penetration, wire penetrations and unused holes in the air handler cabinet

### Clarifications

- Duct tape is not a suitable sealant for ducts. Foil tape may only be used for sealing leaks at the air handler's removable access panels and at filter access panels. Duct boots may be sealed to floor, wall, or ceiling using caulk, foam, mastic tape, or mastic paste.
- Wrap mastic tape at least two times around duct seam touching at least 1 1/2" of duct inner liner and metal collar or sleeve.
- Assemble duct board using code-approved foil tape and coat seams with layer of mastic paste covering seams by 1.5" on both sides and as thick as a nickel.
- Ducts left completely exposed inside conditioned space (e.g. modern loft-style duct systems) are not required to be insulated but must be 90% visible at final inspection.

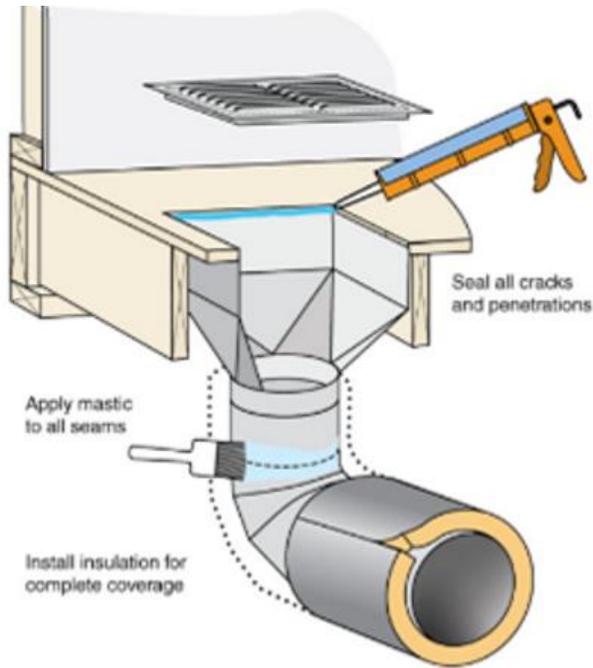
### Confirmation

- The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction and final inspections.

\* Examples of proper ductwork sealing on following page

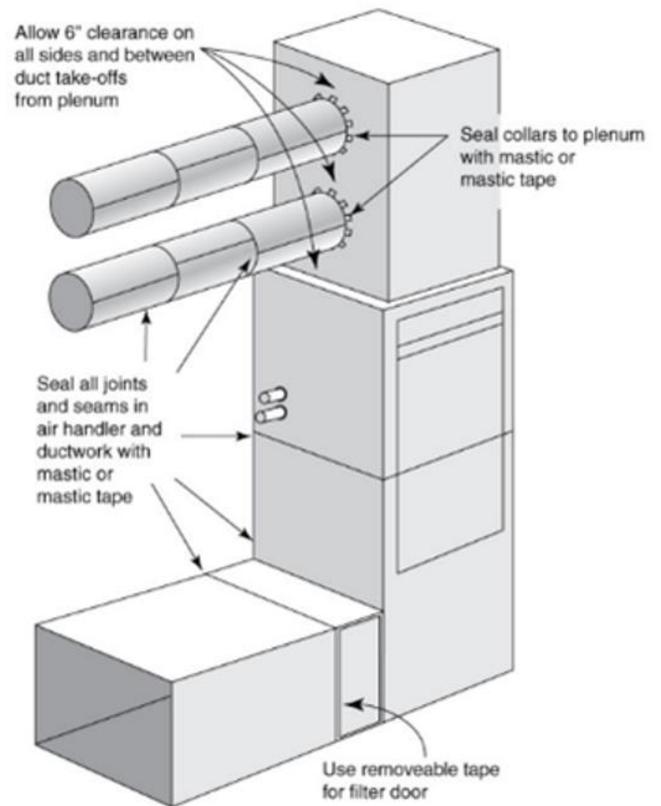
\* Example of proper and improper ductwork installation on following pages

**Examples of proper ductwork sealing:**

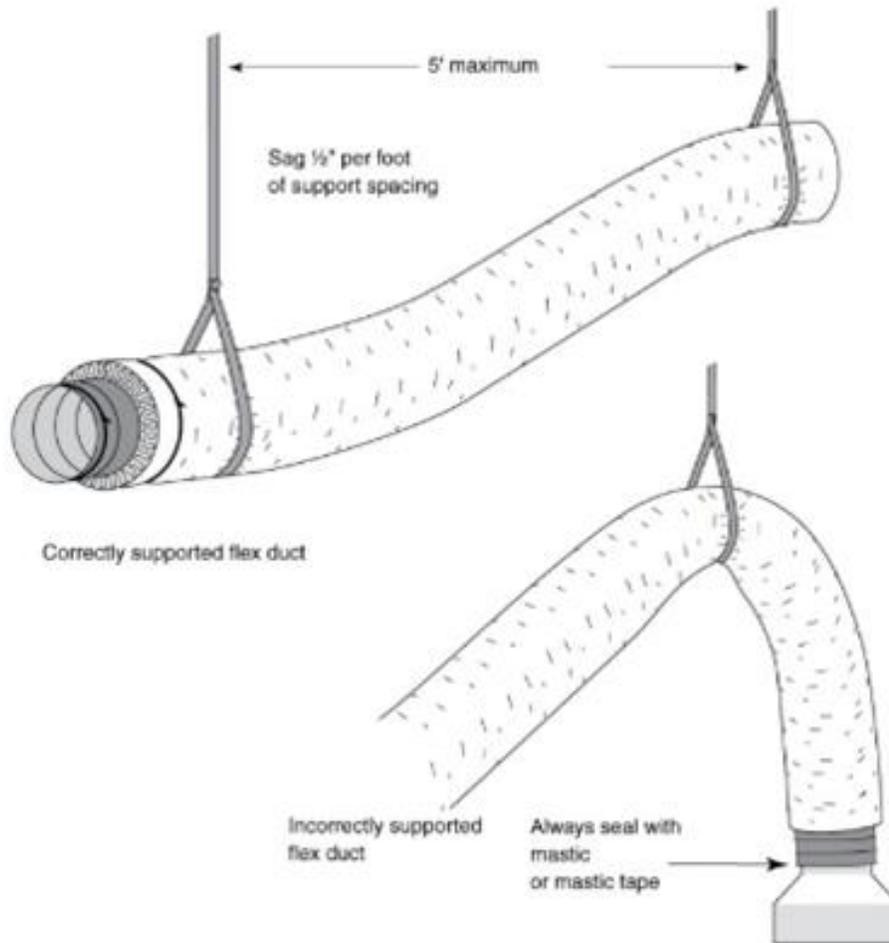


Air seal all seams in ductwork, including ductwork seams, duct-to-boot connections, and gaps where duct boots connect to the subfloor/drywall. Appropriate air sealing materials for ductwork are mastic/mastic tape. Appropriate materials for air sealing boots to subfloor/drywall include mastic, caulk, and/or foam

Air seal all gaps and seams at HVAC equipment, including manufactured seams, penetrations for wires and refrigerant lines, and duct plenums. Appropriate air sealing materials are mastic/mastic tape.



Example of proper and improper ductwork installation:



Properly support all flexible ductwork with  $\geq 1$ " strapping at lengths  $\leq 5'$ .

## ES 7: Filters (Details below):

- Filter easily accessible for occupant
- Access panel includes gasket and fits snugly
- At final, all filters  $\geq$  MERV 6

### Purpose

Filters should be easily accessible so that occupants may change them when needed, this increases the likelihood for good indoor air quality. A snug-fitting gasket door prevents air leakage during system operation.

Higher rated air filters are more efficient at trapping particulate matter from indoor air. HVAC filters should have a Minimum Efficiency Reporting Value (MERV) of  $\geq 6$  to meet EarthCraft requirements.

### Criteria

Filter easily accessible for occupant

- Design system so that the filter is easily accessed by occupants. Easily accessed includes locating the filter in a location that is reasonable for an individual to reach and is not obstructed in any way that would prevent an individual from fully pulling out a filter to remove it.

Access panel includes gasket and fits snugly

- Eliminate filter bypass between the filter and filter rack by sealing the filter access panel to prevent air leakage and ensuring it fits snugly against the exposed edge of the installed filter when closed.

At final, all filters are  $\geq$  MERV 6

- Install an HVAC filter with  $\geq$  MERV 6 (according to ASHRAE 52.2) on all HVAC systems. HVAC design and installation must account for airflow based on filter selection.

### Clarifications

- Filters perform best when the filter rack design includes flexible, air tight (e.g., closed-cell foam) gasket material on the downstream side of the filter and friction fit or spring clips installed on the upstream side of the filter.
- Non-standard efficiency ratings for filters (e.g., 3M's Microparticle Performance Rating (MPR)) and filters that do not have a MERV rating (e.g., electrostatic filters) need prior approval by EarthCraft.
- HVAC system design and installation must be designed to accommodate the criteria.

**Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction and final inspections.

**ES 8: If applicable, test duct leakage based on floor area served (Details below):**

- Leakage to outside  $\leq 3\%$  Not required if ducts are located 100% in conditioned space
- Total leakage  $\leq 6\%$  at final

**Purpose**

The duct leakage test is a diagnostic tool designed to measure the air tightness of heating and air conditioning duct systems and to identify air leakage locations. Tighter HVAC distribution systems more effectively deliver conditioned air throughout a home and ensure comfort goals are met.

**Criteria**

Leakage to outside  $\leq 3\%$ . Not required if ducts are located 100% in conditioned space.

- Duct leakage test result for leakage to outside shall be  $\leq 3\%$  of floor area served. The leakage to outside test is not required if 100% of ductwork, including the mechanical equipment, is located within conditioned space.

Total leakage  $\leq 6\%$  at final

- Duct leakage test result for total leakage shall be  $\leq 6\%$  for all projects.
- If any portion of the distribution system, including the mechanical equipment, is located outside of conditioned space then the total leakage test shall be completed during the final inspection.

The calculation for determining percent duct leakage is:

$$\text{Percent (\%)} \text{ Duct Leakage} = (\text{CFM25} \div \text{floor area served (ft}^2\text{)} \times 100)$$

Where:

**Percent Duct Leakage** may be applied to Leakage to Outside and Total Leakage

**CMF25** is the measured duct leakage at 25 pa pressure difference between the ductwork and exterior.

**Floor area served** is the area of conditioned space served by a single system.

### **Clarifications**

- The leakage to outside and total leakage duct test applies to all ducted HVAC systems. HVAC systems designed and installed to operate without distribution systems (ductless systems) are exempt from this requirement.
- Floor area must be calculated using RESNET standards for conditioned floor area.

### **Confirmation**

The EarthCraft Technical Advisor will diagnostically test compliance during mid-construction and/or final inspections, as applicable to project design.

### CMFRT 1: If designed, improved duct design (Details below):

- Install ducts per ACCA Manual D duct design
- Measure and balance airflow per ACCA Manual B
- Verify supply and return duct static pressure

#### **Purpose**

Improved duct design ensures that HVAC performance and comfort goals are met for a project. A Manual D duct design allows the HVAC contractor to design the distribution system in a way that delivers adequate conditioned air to each room without over pressurizing or depressurizing other areas.

#### **Criteria**

Design and install HVAC ductwork in accordance with an ACCA Manual D. A list of approved Manual D software may be found [here](#).

#### **Confirmation**

- The EarthCraft Builder will provide the Technical Advisor with the balance and pressure test results prior to submitting project for certification.
- The Technical Advisor will review the Manual D duct design prior to the mid-construction inspection. During the mid-construction inspection, the TA will visually verify that the as-built duct design matches the Manual D design.

## CMFRT 2: If ducts are in unconditioned attic, install ENERGY STAR roof

### Purpose

An ENERGY STAR roof serves to cool down the attic interior, reducing the temperature inside the attic, which puts less strain on the duct system.

### Criteria

If HVAC ductwork will be installed in an unconditioned attic, design and construct the building roof using ENERGY STAR certified roof products. Information on ENERGY STAR roof products can be found [here](#).

### Clarification

If ducts are buried in the attic insulation, this is an acceptable alternative to installing an ENERGY STAR roof if the following criteria are met:

- Ducts are insulated to a minimum of R-8
- There is a minimum of R-19 below and above the duct, excluding the R-value of the duct insulation itself
- Total duct leakage is no more than 2% CFA

### Confirmation

The Technical Advisor will visually verify compliance during the mid-construction inspection.

## CMFRT 3: Verify proper refrigerant charge and total system airflow within 20% of design air flow

### Purpose

Verifying correct refrigerant charge helps ensure that the equipment operates at maximum efficiency and decreases the likelihood of premature equipment failure.

### Criteria

- Perform refrigerant charge test to ensure appropriate charge for HVAC equipment with subcooling deviation  $\pm 3^{\circ}\text{F}$  or superheat deviation  $\pm 5^{\circ}\text{F}$ .
- Perform system airflow test using a flow hood, anemometer or other EarthCraft approved equivalent to ensure total system airflow is within 20% of the design airflow.

### Clarifications

This requirement may be met by methods according to ACCA 5 QI-2007:

- Superheat method test measurement within 5% of the manufacturer-recommended charge
- Subcooling method test measurement within 3% of the manufacturer-recommended charge
- Other equivalent method/tolerance approved by the equipment manufacturer

Geothermal heat pumps, mini-split heat pumps and hermetically sealed factory-charged stems may not be appropriate for standard subcooling or superheat refrigerant charge testing. To accommodate these system types, an OEM (original equipment manufacturer) test procedure may be used and documented.

### Confirmation

#### Refrigerant Charge

- The builder must submit documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting the project for certification
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria.

#### Total System Airflow

- The EarthCraft Technical Advisor will diagnostically test compliance of criteria at the final inspection, or be present to observe the test being completed by the HVAC contractor and confirm test results comply with criteria.

## CMFRT 4: Dual-stage compressor

### Purpose

Dual-stage HVAC compressors offer increased efficiency over standard single-stage compressors. These compressors are able to vary their output to provide longer runtimes, which helps control indoor humidity levels and allows for increased filtration of indoor air.

### Criteria

All cooling equipment must have a dual-stage (or two-stage) compressor for improved humidity removal and increased efficiency. The higher stage compressor must comply with the maximum oversizing criteria as required for all cooling equipment.

### Clarifications

- When a dual-stage compressor is used for a heat pump to lower the balance point, size the air conditioner at design conditions for the lower fan speed only. The second stage shall not come on at design temperatures. Use the second stage to size the heat pump at design heating conditions.
- If a system is designed and installed with a variable speed compressor, this requirement will not apply to a project.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## CMFRT 5: If ducted system installed, measure pressure differential $\leq 3$ Pa

### Purpose

Ensure that there will not be a significant pressure difference in separate rooms of the house. Pressure differentials can result in poor system airflow, which may cause damage to the HVAC system and impact indoor air quality by introducing contaminants for outside the building envelope.

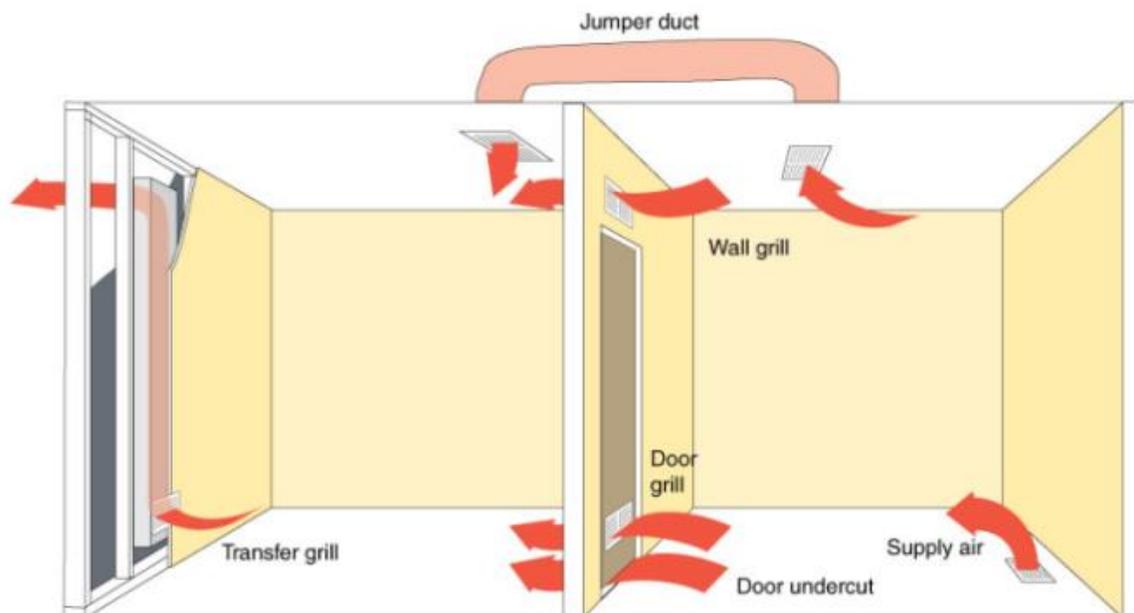
### Criteria

Design HVAC system to operate at balanced system pressures by providing multiple returns or by installing return air pathways for rooms that can be separated from the central return via door closures.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at the mid-construction inspection and will diagnostically test compliance of criteria at the final inspection.

### Examples



## Indoor Air Quality (IAQ)

The average American spends over 90% of their time indoors, so creating a healthy and comfortable indoor environment is an important issue for any resident, especially those who are sensitive to poor air quality. In particular, children, seniors, and individuals with respiratory problems and compromised immune systems may suffer more from indoor air quality problems. EarthCraft Builders can improve the health of a home by installing materials with fewer pollutants, flushing any pollutants out through proper ventilation, and controlling moisture to eliminate mold growth.

The Indoor Air Quality section consists of items that aim to reduce the presence of pollutants and contaminant in the air inside a home. Reducing or eliminating the presence of manmade pollutants such as volatile organic compounds or natural occurring carcinogens such as radon leads to a healthier environment for occupants.

## IAQ 1: Provide whole building and local exhaust ventilation based on ASHRAE 62.2-2016 Ventilation and Acceptable Indoor Air Quality in Residential Buildings:

- Include whole building ventilation sizing in Manual J calculations
- Install labeled, accessible whole building ventilation controls
- Verify whole building ventilation airflow cubic feet per minute (CFM)
- Select a whole building ventilation design (choose one):
  - Balanced system
  - Supply system with  $\geq$ MERV 4 filter prior to outdoor air entering living space or HVAC unit
    - If central fan integrated system is used, HVAC system must be equipped with variable speed motor and thermostat
  - Stand-alone exhaust system designed to operate continuously. All HVAC systems must be equipped with  $\geq$ MERV 13 filter.
- Vent all full bathrooms with ENERGY STAR  $\geq$ 50 CFM on-demand exhaust fan to exterior
  - Bath fans ducted using prescriptive design based on ASHRAE 62.2-2016 or measure airflow CFM at final
- Vent all kitchens with ENERGY STAR  $\geq$ 100 CFM on-demand range hood to exterior
  - Range fan ducted using prescriptive design based on ASHRAE 62.2-2016 or measure airflow CFM at final
  - If range hood capable of  $\geq$ 400 CFM, install make-up air to meet IRC 2012 requirements

### Purpose

Whole-house ventilation introduces fresh air into living spaces to dilute pollutants that cannot be removed completely through spot ventilation and/or filtration, thus providing for a healthy indoor environment.

**Criteria**

Install a whole-building mechanical ventilation system and mechanical exhaust systems that are designed to meet the air flow requirements of ASHRAE 62.2-2016.

The whole building air flow may be calculated based on Section 4.1.1 Total Ventilation

Rate: 
$$Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1)$$

Where: **where**

$Q_{tot}$  = total required ventilation rate, cfm

$A_{floor}$  = dwelling-unit floor area, ft<sup>2</sup>

$N_{br}$  = number of bedrooms (not to be less than 1)

**OR** Projects may use Table 4.1a to determine minimum CFM for whole building ventilation

**TABLE 4.1a (I-P) Ventilation Air Requirements, cfm**

Floor Area, ft <sup>2</sup>	Bedrooms				
	1	2	3	4	5
<500	30	38	45	53	60
501–1000	45	53	60	68	75
1001–1500	60	68	75	83	90
1501–2000	75	83	90	98	105
2001–2500	90	98	105	113	120
2501–3000	105	113	120	128	135
3001–3500	120	128	135	143	150
3501–4000	135	143	150	158	165
4001–4500	150	158	165	173	180
4501–5000	165	173	180	188	195

Local exhaust system airflow CFM may be verified via a field measurement completed during the final inspection, or by designing and installing the distribution system based on the Prescriptive Duct Sizing Table:

**TABLE 5.3 Prescriptive Duct Sizing**

Duct Type	Flex Duct								Smooth Duct							
Fan Airflow Rating, cfm @ 0.25 in. of water (L/s @ 62.5 Pa)	50 (25)	80 (40)	100 (50)	125 (65)	150 (75)	200 (100)	250 (125)	300 (150)	50 (25)	80 (40)	100 (50)	125 (65)	150 (75)	200 (100)	250 (125)	300 (150)
Diameter <sup>a</sup> , in. (mm)	Maximum Length <sup>b,c,d</sup> , ft (m)															
3 (75)	×	×	×	×	×	×	×	×	5 (2)	×	×	×	×	×	×	×
4 (100)	56 (17)	4 (1)	×	×	×	×	×	×	114 (35)	31 (9)	10 (3)	×	×	×	×	×
5 (125)	NL	81 (25)	42 (9)	16 (5)	2 (0.6)	×	×	×	NL	152 (46)	91 (28)	51 (16)	28 (9)	4 (1)	×	×
6 (150)	NL	NL	158 (48)	91 (28)	55 (17)	18 (5)	1 (0.3)	×	NL	NL	NL	168 (51)	112 (34)	53 (16)	25 (8)	9 (3)
7 (175)	NL	NL	NL	NL	161 (49)	78 (24)	40 (12)	19 (6)	NL	NL	NL	NL	NL	148 (45)	88 (27)	54 (16)
8 (200) and above	NL	NL	NL	NL	NL	189 (58)	111 (34)	69 (21)	NL	NL	NL	NL	NL	NL	198 (60)	133 (41)

a. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.  
 b. This table assumes no elbows. Deduct 15 ft (5 m) of allowable duct length for each elbow.  
 c. NL = no limit on duct length of this size.  
 d. × = not allowed; any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop.

### Confirmation

The HVAC Manual J Load Calculation shall include whole building ventilation CFM based on the calculations in ASHRAE 62.2-2016. The Technical Advisor will review the Manual J report to verify system has been designed for ventilation airflow. At final, Technical Advisor shall field verify that installed ventilation airflow CFM meets the minimum continuous airflow required.

### Note:

- Projects may design whole building ventilation CFM using the infiltration credit in ASHRAE 62.2-2016. Technical Advisor shall review Manual J input for reasonableness, and at final shall field verify actual building envelope infiltration and ventilation airflow CFM. If necessary, whole building ventilation shall be field adjusted to comply with ASHRAE 62.2016.
- Projects using the Prescriptive Duct Sizing Table for local exhaust shall document compliance with photo documentation capturing ≥75% of the distribution system

## IAQ 2: Carbon monoxide detector (one per sleeping area, hard wired with battery back-up)

### **Purpose**

Carbon monoxide poisoning is a significant health threat to building occupants can result in long-term neurologic or cardiovascular complications if conditions are not remedied. Due to the possibility of combustion appliances being introduced into the home after construction, CO monitors should be installed even if the house has no attached garage, fireplace or combustion appliances installed within or adjacent to conditioned space.

### **Criteria**

Install one carbon monoxide (CO) detector per floor. If bedrooms are on the floor, install the CO detector in a central location near all bedrooms. CO detectors shall be installed in accordance to manufacturer specifications. All CO detectors must be hard-wired with battery back-up. CO detectors must be certified by CSA 6.19-01 or UL 2034.

### **Clarification**

Combination smoke/CO detectors meet the intent provided they are certified by CSA 6.19-01 or UL 2034.

### **Confirmation**

At final, Technical Advisor shall field verify that combustion detectors have been installed that are certified by CSA 6.19-01 or UL 2034.

### **IAQ 3: No unvented combustion appliances, fireplaces or space heaters within or adjacent to the living space. Separate atmospherically vented and/or fan assisted vented appliances from conditioned space.**

#### **Purpose**

Due to indoor air safety, health, and moisture concerns, it is recommended that unvented appliances never be installed within the conditioned space of homes. Additionally, atmospherically vented and/or fan-assisted draft systems should be installed separate from the conditioned space.

Unvented systems are identified as having no systems to vent combustion by-products to the exterior. Atmospherically vented and fan-assisted appliances rely on surrounding atmosphere to provide for ventilation of combustion by-products to the exterior. Each type of appliance has the risk of introducing harmful combustion gases, such as carbon monoxide, and moisture vapor back into the space in which they are located - greatly adding to indoor humidity levels and increasing the risk of unsafe indoor environmental conditions for building occupants.

#### **Criteria**

Unvented combustion appliances, fireplaces or space heaters should not be installed within or adjacent to the conditioned space of the home. Atmospherically vented and fan-assisted draft appliances should be installed separate from the conditioned space.

#### **Clarifications**

Vent all combustion fireplaces and appliances to remove combustion products as well as process fumes to the exterior of a building.

Atmospherically vented and fan-assisted draft appliances may be installed in unconditioned locations adjacent to conditioned space, however all walls, floors and ceilings separating the appliances from conditioned space shall be air sealed and insulated to meet the IECC 2015.

#### **Confirmation**

- The Technical Advisor will visually confirm compliance during the mid-construction review and final inspection.
- Technical Advisors shall field verify that atmospherically vented and/or fan assisted draft appliances have been separated from conditioned space via a blower door test and visual inspection.

## IAQ 4: If installed, fireplace has ducted outdoor air supply with damper

### **Purpose**

If installed, all fireplaces should be installed with an air inlet designed to provide combustion air during operation to support adequate operation.

### **Criteria**

All fireplaces must use a supply duct supplying outside air for combustion that complies with the fire code.

The combustion air inlet shall be equipped with a manual or mechanical damper that may be opened during operation of the fireplace and closed when the fireplace is not in use. Damper control shall be labeled for occupant use.

### **Confirmation**

The EarthCraft technical advisor will visually confirm compliance during the mid-construction review and final field inspections.

## IAQ 5: If in EPA Radon Zone 1, install a passive radon/soil gas vent system to exterior and label it clearly

### Purpose

Radon is a naturally occurring radioactive gas that is present in the ground at varying concentrations across the country. It has been identified as one of the major causes of lung cancer, and homes susceptible to radon gases should be designed to prevent its entry into the home. This is accomplished through complete air sealing and venting of soil gases to separate the ground from the conditioned space.

### Criteria

Required only if home is located in Radon zone 1, as defined by EPA Map of Radon Zones. The passive radon vent shall be installed to vent soil gases through the roof and shall be clearly marked as a Radon Vent.

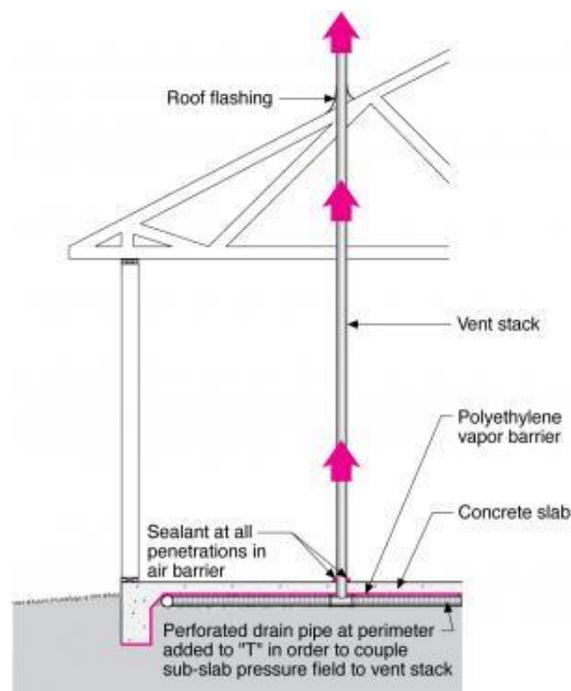
### Additional Resources

- EPA's map of radon zones, including state Radon Information and contacts can be found [here](#).
- EPA's "Building Radon Out" can be found online [here](#).

### Confirmation

The EarthCraft technical advisor will visually confirm compliance during the mid-construction inspection.

### Example



This is an example of a passive radon gas vent system.

**IAQ 6: Low- or no-formaldehyde content for finishes (choose one, details below):**

- Interior trim
- Flooring
- Cabinets and countertops

**Purpose**

Formaldehyde is a colorless, flammable gas (at room temperature) which has a strong odor and is found in resins used in the manufacture of composite wood products and building materials. Exposure to formaldehyde may cause adverse health effects, primarily, irritation of skin, eyes, nose and throat. High levels of exposure may cause some types of cancers.

**Criteria**

Install composite wood products certified as compliant with formaldehyde emissions for at least one of the following:

- California Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products Section 93120
- ANSI/HPVA HP-1-2009
- Kitchen Cabinet Manufacturers Association (KCMA) Environmental Stewardship Program (ESP) 05-12
- GREENGUARD or GREENGUARD GOLD

*At least 90% of a product must meet this requirement to be accepted.*

**Confirmation**

- The builder must present product documentation demonstrating compliance of product criteria to the EarthCraft Technical Advisor at the final inspection.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and visually confirm compliance of criteria at final inspection.

**IAQ 7: Low- or no-VOC content (choose one, details below):**

- Interior paints
- Stains and finishes
- Sealants and adhesives
- Carpet, carpet pad and carpet adhesive

**Purpose**

Interior paints and finishes may contain volatile organic compounds (VOCs) that can be harmful to humans, such as urea formaldehyde (UF), benzene, toluene, and other chemicals. VOCs from interior finish materials are released into the indoor air, creating unpleasant and sometimes toxic odors, with both short- and long-term health effects for workers and occupants. To protect indoor air quality for both occupants and contractor staff, the best approach is to limit use of VOC-containing materials by specifying and purchasing low- or no-VOC products. Paints, sealants, coatings and adhesives are building products that traditionally contain VOCs.

**Criteria**

Use only interior paints and finishes that are certified as low- or no-VOC by at least one of the following:

- CA Section 01350 (CDPH Standard Method V1.1-2010)
- Green Seal Standard GS-11
- Green Wise or Green Wise Gold
- GREENGUARD or GREENGUARD Gold Certification for Paints and Coatings
- Master Painters Institute (MPI) Green Performance Standards X-Green, GPS-1 or GPS-2
- Scientific Certification Systems (SCS) Standard EC-10.2-2007 or Indoor Advantage Gold

Use only sealants and adhesives that are certified as low- or no-VOC by at least one of the following:

- CA Section 01350 (CDPH Standard Method V1-1-2010)
- Green Seal GS-36
- GREENGUARD or GREENGUARD Gold adhesives and sealants

Use only carpet, carpet pad and carpet adhesives that are certified as low- or no-VOC by the Carpet and Rug Institute, Inc (CRI):

- CRI Green Label Plus for carpet and carpet adhesives
- CRI Green Label for carpet pad

*In order to qualify, ≥90% of the interior surface covered by site-applied paints, coatings, sealants or carpet shall use low- or no-VOC products certified by one or more of the third-party standards listed above.*

## Additional Resources

- CA Section 01350: <http://www.calrecycle.ca.gov/greenbuilding/specs/section01350/>
- Carpet and Rug Institute, Inc: <http://www.carpet-rug.org/>
- Green Seal: <http://www.greenseal.org/>
- Green Wise Paint: <http://greenwisepaint.com/>
- GREENGUARD: <http://greenguard.org/en/index.aspx>
- Master Painters Institute: <http://www.paintinfo.com/index.asp>
- Scientific Certification Systems (SCS): <https://www.scsglobalservices.com/>

## Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria.

## HLTH 1: Install whole building ventilation (choose one):

- Energy recovery ventilator
- Whole house ventilating dehumidifier
- Central fan integrated system with  $\geq$  MERV 8 filter for outdoor air prior to crossing HVAC heat exchanger/coils. HVAC system must be equipped with variable speed fan motor and thermostat control.
- Balanced system with monitoring controls for outdoor air humidity and/or temperature
- Supply system with monitoring controls for outdoor air humidity and/or temperature and  $\geq$  MERV 6 filter for outdoor air prior to entering conditioned space

### Purpose

Whole-house ventilation introduces fresh air into living spaces to dilute pollutants that cannot be removed completely through spot ventilation and/or filtration, thus providing for a healthy indoor environment. Advanced whole building ventilation systems account for outdoor air humidity through built-in air tempering, dehumidification and/or sensor controls.

### Criteria

Install a whole building ventilation system designed to meet the air flow requirements of ASHRAE 62.2-2016. Refer to IAQ 1 for CFM sizing information. Projects seeking the Health badge shall install a system design meeting HLTH 1. All air flow CFM verification testing shall comply with ASHRAE 62.2-2016.

### Confirmation

The HVAC Manual J Load Calculation shall include whole building ventilation CFM based on the calculations in ASHRAE 62.2-2016. The Technical Advisor will review the Manual J report to verify system has been designed for ventilation airflow. At final, Technical Advisor shall field verify that installed ventilation airflow CFM meets the minimum continuous airflow required.

### Note:

- Projects may design whole building ventilation CFM using the infiltration credit in ASHRAE 62.2-2016. Technical Advisor shall review Manual J input for reasonableness, and at final shall field verify actual building envelope infiltration and ventilation airflow CFM. If necessary, whole building ventilation shall be field adjusted to comply with ASHRAE 62.2016.
- Projects using the Prescriptive Duct Sizing Table for local exhaust shall document compliance with photo documentation capturing  $\geq 75\%$  of the distribution system

## **HLTH 2: All exhaust fans in full bathrooms designed and installed to activate by humidistat, motion sensor, or timer**

### **Purpose**

A humidistat helps monitor and maintain the set or preferred indoor relative humidity in the air without the need for occupant-initiated operation. Motion sensors provide intermittent spot-exhaust automatically when the occupant is generating pollutants and/moisture. Timers require manual operation, but provide exhaust for a predetermined length of time and prevent fans from operating continuously.

### **Criteria**

Install a bath fan with indoor air humidity control (i.e., a humidistat, motion sensor, or timer) for all bathrooms with tubs and showers.

Provide information on type of system, maintenance, and monitoring requirements in project-specific owner's manual.

### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

*Note: Local exhaust CFM shall meet ASHRAE 62.2-2016. Refer to IAQ 1 for sizing requirements.*

### HLTH 3: Sealed combustion, direct-vent fireplace(s) or no fireplace

#### **Purpose**

In order to ensure good indoor air quality, all fireplaces must be sealed combustion units, as opposed to naturally aspirated units. These systems are completely decoupled from the interior environment through the use of dedicated outdoor air intake and exhaust ducts connected directly to the unit and gasket sealed doors. This design completely disconnects the combustion process from the interior environment, and minimizes concerns of backdrafting of the unit into conditioned space.

#### **Criteria**

All installed fireplaces must meet indoor air quality guidelines below and be sealed combustion, direct-ventilation with permanent, gasketed door.

#### **OR**

Do not install a fireplace.

#### **Clarification**

Fireplaces that meet these guidelines include:

- Gas or propane powered, sealed combustion and direct or power vented as rated by the American Gas Association (AGA) with a permanently affixed glass front.

#### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## HLTH 4: HVAC system designed for $\geq$ MERV 13 pleated filter with minimum 2" filter slot

### **Purpose**

Pleated air filters are more effective than other mechanical air filters because they contain more fiber per square inch than mechanical air filters. This provides a greater surface area and lower resistance to air-flow.

### **Criteria**

Design HVAC system for a  $\geq$ MERV 13 filtration (according to ASHRAE 52.2) on all HVAC systems. Filter slot must be designed to accommodate installed filter.

### **Clarification**

HVAC design and installation must account for airflow based on filter selection.

### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction and final inspections.

**HLTH 5: Follow the below garage ventilation guidelines (Choose one. Details below):**

- **Attached garage: Install exhaust fan vented to exterior with on/off control by motion sensor or timer**
- **Detached garage or no garage**

**Purpose**

Attached garages have the potential to allow carbon monoxide and other pollutants to enter the living space. As a good practice, mechanical ventilation should be provided in any attached garage to vent combustion products produced by vehicles.

**Criteria**

Attached garage: Install exhaust fan vented to exterior with on/off control by motion sensor or timer:

- Install an exhaust fan in an attached garage that operates continuously or operates whenever the garage is occupied and for at least 1 hour after the garage has been vacated.

Detached garage or no garage

- Isolate the garage by a minimum of 4' from the exterior walls or exterior floor of any conditioned area of the house OR
- Design and construct home with an open-carport or no garage

**Clarifications**

- If operating continuously, install an ENERGY STAR certified fan that is rated at a minimum of 75 CFM.
- If operating whenever the garage is occupied and for at least 1 hour after the garage has been vacated, install fan that is rated at a minimum of 100 CFM of airflow and is controlled by a timer or motion sensor.

**Confirmation**

The Technical Advisor will confirm compliance during the mid-construction inspection and verify compliance during the final inspection.

## HLTH 6: No added urea-formaldehyde in all shelves and countertops

### Purpose

Urea formaldehyde is a potentially toxic chemical commonly used as a binder or adhesive in engineered building products.

### Criteria

Do not install shelves or countertops that contain added urea-formaldehyde. Refer to IAQ 6 for information on products that meet this requirement.

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria.

## Plumbing and Irrigation (PI)

Conserving finite fresh water resources has become vitally important in both protecting our environment and helping sustain economic growth in our region. The use of certain strategies like water-efficient fixtures, water-efficient landscaping and irrigation, and reusing water on-site through rainwater or gray water systems can significantly reduce a resident's water consumption as well as their utility bills.

The Plumbing and Irrigation section emphasizes the efficient use of potable water indoors and outdoors. An EarthCraft project aims to reduce water waste and storm water run-off. Strategies include drought adapted landscaping, improved plumbing distributions systems and efficient plumbing fixtures.

**PI 1: High efficiency water heater (determined by Energy Factor; see chart below):**

**Purpose**

High efficiency water heaters use 10-50% less energy than standard models. To reduce the amount of energy needed for water heating, the builder can install high-efficiency electric or gas water heaters.

**Criteria**

Install a high efficiency storage water heater that meets the Energy Factor (EF) or Uniform Energy Factor (UEF) requirements in the following table for gas or electric operation:

Tank Size	Gas EF	Electric EF	Gas UEF	Electric UEF
20 - 55 gal	0.65	0.95	0.61	0.92
55 - 100 gal	0.75	1.97	0.76	2.03
< 2 gal	0.82	0.93	0.81	0.91

**Confirmation**

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder and visually confirm compliance of criteria at final inspection.

**Examples**

**Electric Storage Tank**



A high-efficiency heat pump water heater

**Gas Storage Tank**



A low efficiency gas water heater. If installed, gas tanks must be 100% separated from living space

## PI 2: Insulate 100% of hot water pipe with >R-3

### Purpose

Installing insulation on hot water lines helps keep the water warm between uses, saving energy and conserving water.

### Criteria

Insulate all hot water pipes to R-3 or greater using polyethylene, neoprene, fiberglass or other insulation types. Fit insulation tightly around hot water pipe, face seam down and secure insulation every 2 feet using wire, tape or clamp. Install insulation on all piping elbows to adequately insulate 90-degree bend.

### Exemptions

Hydronic heating systems are not required to insulate pipes in slabs or other approved materials intended for radiating heat into home and therefore do not apply to this criteria.

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will visually confirm compliance of criteria at mid-construction.

### Examples

#### Correct



Insulate 100% of hot water pipe

### PI 3: Heat trap on all storage water heaters

#### **Purpose**

Heat traps increase overall efficiency for storage water heaters by preventing heat loss from inside the storage tank when flow stops.

#### **Criteria**

If installing a storage water heater, either purchase storage water heater with a heat trap pre-installed or install heat trap on storage water heater.

#### **Clarifications**

Appliances equipped with an internal heat trap may be verified through the unit specification sheet supplied by the manufacturer.

#### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## PI 4: Water pressure <60 PSI for fixtures

### **Purpose**

Reduced water pressure saves water, conserves energy, and helps ensure proper operation of fixtures and appliances.

### **Criteria**

Upon installation of the plumbing system, verify that the static service pressure is a maximum of 60 pounds per square inch (psi) (414 kilopascal [kPa]).

### **Clarifications**

Units supplied by a municipal water supply must either use pressure regulating valve (PRV) upstream of all fixture connections or provide documentation from the public water supplier stating that water pressure will not exceed 60 psi.

Units supplied by groundwater wells must meet this requirement by installing a pressure tank.

### **Confirmation**

The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification, or water pressure may be verified during final inspection.

## PI 5: WaterSense labeled toilets, showerheads, lavatory faucets and accessories (all must comply; Details below):

- Toilets:  $\leq 1.28$  gpf
- Showerheads:  $\leq 2.0$  gpm. Exception: one (1) showerhead may be  $\leq 2.5$  gpm
- Lavatory faucets:  $\leq 1.5$  gpm

### Purpose

WaterSense is a U.S. Environmental Protection Agency program designed to encourage water efficiency through the use of a special label on consumer products. This label distinguishes the product as one that is beneficial for the environment through design that minimizes water use while meeting specific performance criteria. EPA criteria must be met in order for a product to receive a WaterSense label.

### Criteria

WaterSense labeled toilets, showerheads, lavatory faucets and accessories (all must comply; Details below):

- Toilets:  $\leq 1.28$  gpf
- Showerheads:  $\leq 2.0$  gpm. Exception: one (1) showerhead may be  $\leq 2.5$  gpm
- Lavatory faucets:  $\leq 1.5$  gpm

### Additional Resources

A list of WaterSense labeled fixtures can be found [here](#).

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria at final inspection and compare to installed fixtures.

## PI 6: Irrigation system (details below):

- Must have a weather-based controller
- Does not water hard surfaces such as sidewalks and home foundation

### Purpose

Water saving irrigation methods, such as rain sensors and shut-off devices, distribute water much more efficiently to landscaping. This conserves water because these devices are able to adjust their watering to current weather conditions. Overspray should be avoided because the excess water that cannot be absorbed will empty into the streets and local waterways, potentially impacting water quality. Therefore, irrigation systems should be designed to avoid overspray onto impervious surfaces.

### Criteria

- Design irrigation system with zones based on water needs in each planting area.
- Do not water hard surfaces such as sidewalks and home foundation. Attention should be given to the sprinklers at the tops and bottoms of sloped areas to prevent runoff.
- Provide weather station or soil moisture sensor on irrigation system
- Equip irrigation systems with technology that inhibits or interrupts operation of the irrigation system during periods of rainfall or sufficient moisture (e.g., rain sensors, soil moisture sensors)

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria.

## PI 7: All pools or spas must have an appropriate cover

### Purpose

Covers over installed pools and spas serve to reduce heat loss and evapotranspiration.

### Criteria

Any installed pools or spas must have an appropriate cover. Provide information on type of system, maintenance, and monitoring requirements in project-specific owner's manual.

### Confirmation

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

### Example

**Correct**



## PI 8: Ornamental water features must recirculate water

### **Purpose**

When ornamental water features are included in a project they should be designed to be as energy- and water-efficient as possible through recirculation.

### **Criteria**

Install ornamental water feature that recirculates water from the feature itself and serve a beneficial use.

Provide information on type of system, maintenance, and monitoring requirements in project-specific owner's manual.

### **Confirmation**

The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## PERF 2: Confirmed HERS H2O Index <85

### Purpose

The HERS H2O Index is developed by RESNET (the Residential Energy Services Network) is a measure of the water usage of the rated building as compared to a hypothetical reference building which is built to current code requirements. A score of 100 indicates that the rated building operates the same as the reference home of the HERS Index (a standard new home constructed in 2006). A HERS H2O score of  $\leq 85$  means that the rated building must use water  $\geq 15\%$  more efficiently than current codes requires.

### Criteria

Complete the HERS H2O Index section of the HERS model for the home. All required inputs must be provided.

### Confirmation

The HERS H2O collects information on indoor and outdoor domestic water use, including all indoor plumbing fixtures, pools and irrigation systems. The following information will need to be provided:

- Indoor plumbing fixture flow rate specifications for kitchen, lavatory, showers and toilets
- Select the vintage for the dishwasher and clothes washer:
  - "ENERGY STAR" if the appliance is labeled, "Standard" if appliance is less efficient than ENERGY STAR minimum, or "Best Available" if appliance is more efficient than Energy Star. The clothes washer has an additional option, "2008", which represents appliances built to efficiency standards of 2008 and later. If a clothes washer was manufactured in 2008 or later and is not ENERGY STAR rated or more efficient than the minimum ENERGY STAR standard, the "2008" option should be used.
- If project has a hot water recirculation pump, provide specifications on standard system pipe length, loop and branch length and pump watts. Follow RESNET approved procedure for determining pipe lengths:
- If system does not have a recirculation pump, calculate standard pipe length. Input the distance from the hot water to the farthest hot water fixture, measured longitudinally from plans, assuming the hot water piping does not run diagonally, plus 10 feet of piping for reach floor level, plus 5 feet of piping for unconditioned basements.
- If project has an outdoor irrigation system, determine sum of all irrigation flow rates through one of the following:
  - Timed measurement in gallons per day
  - If house has a digital water meter, time flow rate with all taps open to determine gallons per day

## Performance Badge (PERF)

- Document if project has an inground pool
- Determine if project uses a water softener

## ENV 7: Irrigation (Details below):

- Micro-irrigation system (e.g., drip irrigation) with pressure regulator, filter and flush end assemblies
- Provide weather station or soil moisture sensor on irrigation system

### Purpose

Drip irrigation systems use 20% to 50% less water than conventional pop-up sprinkler systems and can save up to 30,000 gallons per year by delivering low volumes of water directly to plants' roots, minimizing losses to wind, runoff, evaporation, or overspray.

Weather-based irrigation controllers, which employ a "smart" irrigation control technology that uses local weather data to determine when and how much to water, can save an average home over 7,500 gallons annually. Soil moisture sensors measure the moisture in the soil and tailor the irrigation schedule accordingly. Also consider rain sensors and rainfall shut-off devices that turn off irrigation on rainy days.

### Criteria

1. If installed, micro-irrigation system (a low-pressure irrigation system that sprays, mists, sprinkles or drips) includes a pressure regulator, filter and flush end assemblies. Micro-irrigation shall be installed on separate zones from the rest of the irrigation system if sprinkler heads are used in other parts of the landscape.

AND

2. Provide a weather station or soil moisture sensor on the irrigation system. Refer to credit WE6 for explanation on weather-based controllers

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will visually confirm compliance of criteria at final inspection.

## Lighting and Appliances (LA)

Approximately 65 percent of U.S. electricity is generated by burning coal and natural gas, which releases greenhouse gases and other air pollutants into the atmosphere, contributing to climate change and air quality problems. Lighting and appliances use a significant amount of energy in buildings and selecting ENERGY STAR certified products, which use less energy than conventional models, and high-efficacy lighting can significantly lower residents' electricity consumption and their energy bills.

## LA 1: High-efficacy lighting in $\geq 90\%$ of all permanent indoor and outdoor fixtures

### Purpose

Efficacy is the ratio of light produced to the amount of energy consumed. The higher the efficacy, the more light is produced for a given amount of energy - this results in reduced electric bills for home owners and longer bulb lifespans.

### Criteria

Install high-efficacy lighting in  $\geq 90\%$  of all permanent fixtures. High efficacy lighting includes compact fluorescent bulbs, LED bulbs, T-8 or smaller diameter linear fluorescent bulbs, or bulbs with a minimum efficacy of:

- 60 lumens per watt for bulbs over 40 watts
- 50 lumens per watt for bulbs from 15 watts to 40 watts
- 40 lumens per watt for bulbs 15 watts or less

### Clarification

Any bulb that is ENERGY STAR rated will qualify

### Additional Resources

Explanation of high-efficacy lighting can be found [here](#).

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria at final inspection.

### Examples

#### Correct



## LA 2: If installed, ENERGY STAR qualified dishwasher

### Purpose

ENERGY STAR dishwashers must exceed the minimum federal efficiency standards for both energy and water use. A new ENERGY STAR certified dishwasher uses less than half as much energy as washing dishes by hand and saves nearly 5,000 gallons of water a year.

### Criteria

All installed dishwashers must be ENERGY STAR qualified.

### Clarification

As products and ENERGY STAR qualifications are periodically updated, the product must be labeled as an ENERGY STAR qualified product at the time it was purchased.

### Additional Resources

A list of qualified products can be found [here](#).

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and will visually confirm compliance of criteria at final inspection.

### LA 3: If installed, ENERGY STAR qualified refrigerator

#### **Purpose**

ENERGY STAR refrigerators are about 9% more energy efficient on average than models that meet the federal minimum energy efficiency standard.

#### **Criteria**

All installed refrigerators must be ENERGY STAR qualified.

#### **Clarification**

As products and ENERGY STAR qualifications are periodically updated, the product must be labeled as an ENERGY STAR qualified product at the time it was purchased.

#### **Additional Resources**

A list of qualified products can be found [here](#).

#### **Confirmation**

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and will visually confirm compliance of criteria at final inspection.

## LA 4: If installed, ENERGY STAR qualified clothes washer (water factor $\leq 6.0$ gal)

### Purpose

ENERGY STAR certified clothes washers save on energy and water costs — they use about 40% less water and about 25% less energy than a regular washer.

### Criteria

Select an ENERGY STAR-rated washer and compare efficiencies between units by using the EnergyGuide label.

All installed clothes washers must be ENERGY STAR qualified with a water factor of less than or equal to 6.0 gallons.

### Clarification

As products and ENERGY STAR qualifications are periodically updated, the product must be labeled as an ENERGY STAR qualified product at the time it was purchased.

### Additional Resources

A list of qualified products can be found [here](#).

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria and will visually confirm compliance of criteria at final inspection.

## **Education and Operations (EO)**

An EarthCraft house can provide a homeowner with increased occupant comfort and well-being, as well as energy savings from improved building performance, but without proper homeowner education these benefits may not be fully realized.

The Education and Operations section focuses on providing a homeowner with the necessary materials and manuals to properly operate their home's systems in order to maximize energy and water performance and promote occupant health. Additionally, homeowner education provides resources on specific EarthCraft strategies and features. This section helps to ensure that the EarthCraft program is marketed and represented accurately in the public realm.

## EO 1: Provide homeowner with project-specific owner's manual

### Purpose

The homeowner's manual is a resource available to homeowners that outlines the proper operation and maintenance for the various systems, equipment and EarthCraft features of their home.

### Criteria

Manual must contain, at a minimum, the following:

- Instructions for proper HVAC system operation and maintenance
- Instructions for proper operating procedure for irrigation system
- Overview of general home maintenance activities and frequency
- A copy of the EarthCraft certificate

### Clarification

Equipment manuals are acceptable, but shall be supplemented with clear and specific instructions to the homeowner on when and how equipment shall be used.

### Additional Resources

EarthCraft has a template available for download at [www.earthcraft.org/earthcraft-professionals/resources](http://www.earthcraft.org/earthcraft-professionals/resources)

### Confirmation

- The builder must present documentation demonstrating compliance of criteria to the EarthCraft Technical Advisor prior to submitting project for certification.
- The EarthCraft Technical Advisor will review documentation provided by the builder for compliance of criteria.

## EO 2: EarthCraft House Certified Builder

### **Purpose**

To ensure that each house is completed by a builder that is familiar with the EarthCraft standards and expectations, builders must be certified by EarthCraft and satisfy all applicable credential requirements.

### **Criteria**

The home must be constructed by an EarthCraft Certified Builder that is in good standing with program administrators.

### **Clarification**

EarthCraft administrators will verify this requirement at registration. A project registration will not be processed if this requirement is not met.

### **Additional Resources**

Information on how to become an EarthCraft builder and credential maintenance can be found at <https://www.viridiant.org/residential-programs/current-earthcraft-builder-certification-process/>

### **Confirmation**

Once project registration is submitted, EarthCraft administrators will confirm the builder associated to that project is certified and in good standing.

## EO 3: Market EarthCraft House program

### **Purpose**

Marketing the EarthCraft House program helps educate the local market and drive continued demand for high performance development.

### **Criteria**

Include EarthCraft House logo in all print materials, websites, advertisements and other promotional materials associated with project promotion.

Post an EarthCraft House sign in the front yard of the home during construction.

### **Clarification**

Technical Advisors will verify that proper on-site marketing (i.e. EarthCraft House sign) is installed in the front yard of the home during construction.

### **Additional Resources**

The EarthCraft logo may be requested by reaching out to [marketing@earthcraft.org](mailto:marketing@earthcraft.org). All additional marketing resources can be found at [www.earthcraft.org/earthcraft-professionals/resources/marketing-logo-guidelines/](http://www.earthcraft.org/earthcraft-professionals/resources/marketing-logo-guidelines/)

### **Confirmation**

The EarthCraft Technical Advisor will verbally and visually confirm compliance of criteria with the builder at the pre-drywall and final inspections.