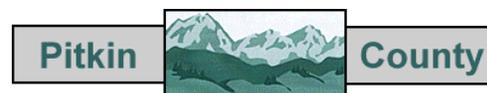


City of Aspen / Pitkin County
Efficient Building Program
Resource Guide



INTRODUCTION

SUSTAINABILITY:

“Meeting our present needs without compromising the ability of future generations to meet their needs.”

A typical home in this country requires about one acre of forest to build and generates roughly 4 pounds of waste per square foot. Manufacturing the cement for the 55 yards of concrete in the foundation generates over 20,000 lbs. of CO₂ emissions. In 1990, American households consumed \$110 billion worth of energy alone. Buildings consume vast amounts of our resources and threaten the ecological systems that support life, from the ozone layer to the world's forests. Changing the way we build has become imperative. Environmental efficiency will no longer be an option in our future.

The building industry is beginning to respond to these concerns for a number of reasons. Consumers are demanding environmental responsible building. National codes and regulations are beginning to require greater efficiencies in the construction and operation of buildings. But the number one driving factor is the cost-savings associated with environmental efficiency. As the cost of our natural resources continue to increase, resource efficiency becomes much more cost-effective.

New trends in the building marketplace, focusing on efficiency are evident. There is consumer interest in materials that are renewable, biodegradable, and locally produced. Waste and pollution reduction can now be cost-effective. We are recycling more, and new products made from recycled materials are increasingly more available. Meanwhile, construction methods are being developed to increase efficiency and reduce job-site waste. Concern over toxins entering the built environment is evidenced by the advent of new, less toxic materials.

The mission of the City of Aspen / Pitkin County Efficient Building (EB) Program is to increase the efficiency of our local building industry in order to preserve our natural and human resources. Flexibility is built into the program to accommodate a wide range of alternatives. This program strongly supports the concept of “closing the loop” by requiring recycling and encouraging the purchase of recycled and recyclable materials. Energy efficiency is a key component not only for the environmental benefits, but also to significantly reduce the operating costs of our housing stock. Another benefit of the EB Program is improved indoor air quality.

To facilitate the application for, and construction of, efficient buildings, this Resource Guide has been created to supplement the Checklist and Guidelines. In the beginning of the guide, each checklist item is discussed; in the back are resources and suppliers. There you will find a list of books, websites, suppliers, etc. This list is in no way intended to be exhaustive, but a dynamic document that can ‘change with the times.’

Every project demands a dedication to these practices and encourages the exploration into even greater efficiencies. Through the EB Program, the City of Aspen and Pitkin County are striving to reduce the impacts and waste in the building industry.

1.0 ADMINISTRATION

For additional information about the City of Aspen / Pitkin County Efficient Building Program, the Checklists, Guidelines, or this Resource Guide, please contact the City of Aspen Community Development Department at 970.920.5440 or the Pitkin County Community Development Department at 970.920.5526.

1.1 Point requirements

The City of Aspen / Pitkin County Efficient Building Program is point-based. The amount of points required is based on the size and type of project. (Please refer to the Guidelines for the Point Schedule.) Although there are some mandatory measures, the majority of points can be chosen from over a hundred different measures from eleven different categories. Square footage is as defined by the currently adopted building codes. For measures where a graduated point scale is used, the following shall apply: **Quantity Level 1** = 10% -25%, **Quantity Level 2** = 26% -50%, **Quantity Level 3** = 51% -75%, and **Quantity Level 4** = 76% -100%.

1.2 Inspection and compliance

For a description and explanation of the inspection and compliance component, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines. The compliance aspect to this program is very compatible with the current permit application process. The Checklist is simply an extension of this process and is required upon submittal of any residential building permit application. If a measure is listed as “Inspected”, staff may inspect these measures in conjunction with regular building inspections, or require appropriate documentation. Inspections are listed as **PC**: Plan Check, **1**:Foundation, **2**: Framing, **3**:Insulation, **4**:Rough-in, **5**: Final. All materials marked off on the checklist classified as “Inspected”, must be identified on the plans. If a measure is listed as “Self-Certified”, then the signature on the Checklist indicates compliance. The Building Department reserves the right to inspect and verify documentation for any measure at any time. If for any reason an inspection fails and the checklist has to be revised for compliance, then a revised EB Checklist must be resubmitted to the building department within 30 days of the failed inspection.

1.3 Mandatory measures

Some measures in the EB Program are required for all projects. Measures identified with shading (i.e. **2.1**) indicate mandatory compliance (*required*) for all projects. Measures identified with a dark outline (i.e. **2.1**) indicate mandatory compliance (*required*) for all publicly-funded affordable housing (PFAH) projects.

1.4 Total required point calculations

For a description and explanation of the total required point calculation, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines.

General note on acquiring alternative materials

Many products mentioned in this document may represent new technologies that may not have widespread distribution. It is highly recommended that as you consider the various strategies and products, that you anticipate longer lead times to acquire these materials.

2.0 CONSTRUCTION/DEMOLITION AND CONSTRUCTION DEBRIS RECYCLING

2.1 Deconstruction plan submitted with permit application

Reuse of salvaged building materials closes the loop in recycling. Pitkin County and the City of Aspen are very interested in increasing the reuse of deconstruction waste and reducing the amount of all construction and demolition waste sent to the landfill. The intent of this measure is to create an inventory of material to be removed from the site. Although the applicant is not required to deconstruct, 60% recycling is encouraged. Please see the City of Aspen / Pitkin County Efficient Building Program Residential Deconstruction Plan for additional information. When computing volume, the following are some general conversion rates:

Wood	300 lbs./cu.yd. and 6.7 cu. yd./ton
Cardboard (loose)	30-100 lbs./cu. yd. and 20-50 cu. yd./ton
Drywall	400 lbs/cu. yd. and 5 cu. yd./ton
Mixed Waste	350lbs./cu. yd. and 5.7 cu. yd./ton



2.2 Demolition debris reduced

When a house is due for tear down, the most efficient use of the material is to deconstruct the house (measure 2.2.6), so that the materials may be reused in another house. Not only does deconstruction take advantage of valuable materials, but it can save hauling and landfill costs, as well as produce revenue if the material is sold, either on-site or at a used building material store. If deconstruction is not an option, sorting the material and recycling it (measures 2.2.1 – 2.2.4) is the next best use, albeit labor-intensive. The third option is to compact the material on site using a shredder and/or grinder (measure 2.2.5). Compacting the material on-site reduces transportation impacts and costs. Some machines will even sort the material that has been compacted, allowing for it to be recycled, and/or composted.

- 2.2.1 Wood recycled**
- 2.2.2 Metal recycled**
- 2.2.3 Concrete recycled**
- 2.2.4 Carpet pad recycled**
- 2.2.5 Compaction – Grinding, shredding, crushing, etc.**
- 2.2.6 Material salvaged for reuse (i.e. Deconstruction)**

2.3 Deconstruction materials donated to a non-profit organization

In addition to keeping the building materials out of the waste stream, materials donated to a reseller can benefit the general public and/or non-profit agencies, such as Habitat for Humanity. Materials donated to Habitat for Humanity can be donated to their account at Construction Junction, or contact their office.

2.4 Construction debris recycled

On average, over 60% of residential construction waste can be recycled. Recycling construction debris lessens the impact of residential construction on our local landfills, it helps to provide a market for recyclable material, and can potentially reduce construction waste management costs. To facilitate jobsite recycling, the various materials should be sorted on-site. Contact a local hauler for this recycling.

- 2.4.1 Wood scrap**
- 2.4.2 Metal scrap**
- 2.4.3 Cardboard generated at the site**

USE OF RESOURCE-EFFICIENT MATERIALS (Part II of section 2.0)

2.5 Reclaimed lumber

Reclaimed wood offers an environmental benefit because it reuses existing materials and therefore reduces the impact that the materials would have had on our local landfills, had it not been reclaimed. The use of reclaimed lumber also reduces the impact of timber harvesting. Reclaimed timber frames can receive credit of this measure.

2.6 Reclaimed interior or exterior trim

See benefits listed above. Most wood suppliers can order reclaimed material.

2.7 Recycled-content carpet

Many carpet manufacturers are producing carpet made from recycled plastic. Purchasing recycled-content carpeting is one way to help close the loop in manufacturing. Products include but are not limited to Interface, Collins & Aikman, Wabi-Sabi by Interface, Second Nature, Envirotech, Envirelon, and Mohawk Aladdin. Most carpet retailers also offer a recycled content carpet.

2.8 Recycled-content decking materials

Recycled-content decking takes advantage of recycled waste wood fiber and recycled plastic resins in its construction. This combination also produces a maintenance-free, yet durable surface. Products include, but are not limited to recycled plastic lumber such as, EcoDeck and Epoch; and plastic/wood composite lumber such as, ChoiceDek™, NexWood, and Trex.

2.9 Recycled-content sheathing

Sheathing represents a significant percentage of the building materials on any given project. Using recycled-content sheathing therefore has a significant environmental benefit. Products include but are not limited to Thermo-Ply (www.simplex-products.com) and Homasote, (www.homasote.com).

2.10 Recycled-content or fiber cement siding

Recycled-content siding has the same benefits as recycled-content sheathing. Fiber-cement siding also has many benefits in that it is a very durable material, and therefore has less maintenance and disposal impacts. It should be noted, that just like wood siding, durability depends on how well the material is sealed and backvented. Composition siding, such as Cladwood® is considered recycled-content siding. Fiber cement products include but are not limited to Cemplank, Hardi-Plank, and CertainTeed-WeatherBoards.

2.11 Recycled-content ceramic tile

Recycled-content tile is made from either recycled glass or feldspar tailings, which is a post-industrial waste product. These products represent an excellent example of resource-efficient manufacturing. Products include but are not limited to Summitville, Blazestone®, Environmental Stone, and Oceanside tiles.

2.12 Recycled-content roofing

The two primary benefits of recycled-content roofing are that it provides an outlet for the recycled plastic and metal stream and it has end-of-life recyclability. Products include but are not limited to Authentic Roof™ 2000, Eco-Shake, Eco-Star, Majestic Slate, (all designed to look like wood shakes or slate) and Ondura, Rustic Shingle, and reclaimed slate roofing.

2.13 Rapidly renewable content flooring

Rapidly renewable resources require far less land to produce the same amount of material as other resources. For example, bamboo grass is a renewable resource that grows to a harvestable size in as little as five years. Bamboo flooring is a very hard and durable, wood flooring substitute. Cork is also a renewable resource that comes from the bark of the cork oak tree, and can be harvested sustainably every ten years. There is almost no material waste in the manufacturing of cork flooring. The above mentioned benefits outweigh the transportation impacts of importing these products from

overseas. Also be aware that although bamboo is resource-efficient, there are indoor air quality concerns related to the binders used in most products. Products include but are not limited to linoleum, bamboo, cork, and wool carpet. Many flooring suppliers can order these products.

2.14 Built in kitchen recycling center to include 2 or more bins

A built-in recycling bin encourages recycling behavior, thus encouraging more household waste to be recycled. Cabinets with built-in recycling centers are available where most cabinets are sold.

3.0 LAND USE AND WATER CONSERVATION

3.1 Keep footprint simple

Keeping the footprint of a building simple by reducing the amount of corners, exterior wall and/or roof area, typically reduces waste and increases energy efficiency. These two benefits usually end up saving money as well. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines.

3.1.1 4 corners

3.1.2 6 corners

3.1.3 8 corners

3.2 Xeriscape Landscaping

Landscape watering represents a significant portion of consumed treated water in the summer months. Xeriscaping reduces home water use dramatically, provides a low-maintenance landscape, and reduces the grass-clipping impact on local landfills. Most landscape contractors are capable of xeriscaping and irrigation. For a list of draught-tolerant plantings refer to **The Rocky Mountain Plant Guide**, available at most nurseries. This guide is not intended to be exhaustive, or necessarily specific to all areas and climates. Consultation from a landscape architect, nursery, and/or a landscape professional is recommended.

3.2.1 Addition of organic material to and aeration of soil. Organic material can include, but is not limited to, manure and compost.

3.2.2 Reduction of turf areas. This reduces home water use dramatically, provides a low-maintenance landscape, and reduces the grass-clipping impact on local landfills.

3.2.3 All planting beds mulched with wood chips at least 2" deep. (Except desert plantings.) Mulch will hold water better than soil and minimize evaporation.

3.2.4 Appropriate use of low-water-demand plants. Low-water-demand plants reduce home water use and provide a beautiful, low-maintenance landscape. All plants should be grouped by water needs.

3.2.5 Zoned irrigation system. Zoned irrigation systems typically irrigate more efficiently than sprinklers or watering by hand, thus reducing water usage. Systems should have timing controls. High-water zones should not be immediately adjacent to large hardscapes such as driveways or streets, and for efficient irrigation, they should not be installed in areas less than 15 feet wide. The remainder of the landscape should include low to moderate water demanding plants, and should be irrigated with drip irrigation, bubbler, or micro-spray systems.

3.3 Water conservation by performance

Water heating represents a large percentage of a home's utility bill. Therefore, low water-use fixtures and appliances not only save water, but save energy and money too. These savings typically translate into hundreds of dollars and thousands of gallons per year. Points are awarded for faucet aerators (low flow), low-flow showerheads, and toilets that exceed the current building code requirements. These items are low-cost items that are easy to install. Don't let the low-flow title fool you, they work very well. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines. Most suppliers offer water-saving fixtures, or they can be found on-line.

3.3.1 One point is earned for every one gallon per minute savings over code.

CODE: Showerhead = 2.5 gpm; Toilet = 1.6 gpm; Lav. faucet = 2.2 gpm; Kit. faucet = 2.2 gpm

Example:

Showerhead code = 2.5 gpm

(2) 2.0 gpm showerheads installed = .5 gpm saved on each shower = 1 gpm = 1 point

3.3.2 Dual flush toilet: A water-saving toilet that has a 1.6-gallon flush for solids or a half-flush (0.8 gallons) for liquids. Average flush is just 1 gallon.

3.3.3 Composting toilet: Composting toilets are toilet systems which treat human waste by composting and dehydration to produce a useable end-product that is a valuable soil additive.

3.3.4 Only one showerhead in all showers

3.4 Drip or no irrigation

Needless to say, installing no irrigation can save even more water than the most efficient system. However, drip irrigation is the next best approach. Drip irrigation is a much more efficient method of watering than typical sprinkler systems. Less water is wasted on evaporation and therefore more water is conserved.

3.5 Engineered swales to filter storm water runoff

Engineered swales serve as a natural storm water pollution filtration system. These landscaped swales can visually enhance a site, reduce on-site infrastructure costs, reduce municipal water treatment costs, and improve water quality. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines, or contact a civil engineer. For city projects, an engineered site drainage plan is required by code.

3.6 Planting trees beyond requirement

Trees have the ability to reduce the ambient temperature around them, visually enhance their surroundings, offer shade for nearby buildings (thus potentially reducing the need for mechanical cooling), stabilize soil, and the list goes on. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines.

3.7 Save and reuse all topsoil and/or excavated fill on site

Good topsoil is a rare commodity in this area. Saving and reusing topsoil/fill on-site reduces local landfill impacts, reduces transportation impacts both coming and going, and reduces the import fees of new soil. If soil cannot remain on-site, networking with other contractors to find a use for the soil in place of landfilling it is recommended. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines.

3.7.1 Topsoil from the site must be reused on site.

3.7.2 Use 100% of excavated fill on-site.

3.8 Site-rock reclaimed on site

Often times, site-rock can be used for veneer and/or landscape applications or for retaining walls. Saving and reusing rock on-site reduces local landfill impacts, reduces transportation impacts both coming and going, and reduces the import fees of new material. If rocks cannot remain on-site, networking with other contractors to find a use for the rocks in place of landfilling it is recommended. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines.

3.9 Non-potable water used for irrigation

Although Graywater systems can be difficult to incorporate, rainwater collection doesn't have to be. Rainwater collection systems utilize a 'free' source of water for irrigation that reduces the impact on storm water run-off systems, and saves on treated water usage. Irrigating with ditch or river water is also considered non-potable, providing it is available. For more information about this measure, please see the City of Aspen / Pitkin County Efficient Building Program Guidelines. Check with local code officials before incorporating any type of system.

3.10 Pervious materials in “hardscape” areas

Pervious paving materials greatly lessen the impact on storm water run-off systems by allowing water to percolate into the ground rather than flowing down the street collecting pollutants. Allowing as much precipitation to permeate the soil also tends to disrupt the natural water cycle less than excessive hardscaped areas. Products include but are not limited to Drainstone, Turfstone, Grasspave (www.invisiblestructures.com), TuffTrack, GrassRoad Paver 8 Plus (www.NDSPRO.com), Grassy Pavers (www.rkmfg.com), the Geoblock System (www.prestogeo.com), and gravel.

4.0 FRAMING & MATERIALS

4.1 Incorporate optimal value engineering (OVE) framing techniques

“Optimum value engineering” refers to a set of practices that save material and money by reducing the amount of materials and time used in construction. These practices typically rely on an up-front investment in design and engineering time, as well as framing crew training, as a means of achieving these savings. This initial investment typically produces significant long-term savings. Incorporating less wood into a house also allows more room for insulation and has proven to reduce drywall cracking.

4.1.1 24” O.C. studs: 24” o.c. framing uses less wood than 16” o.c. Be sure to verify structural loads.

4.1.2 Two stud corners: Two stud corners still allow for dual-sided exterior nailing and provide backing for drywall with the use of drywall clips, which also reduce cracking.

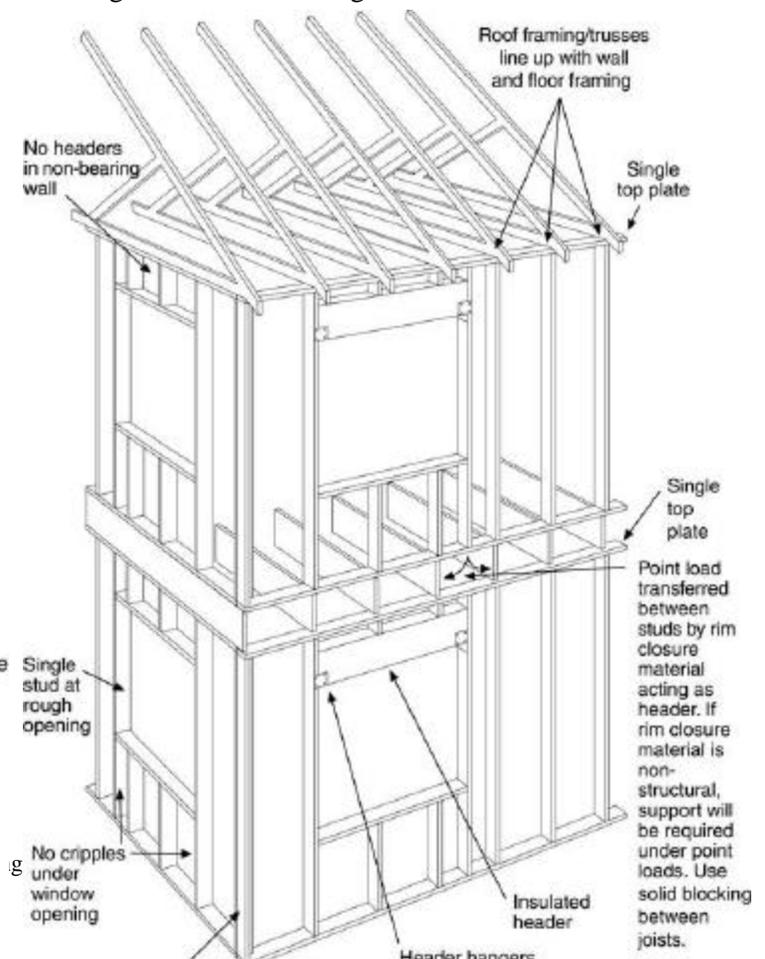
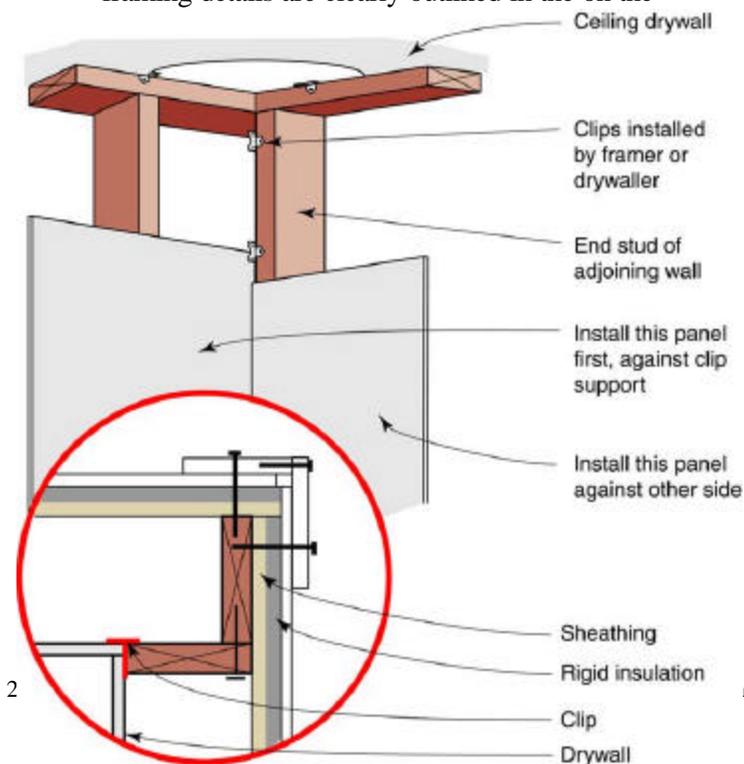
4.1.3 Efficient headers: This includes site-built or pre-manufactured, insulated headers, and/or eliminating headers when not necessary. You can also save wood & space by using header brackets instead of trimmer studs.

4.1.4 Stacking joists over studs with single top plates: Most codes allow for the elimination of a top plate when members are stacked. Walls are then tied together with nail plates.

4.1.5 Build with two-foot increments for reducing waste: Since a majority of building materials come in two-foot increments, there is less waste if the building was designed to take advantage of a materials’ dimensions.

4.1. All framing members shown on drawings in plan and elevation:

A picture is worth a thousand words, and so is a drawing. If efficient framing details are clearly outlined in the on the



drawings, it is much more likely they will be used in the field. They will also make lumber take-offs much more accurate.

These details taken from *Builder's Guide – Cold Climates*; courtesy of Building America, Energy and Environmental Builders Association and Building Science Corporation. They are intended to serve as examples only for measure 4.1. This book is available at www.eeba.org.

4.2 Oriented Strand Board in subfloors

Engineered lumber products, such as OSB, offer significant environmental savings over plywood in that it utilizes fast-growing, small-diameter trees efficiently. There are now OSB

products available that are designed to be weather-resistant in flooring & roofing applications. Products include but are not limited to Louisiana Pacific's 'BarrierFloor™', and Huber's 'Advantech.'

4.3 Oriented Strand Board (OSB) in wall sheathing

Engineered lumber products, such as OSB, offer significant environmental savings over plywood in that it utilizes fast-growing, small-diameter trees efficiently.

4.4 Low-toxic Oriented Strand Board (OSB)

Most OSB is made with urea formaldehyde that will continue to outgas high levels of VOC's for several months. Specify low-toxic Oriented Strand Board (OSB) when purchasing. Products include but are not limited to Huber's 'Advantech' and other GREENGUARD™ Certified products.

4.5 Finger-jointed studs or engineered studs used for wall framing

Finger-jointed studs are fabricated from short pieces of 2x4 or 2x6 material that are glued together to form standard stud lengths. Not only are they resource-efficient, but also they tend to be straighter and less expensive than solid sawn studs.

4.6 Finger-jointed trim

Finger-jointed trim is fabricated from short pieces, which are glued together to form standard trim lengths. Not only are they resource-efficient, but also they tend to be straighter and less expensive than solid sawn trim.

4.7 FSC® certified materials

FSC® (Forest Stewardship Council) certified forestry principles include forest management for biological diversity, long-term forest health and long-term economic well-being of local communities. As a true third party, FSC® certification is considered to be the most well-respected of all the certifiers. Certified material is still difficult to obtain and a longer lead time should be anticipated.

4.8.1 FSC® certified lumber

4.8.2 FSC® certified cedar shakes

4.8.3 FSC® certified trim

4.8.4 FSC® certified cabinets

4.8.5 FSC® certified windows and/or doors

4.8.6. Outdoor structures, decking and landscaping forms made with dimensional FSC certified lumber



4.8 SFI™ certified materials

SFI™ (Sustainable Forestry Initiative) certified forestry principles are similar to FSC's principles. SFI™ is a program of the American Forest & Paper Association. Certified material is still difficult to obtain and a longer lead time should be anticipated.

4.8.1 SFI™ certified lumber

4.8.2 SFI™ certified cedar shakes

4.8.3 SFI™ certified trim

4.8.4 SFI™ certified cabinets

4.8.5 SFI™ certified windows and/or doors

4.8.6. Outdoor structures, decking and landscaping forms made with dimensional FSC certified lumber



4.9 Engineered lumber used in floors and roofs

Engineered lumber products, such as “I” joists, offer significant environmental savings over solid sawn lumber in that it utilizes fast-growing, small-diameter trees efficiently, as opposed to harvesting old growth trees.

4.10 Engineered lumber used to replace 2x10s or 2x12s for structural bearing applications

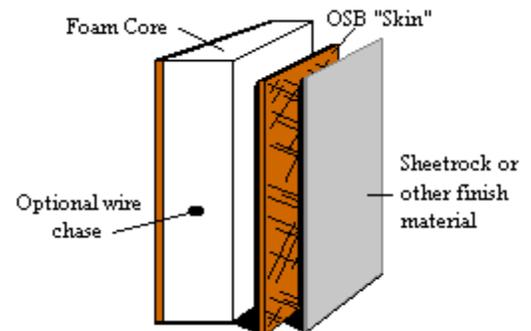
Engineered lumber products, such as “I” joists and other laminated beams & columns, offer significant environmental savings over solid sawn lumber in that it utilizes fast-growing, small-diameter trees efficiently, as opposed to harvesting old growth trees.

4.11 Structural alternatives to wood-frame construction

Alternatives to typical wood-frame construction can offer greater resource and energy efficiency. Examples include but are not limited to Straw Bale, Rammed Earth, and Adobe. These systems all use renewable resources more efficiently than typical wood-frame construction and can often allow for unskilled labor, reducing construction costs.

4.12 Structural Insulated Panels (SIP's) used for exterior walls and/or roof

‘SIPs’ as they are commonly referred to as, are manufactured panels of an insulating material, typically expanded polystyrene, sandwiched in between two layers of an engineered sheet good, typically OSB. There is also a SIP panel made of compressed straw sandwiched between a wheat-based sheetgood. Structural Insulated Panels tend to be more resource and energy-efficient than typical wood-framed homes. They produce very air-tight homes, so although mechanical ventilation is recommended for most homes, it is *strongly* recommended for SIP homes. SIP panels also take advantage of a factory-controlled environment for manufacturing and are typically less labor intensive to install.



4.13 Factory-built or panelized construction for exterior walls and/or roof

Premanufactured components tend to be more resource and energy-efficient than typical wood-framed homes. They take advantage of a factory-controlled environment to maximize efficiency. Points can also be earned for measures 2.3, 4.1, 4.3, 4.4, 4.8, 4.9, & 4.11 if documentation is provided.

4.14 Recycled-content Insulated Concrete Forms (ICF's)

This product offers the energy-efficiency benefits of insulated concrete forms combined with the resource-efficiency of using fly ash in the form itself. Using fly ash,



a coal-fired power plant waste product, utilizes an otherwise landfilled product. Products include, but are not limited to Perform Wall and Rastra®.

4.15 Insulated Concrete Forms (ICF's)

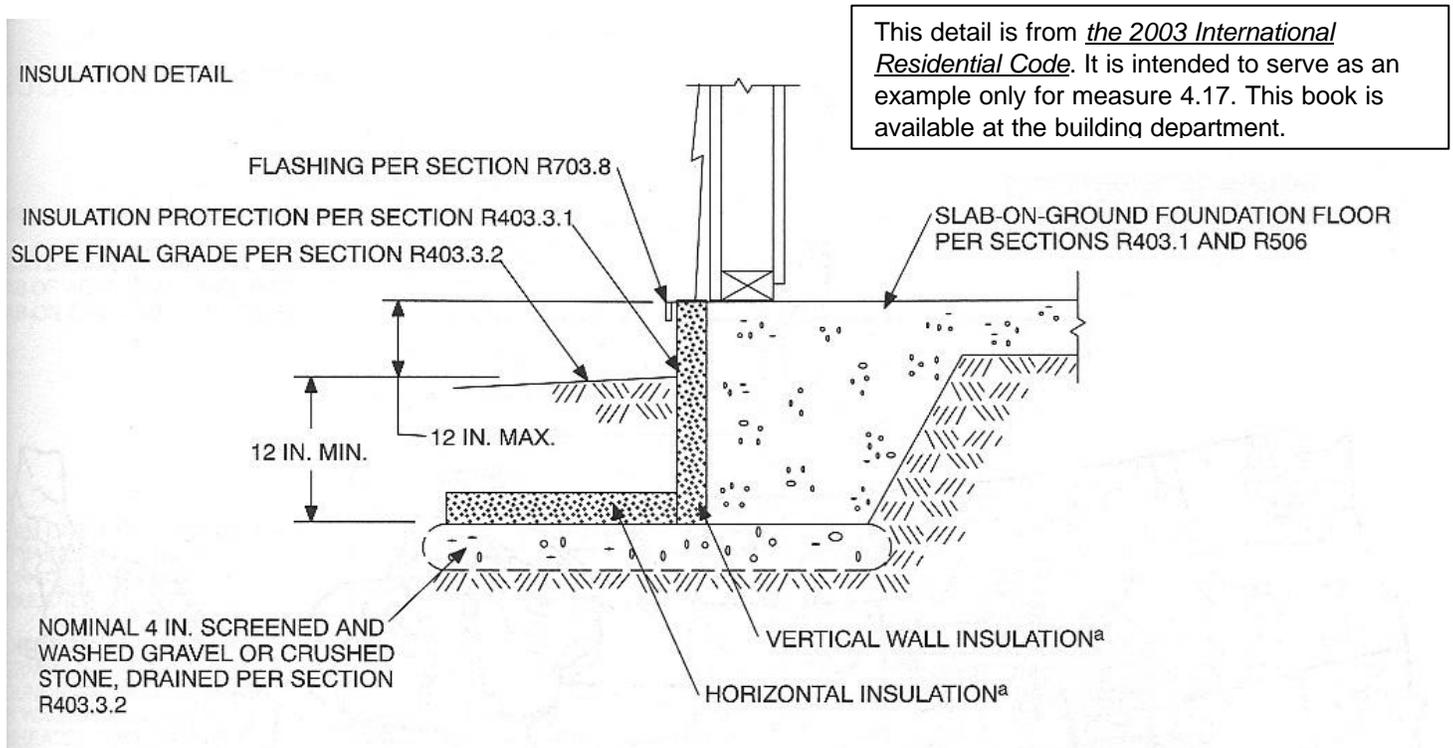
Insulated concrete forms, or ICF's as they are commonly referred to as, are permanent forms with integral insulation that are not disassembled after the concrete has cured. The advantage of ICF's are that they are less labor-intensive, more energy-efficient through better insulation value, and some "waffle" systems use less concrete than typical foundation walls.

4.16 Non-solvent based foundation waterproofing

Solvent-based waterproofing products tend to have a high VOC content and may be a source of groundwater contamination. Products include, but are not limited to Safecoat's® DynoSeal and Tremco's Mulseal™.

4.17 Frost-protected shallow foundation

A frost-protected shallow foundation (FPSF) is a practical alternative to deeper, more-costly foundations in cold regions with seasonal ground freezing and the potential for frost heave. A FPSF incorporates strategically placed insulation to raise frost depth around a building, thereby allowing foundation depths as shallow as 16 inches. The FPSF has been so well-received in Nordic countries that it is considered standard practice for residential buildings in Scandinavia. The advantages are greater energy-efficiency with slab edge insulation, and by reducing the foundation depth, you reduce excavation and concrete costs while minimizing the impact to the site.



4.18 20% or more fly ash content in all concrete

Using fly ash, a coal-fired power plant waste product, in concrete mixes not only utilizes an otherwise landfilled product, but it reduces the use of high embodied energy cement. All concrete batch plants in the Roaring Fork Valley offer, if not already use, fly ash content for their concrete. The actual percentage used should be verified. Typically a 50% mix is the maximum for structural concrete depending on the season, but a structural engineer must design mixes exceeding the standard mix. It is recommended that the design team get a mix design submittal from the batch plant before construction.

It is possible to verify Flyash in the mix the day of the pour with a batch weight ticket, but it is very important to let the plant, the driver and the sub-contractor know that you are requesting it.

5.0 ENERGY CODE MEASURES

Buildings consume 36% of all energy used in the U.S. This translates into over \$220 billion to heat, cool, and power our buildings. Energy consumption is also a major cause of acid rain, smog, and global warming. Saving energy allows individuals and communities to become less dependent on energy and less vulnerable to price fluctuations. It grants the environment time to recover from damage caused by energy use. In addition, it lets future generations also enjoy economic prosperity and the use of fossil fuels. The City of Aspen and Pitkin County have also identified energy efficiency as a tool for building affordable housing.

5.1 Performance exceeding energy code requirements

The Aspen / Pitkin Energy Conservation Code currently requires energy calculations be submitted with all residential building permits. These calculations, typically generated by computer programs (REScheck for example), provide a percentage number representing the difference between code and the proposed project. One point is available for every five percentage points higher than code. For example, 10% better than code would earn 2 points. Points can not be earned if snowmelt and/or a heated pool/spa is incorporated into the project.

5.2 Window quilts or insulated window shades

Insulating shades are very effective for insulating windows and improving comfort indoors. Products such as Window Quilt® have a built-in vapor barrier and edge seals to prevent water damage caused by condensation, while adding an R-5 to the window. Single, double & triple cell cellular blinds can also help keep the cold out. Some blinds use side tracks which attach to your window frame and specially fitted end caps which along with the specially notched sides of the shades minimize energy loss. Available at some window treatment stores.

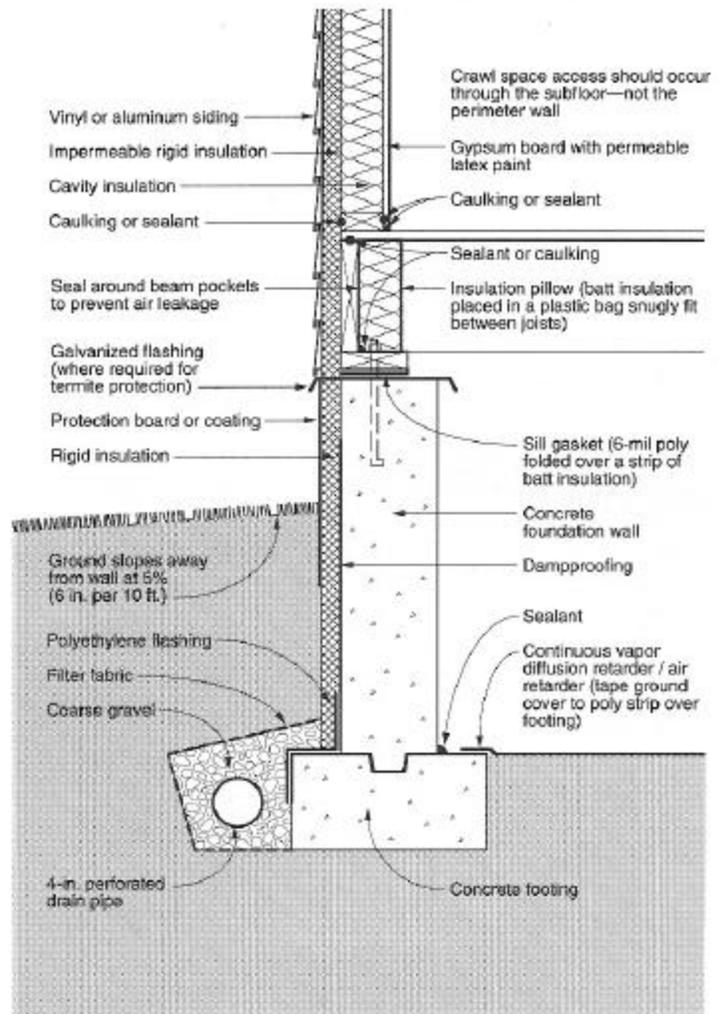
5.3 Mechanical equipment centrally located

Centrally located equipment reduces the size and therefore much of the inefficiency of a distribution system. Centrally located is defined as having no mechanical run (distribution system of conditioned air or water) being longer than 2/3 the distance of the longest diagonal dimension of the house.

5.4 Energy Star® (5 star) house

Energy Rated Homes of Colorado (E-Star™) is the local home energy rating organization. An energy rating quantifies a homes' energy efficiency, and also suggests cost-effective improvements. These ratings also include a Blower Door Test that quantifies air infiltration (see section 9.5). But most importantly, an energy rating can provide the solutions for increased comfort and reduced energy bills. An Energy Star® certified house is simply a house that scores an 86 or higher through an energy rating. A rating score of 82 or higher can also act as an alternative to energy calculations for The Aspen/ Pitkin Energy Conservation Code.

5.5 Energy-10 analysis



Energy-10 software is a design tool that analyzes the energy and cost savings that can be achieved through more than a dozen sustainable design strategies. Hourly energy simulations help you quantify, assess, and depict the benefits of daylighting, passive solar heating, natural ventilation, well-insulated envelopes, better windows, lighting equipment, and more.

5.6 All duct work sealed with mastic

The efficiency of a heating system is significantly lowered by a poor distribution system. For example, an 80% efficient furnace may only operate at 72% efficiency if the ductwork is leaking warm air to a crawlspace, attic, or a wall cavity. Leakage in the duct system can also be hazardous to your health. All ducts, plenums, and register boots should be sealed with mastic. Ductwork should be contained inside the heated house instead of along exterior walls or in attics, or crawlspaces. However, if this is not possible, ducts that run outside the building envelope should be insulated and sealed.

5.7 Insulate all hot water pipes to all locations to R-2.5

Pipe heat loss is wasted energy. Pipe insulation is a very cost-effective method to saving energy and reducing the 'wait time' for hot water. Insulated or not, it is recommended that pipe

This detail is from *Moisture Control Handbook* by Joe Lstiburek and John Carmody. It is intended to serve as an example only for measure 5.8. This book is available at

5.8 Unvented crawlspace (conditioned, insulated walls, vapor barrier, etc. per code)

The key to an unvented crawlspace is keeping moisture out of the crawlspace. This can be accomplished by controlling rainwater around the perimeter with gutters and proper grading, controlling groundwater with a foundation drain, controlling capillary suction with foundation dampproofing, controlling air movement into the space by air-sealing all of the penetrations in the walls as well as a continuous air/vapor barrier over the crawlspace floor, and controlling condensation by insulating the exterior walls and rim joist cavity. The building official must approve unvented crawlspace designs.

5.9 Side-arm hot water heater

An indirect-fired water heater circulates water through a heat exchanger in the boiler. This heated water then flows to an insulated storage tank (Side-arm hot water heater). Because the boiler does not need to operate frequently, this system is more efficient than an under-fired hot water heater. In fact, when an indirect water heater is used with a highly efficient boiler, the combination may provide one of the least expensive methods of water heating. These products are available through plumbing/mechanical contractors.

5.10 Energy-efficient boiler or furnace

The cost of a heating system has three components: the initial purchase/installation price, the cost of repairs and maintenance, and the cost to operate it. To figure out how much you'll spend over the lifetime of the system, you have to look at *all* of these costs. The appliance with the lowest initial purchase price, or even the one with the best repair record, isn't necessarily the one that costs the least to operate over the long term. For this program, an energy-efficient boiler is 87% efficient or better. In certain applications, modulating boilers or sequentially staged boilers will also qualify. Sizing the equipment is also very important in creating an energy efficient system. Manual J is the industry standard for sizing equipment. It is recommended that you have your mechanical contractor size your equipment using Manual J. These products are available through plumbing/mechanical contractors.

5.10.1 87% (min.) efficient boiler or 94% (min.) efficient furnace

5.10.2 Modulating or sequentially-staged boilers

5.11 Outdoor reset thermostat

In order to optimize the efficiency of a heating system, the heat loss should be equal to the heat supplied. An Outdoor Reset Thermostat is a control device that measures both the outside temperature and the system supply water temperature. This essentially helps to 'balance' the system to achieve much greater efficiency at very low cost. These products are available through plumbing/mechanical contractors.

5.12 High-efficiency gas hot water heater

A typical gas hot water heater ranges between 50 - 60% efficient. A high-efficiency hot water heater is any water heater that is 88% efficient or better. Products include, but are not limited to 'Polaris' by American Standard, and Voyageur made by Heat Transfer Products. These products can cost as much as \$1,500 *more* than typical hot water heaters, and are available through plumbing /mechanical contractors.

5.12 Manual J calculations used for sizing mechanical equipment

Created by The Air Conditioning Contractors of America, Manual J is the industry standard for estimating equipment sizing loads associated with residential structures. This method more accurately takes into account the specific components of a house, as opposed to the common 'rule of thumb' strategy.

6.0 PLUMBING

6.1 Tankless water heater

Tankless, or point of use water heaters, heat the water where it is needed without incurring the standing tank losses from conventional hot water heaters. Tankless heaters have capacity limitations. Products include but are not limited to Takagi and Aquastar. They are available through plumbing contractors. Consult with a mechanical contractor to verify that your use is appropriate.

6.2 "On-Demand" hot water switch

Running faucets and showers until the water gets hot wastes water and energy. On-demand hot water pumps circulate hot water to the faucet or showerhead by automatic aquastat control or with a push of a button. Constant circulation systems are not acceptable for this measure. These products are available through plumbing contractors.

7.0 ELECTRICAL

7.1 Energy Star[®] Rated appliances

The Energy Star[®] program is an EPA-sponsored program created to provide consumers with easily understandable standards of energy efficiency, including household appliances. The cost of owning a home appliance has three components: the initial purchase price, the cost of repairs and maintenance, and the cost to operate it. To figure out how much you'll spend over the lifetime of the appliance, you have to look at *all* of these costs. The appliance with the lowest initial purchase price, or even the one with the best repair record, isn't necessarily the one that costs the least to operate. Energy Star appliances reduce operating costs compared to conventional appliances. Most manufacturers have Energy Star[®] rated appliances available.



7.2 Clothesline

Drying clothes on an indoor or outdoor clothesline is more energy-efficient than any machine dryer on the market. An installed clothesline is an incentive not to use the dryer as often. Available at most hardware stores.

7.3 Energy-efficient clothes washer

Horizontal axis clothes washers are generally more energy-efficient than vertical axis clothes washers. Using an energy-efficient washer will save both water and energy, typically 25-40% less water and 50-65% less energy. To qualify for this measure, washers must be selected from tier 2, 3, 4A, or 4B from the list at www.cee1.org. These models are available at most stores where appliances are sold.

7.4 Compact fluorescent bulbs

Electric lighting uses energy in two ways: it uses electricity directly to produce the light, and it produces waste heat. Compact fluorescent lights (CFL'S) cut electrical consumption by as much as 50% without producing all of the waste heat that incandescent bulbs produce. New CFL and other fluorescent lamps technology create better light quality without the hum-and-flicker of obsolete fluorescent technology. T8 & T5 fluorescent bulbs also qualify. Available at most stores where light bulbs are sold.

7.5 Efficient light controls

Efficient light control systems can provide high-quality light when and where it's needed, with less energy consumption and maintenance costs. These systems can be as basic as a basement light with an occupancy sensor, or as complex as a home automation system.

8.0 INSULATION

8.1 Wall insulation is 70% recycled material

Recycled insulation has many benefits. While creating an outlet for recycled material, it also reduces energy consumption and increases comfort in the home. Products include but are not limited to cellulose, cotton, mineral wool, and Ottawa Fibre fiberglass insulation.

8.2 Ceiling insulation is 70% recycled material

See benefits and resources listed above.

8.3 Blown / sprayed insulation

Blown / sprayed insulation, such as cellulose or blown fiberglass, out-performs most other insulation products in regards to energy efficiency . Blown / sprayed insulation tends to insulate more effectively and reduce air infiltration, with a small cost premium compared to fiberglass batt insulation.

8.4 Formaldehyde-free or low-toxic insulation

The added benefit to low-toxic insulation is improved indoor air quality. Formaldehyde, a common ingredient in many building products is a suspected carcinogenic hazard. Products include but are not limited to most cellulose products, Johns Manville's Thermal-SHIELD Free™, Sound-SHIELD Free™; CertainTeed's Insulsafe 4®; Owens Corning's Miraflex®, and GREENGUARD™ Certified products. Products are available at most building material stores as well as from insulation companies.

8.5 Single-pane windows upgraded (additions / remodels only)

The insulation value created by two panes of glass effectively cuts the heat loss to ½ that lost through single glazing. Insulating glass with Low E coating(s) reduces the likelihood of condensation forming on the glass, improves comfort, reduces street noise, and is much more difficult to break than single glass. Refer to The Aspen / Pitkin Energy Conservation Code for minimum standards.

8.5.1 Double-glazed (max U-value = 0.40)

8.5.2 Double-glazed with low-e coating (max U-value = 0.35)

8.5.3 Spectrally selective film applied to historic windows: These films filter out solar heat and reduces fabric fading, but typically do not improve winter comfort.

8.6 Existing ceiling/roof insulated to R-38 or capacity for fixed space (additions & remodels only)



Insulation reduces heat loss from the house, keeping it more comfortable and lowering energy bills. Adding insulation to an attic, such as a blown-in product, is typically a very cost-effective energy-efficient improvement for all seasons.

8.7 Existing walls insulated to capacity or rigid insulation added to exterior walls (*additions & remodels only*)

Adding insulation to exterior walls has a similar benefit to adding it to the ceiling. Although adding ceiling insulation tends to be more cost-effective than adding wall insulation, adding wall insulation tends to be more effective at increasing comfort levels in the home.

9.0 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

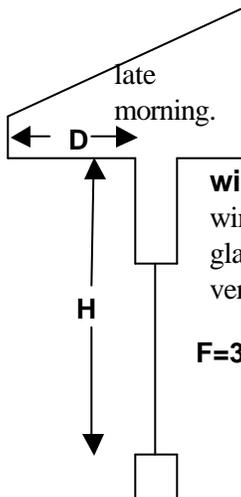
9.1 Air destratification system

Well-designed air destratification systems relocate warm air to where it's wanted, or not wanted, depending on the season. These systems generally increase comfort while consuming less energy than a central air conditioner. Strategies to create cooler buildings include but are not limited to ceiling fans, heat siphon fans, and a variety of other strategies designed to cool buildings. The products are available through mechanical contractors, building material stores, and other relative retail stores.

9.2 Natural cooling

The Roaring Fork Valley is considered a heating climate. This implies that mechanical cooling is not necessary if proper design strategies are implemented. These strategies can be as simple as a properly-sized overhang or a properly-placed deciduous tree. The advantages of incorporating the strategies listed in the guidelines are increased comfort, lower initial costs, lower energy consumption, lower utility bills, design flexibility, and elimination of unsightly, noisy and expensive air conditioning equipment. Note that the strategies listed below all involve minimizing solar gain. This does not mean glazing must be minimized, but that it must be managed by proper overhangs, the addition of thermal mass, etc.

9.2.1 Vertical shading devices for = 75% of east and west-facing glass: Solar heat contributes approximately 50% of the heat accumulating in the home. West or southwest windows contribute a great deal of solar heat and can cause early heat build up in summers in the afternoon, just when you want it least. East windows begin heating the home early in the



9.2.2 Reflective films on = 75% of east and west-facing glass or use windows with a Solar Heat Gain Coefficient of less than 0.45: Metalized plastic window films can block 50% - 75% of the solar heat on glass. Reflective films repel solar heat, cut glare, and reduce fading. Windows with a low SHGC also reduce solar gain. With either option, verify that the glass still offers good light transmittance.

9.2.3 Radiant heat-reflective barriers installed on = 90% of roof applications: A radiant barrier can be stand-alone foil, foil-faced insulation, or a paint-based product. Radiant barriers work in two ways: They reflect radiant heat and they retard radiant heat's emittance. Radiant barriers must face an air space to be effective. Products include but are not limited to Astro-Foil™ and R+Heatshield®.

9.2.4 Landscaping that shades = 75% of east and west facing glazing during the summer season (June-August).

9.2.5 Properly sized overhangs for = 75% of south facing windows. South-facing windows are responsible for most of the solar heat gain in a house. The formula below will result in window overhangs that shade 100% of south-facing window glazing on June 21st (the summer solstice), while still allowing for winter solar gain. Applicants should use this formula as a guide for sizing all south-facing overhangs. This strategy allows heat in during winter and blocks it in summer.

D=H/F where:

D=Distance of overhang from face of glass

H=Height from bottom of glass to top of overhang

F=3.38 (F is a value corresponding to the noon sun altitude angle on June 21st, which results in 100% window shading).

9.3 No mechanical air conditioning

In addition to the benefits listed above, the elimination of air conditioning also reduces the potential ozone depletion from compressed refrigerants. Needless to say, not installing mechanical air conditioning is a significant cost savings.

9.4 Evaporative cooling

Evaporative coolers (also called swamp coolers) reduce the air temperature of outdoor air. Outdoor air is passed through water-soaked pads that humidify the air for inside the home. If mechanical cooling is used, evaporative cooling is preferred because it does not use refrigerants, costs significantly less to install, uses approximately 10% of the energy that unitary air conditioning systems use, and introduces humidity to the air. These products are available through mechanical contractors. (See 5.4)

9.5 Air infiltration rate below specified levels

Building scientists agree that an energy efficient house should have a tight building envelope (low air infiltration) accompanied by proper ventilation. After all, a house can't be too tight, but it can be under-ventilated. Holes and gaps in and around a house contribute significantly to heat loss or gain, and is one of the most common comfort problems in homes. Air infiltration in the wrong location can also lead to moisture problems, and therefore indoor air quality problems. A blower door test (See section 5.4), which identifies and quantifies air leakage, is required upon completion of the house.

9.5.1 0.40 NACH (Natural Air Changes per Hour)

9.5.2 = 0.35 NACH (Less than 0.35 NACH mechanical ventilation required)

9.6 Whole-house fan

Whole-house fans provide an effective way to ventilate a house. They are typically centrally located and exhaust heat from the house and into the attic, where it is then vented out through vents. Insulated covers on these fans increase their energy efficiency. Products include but are not limited to the Tamarak HV series whole house fans. Products are available through some mechanical contractors and suppliers.

9.7 Convert electric resistance heat to gas (additions/remodels only)

Although electric systems have higher efficiencies than gas systems, electric heat can be as much as 3 times as expensive as natural gas in Colorado. Electric heat is not considered energy-efficient due to the negative environmental impacts from high resource consumption and emissions at the power generation plants. Gas heat includes but is not limited to gas-fired forced air, gas-fired hot water baseboard or in-floor, or gas appliances. This measure is available through most mechanical/plumbing contractors.

9.8 Replace electric water heater with a gas water heater (additions/remodels only)

See benefits listed above. This measure is available through most mechanical/plumbing contractors. Energy Star[®] rated products are recommended.

9.9 Hydronic heat

Hydronic heating systems combine a boiler or hydronic heat pump with heat emitters, piping, and controls. Hydronic (hot water baseboard or in-floor) heating is considered to be a safer, more effective, and a more affordable method of space heating than most alternatives. This measure is available through most plumbing contractors.

9.10 Mechanical heat recovery ventilator (HRV) or air to air heat exchanger

Buildings can't be built too tight, only under ventilated. The down-side to some mechanical ventilation systems is that they introduce unconditioned air into a house. Heat recovery ventilation systems provide ventilation of conditioned air, which increases comfort and energy efficiency. Heat-recovery ventilation systems can be stand alone ventilation systems or tied into forced-air heating. Products include but are not limited to mixing-box ventilators and heat recovery ventilators such as the Venmar AVS Solo, the Vent-Aire ECS45M, and the PerfectAire® Fresh Air Exchanger. These products are available through most mechanical contractors and suppliers.

10.0 SOLAR

There have been great improvements in the solar industry over the past two decades. Designing a home to take advantage of solar energy is not difficult, but does require attention to detail. Computer modeling software such as the Department of Energy's 'Energy Plus' or SBIC's 'Energy 10' are available online for assisting in the design of solar homes. With or without the use of these programs, consulting with architects and/or builders familiar with solar design is highly recommended.

10.1 Passive solar space heating

The basic idea of passive solar design is to allow daylight, heat, and airflow into a building only when beneficial. The objectives are to control the entrance of sunlight and air flows into the building at appropriate times and to store and distribute the heat and cool air so it is available when needed. Many passive solar design options can be achieved at little or no additional cost. Avoid west-facing glass – as this exposure is difficult to shade and tends to overheat, south west glass can also be brutal in the summer. Adding deciduous trees on south and west exposures helps shade the exposure in summer. Also windows with a solar heat gain coefficient less than 0.45 can reduce over heating. Others are economically viable over a building life-cycle. For more information, the Sustainable Buildings Industry Council (SBIC) offers a comprehensive resource for passive solar design. This resource, called the Guidelines for Home Building provides all the information required for solar home design in a climate-specific, user-friendly format, including rules of thumb and performance potential data. Manual worksheets and the Builder Guide (DOS based) or Builder Guide for Windows® software's produce dependable energy use calculations. Builder Guide automates the calculations in the Guidelines worksheets. The DOS-based and Windows®-based programs are user friendly and include built-in help text and a User Manual.

Below are the prerequisites for the passive solar space heating requirements. (Also see sections 9.1 & 9.2)

10.11 - East-west axis should be oriented within 30 degrees east or west of true south: When glazing is oriented more than 30° off true south, not only is winter solar performance reduced, but summer air conditioning loads also significantly increase, especially as the orientation move west. It should be noted that 5° is ideal, 15° is almost as good, and 30° off true south, although less effective, will still provide a substantial level of solar contribution.

10.12 - Overhangs are designed so that south facing glazing is not shaded between 10 am and 2 pm on the winter solstice, and is totally shaded between 10 am and 2 pm on the summer solstice:

As mentioned above, the concept of passive solar design is to keep the sun out in the summer, and allow it to enter in the winter. Because of the different angles of the sun during different seasons, a properly sized overhang can successfully manage the sun.

10.13 - Solar access should be unimpeded: Passive solar design needs the sun, therefore the sun's rays should not be impeded by other homes, geographic features, evergreen trees, etc. Ideally, the glazing on the house should be exposed to sunlight with no obstructions within an arc of 60° on either side of true south, but reasonably good solar access will still be guaranteed if the glazing is unshaded within an arc of 45°.

10.14 Sun tempering

In addition to the 10.11-10.13 prerequisites, south facing glazing should equal 6-7% of the total heated floor area. This percentage should allow for some supplemental heat, but not enough to overheat the house in the summertime.

10.15 Passive solar

True Passive solar design takes sun tempering a step further. In addition to the 10.11-10.13 prerequisites, south facing glass should equal 7-12 % of the total floor area. 5.5 sq.ft. of uncovered, sunlit mass floor must be added for each square foot of south facing glass over 7 % of the floor area. The maximum floor mass that can be considered as “sunlit,” may be estimated as about 1.5 times the south window area. An additional 1.0 sq. ft. of south facing glass may be added for every 40 sq. ft. of thermal mass in the floor of the room, which is not in the sun. An additional 1.0 sq. ft. of south facing glass may be added for each 8.3 sq. ft. of thermal mass placed in the wall or ceiling of the room. Mass in the wall or ceiling does not have to be located directly in the sunlight, as long as it is in the same room with no other wall between the mass and the area where the sunlight is falling. Types of thermal mass which can be used include: concrete floors, two layers of sheetrock, exterior sheet rock, gypcrete (2 inches), tile floors, masonry, thick plaster, adobe walls, stone fireplaces, etc.

10.2 Solar heating system for domestic hot water

Solar hot water systems designed for domestic hot water use solar collectors to harness the heat from the sun to heat the water. By reducing fossil fuel energy consumption, solar hot water systems lower energy bills and help create energy independence. These systems are very simple and cost-effective. The Community Office for Resource Efficiency provides \$1,000 rebates on solar hot water systems installed in the Roaring Fork Valley (See CORE website, www.aspencore.org, for incentive requirements). Federal tax credits may also be available in the future. No points can be earned if snowmelt and/or a heated pool/ spa is incorporated into the project. Solar hot water systems may be installed off-site if approved by CORE.

Table 1. Orientation Adjustment Factor Table
Collector Tilt, Degrees From Horizontal

		0	10	20	30	40	50	60	70	80	90
Collector Degrees From True South	0	87.0%	93.2%	97.6%	99.9%	100%	98.0%	93.9%	87.8%	80.0%	70.7%
	10	87.0%	93.1%	97.4%	99.7%	99.8%	97.7%	93.6%	87.6%	79.9%	70.7%
	20	87.0%	92.8%	96.9%	99.0%	99.1%	97.1%	93.0%	87.1%	79.6%	70.7%
	30	87.0%	92.4%	96.1%	98.0%	97.9%	95.9%	92.0%	86.2%	79.0%	70.5%
	40	87.0%	91.8%	95.0%	96.6%	96.4%	94.3%	90.5%	85.0%	78.1%	70.0%
	50	87.0%	91.0%	93.7%	94.8%	94.3%	92.2%	88.5%	83.2%	76.7%	69.1%
	60	87.0%	90.0%	92.0%	92.7%	91.9%	89.6%	86.0%	80.9%	74.7%	67.6%
	70	87.0%	89.0%	90.1%	90.2%	89.0%	86.6%	82.9%	78.1%	72.2%	65.5%
	80	87.0%	87.9%	88.1%	87.4%	85.7%	83.0%	79.3%	74.6%	69.1%	62.8%
	90	87.0%	86.7%	85.8%	84.3%	82.1%	79.1%	75.2%	70.6%	65.3%	59.5%

Note: Interpolate for collector tilt and degrees between those listed on the table.

Study the chart and note that:

A solar hot water or PV system tilted at 40 degrees and facing due south receives the most sun in a calendar year. If this optimum standard is 100% then:

- A vertical south facing window receives only 70 % as much sun.
- A vertical east or west facing window receives 60 % as much sun.
- A collector flat on the ground, with no tilt, facing any direction gets 87% as much sun. (This is because much of the sun's energy comes in the summer when the Sun is high overhead)
- A roof pitched between 10 and 50 degrees can be oriented anywhere within 60 degrees of true south and still receive more than 90% of the sun's annual energy.

The key take home: It is true that to heat a building with winter sunlight you need to aim your building's windows at the sun. Passive solar buildings need to face south. However, to capture year-round solar energy on a roof, the acceptable design envelope is much larger. This may seem counterintuitive until you think about how the sun actually moves through the sky. From March through September the sun is high overhead and thus neither roof orientation nor roof pitch is as critical as it would at first seem.

The only time this general rule doesn't apply is if you have an off grid house where winter solar thermal or PV production is absolutely critical; a backcountry ski hut, for example.

10.3 Active solar pre-plumbing

To pre-plumb for solar, follow these simple instructions. A typical solar system has one or two 4-foot by 8-foot panels on the roof, a solar storage tank in the mechanical room, an electronic control system, pump, small expansion tank, and a few other plumbing fittings. To simplify the eventual solar installation, run two copper lines and a 3-conductor thermostat wire from the mechanical room to the roof that will host the solar system. This is very easy to do when you are building the house. The pipe, insulation, and fittings should cost \$100-\$200. For more information, contact CORE or a solar contractor. No points can be earned if snowmelt and/or a heated pool/spa is incorporated into the project.

10.4 Active solar space heating combined with solar domestic hot water system

Active solar space heating systems have the same benefits as listed above, but can be combined with solar domestic hot water systems to further reduce fossil fuel energy consumption. No points can be earned if snowmelt and/or a heated pool/spa is incorporated into the project. Solar hot water systems may be installed off-site if approved by CORE.

10.5 Solar-generated electricity

The amount of solar energy produced by the sun per hour is equal to the total worldwide energy consumption per year. Solar-generated electricity can be used for off-grid applications where tying to the grid is prohibitive, or it can be used in conjunction with the grid. Grid-inertie systems (using the electrical grid for storage instead of batteries) has reduced the cost of solar-generated electricity considerably. No points can be earned if snowmelt and/or a heated pool/spa is incorporated into the project. It should be noted that for houses over 5,000 square feet, a two kW system can achieve credit for both this program and for the Renewable Energy Mitigation Program (REMP). Solar-electricity systems may be installed off-site if approved by CORE.

10.5.1 System size of 1 KW

10.5.2 System size of = 1.5 KW

11.0 INDOOR AIR QUALITY

Considering the average American spends 90% of his or her time indoors, the EPA's recent proclamation that "*indoor air pollution in residences, offices, schools, and other buildings is widely recognized as one of the most serious potential environmental risks to human health*", shouldn't be taken lightly. The inundation of solvent-based building

materials into the marketplace, the increased use of atmospherically-vented appliances, and a lack of moisture control in the home has contributed to the problem of poor indoor air quality. Eliminating these pollutants is the most effective way to improve indoor air quality.

11.1 Low VOC and/or low-toxic interior paint

Most latex paints, although preferable to oil based paints, have high VOC content and contain harmful biocides and preservatives, such as formaldehyde. VOC's have a potential impact on indoor air quality, as well as contributing to smog. It should be noted that even zero-VOC paints may use a colorant system that contains VOC's. Low VOC / non-toxic paints are one alternative to typical paint products. Petrochemical-free plant or mineral based paints offer more alternatives. Chemically-sensitive people should experiment with any product, prior to application. Products include but are not limited to AFM's Safecoat products, Benjamin Moore's Pristine[®] Eco-Spec[™], Devoe's Wonder-Pure[™], Glidden's Healthspec, Kelly-Moore's Enviro-Cote, Sherwin-Williams' HealthSpec[™], BioShield, Livos[®], EarthTech and GREENGUARD[™] Certified products.

11.2 Solvent-free and/or low toxic construction adhesives

Wood adhesives commonly contain harmful solvents. However, solvent free solutions are readily available. Products include but are not limited to Franklin's Titebond ES 747, Safecoat's '3 in 1' Adhesive, Elmer's Carpenter Glue, Phenoseal's 'Does it All!' caulk, 100% Pure Silicone Caulk and GREENGUARD[™] Certified products.

11.3 High efficiency air filter

EPA studies of human exposure to air pollutants indicate that indoor air levels of many pollutants may be 2-5 times, and occasionally more than 100 times, higher than outdoor levels. These levels of indoor air pollutants are of particular concern because it is estimated that most people spend as much as 90% of their time indoors. Forced-air systems come with a throw-away filter media, either fiberglass or washable sponge media. These are designed to keep the blower/motor assembly clean. They ARE NOT designed to protect the occupants of the home or building from harmful airborne particles. Pleated filters, electrostatically-charged filters and other high efficiency filters are designed to remove the harmful particles. HEPA systems are the top of the line, and are specifically designed to remove respirable size particles from the conditioned air. HEPA filters can filter bacteria, viruses, gases, pollen, dander, mold, fungi, and/or smoke. High efficiency filters are available through some mechanical contractors.

11.4 Rough-in for radon mitigation

Radon is a clear, odorless gaseous by-product of the natural breakdown of uranium in soil, rock, and water. While radon gas dissipates in open spaces, it tends to cling to particulate matter and accumulates when enclosed. The surgeon General has stated that radon exposure is second only to tobacco smoke as a cause of lung cancer. Radon mitigation systems are designed to ventilate this gas out of the house before it has a chance to accumulate. Radon testing can be difficult, and not always conclusive. Radon may not be evident until the home is finished. A 'Rough-in' system includes the infrastructure that can be installed easily during construction. Then, once the house is complete, it can be tested for radon. If the radon test is positive, which the EPA considers 4.0pCi/L (pico-curies per liter of air) or higher then the rest of the system can be completed. (Refer to 11.5)

11.5 Radon mitigation system

The EPA recommends that any radon mitigation system should reduce the levels of radon to the range of 1.0 and 1.5pCi/L (pico-curies per liter of air). See benefits and resources listed above.

11.6 Solvent-free and/or low-toxic wood finishes

Most standard sealers for wood are solvent based and contain several highly toxic chemicals that outgas for long periods of time after application. Low-toxic alternatives are water based or natural finishes. Products include but are not limited to AFM's Safecoat products, BioShield, Livos[®], OS Hardwax, EarthTech and GREENGUARD[™] Certified products.

11.7 Low toxic floor coverings

The EPA has stated that a typical carpet sample may contain at least 120 chemicals, many of which are known to be neurotoxic. Out gassing from carpeting can persist at significantly high levels for up to three years after installation. Once discarded, carpet is neither renewable nor biodegradable. Generally, the manufacturing process doesn't include chemicals, but some wool carpeting is sprayed with pesticides. Verify that the carpeting is chemical-free. Carpet products include but are not limited to Earth Weave. Vinyl chloride fumes emitted from vinyl flooring are a known carcinogen. Natural linoleum and cork are natural alternatives, that have proven to last longer than vinyl or VCT flooring and do not have to off-gas. Nature's Own, for natural carpet. Other products include, but are not limited to cork flooring, linoleum, earthen floors and GREENGUARD™ Certified products.

11.8 Carbon monoxide detector

Exposure to carbon monoxide can cause depression, fatigue, irritability, an inability to concentrate, or possibly even death. Recent testing has shown carbon monoxide infiltration from the garage into the house is a common occurrence. Carbon monoxide detectors can warn occupants of this problem. CO detectors are available at most hardware stores.

11.9 Non-atmospherically-vented (sealed combustion) gas furnace/boiler & water heater

Atmospherically-vented appliances draw combustion air in from the surrounding room, which can often lead to back-drafting, where the combustion gases exhaust back into the house, instead of up the flue. Non-atmospherically-vented appliances are safer and are often more efficient than atmospherically-vented appliances. These units have no openings from the home into their heat exchangers or chimneys, instead they have a sealed flue which brings in air from the outside. These products include sealed combustion, direct vented, power vented, or induced draft combustion appliances. Products are available from mechanical /plumbing contractors or plumbing supply stores.

11.10 Sealed mechanical room

Back drafting can occur with atmospherically-vented combustion appliances. Mechanical rooms with atmospherically-vented equipment should be thermally separated from the rest of the house. This includes a continuous air barrier and a solid-core, weather-stripped door, as well as R-11 insulation in common walls and ceilings/floors.

11.11 Exhaust fan installed in attached garage or no attached garage

Installing an exhaust fan in a garage can eliminate the hazards mentioned in measure 11.9. Exhaust fans should be designed for continuous operation and be energy efficient. It is recommended that the fan be set on a timer to coincide with vehicle use, or incorporate a sensor switch. Products include but are not limited to Panasonic exhaust fans and Tamarak's Preventilator 2. Building a detached garage is a safer alternative.

11.12 Elimination of all particleboard inside envelope of house

Particleboard is typically found throughout the house in cabinetry, shelves, stair parts, to pre resins-manufactured furniture, and sometimes sub-flooring. Most particleboard is made with urea formaldehyde that will outgas high levels of VOC's for several months. Alternative, less toxic products include but are not limited to SierraPine's Medite and Medex, Isobord, ALLGREEN MDF®, Hemp MDF, Phoenix Biocomposites' Environ, NewStone Biocomposite, Dakota Burl, and wood. Another alternative is to use wire shelving for closets or formaldehyde-free engineered products for stair treads.

11.13 Elimination of all medium density fiberboard (mdf) made with urea-formaldehyde used inside envelope of house

See hazards listed above. (Products)

11.14 All exposed particleboard (cabinets, counter tops, stair treads, shelving) sealed with 3 coats of low VOC, latex paint or finish

Sometimes it is difficult to completely eliminate particleboard from a house. The next best approach is to seal it well to reduce outgasing. Products include but are not limited to AFM's Safecoat products, Benjamin Moore's Pristine[®] Eco-Spec[™], Devoe's Wonder-Pure[™], Glidden's ProMaster, Kelly-Moore's Enviro-Cote, Sherwin-Williams' HealthSpec[™], BioShield, Livos[®], and EarthTech.

11.15 American Lung Association "Health House"

Health House Advantage[®], 877.521.1491, www.healthhouse.org - Health House[®] is a national program developed by the American Lung Association of Minnesota to raise the standards of home environments. Health House Advantage[®] creates criteria and testing for climate-specific performance standards for indoor air quality. Applicants should expect a somewhat onerous and expensive process, but a very healthy house.

11.16 Mechanical ventilation installed

Once we started using revolutionary products such as plywood, good windows, and other engineered products, homes got tighter. Then we started introducing indoor air pollutants to the interior of homes. Remember that a house can't be too tight, but it can be under-ventilated. ASHRAE standards suggests a minimum ventilation rate of 15 CFM per person or minimum of 0.35 air changes per hour. Mechanical ventilation systems can be as simple as a stand-alone exhaust and/or supply fan system, or can be tied into a forced-air heating system with an ECM/Blower or Fan Flow Controller. Systems and products are available through most mechanical contractors.

12.0 INNOVATIVE POINTS

12.1 Innovative product or design

Energy efficiency and renewable energy technologies have made great strides in the past decade, but there is still a world of room for improvement. These points are intended to provide an incentive to be creative in the pursuit of sustainability.

12.2 Alternative fuel infrastructure for vehicle use

Excessive fossil fuel consumption is not limited to buildings. More efficient alternatives for fuel use in vehicles are increasing rapidly. Alternative technologies include Natural Gas, Biofuels, Propane, Ethanol, Electric, and Fuel Cells. These points are intended to provide and incentive for the use of such alternatives.

12.3 Location-efficient project

A Location-Efficient Project is one located near a public transit stop (within a ¼ mile). This location-efficiency has the potential to save money and energy typically expended on driving.

12.4 Ground source heat pump

Ground source heat pumps are electrically powered systems that take advantage of the earth's relatively constant temperature to provide heating, cooling, and hot water for homes and commercial buildings. The system does not convert electricity to heat; rather, it uses electricity to move thermal energy between the ground and the building and condition it to a higher or lower temperature according to the heating or cooling requirements. GSHP systems conserve energy and, because they move heat that already exists rather than burning something to create heat; they reduce the amount of toxic emissions in the atmosphere. They use renewable energy from the sun, and because the system doesn't rely on outside air, keeps the air inside of buildings cleaner and free from pollens, outdoor pollutants, mold spores, and other allergens.

“...When you build a thing you cannot merely build that thing in isolation, but must also repair the world about it, and within it...and the thing which you make takes its place in the web of nature.”

-Christopher Alexander, Architect, 1977