GUIDE

to the

SINGLE-FAMILY HOME RATING

Version 2008

AUSTIN ENERGY
GREEN BUILDING

Austin Energy Green Building Single-Family Program

Mary McLeod, Coordinator
Miki Cook
Dick Peterson
John Umphress
Bryan Bomer
Jessica Galloway

Disclaimer

The purpose of this Guide is to explain and clarify the Green Building Measures listed in the Austin Energy Green Building Single-Family Home Rating, Version **2008.**

It reflects best practices known at this time by the Austin Energy Green Building staff for design and construction in the conditions of Austin, Texas. It is not intended to eliminate or substitute for the designer's and builder's own judgment or accepted engineering and construction practices.

Implementation of specific measures must be made in compliance with all current building codes and local, state, and federal regulations. Health and safety measures are not intended as medical advice.

Austin Energy Green Building relies on its participants to submit accurate rating information to the best of their ability.

Web sites and References

Please note that web sites and references may change and/or material may become outdated.

GUIDE to the SINGLE-FAMILY HOME RATING VERSION 2008

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INTRODUCTION: WHAT MAKES A HOME GREEN?

The Austin Energy Green Building (AEGB) Single-Family Home Rating assesses the design, construction, and performance of new homes according to a set of Basic Requirements for All Ratings and the extent to which they incorporate a set of recommended green building Choice Measures For Points. The Rating also serves as an educational and marketing tool for AEGB participants and homebuyers and provides a handy means of comparison for both building professionals and homebuyers.

It is crucial to recognize that a home could incorporate many of the measures listed below, achieving a high number of points and still not be a high-quality green home. This could happen if the measures are not combined in a holistic way, in accordance with a clear understanding of building science. The home performance tests measure many aspects of building quality (mainly air movement) but cannot measure many others. AEGB encourages architects, designers and builders to improve their knowledge of building science in order to design and build homes that work as intended over a long lifetime.

This Guide is intended for use as a handbook that accompanies the Rating.

In order for the AEGB to assess and rate a home, there must be some consensus regarding what a green home is. There is broad agreement nationally and across many disciplines and professions that in order for a home to be labeled "green," it must address several concerns related to the environmental impacts of the building industry and the residential sector of the U.S. economy. These concerns can usually be divided into the five environmental impact topics listed below. Each topic can include several design, specification, construction, and performance steps and some are relevant to several different building professions and trades. In addition, the scope of each topic will vary significantly with geography, climate, demographics, and building practices.

- ENERGY
- WATER
- MATERIALS AND PRODUCTS
- HEALTH AND SAFETY
- COMMUNITY

Energy

Energy affects all facets of home design, construction, and operation, from drawing the initial plans to installing light bulbs and operating appliances. Energy use over the lifespan of a building may be the single most important environmental and economic issue to address in a home. Excessive fossil-fuel energy that is used to power our homes results in significant environmental impacts on a local as well as global scale, and unnecessarily increases the home's annual operating and maintenance costs.

The green building measures listed in the Rating address the issue of energy-efficiency for the entire life of a home – starting with design, through the construction process, including operation and maintenance, and even considering repairing and remodeling. Design techniques, such as placing the home on its site to best respond to climatic conditions and site characteristics, are strongly encouraged. In Central Texas, where hot, humid conditions prevail, mechanical cooling is typically the largest energy-user in homes. Many of the listed green building measures, therefore, address ways to keep a home cool by *design* measures, such as shading, proper sizing and placement of windows, and a "cool roof" assembly.

Proper construction of the thermal envelope is critical in building an energy-efficient home, both in terms of products selected and quality of workmanship. There are several locations in a homes exterior walls and roof, especially in wood frame construction, where air leakage is a particular problem. These include electric boxes and services, framing around doors and windows, basement walls at sill plates and headers or band joists, the top of interior partitions and exterior walls, exhaust fans and dryer exhausts, plumbing vent pipes or stacks, supply and return pipes for air conditioning systems and heat pumps, and any other locations where exterior walls and ceilings are traversed by services, vents, and pipes. Openings such as these allow air to exfiltrate or infiltrate, and must be properly sealed to protect insulation, reduce drafts, reduce heating and cooling costs, and to avoid warranty repairs after construction has been completed.

Air barriers are systems of materials designed and constructed to control airflow between a conditioned space and an unconditioned space. The air barrier system is the primary air enclosure boundary that separates indoor (conditioned) air and outdoor (unconditioned) air. To function properly in the long term, an air barrier must be durable, strong, and continuous. A house wrap or gypsum board product facing the interior side of an exterior wall and partially supported on the other side by insulation can act as an air barrier. Homes that have a properly installed air barrier system can operate properly with a smaller cooling system as the cooling load does not have to compensate for a leaky building. To be contiguous, interior air barriers must be installed on attic-side of knee wall insulation and interior side of tubs, showers, and fireplaces located on exterior walls.

A house cannot be too air-tight (but it can have too little controlled ventilation). When people speak about walls needing to breathe, they mean that water vapor (not air) should be able to pass through walls and dry to either side. The Central Texas climate includes some cold days as well as many hot, humid days, so sometimes walls need to dry to the outside and sometimes to the inside.

The quality of workmanship in the cooling system, especially the duct and air-supply components, is also critical to efficient cooling of homes. High-efficiency heating and cooling systems, well-sealed ductwork, sufficient, controlled ventilation, and proper controls are all key components of an efficient HVAC system. Consequently, many of the green building measures focus not just on the equipment and materials selected, but also on the proper installation and quality of construction of cooling system components.

Using products such as compact fluorescent bulbs and Energy Star appliances can significantly reduce operating energy use. Implementation of these green building measures results in a home that is both energy-efficient and less costly to operate and maintain.

In addition to energy conservation and efficiency measures, points are also awarded for the use of renewable energy sources, including both “passive” and “active” techniques. Passive techniques such as natural ventilation, shading and daylighting must be considered during the design phases of the project. Active systems appropriate for residential applications include solar water heating and solar photovoltaic power systems. With a substantial amount of average annual sunshine, solar water heating devices for domestic water and swimming pool heating and photovoltaic systems that provide electric power for homes can perform well year-round in Central Texas.

To assess the quality of workmanship of a home’s thermal-envelope and the HVAC-system installation, various tests must be conducted by a qualified 3rd-parter tester (not the same person/company that installed the system), as required by the City of Austin residential building code amendments, effective January 1, 2008. These tests include a duct-leakage test, envelope air leakage, static pressure test, supply airflow, return-air sizing and combustion-gas back-drafting. In most cases, one person can perform all the tests in one visit at a modest cost that will be quickly recouped by the homeowner by reduced utility bills.

Water

Water use in the Austin metropolitan region has dramatically increased with the rapid growth of the area’s population. Water use has reached near capacity levels during several summers over the past decade. In addition, water quality issues have entered the limelight as development moves to the outskirts of Austin into environmentally sensitive areas. Competing uses for water – domestic, industrial, agricultural, and recreational – will further aggravate the situation in the near future.

Green building measures under this topic include indoor and outdoor uses. Water conservation for indoor uses has improved since code requirements for plumbing fixtures became effective in the 1990s. Consequently, most of the measures address outdoor water use. In the Austin area, summertime water-use is more than double wintertime use, due to landscaping watering, particularly turfgrass watering. Hence, climate-appropriate landscaping, organic mulch and soil amendments, and rainwater catchment are top concerns.

Materials and Products

Green building measures address four issues associated with the use of building materials and products: resource depletion, environmental burdens of manufacturing, product durability, and solid waste management. In addition to using environmentally preferred materials and products, measures that can reduce the amount of materials and products that go into a home are also listed. Low-maintenance and durable materials and products reduce replacement and repair. Planning ahead for change can facilitate future remodeling.

Green materials and products are ones that have one or more of the following attributes:

- Reused or salvaged
- Recycled-content and recyclable
- Resource-efficient during production and/or installation
- Rapidly renewable
- Low embodied-energy
- Locally produced
- Durable, low-maintenance
- Recyclable
- Biodegradable

It is extremely difficult to accurately assess the environmental performance of a building material or product over its entire life cycle. In many cases, the AEGB relies on third-party certification organizations to help with this task. For example, the Forest Stewardship Council (FSC) certifies wood products that come from sources that follow a set of FSC sustainable-forest-management practices. Thus, several of the green building measures mention FSC certified wood. Other recognized third-party certification organizations include Green Seal, GreenGuard, and Energy Star.

In Central Texas, there is an abundant supply of locally produced building materials and products. Stone such as granite and limestone are durable, no-maintenance building materials. Local wood such as cedar/juniper, often cleared from property prior to development, is a good choice for casing, trim, and cabinetry. Local hardwoods, locally milled, like pecan and mesquite, make easily maintained, durable flooring materials. In addition, composite recycled wood/plastic decking and trim products are manufactured in the region.

Health and Safety

Health concerns have increased in prominence as homes have become tighter and more energy-efficient. In addition, modern building materials and products are typically more processed and may contain chemical compounds that are irritants to some people when used under indoor conditions.

The three ways to improve indoor conditions are a) eliminate or reduce the source, b) adequately ventilate the space, and c) provide filtration of the indoor air. The green building measures include all three of these. Eliminating or reducing the source of indoor pollutants and contaminants is the best strategy. Examples are low VOC and zero VOC paints, formaldehyde-free cabinets and insulation, and having the garage detached from the house. The second group of options includes exhaust fans and outside air intake. Installing pleated-media or electronic filters are examples of implementing the third strategy.

Humidity control is extremely important in Central Texas homes. High humidity conditions that foster mold and mildew growth consistently occur year-round. Poor construction methods and over-sized cooling systems exacerbate this problem. The source cannot be easily eliminated, so mechanical ventilation and dehumidification are often the best solutions. In addition, installing a hygrometer to measure humidity levels in a home is strongly recommended to help occupants become aware of how they operate their home.

For outside the home, pest management is probably the most critical health and safety issue. Many steps can be taken to avoid the use of chemical pest treatments. Keeping wood away from the soil, installing physical termite barriers, treatment with non-toxic materials, and proper landscaping—these are all important considerations.

Community and Neighborhood

Green building measures under this topic improve the quality of “community” in Central Texas. They include location of a home near “life-support systems” of jobs, shopping and recreation. They include design features, such as front porches to encourage neighborhood interaction and safety.

Visitability and accessibility measures can potentially extend the useful life of a home for its occupants as they grow older or become infirm, or simply make a home more livable for anyone who may experience temporary mobility problems from a sports injury or accident. Homes built under the City of Austin’s S.M.A.R.T. Housing Program must comply with Austin’s Visitability requirements.

Small lots and lots with garage apartments and “granny flats” improve affordability and neighborhood diversity.

HOW THE SINGLE-FAMILY HOME RATING WORKS

Star Ratings

The Rating has five levels indicated by stars: One Star is the entry level, Five Stars the highest or "greenest" level.

Basic Requirements for All Ratings

All of the Basic Requirements must be fulfilled for a house to qualify for any Rating. (See page 2 of the Rating.) Compliance with all of these measures satisfies the requirement for a 1-Star Rating without any additional points from Section B, which is the a la carte "Measures for Points" available for 2-Star through 5-Star Ratings.

Measures for Points

The Rating is a record of points credited for green measures implemented. No negative points are assigned for failing to implement a given measure. It is not possible for a given house to implement all of the recommended green building measures; in fact, many are mutually exclusive. In addition to Basic Requirements for All Ratings, Three Star, Four Star, and Five Star Ratings have particular measures that must be achieved, called Special Star Requirements, in addition to attaining the required number of points. These are indicated below and on the Rating document next to the point totals. (See "Star Levels" at the top of page 1 of the Rating.) The following are the point requirements and special star requirements for each level of Star Rating for homes with 5 tons or less cooling equipment installed:

- 1 STAR 0 points
- 2 STAR 50--74 points
- 3 STAR 75--99 points plus 3.01 or 3.02 or 3.03; and 4.17; and 4.18 or 4.19
- 4 STAR 100-124 points including all 3-Star requirements plus 10.07 or 10.08
- 5 STAR 125 or more points, including all 3-Star and 4-Star requirements, plus all of the following: 3.04, 3.05, 11.06, 11.08

TCV Score

TCV (Texas Climate Vision) is a collaborative effort of Energy Systems Laboratory (ESL) and Austin Energy, funded by the US Department of Energy (DOE) and the Texas State Energy Conservation Office (SECO). The mission of the endeavor is to realize 20%-40% increases in residential building energy-efficiency through a combination of better building codes, improved processes, inspection and testing verifications, and the use of computer modeling to provide analysis of energy use when compared to the 2006 International Energy Conservation Code (2006 IECC). The TCV Project is intended to serve as a pilot program by providing technical assistance, advanced modeling, training and support. One of the key benefits from the resulting energy savings will be a reduction in the NOx emissions from energy generation, which can reduce dangerous ozone concentrations and improve air quality in the Austin metro area.

The goals of TCV include:

- increasing the number of homes built in Texas that are at least 20% better than the 2006 IECC baseline
- increase the number of builders and building officials that are familiar with high-performance homes
- increase the number of high-performance homes being built
- aid in the marketing of high-performance homes
- increase the number of homes built with properly sized HVAC systems and performance-tested
- quantify emissions-reductions resulting from these efforts

To accomplish this, web-based software is being developed to model building plans and specifications, as well as verify compliance with and performance above 2006 IECC standards. The software uses the DOE-2 simulation program to provide predictable energy performance based on local climate considerations and design factors. AEGB plans to implement TCV compliance requirements within the Green Building Rating.

Point Values

Points for each green building measure range in value from 1 to 5 and are assigned according to a measure's environmental impact. For example, under SECTION 3: DESIGN, achieving measure 3.01 - "Energy-efficient design allows for a minimum of 600 sq. ft. of living space per ton of cooling" - receives 2 points, whereas implementing measure 3.07 - "No fireplace located within conditioned space" - receives 1 point. The former measure will have a major impact on the energy consumption of the home whereas the latter measure will have a smaller impact. Difficulty of implementation and cost of installation are *not* factors used to determine points.

Additions and Innovations

Although the Rating is fairly comprehensive, it obviously does not include all possible green building measures. We set a limit of three printed pages, so we picked the most common and easiest to assess.

You, the green building professional, may have your own suggestions you'd like to propose for consideration. AEGP welcomes ideas for further measures that may qualify for bonus points. List them in SECTION 12: ADDITIONS AND INNOVATIONS and discuss their potential point value with your AEGB Representative/Rater.

Compliance Verification and Documentation

The following verification and documentation is required:

Completed preliminary Single-Family Rating

Complete Manual J Report
See Manual J Inputs for required Reports.
Manual J accuracy and equipment specifications must be approved by AEGB

Conditional Approval

Rough inspection
Post rough-in mechanical and pre-drywall) by AEGB Representative/Rater

Final inspection
By AEGB Representative/Rater upon substantial completion

Home Performance Testing
Documentation upon substantial completion by approved 3rd party inspector

Other documentation may be required for items that cannot be verified by inspection (e.g. toilet model, shower-head flow rate, construction-waste recycling)

Final Approval

RESOURCES

The Sustainable Building Sourcebook

The Sustainable Building Sourcebook is a supplement to both the Rating and this Guide. See the link in **www.austinenergy.com/go/greenbuilding**. The Sourcebook provides more detailed explanations for many measures, as well as regulatory information, performance standards, installation guidelines, and sources of assistance, all pertaining to the Austin metropolitan region.

Other

Federal Government
www.eere.energy.gov/buildings

www.energystarhomes.com

http://www.pathnet.org

Building Science

www.eeba.org for the Builder's Guide: Hot Humid Climate and other books

www.fsec.ucf.edu

www.buildingscience.com

www.buildingbetterhomes.com

Other helpful websites

www.globalgreen.org

www.usgbc.org

www.sbicouncil.org

www.gbapgh.org

www.rmi.org

www.cmhc-schl.gc.ca/cmhc

BASIC REQUIREMENTS FOR ALL RATINGS

Rated homes must meet all of the following Basic Requirements to qualify.

1. Energy-efficient home design allows a minimum 500 square feet of living space per ton of cooling capacity as calculated by a correct Manual J, based on actual site orientation, plans and specifications

One year in Central Texas is enough to convince anyone that heat is the main climate problem we have to live with. If a home is appropriately designed for comfort in a hot climate, the mechanical cooling system won't have to work so hard to meet modern comfort expectations and occupants won't be bankrupted by their electric bills. Appropriate design for a hot climate is the responsibility of the architect or designer. Whether the design and specifications actually are appropriate is ascertained by an accurate Manual J calculation.

The Manual J calculation was developed by the Air Conditioning Contractors of America (ACCA) to determine the heating and cooling loads on a home (existing or to-be-built). The loads determine the correct size of the heating and cooling equipment. The calculation must be based on actual design, specifications, and orientation of a project, applicable climate data, and other correct inputs. **It is a code requirement in the State of Texas that heating and cooling equipment be sized in accordance with Manual J.** Note: the Austin Energy Green Building requires that a copy of the detailed Manual J report be submitted with the Rating.

If a home cannot be comfortably cooled with a maximum of one ton of cooling per 500 square feet of net living space (floor area derived from the Manual J), based on an accurate Manual J calculation, the Austin Energy Green Building does not consider it to be an appropriate design for Central Texas and it will not be rated.

In order for a home to be energy-efficient in the central Texas climate, it is critical that the air-conditioning system be "right-sized." The obvious problem with under-sizing cooling equipment is that the system will not maintain the desired temperature in hot weather. Oversized cooling equipment, on the other hand, can cause other severe problems especially equipment short-cycling, which results in increased energy use and uncomfortably high humidity. Moreover, both the installed cost and operating cost are unnecessarily increased with oversized cooling systems.

A number of studies show that residential cooling systems are consistently and drastically oversized, especially when simple "rules of thumb" are used to select equipment. Yet, complaints about uncomfortable rooms and high energy costs are common, regardless of climate or the size of the air conditioning equipment. For example, a room that is too hot (or too cold in the winter) may not be getting enough air to it--even if the system is over-sized--because of poor duct design and construction. On the other hand, a high humidity level in a home located in a humid climate is a good indication that the cooling equipment really is too large.

Another important point to make about oversized cooling units is that they may never reach their predicted operating efficiency, expressed as a SEER (seasonal energy-efficiency ratio) number, before shutting off. For example, an oversized 14.0 SEER unit might never run at more than an 8.0 or 9.0 SEER. (As an analogy, think of city driving versus highway driving). Furthermore, a big burst of energy is required when the unit turns on, so frequent cycling is particularly bad. It wears out the equipment faster as well. **A smaller unit running continuously will operate at a higher efficiency and cost less to run than a larger unit running less often.**

When a home's cooling load is calculated correctly, the **Manual J** method will determine both the sensible load (temperature) and the latent load (humidity) for the home. When the capacity of the cooling equipment matches the sensible and latent loads from this calculation (describing how much a unit dehumidifies in relation to how much it cools), then the proper equipment can be installed to adequately perform both tasks in the most cost-effective manner to provide year-round occupant comfort. Careless selection of equipment can result in a system that is too large or not matched for the load.

Manual J calculations must be performed for each individual home, taking into account the specifics of the building's location, orientation, design, window sizes and placement, exact solar heat gain coefficient and U-value, shading elements, roofing type and color, duct type, and roof/wall/duct insulation, etc. Load calculations must be performed for the entire structure so that the capacity of heating and cooling equipment can be properly specified. In addition, a load calculation needs to be performed for *each room* in the home so that the conditioned air requirements for each room can be determined.

Several software programs are available that perform residential **Manual J** calculations. The following software packages are recommended:

RHVAC by Elite Software (www.elitesoft.com)

Right-J by Wrightsoft Corporation (www.wrightsoft.com)

Manual J Version 8 cautions against oversizing by more than 15%, but the ½ ton increments in equipment capacity can make matching difficult, especially for smaller structures. Careful selection of the condenser and evaporator coil is often required to achieve the closest match possible. The builder needs to verify that the equipment installed matches that specified in the load calculations. Lack of availability at present of half-ton increments for variable-speed equipment also presents a sizing challenge.

NOTE: Inverter controlled systems, like some mini splits, can be of a larger capacity due to their ability to operate at part capacity. This may be necessary for smaller structures.

Note: Production home builders that are building the same home plans in multiple locations using the same building specifications within the same development may perform a Manual J calculation based on the "worst case" orientation for each home plan for purposes of Pre-Approval of their rating for the development. They should be aware, however, that this may result in high humidity and lack of comfort in homes with optimum orientation.

2. Cooling and heating equipment minimum efficiency for split systems

Cooling equipment minimum efficiency: 14.0 SEER for split systems/11.5 EER

Gas furnace rated at ≥ 80 AFUE or Heat Pump rated at ≥ 8.2 HSPF

Every cooling unit is assigned an efficiency rating known as its "seasonal energy-efficiency ratio" (SEER). The SEER is defined as the total cooling output (in British thermal units or Btus) provided by the unit during its normal annual usage period divided by its total energy input (in watt-hours) during the same period. The higher the SEER rating, the more energy efficient the cooling unit is. The current Federal minimum for residential cooling equipment is 13.0 SEER.

Selecting equipment with a higher SEER rating can save energy and money, but only if the equipment was properly sized and installed so as to deliver the rated cooling capacity at the rating SEER rating. Efficiency (and comfort) is more dependent on quality of the installation than on the SEER rating of the equipment.

The efficiency of new gas furnaces is measured by the annual fuel utilization efficiency (AFUE), a measure of seasonal performance. Specifically, AFUE is the ratio of heat output of the furnace compared to the total energy consumed by a furnace. Furnaces today are between 78% AFUE and 96% AFUE. Traditional "power combustion" furnaces are 80-82% AFUE. Above 90% AFUE, a furnace is "condensing," which means it recaptures some of the heat wasted in traditional systems by condensing escaping water vapor. Specify a sealed-combustion furnace, which will bring outside air directly into the burner and exhaust flue gases (combustion products) directly to the outside, so they pose no risk of introducing dangerous combustion gases into the house. In furnaces that are not sealed-combustion units, back-drafting of combustion gases can be a big problem.

In warm climates, heat pumps may be preferable to condensing gas furnaces. Central heat pumps operate much like a central air conditioner except that they can reverse the cycle in the winter to deliver heat to the house. Because heat pumps provide both heating and cooling, they have two efficiency ratings: seasonal energy-efficiency ratio (SEER) for their cooling and heating system performance factor (HSPF). HSPF is calculated by dividing the total annual heating requirements, including all energy inputs, by the total electric power used. New hybrid gas furnace heat pumps combine the comfort of gas heat with the efficiency of a heat pump. Either type of heat pump will operate very energy-efficiently in mild or warm climates.

Other heating and cooling systems also provide high efficiency but may be much more expensive, so the payback savings must be analyzed. Ground-source heat pumps draw heat from the earth and transfer it to the conditioned space. Because temperatures underground are nearly constant year-round (e.g. warmer than the outside air during the winter and cooler than the outside air during the summer), a ground-source heat pump can be much more efficient than an air-source heat pump and appropriate for both warm and cold climates. If not designed properly, with adequate ground space, there could be problems with such a system in Central Texas.

A hydronic or radiant floor heating system is also efficient, especially when combined with a solar water collection system or as a secondary function of a heat pump. In the latter case, water heated by the sun in a roof panel is circulated in tubes between the home's foundation and hard surface flooring. Since heat rises, this installation provides continuous added heat to the home's living space. Although radiant floor heating is very pleasant and effective, it is seldom used in Central Texas because most people want a cooling system as well. That requires a dual system, however, since cold air distributed by a duct system is the only practical cooling system available at present. If you plan to use these or other high efficiency heating and cooling systems, discuss these with your AEGB Representative/Rater for consideration of additional points under Section 12: Additions and Innovations.

3. Window minimum efficiency: $\leq$ 0.35 solar heat gain coefficient (SHGC); $\leq$ 0.55 U-value in Climate Zone 2 (or Zone 3: $\leq$ 0.40 and $\leq$ 0.40)

Window products must be rated, certified, and labeled for both thermal conductance (U-Factor) and solar heat gain (SHGC) in accordance with the procedures of the National Fenestration Rating Council (NFRC) at levels which meet the qualification criteria for the Climate Zone in which the home is located. A product's energy-efficiency for a given climate is based on its impact on heat gain and loss in cold weather and heat gain in warm weather. Windows that are energy efficient in Minnesota will not necessarily be energy efficient in Texas and vice-versa.

Of all the measures of window performance, solar heat transmittance is the most critical in southern climates like Central Texas where cooling loads in the summer are much greater than heating loads in the winter. The SHGC of a glazing material is defined as the ratio of solar radiation transmitted through the material to solar radiation striking the surface of the material at a 90^{o} angle. It includes not only the direct solar heat transmitted through the glazing, but also the solar radiation first absorbed by the glazing and then re-radiated as heat back to the indoors. Typical single-pane glass, for example, has a SHGC of 0.87 meaning that 87% of the solar heat gain falling on the outside surface of the glass is actually transmitted to the inside of the home.

Windows and glazing with a southern low-e coating achieve a SHGC of 0.40 (energy code maximum) or even much lower, as is now common in the Austin area. A special spectrally selective coating, called low-E for low emittance, is applied to one interior surface of a double-pane window. This low-E coating improves thermal performance by retarding the emittance of radiant heat from the pane***. In warm climates, the coating is applied to the inside surface (air-space side) of the outer pane (Southern type).*** Consequently, radiant heat-flow from the outer to the inner pane is greatly reduced, thereby decreasing heat radiation to the interior of the house. Such windows also provide some help in keeping in winter heat. Low-e coatings also block ultra-violet light, which causes fading in rugs, upholstery, and fabrics.

Southern low-e glazing has played a big role in enabling smaller heating and cooling equipment to provide comfort and lowering energy bills. It also allows for shorter duct-runs (it is now seldom necessary to place supply registers at exterior walls), thus reducing many problems with ducts, such as leakage and friction losses.

4. Wall insulation: Energy Star Grade I installation; OR batts + insulative exterior sheathing with R-value of ≥ 2.0, taped at seams; OR "total fill" type (e.g. blown cellulose, BIBs, spray foam, SIPs)
Note: the first alternative is required for SMART Housing Rating

Insulation is installed to slow the transfer of heat. An insulation system works effectively only when it is uncompromised by air leaks. To be considered "Grade I the insulation may have voids and gaps no greater than 2% voids and may not be compressed in the cavities. It is extremely difficult to install batt insulation without gaps or crushes between the batts and studs or around electrical and plumbing boxes, fixtures and lines.

As an alternative, rigid foam board sheathing, having an R-value of at least R-3 can be added to the exterior of the wall to supplement a less than Grade I installation. Spray or blown-in insulation systems can also be used to completely fill such spaces. Spray-in or "total fill" insulation products, such as damp-blown cellulose, BIBs (blown-in-blanket system), and sprayed polyurethane foam provide a more complete insulation system than batt insulation.

5. Floor insulation over ambient or unconditioned space: ≥ R-13 with air barrier

Floors over crawl spaces, garages or other unconditioned spaces must be insulated to the above standard. For insulation to be effective it must be encased on six sides by an air barrier. The subfloor of the floor above the unconditioned space and, in the case of a garage, the ceiling drywall, act as air barriers, as do the floor joists and rim bands, thus creating the required enclosure of the insulation.

Since the cavity depth between the subfloor and the drywall can be significantly greater than the thickness of R-13 insulation (which is typically 3 ½ inches thick), the entire cavity depth will not be filled, however. The insulation must be installed so that it touches the air barrier in order to effectively reduce heat loss. For floors over unconditioned space, the insulation must touch the underside of the subfloor. Unless great care is taken during installation, floor insulation tends to sag over time and pull away from the subfloor, which negates its insulating benefits. Therefore, it is necessary to provide support within the cavity, at a maximum spacing of 24" on center, to maintain the contact between the insulation and the subfloor.

6. Blocking for grab bar installed in all showers and tub-shower combinations

At any time in life, a home occupant may need the added safety of grab bars in showers and tubs. It's just common sense to install blocking for grab bars during the framing stage, so sturdy bars can easily be added to a home when the need arises. The following describes blocking requirements:

a. Lateral two-inch by 6-inch or larger nominal wood blocking must be installed flush with stud edges of bathroom walls within the tub +/or shower space.

b. The centerline of the blocking must be 34 inches from and parallel to the interior floor level.

Note that if you are building in the City of Austin S.M.A.R.T. Housing Program, this blocking requirement applies to the entire bathroom, except behind the lavatory. (See 3.21 for City of Austin Visitability Ordinance.)

7. Gas water heater minimum efficiency (EF):

40 gallon ≥ 0.61; 50 gallon ≥ 0.59; 60 gallon ≥ 0.57; 80 gallon ≥ 0.53; Tankless ≥ 0.80
Or WH is solar thermal: Or if no gas available in right-of-way, electric WH meets current Austin code requirements

Water heating is the second largest energy expense in the average home, typically accounting for between 15 and 20% of the total energy used. In 2004, the U.S. Department of Energy adopted minimum efficiency standards for residential gas water heaters, with energy factors ranging from 0.61 for smaller (30 gallon) storage heaters and 0.58 for larger ones.

The energy factor, or EF, represents the amount of energy that goes to actually heating the water. For example, 40% of the gas consumed by a water heater with an EF of .60 is wasted. The most efficient conventional gas-fired storage water heaters have EFs ranging from 0.60 to 0.65 (depending on their capacity), with condensing storage water heaters having EFs above 0.90. Many demand (tankless) water heaters have an EF of .80 or higher. Note that large water heaters have large stand-by losses and low efficiencies and are not rated. For energy factors, see the GAMA (Gas Appliance Manufacturers Association) Directory: www.gamanet.org.

When calculating the capacity needed to serve new construction or a remodel, do not rely upon the gallon capacity of the storage tank. Instead, select capacity based on the first hour rating, which is a factor of storage volume and burner output, and the hour of the day when hot water use will be the highest. Many 40 gallon heaters have a first hour rating of 75 to 80 gallons – these often have the highest EF as well. Most homes with low-flow plumbing fixtures and water-efficient appliances are easily served with a 40 gallon – or smaller - heater.

8. No unvented gas logs/fireplaces installed

It is not safe practice to install unvented gas logs, fireplaces or heaters in living spaces. They should not be legal. Today's houses are being built much tighter than in the past, for comfort and energy-efficiency. As a result, concerns about healthy indoor air quality are becoming more important. In trying to keep indoor air healthy, unvented gas logs, fireplaces, and heaters must be avoided in new homes.

The recent popularity of unvented gas logs in fireplaces has led to questions about their safety due to the potentially harmful combustion gases created by a large gas appliance burning inside the house without any venting. Field experience has indicated that a lack of venting introduces carbon monoxide, carbon dioxide, nitrous oxides, sulfur dioxide, water vapor and other undesirable combustion products, while reducing oxygen in the home—all a recipe for illness and even death.

9. Exhaust fans venting to outside for cooktop/stove/microwave and baths with a tub or shower

Better construction practices result in tighter homes with significantly reduced air infiltration. Unlike commercial buildings, residential fresh air ventilation is rarely automated and is primarily the responsibility of the occupants. With new construction being relatively air-tight, natural ventilation through windows, along with intermittently operated kitchen and bathroom exhaust fans, are important sources of outside air.

Control of indoor humidity levels is also important. In Austin, relative indoor humidity levels often rise above 60%. At that point, molds and mildew grow, severely impairing indoor environmental quality (IEQ). Odors and unhealthy fumes from cooking also reduce IEQ. Point-source removal of fumes and humidity by exhaust fans vented to the outside (not just to the attic space) removes these potential contaminants. It is important that the occupants be educated about the use of these systems to achieve adequate ventilation

The recommended ventilation rate for a bathroom is in the range of 8-12.0 ACH (air changes per hour). The exhaust of air should continue for at least 20 minutes after use. To calculate the cubic feet of air per minute required to provide this, divide the cubic feet total of the room by five (LxWxH/5=CFM). For example, if the bath is 8'x11' with a ceiling height of 9', 159 CFM is needed. Note: this is a minimum CFM.

Fans for ranges or cooktops should be appropriately sized. Fans with a capacity exceeding 200 CFM can depressurize a home, leading to uncontrolled infiltration and potential backdrafting of fireplaces and combustion appliances. Larger capacity fans should be avoided. If installed, they should have some provision for introducing make-up air into the home.

10. Ceiling fans: minimum of 2 installed within heated and cooled space

Ceiling fans provide an easy, inexpensive mechanism for achieving comfort in a home. People feel cooler when there is air moving rapidly over their skin (wind chill effect). Use of a ceiling fan can allow occupants to set their thermostats four or five degrees higher, yet still be comfortable.

A ceiling fan doesn't change the air temperature--it simply makes occupants feel cooler by moving air over the skin—but that's what matters for comfort. Consequently, ceiling fans should only be used when the room is occupied. They can also be used to facilitate the movement of warm air in the home during the heating season by inhibiting air-stratification. In winter, fans should be set at low speed to avoid creating draft, but still push warm air down from the ceiling to occupant level.

Ceiling fan/light combination units that have earned the ENERGY STAR label are about 50% more efficient than conventional fan/light units. Reversible, variable-speed ceiling fans provide the best option for use during both the cooling and heating seasons. Most residential ceiling fans (and all ENERGY STAR qualified fans) feature the ability to reverse the motor and airflow direction, allowing one to operate the fan year-round. In addition, look also for fans (such as the Hampton Bay "Windward" fan) with advanced blade design and fluorescent lights for more air movement and cooler light to reduce unwanted heat gain.

11. A minimum of 75% of all lamps/bulbs are Energy Star-compliant

At present, most such lamps (the technical term for bulb) are fluorescent. Fluorescent lamps have many advantages over incandescent lamps/bulbs:

- Last up to ten times longer per lamp (especially handy in hard-to-reach fixtures)
- Give off the same amount of light for one-fourth of the kilowatts used — an 18-watt fluorescent is about equal to a 75-watt incandescent
- Generate almost no heat, so the cooling system doesn't have to work longer to compensate

You may have had a low opinion of fluorescent lighting in the past (unpleasant color, slow to light, flicker, noisy), but you don't need to any more. Fluorescent lights now come in just about any color tone you could want (both color temperature and color rendering, affecting the look of the light and how it makes things look), and they have electronic ballasts which insure that they start up quickly and have no flicker or buzz.

Lighting companies that cater to commercial customers typically have a large selection of higher-quality lamps--in regard to longevity, color temperature and color rendering, size, shape and style--than do most home lighting companies.

Note: fluorescent light *fixtures* are preferable to standard fixtures, since they have separate ballasts. If there is a failure of the ballast or lamp, they can be replaced individually, which saves money. Such fixtures are widely available for modest prices.

12. Low-VOC (volatile organic compound) interior wall and ceiling paint: VOC level of 100 grams per liter or less, or is CoA recycled paint

Volatile organic chemicals (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products found in homes including: paints and lacquers, paint strippers, cleaning supplies, building materials and furnishings, glues and adhesives, permanent markers, and photographic solutions. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored.

U.S. EPA studies found levels of about a dozen common organic pollutants to be 2 to 5 times higher inside homes than outside, regardless of whether the homes were located in rural or highly industrial areas. Additional studies indicate that while people are using products containing organic chemicals, they can expose themselves and others to very high pollutant levels, and elevated concentrations can persist in the air long after the activity is completed.

Most household paints contain VOCs that easily evaporate when exposed to air. This evaporation continues for a long time, even after the paint is dry. This process is known as *out-gassing and* may cause a variety of health problems, including irritation of the eyes, nose, throat and upper respiratory system, and a weakened immune system. Many of these chemicals also contribute to problems of regional low-level smog and to the global greenhouse effect. The lower paint's VOC level, the less threatening it is to people's health.

Note that oil-based paints have greater out-gassing than latex at the time of painting, but typically cure more quickly than latex paints, which may out-gas for many months, particularly in warm, humid weather. Be aware that paint labels do not always give you the information you need. Some may say "Low-VOC", but have higher levels than this standard. Some labels state only a maximum. In that case, the actual amount is typically much lower. An inquiry with the manufacturer for accurate information may be required.

For more information see the EPA's webpage about indoor air quality and organic chemical gases: www.epa.gov/iaq/voc.html

13. Minimum of 2 toilets selected from current Austin Water Conservation Program Rebate list

As a result of toilet research over the last few years, new, more effective designs are being developed. Toilets on the City of Austin Water Conservation list are selected for both good flushing performance and water conservation over time.

The toilets on the rebate list were selected because they meet two criteria. First, they have very good flushing performance. Second, for gravity toilets, they do not use more than two gallons per flush, no matter which replacement flapper is used. Many toilets use an early-closure flapper, which if replaced with a standard flapper, use 3-4 gallons per flush.

Only the styles listed for each toilet (round, elongated, ADA) meet this requirement. Other styles may be available for the same model of toilet, but do not meet the eligibility requirements for performance and water-savings.

The criteria to select the models listed above were based on three studies:

- "Maximum Performance (MaP) Testing of Popular Toilet Models", Veritec Consulting and Koeller and Company;
- Consumer Reports, October 2002;
- "Water Closet Performance Testing" prepared by the National Association of Home Builders Research Center, September 2002, as well as test results for individual models from Veritec.

Check to see if a rebate applies to the job—whether new construction or replacement.

14. Planting beds have at least 6" of soil containing 25% compost (e.g. Dillo Dirt™) and minimum depth of 2" organic mulch

Deep, nutrient-rich soil is the key to healthy plants. Such soil retains moisture well. It acts like a bucket holding water--the deeper the bucket, the more water is stored. Plant roots are able to reach down into the soil depths and use the water stored there. Shallow soil results in plants with shallow root structures. That results in less healthy, less drought-tolerant plants.

Besides adding nutrients, the compost breaks up clay particles and makes the soil friable or crumbly, so plants can develop more easily. Compost and composted-sludge products, such as Austin's own Dillo Dirt™ (see below), are excellent nutrient-rich soil additives. Such products release nutrients slowly, reducing the need for fertilizing and minimizing the risk of fertilizer washing out and becoming a source of pollution.

"Dillo Dirt™" is a compost made by the City of Austin since 1989. If you know Austin, you will not be surprised to learn that it was the first program of its kind in the state and one of the oldest in the nation. All yard trimmings collected curbside across the City as well as some of our treated sewage sludge are combined and composted to create Dillo Dirt™. The heat generated in composting (130 to 170 degrees Fahrenheit) is sufficient to eliminate human and plant pathogens. After active composting for over a month, this compost is "cured" for several months, then screened to produce finished Dillo Dirt™.

Dillo Dirt™ easily meets all Texas and EPA requirements for "unrestricted" use, which even includes vegetable gardens, if you desire. Like many other composts, Dillo Dirt™ has many benefits to the soil and plants. Composts add to the organic matter in the soil, reducing the need for watering. Organic matter feeds the microbes in the soil as well as plants, fostering a healthier environment. Dillo Dirt™ is made from totally recycled materials, and this recycling is less expensive to citizens than landfilling these materials. For more information and a list of current suppliers of Dillo Dirt visit www.ci.austin.tx.us/water/dillo.htm. Note that treated sludge in some other parts of the country may not meet the same safety standards.

Saving soil moisture is an important use of mulch in Central Texas. A mulch layer on the soil surface allows the soil to soak up more water.

Mulches help plants by gradually increasing soil fertility. Organic mulches enrich the soil as they decay and provide a better environment for plant growth. Organic mulch such as straw or leaves can be turned under the soil at the end of the season. This helps build the soil's nutrient content. Mulch should be turned under as soon as the gardening season is over so it breaks down before the garden is replanted. Soils high in organic matter are easier to till and better suited to vegetable gardening.

Most mulches also provide excellent weed control. Mulches do not prevent weed seeds from sprouting. However, weed seedling emergence is blocked by a mulch layer thick enough to exclude light. A 3-inch layer of mulch on the soil surface keeps most annual weed seedlings from coming through. Weeds that do manage to break through are removed more easily from mulched soil. Hard-to-control weeds such as nutgrass and johnsongrass may come through the mulch layer but can be pulled more easily or covered by fluffing the mulch with a fork.

Non-plant-based mulches, such as gravel, are not recommended for this area because they retain and reflect a lot of heat.

In summary, mulching helps retain moisture in the soil, keep roots cool, slows weed growth, and reduces erosion. The result is a reduced need for watering, weeding and replacement planting. For sloped areas, mulching (especially shredded types) helps prevent runoff. Mulch needs to be reapplied as it decomposes and is best obtained from regionally derived materials, such as cedar, pecan hulls, pine needles, straw, wood chips, etc.

15. A minimum of 90% of new plants from current *Grow Green* plant list [≥7 plants minimum]

Plants appropriate for Austin's climate conditions are now readily available at most Austin nurseries.

Some people move to Austin and try to surround themselves with plants they are familiar with from their past homes. These plants are often poorly suited to our climate and soils. By choosing native and adapted plants, a person becomes more knowledgeable about, more aware of, and more connected to the land of Central Texas.

The plants on the City of Austin GrowGreen plant list do well in Central Texas conditions. Once established, they can save time and money, since they require very little care, water, fertilizer and pest control. Our native landscape is the inspiration for this guide to earthwise plant choices for Austin area gardens. The Grow Green plant list was created to help people select beautiful native and adapted plants which are naturally drought tolerant and resistant to pests and diseases. The less watering, fertilizing, and chemical control required in a yard, the more the home occupant contributes to the conservation and preservation of our precious water resources - our streams, lakes, and aquifers.

For more information:

Grow Green Plant List: www.ci.austin.tx.us/growgreen

16. Current City of Austin IRC, IECC Codes, and Amendments must be met, regardless of project location (including complete air barrier and restrictions on electric water heaters). Some elements of code may not apply to renovations but duct testing is required for all Ratings.

The State of Texas has adopted both the International Residential Code (IRC) and the International Energy Conservation Code 2001 (IECC) for all municipalities in the state. The City of Austin has added several additional amendments to these codes. These standards apply to all Austin Energy Green Building-rated homes, regardless of whether they are located within the City of Austin.

http://www.ci.austin.tx.us/development/downloads/2006_energy_code.pdf

SECTION 1: PLANNING PROCESS

1.01 AEGB *Green by Design* workshop attended by homeowner before completion of design phase

When people have a good understanding of what green building is all about *before* purchasing a lot or planning a new home or remodeling an existing one, they make smarter choices and get better results—greater comfort and convenience, lower utility bills, better durability and less maintenance, better health, higher resale value, and reduced environmental impact.

At the *Green by Design* workshop, attendees learn that a good home is the result of teamwork among all the people responsible for designing, building and operating it. They learn that a good home must be designed for the conditions it will "live" in, both the macro-conditions of its region and the micro-conditions of its site. They learn that a house is a system - its site, materials and products, methods of construction, mechanical systems, and occupant behavior all interact together for success or failure. The goal of the workshop is to show people how to design, construct, and operate better homes that will provide the most long-term benefits to the owners, their neighborhood, and their community.

1.02 AEGB *Green by Design* workshop attended by current designer staff +/or builder staff

Although not meant to be an in-depth technical seminar, *Green by Design* nevertheless offers building professionals a helpful overview as well, and lets them know what homeowners are learning about green building.

1.03 Documented design team meetings held in design/planning stage of project (including the designer, builder, and mechanical contractor)

***The importance of a team approach to the design and construction of a green home cannot be over-emphasized. It is the basis of green building. Through the sharing of expertise, better decisions are made, costs are reduced, and the design and building process goes more smoothly*.**

The designer, builder, engineers, mechanical, and other relevant building professionals (as well as the homeowner if the home is custom-designed and built), all need to be working together to ensure that green measures will be incorporated into the design, building, and operation of the home. Having both a designer/architect and builder/contractor who have previous experience in constructing green-rated homes will greatly facilitate the implementation of the green building measures described in this Guide.

Green building begins with design. The designer/architect needs to understand and develop green building goals before starting the design process, so they are an integral part of decisions about aesthetics and function. The most important elements of green building are design issues and cannot be simply tacked on later in the construction process. The designer/architect needs to work in conjunction with other participants of the design and construction team to ensure that all parts and systems will work together to fulfill the green goals.

Green designs must be properly implemented during the construction process. If the builder/contractor understands the green goals of the project, then the reasons for related design and construction choices will be clear and the every-day decisions that the builder must make on the job site will be compatible. Execution of the construction work will be easier and less costly than working with a contractor who is not familiar with the Rating. Coordination with trade contractors, especially the mechanical contractor, is also critical to the success of the project.

SECTION 2: SITE SELECTION

2.01 Lot size is less than 5,750 sq.ft.

A small lot may appear to pose design problems and constraints but it can encourage (if not force) one to design and construct a space-efficient, or not-so-big, home. (See 4.02 below.) Building on a small lot also increases density, thereby decreasing the need for sprawling new development and supporting infrastructure. Increased density typically reduces automobile use and resulting pollution, since jobs, mass-transit, “life-support” businesses, and recreational facilities are more likely to be located close by. Moreover, the cost of development infrastructure increases as lot size increases. (See 2.02 below.) Depending on zoning ordinances, there are several neighborhoods in the City of Austin that allow lot sizes between 3,600 and 5,750 sq. ft.

2.02 Street, electricity, water, wastewater have been in place for a minimum of 25 years

As developable land in central urban areas becomes more scarce and costly and may require clean-up, developers usually purchase land surrounding existing development. Consequently, infrastructure is being extended to support development that is further and further from existing sewer facilities, water supplies, roads, and electricity. In situations where state and local governments provide these services, this growth can ultimately cost taxpayers more money than the residential development provided to the city or town in return for its investment.

Several factors regarding a development's form are relevant. When other variables are held constant, the cost of extending infrastructure *increases* as:

- The distance to established service centers increases;
- Lots become more widely dispersed;
- Lot size typically increases.

Building in areas where the infrastructure for development--streets, electricity, water and wastewater--have been in place for at least 20 years reduces environmental damage caused by urban sprawl. Homes using existing infrastructure place less demand on city services, which are paid for by all taxpayers and utility ratepayers. Because existing developments are usually closer to shopping and job centers, building in these neighborhoods also minimizes impacts by reducing automobile miles traveled each day.

2.03 Public transit stop is within a ¼ mile walk

2.04 Food store is within a ½ mile walk

2.05 Public hike and bike trail, green belt, or park is within a ½ mile walk

Building homes within close proximity to public transit stops, retail establishments such as a corner grocery store, and green belts or parks gives homeowners an easy opportunity to travel short distances without needing to drive their personal car. Using public transit eliminates pollution caused by automobiles and eliminates the stress of driving. In some cases, it may eliminate the need for the homebuyer to have a second automobile. After a day of working or commuting in rush-hour traffic, many people would consider it a great convenience to be able to walk to the market instead of getting back into their automobiles and driving miles to a shopping area.

In addition, homebuyers today are looking for neighborhood amenities, such as a trail, green belt, or park. Such an amenity can raise the quality of the buyer’s life and increase the value of the home significantly. A recreational area provides a place for people to get out in the fresh air, exercise, walk the dog, and meet neighbors. This can help create a neighborly community and a safe place for children to live.

SECTION 3: DESIGN

3.01 Energy efficient design allows for a minimum of 600 sq. ft. of living space per ton of cooling capacity if home is 1500 sq. ft. or larger (for smaller homes: square footage per ton must be approved by AEGB for these points if 600 sq. ft. is not met)

3.02 OR Home design allows for a minimum of 700 sq. ft. of living space per ton of cooling capacity

3.03 OR Home design allows for a minimum of 800 sq. ft. of living space per ton of cooling capacity

The amount of square feet of living space that can be properly cooled per ton of cooling is a good indicator of a home's energy-efficiency. If a home cannot be adequately cooled with one ton of cooling for every 600 square feet or more of living space, then the home is not appropriately designed for the central Texas climate (or the Manual J calculation was incorrect).

Reaching this standard does not require unusual design or specifications, since current building and energy codes, correctly applied, and home-performance testing result in quite energy-efficient homes. Cooling capacity (expressed in tons of AC) must be adjusted according to these changes.

Over-sized units will run for a short amount of time to reach the thermostat set-temperature. This results in frequent on-off cycling and insufficient run-time, which have many bad effects:

- The unit uses an increased amount of electricity to start up;
- Frequent starts cause the unit to wear out faster;
- The unit never reaches the efficiency for which it was designed (e.g. a 13.0 SEER unit may operate at only about an 8.0 SEER efficiency—it's like town driving instead of highway driving);
- The unit runs too briefly for adequate dehumidification to occur, since it typically takes at least ten minutes of run-time for the coil to get cold enough to start dehumidifying. Dehumidification can only occur while the unit is running. An over-sized unit results in conditions that are cold and clammy.

With a system that properly cools 600 sq. ft. per ton, the homebuyer will have a system that is *less expensive to purchase and operate* and, more importantly for comfort, one that will *dehumidify much better* than an over-sized one.

NOTE: Because of the difficulty in matching equipment to smaller structures, Austin Energy Green Building may make exceptions to this requirement on a case-by-case basis. However, the goal will always be to match the equipment capacity to the load. Inverter controlled systems, like some mini splits, can be of a larger capacity due to their ability to operate at part capacity.

3.04 Indoor heating and cooling equipment is located within the thermal envelope (i.e. insulated space), OR home has no interior H+C equipment

Typically in southern climates, the indoor components of heating and cooling systems (air handler and ducts) are placed in an unconditioned, vented attic. If insulation is installed at the floor of the attic, then these components are located in an unconditioned space outside the home's thermal envelope or insulation barrier. One reason for locating equipment in an attic is to retain every square foot of floor area for living space. Another reason is for access to the equipment. However, locating mechanical equipment outside of the thermal envelope is extremely detrimental to energy-efficiency.

Placing indoor heating and cooling equipment within the thermal envelope of the home substantially increases the energy-efficiency of the system. In summer, unsealed attics in southern climates regularly reach temperatures of over 140 degrees, so obviously that's a poor environment for ducts filled with cold air. Equally, it makes no sense in winter, either.

3.05 All ductwork is located within the thermal enclosure/envelope OR home has no ductwork

According to code, ductwork installed in unconditioned spaces in all new homes must be insulated with R-8 insulation. This amount of insulation is not sufficient, however, to totally protect the cold air in the ducts from heat gain in hot attics that regularly reach temperatures of over 140 degrees in summer (reverse in winter). Moreover, ducts often leak a large volume of conditioned air, leading to problems with air distribution, operating cost, and health issues.

For optimum performance, air distribution components of an cooling system should be located within the conditioned space. Placing the HVAC ductwork within the thermal envelope of the home substantially increases the efficiency of the system. Here are some ways to get ductwork within the thermal envelope:

- Insulate the attic at the roof deck with polyurethane spray foam;
- Provide roof-trusses with insulated chases;
- Drop ceiling areas (e.g. hallways) to provide a duct chase;
- Construct furred-downs/outs/ups for chases in locations where they will not be odd or unattractive (e.g. in closets, utility rooms);
- Run ducts between the floor joists of multi-story homes;
- Install exposed ducts in the living space (more aesthetically acceptable in some designs than others).

Most of the measures listed above must be considered during the design phase. Interior duct chases, ceiling furr-downs, and openings in floor and roof trusses must be indicated in construction drawings and specifications.

Ductwork is inherently problematic. Heating and cooling systems that do not require ductwork (such as mini-splits) avoid these problems.

3.06 All water heaters in 1-story home are located within 20 piped feet of appliances and/or fixtures they serve; 30 piped feet for 2-story

Limiting hot water supply runs can reduce both energy and water use by reducing the time that it takes for hot water to reach points of use. The length of plumbing runs is generally determined by the design of a residence, both in its shape and size, as well as the location of appliances and bathroom/kitchen fixtures. When hot water is drawn into the household plumbing and allowed to cool, the loss of the energy used to heat the water is called “standby loss.” (Storage tank water heaters also incur standby losses, especially when storage capacity exceeds household needs.) The longer the length of pipe to reach a faucet, the greater the standby losses will be and the more water will be wasted while the user waits for hot water to arrive.

Short runs for hot-water supply reduce the amount of pipe or tubing to connect appliances and fixtures to the water heater and can also reduce labor. In larger or spread-out houses, it may be necessary to have two water heaters to reduce standby losses. Another solution (where appropriate) is to use smaller diameter pipe, which further reduces standby losses.

3.07 No fireplace within conditioned space

Most modern fireplaces are not designed to provide heat: their main purpose is aesthetic value. In fact, most models tend to make a house less energy efficient.

3.08 Covered, usable front porch (minimum: side 6', minimum area 100 sf)

3.09 Covered, usable porch other than front porch (minimum: side 6', minimum area 100 sq. ft.)

A usable, covered front porch helps anchor a home to its site and makes a transition from public space to private space. It promotes interaction with neighbors and increases neighborhood security and sense of community. It provides weather protection at the entry door and a comfortable extension of living space, usable most of the year in the Central Texas climate.

Creating outdoor living spaces can extend the livable area of a home. We take it for granted that our homes are divided into rooms, but the concept of having similar "outdoor living spaces" doesn't as easily occur to us. Yet the more conscious we become of outdoor living spaces, the more we can tailor them to suit various seasonal activities. For example, outdoor cooking during the summer eliminates heat gain and moisture generation from inside the home.

In addition to creating more living space, covered outdoor spaces provide cooling shade and weather protection to the walls and windows of a home. Shading the walls, especially the east or west walls, will reduce heat build-up in the home, making it more comfortable to live in and reducing energy costs. Covered east and west outdoor areas can also allow more windows to be placed on those walls without the heat gain that would normally result from such window placement. This can be especially important if there is a desirable view to the east or west.

3.10 All roof overhangs project a minimum of 24" horizontally

Appropriately sized roof overhangs have two major functions: they block unwanted, hot summer sun from heating a home and they help protect the home from moisture damage caused by precipitation. Due to the seasonal changes in the sun's path, properly sized overhangs can block direct summer sunlight from entering windows and allow heat gain through windows from winter sunlight. Overhangs can also enhance a home's visual appeal by emphasizing the sheltering roof. The benefits are greater comfort, lower energy bills, and reduced maintenance problems and costs.

Ideally, roof overhangs should be sized according to the direction they face, since each direction gets a different amount of sun. Since that is not usually practical, however, at Austin's latitude, a 24" wide overhang will shade most south-facing glazing (typically all of a one-story or top story of a multi-story home) during the midday hours of summer. It will provide reasonable rain protection as well. While gable roofs provide full shading of windows on just two exposures, hip roofs will provide shading and weather protection on all four exposures.

3.11 Overhang projection factor for all windows facing east and west is > 0.5

Shading windows in the summer to prevent excessive solar gain can greatly reduce overheating of a house and cut cooling bills. Overhangs are not as effective on east or west facing windows because, when the sun is low in the east in the morning and low in the west in the afternoon, shallow overhangs provide no protection. Deeper overhangs are necessary in order to provide some protection, and porches, especially on the west side, will give the most benefit.

The projection factor is calculated by dividing the depth of the overhang by the distance from the bottom of the window to the bottom of the overhang. So, a 2 foot overhang over a 3' wide x 5' tall window, where the top of the window is 1' below the bottom of the overhang, would be calculated as follows:

2' overhang divided by (5' high window + 1' height from top of window to bottom of overhang) = 2/6 = 0.33

In the above example, the project factor does not meet the requirement for points. If the overhang was increased to a 3' depth, then 3/6 = 0.5, which would qualify for the points. Of course, a 6' or deeper porch would provide the best shading for the window.

3.12 Windows designed for daylighting (e.g. high windows not requiring privacy treatment)

While good lighting design and efficient fixtures and lamps help reduce energy consumption in a home, good daylighting can sharply reduce consumption during daylight hours. Furthermore, natural daylight creates healthier environments by improving occupant mental well-being. When properly designed, transom windows, clerestories, and dormers can provide a large portion of lighting needs without undesirable heat gain or glare. To be counted for these points, windows must be located high on exterior walls so window treatments are not required for shading or privacy. A home designed with adequate overhang projects and the use of awnings or other shading devices can significantly reduce or negate heat gains while allowing natural sunlight to penetrate a room. Sunlight itself actually carries less heat than is produced by incandescent lamps. This can result in smaller sensible-cooling loads and may allow the downsizing of cooling systems, reducing the initial cost of equipment. Properly designed daylighting strategies can reduce both lighting and cooling energy and control glare.

3.13 Designed, effective cross-ventilation in main living areas

3.14 Designed, effective stack ventilation (e.g. operable cupola, clerestory exhaust)

In Central Texas, natural ventilation plays an important role in maintaining comfort, providing fresh air, and reducing the need for mechanical cooling, especially on days when the relative humidity is low.

Natural ventilation relies on air pressure differences to move fresh air through buildings. Air pressure differences can be caused by wind or the buoyancy-effect created by differences in temperature or humidity. Both cross-ventilation - air flow horizontally through the home - and stack-effect ventilation - buoyant, upward movement of air - should be considered while designing the home, taking into consideration that the summer prevailing breezes come from the south or southeast off the Gulf of Mexico. The amount of ventilation will depend on the size and placement of openings in the home, giving equal consideration to supply and exhaust. Open floor plans, as well as openings between rooms, should also be considered to provide a continuous airflow path through a home.

Cross ventilation

These points will be given if the main living area of the home (living, dining, family room) allow air to move through it even if the door is closed. This requires an operable window on more than one wall.

Cross ventilation is induced by wind pressure. Wind causes a positive pressure on the windward side and a negative pressure on the leeward side of a home. To equalize pressure, fresh air will enter any windward opening and be exhausted from any leeward opening. An open floor plan facilitates air movement. Major living spaces and rooms should be designed with openings in opposite walls whenever possible. Corner rooms should have windows on both exterior walls whenever possible. In addition, installing operable transoms above interior doors is a good way to facilitate air movement through rooms that frequently have closed doors.

Window styles play a role in enhancing cross ventilation. Casement windows provide the largest opening area and a right or left opening can be selected for a given room to best direct air into or out of a room. Furthermore, casements seal more tightly than other window styles. Awning windows can be left open during light rain (if the wind is low). Double-hung windows, which open at both the bottom and the top, increase ventilation as well.

Sometimes wind flows at an acute angle or parallel to a wall rather than perpendicular to it. In this case, it is still possible to induce wind ventilation by architectural features or by the direction a casement window opens. For example, if the wind blows from southeast to northwest along an east-facing wall, the first window (closer to the south) would have hinges on the right-hand side opening toward the wind to the south acting as a scoop and directing air under positive pressure into the room. The second window (closer to the north) would hinge on the left-hand side opening down-wind to the north, allowing air under negative pressure to draw air out of the room.

Stack-effect ventilation can occur when no breeze is available since it relies on convection--the fact that hot air rises. It requires the design of a high vertical architectural component such as a stairwell, cupola, monitor, or clerestory, with high operable windows or other exhaust vents. Outside air enters through lower windows, heats up inside the house, rises to the top and exits out operable windows or vents at the top. The greater the distance between the intake and the exhaust, the greater the temperature differential that can be created, the faster the air will move (like a fireplace chimney), and the greater the cooling effect. This will be especially useful in the spring and fall of the year, when cooling may not be required.

In summary, a home can be designed to take advantage of either cross ventilation, stack ventilation, or both. Orientation of the home toward prevailing breezes, layout of interior spaces, and window style, size and placement and/or a thermal-chimney should be carefully designed and constructed to maximize passive cooling by ventilation. For ventilation to work, windows and vents need to be operated properly both seasonally and daily. In Central Texas, spring and fall are the best times of year to utilize natural ventilation, unless the relative humidity of outdoor air is unpleasantly high.

3.15 Shading on east and west walls of living space for at least 50% of wall area (e.g., covered porch, pergola, trees)

Shading the east and west walls of a house is an effective way to lower cooling costs and increase comfort, since one or the other of these walls is always in the sun's path. The solar heat gain is transmitted rapidly through the windows and slowly through the exterior walls, gradually passing through even well insulated structures into the living space. Heat transfer through the walls continues during the night.

Properly situated new or existing trees or architectural features such as a pergola or trellis can shade the east and west walls of a home and significantly reduce cooling loads. Trees are particularly helpful, not only because they provide shade, but because they also create an area of cooler air around the house, due to transpiration of moisture from the foliage.

3.16 Total glazing area is no greater than 18% of conditioned floor area

In hot, humid climates, a good thermal envelope helps slow down heat transfer from outside to inside. The R-value of even minimally insulated walls and ceilings always provides better thermal protection than any window or skylight available on the market, however. Windows and skylights are in essence "holes" in the thermal envelope. For that reason, it helps reduce energy costs to reduce window area.

Since many inefficiently designed homes have unnecessary wall projections and changes in walls that can adversely skew the window-to-wall ratio, a better gauge of an acceptable glazing area is the percentage of total window and skylight area to total conditioned floor area.

3.17 Glazing on east and west walls combined does not exceed 25% of total glazing area; glazing on west wall does not exceed 10% of west wall and glazing on east wall does not exceed 10% of east wall

Window sizing and placement are usually the main determinant of a home's cooling costs. It is extremely difficult to protect glazing on east and west walls from the sun's heat, since it is always in the sun's path. Adding an unshaded 6' sliding glass/patio door to the west side of a home can increase the cooling load by almost half a ton.

Reducing glazing area on east and west walls is one of the most effective ways to increase comfort and reduce utility bills. A good design guideline is to limit glass on these walls to no more than 25% of the total glazing area and to allow no more than 20% of an east and west wall area to be glazing.

Following this recommendation, most windows will be placed on the north and south sides of a home. Windows on the north provide very good light quality (the kind artists like) and will not contribute significantly to heat gain in the summer. (Some heat gain due to diffuse or reflected solar input will occur.) North-facing windows are not a problem in Central Texas, except on very wind-swept sites. Windows on the south reduce utility bills in both winter and summer, due to the changing sun path: in winter the low sun helps heat the home and in summer the high sun is easily kept from shining on the windows with small overhangs and other shading devices.

3.18 No skylights into conditioned space (solar tubes are acceptable)

In Central Texas, having a skylight in a house is much like punching a hole in the roof and letting the sun's heat pour in. Although skylights add light to dark interiors, that light comes at the cost of increased cooling bills and lowered comfort. They also are potential leak points in the roof during our torrential rains. In winter, they contribute to heat loss.

There are better ways to get light into the interior of a home without a lot of heat gain - for example, light tubes or windows placed high on vertical walls, well protected by overhangs.

3.19 Garage is detached from the house; or house has no garage

OR 3.20 Attached garage has exhaust fan with timer; or passive roof vent with supply intake vent openings are installed a minimum of 18" above finish floor

A vehicle exhausts fumes that are dangerous and easily trapped in a garage. Even after it is turned off, fumes are emitted until the engine is cool. If the garage is attached to the house, fumes easily migrate into living space and ductwork, endangering the health and safety of occupants. An exhaust fan on an automatic timer exhausts these fumes to the outdoors. A passive roof vent with supply intake vent openings in the garage walls or door help as well. A garage structure separate from the home, a carport, or no garage at all eliminate this risk.

3.21 Basic access to house provided according to City of Austin Visitability Ordinance

Homes built to the City of Austin Visitability Ordinance make a home "visitable" to mobility-impaired guests. Moreover, if occupants become mobility-impaired, even temporarily, they will still have easy access to critical rooms of a home and easy use of the electrical controls. Building to this standard is a requirement for all City of Austin-financially-assisted housing projects.

The specific requirements are:

1. One ramp or no-step entrance on an accessible route with an entrance door that has a minimum net-clear-opening of 32 inches and a lever handle. It may be at the front, side, or back of the house.
2. Interior doorways on the first floor have a minimum net-free-opening of 30 inches and lever handles (except doors leading to closets less than 15sf).
3. A minimum 36-inch-wide level route through hallways and passageways throughout the first floor of the dwelling unit, with ramped or beveled changes at door thresholds.
4. Reinforcement in first floor bathroom walls, utilizing lateral two-inch by six-inch-or-larger wood blocking installed flush with stud edges of walls. The centerline of the blocking must be 34 inches from and parallel to the floor.
5. First floor light switches, thermostats, receptacles, and electrical panels must be within 18" and 42" above the floor, and outdoor electrical panels adjacent to an accessible route must be installed to the same height requirements.

OR

3.22 Home incorporates Barrier-Free Universal Design Elements

A barrier-free home includes a number of features that allow more independent living. The list below is a summary of the components required to be installed in the home to meet the requirements of this credit:

Minimum One Accessible Entrance

1. Accessible route and level entrance
2. Covered entry
3. Minimum 32” clear opening of door
4. Full length sidelights at entry doors

Interiors

1. 36" minimum-clearance access corridors (hallways) throughout home
2. Minimum 30” interior door openings
3. Lever door handles
4. Adjustable-height closet rods
5. Light switches between 44" and 48" above floor
6. Electrical receptacles at 18" above floor
7. View-windows with a sill height of 36" or less

Kitchens

1. Knee space under the sinks and cooktops
2. Lever-type water controls
3. Variable height work surfaces
4. Contrasting border treatment on counter tops
5. Pull-out shelves in base cabinets
6. Pantry cabinets with full length shelves

Bathrooms

1. Grab bars in the tubs and showers
2. Mirrors extending to backsplash behind sinks
3. Offset controls in tubs and showers
4. Adjustable-height showerheads
5. Mixer valves with pressure balance and hot water limiter

SECTION 4: MATERIAL EFFICIENCY AND CONSTRUCTION WASTE

4.01 Lot has more than one dwelling unit

Having more than one dwelling unit per lot increases density and decreases sprawl. This results in reduced need for utility and transportation infrastructure expansion. That, in turn, results in money saved on development costs. When a home site has more than one living unit, it also has the potential for rental income, which can be an excellent investment and hedge against property tax increases and other expenses.

4.02 Existing home removed from site is reused (whether deconstructed and recycled or moved)

Redevelopment and/infill building in established neighborhoods often result in the demolition and disposal of older/smaller houses. From a resource-use perspective, this is extremely wasteful – the resources and energy that went into the demolished house are lost, while additional resources and energy are used to build the replacement.

Depending upon the condition and location of the existing house, it can likely be moved to another location. Depending upon lot size and zoning, a small house can sometimes be reused on site by moving it to another portion of the lot to make room for an additional residence.

Even if a house’s overall condition makes it a poor candidate for renovation, much of the structure is often salvageable. The type and quality of wood used in an older home is often unobtainable today – it could be used as attractive trim or architectural details in the house that replaces it. Solid wood siding on interior walls may be re-milled for cabinets, stair treads and other trim. Doors and other fixtures can often be reused, and are often more distinctive and affordable than contemporary replacements.

Affordable housing non-profits, like Habitat for Humanity, may be available for deconstruction. These groups will use some materials in their own projects while offering remaining materials for sale so as to fund their own homebuilding activities. A tax-deductible donation may be possible in some cases.

4.03 Project is renovation of, and/or addition to, an existing home

While the AEGB Single-Family Home Rating is primarily applicable to the design and construction of new residences, substantial improvements in energy-efficiency and water use, as well as resource efficiency, can be realized in the renovation of and additions to existing structures. Renovations are a resource-friendly means of increasing the volume of existing housing stock, as they extend the life of building materials already in use, and avoid demolition/disposal of existing housing. If done carefully, an addition can substantially increase the square footage while having little impact the overall energy use of the house.

The look and feel of a neighborhood or community is determined by the size and appearances of houses, as well as their setbacks from the street and adjacent houses. Renovations/additions can usually be performed without altering the look and feel of the community. They can also renew older neighborhoods, where the transportation and utility infrastructure already exist.

4.04 Home is factory-built modular construction on permanent foundation

Modular homes (not “manufactured” housing) can often outperform site-constructed homes from the standpoints of energy-efficiency, efficient use of building materials and waste reduction. When modules are assembled in a factory setting, greater quality control is often the result, and the process is inherently resource-efficient because there is very little material waste in a factory. Additionally, building materials are not lost to theft or damage from the elements. Designers can prepare material lists so as to most efficiently utilize materials.

Modular construction greatly reduces the influence played by the weather. Modules are constructed in factories, under conditions that are superior to those found on construction sites. Modules can usually be constructed in one week, and assembled on site in a single day, almost eliminating delays due to inclement weather.

Under Texas law, factory-built homes are required to meet the codes of localities where they are erected. Because modules have to withstand the stresses of transportation and handling, they are often more resistant to natural forces than are site-built homes.

4.05 Conditioned space: maximum of 1,500 sq. ft.

4.06 OR Conditioned space: maximum of 1,200 sq. ft.

4.07 Conditioned space: maximum of 900 sq. ft.

Common practice today is to build ever-larger homes with as much “cheap” space as possible. “Cheap” space includes living, dining, family rooms, and bedrooms, which are less expensive to build than kitchens and bathrooms, since there are no expensive fixtures and utilities to install in these rooms. While inexpensive to build, this space is just as expensive to heat, cool, illuminate, clean and furnish as any other space. The construction of excessively large homes consequently requires the homebuyer to spend more to purchase the home and more in operating costs, while not necessarily receiving more in function and beauty.

As the average American home size has steadily increased since 1940, the average family size has decreased. Smart design results in a home with enough space for a convenient, comfortable lifestyle, for its occupants without additional unneeded space. Square footage is not a component of beauty and elegance. Excessive size is frequently just an excuse for bad design. It results from not taking the time to solve design problems in more intelligent and aesthetically satisfying ways.

As Susan Susanka, author of “The Not So Big House” has stated, “the problem is that comfort has almost nothing to do with how big a space is. It is attained, rather, by tailoring our houses to fit the way we really live, and to the scale and proportions of our human form.” Designing and building a “not-so-big” house results in a home that offers greater comfort with less consumption of energy, water, and material resources and reduced impacts from both the construction and operation of the home than an unnecessarily large home. Many homeowners are heeding Susanka’s message. According to Builder Magazine, surveys show that although most Americans want bigger houses (51%), *an almost equal number (49%)say they would prefer a smaller house with more amenities for their money.*

4.08 Exterior rough-in dimensions are modules of 4’-0”

Designing to a 4’ grid reduces waste, since most standard building products are sized in multiples of 2’ and 4’ and many building components, such as floor and roof trusses, are typically laid out on 24” centers. Constructing on this grid saves time as well as materials, since fewer cuts may be required and less material is wasted.

4.09 Exterior walls system is constructed off-site (e.g. panelized wood frame, SIPs)

Traditional framing techniques call for constructing wall panels on the structure floor, then lifting or tilting them into place. Sometimes, the exterior sheathing is installed while the panel is still lying flat on the floor, but the extra weight reduces the length of each wall section so more workers are required to perform each lift.

Factory construction of entire wall assemblies leads to more efficient use of materials. Smaller cutoffs are used for blocking. The panels may also be built on waist-high assembly stations, reducing worker fatigue. In addition to reduced waste, the panels are true and square, since they are built with jigs to assist in assembly. In some cases, adhesives may be used in addition to fasteners.

The wall sections are numbered and loaded for delivery so the first wall section off the trailer is the first one needed on site.

Structural Insulated Panels (SIPs) are a “sandwich” panel product consisting of an insulated foam core, with an inner and outer layer of structural sheathing material – usually OSB (oriented strand board). They are available from various manufacturers and can be reliably used in place of conventional studs, plywood, and insulation systems that use more natural resources and are more labor-intensive. SIPs provide greatly reduced air-infiltration, high R-values, rot/pest/fire resistance, and are easier and quicker to install.

OR

4.10 Exterior wall system is ICF, ACC block, straw, earth or other AEGB-approved system)

There are many types of effective exterior wall construction products and techniques other than conventional wood framed walls. They may be known as “solid”, “advanced”, “alternative”, or “innovative” systems, and have a variety of advantages, depending on the system. They are typically very energy-efficient and quiet.

Here are some examples:

Insulating Concrete Forms (ICFs) are modular, panel or block-like, permanent, concrete forms with hollow-core interiors that are stacked or set in place and then filled with steel-reinforced concrete, creating a monolithic concrete structure. Foam types, assembly methods, and amount of concrete needed vary, depending on the manufacturer. Advantages are high insulation values, high strength, easy and rapid installation, rot/pest/fire resistance, and low maintenance.

Aerated autoclaved concrete (ACC) blocks are made of cement, sand, lime, and an aerating agent, and are baked in an autoclave. These lightweight and strong cement blocks are stacked together, much like bricks, and can be finished in a variety of methods, typically with stucco on the outside and plaster on the inside. Advantages are rot/pest/fire resistance, low maintenance, and ease of installation. The R-value is adequate for Central Texas.

Straw bales can be stacked like blocks and provide a highly insulative, natural wall system, usually given a stucco finish. The bales can be either the structural support for the roof or serve as an insulative infill in a post-and-beam type wall construction. Straw has low embodied-energy and is a waste product (do not confuse it with hay). It has no nutritive value and is largely composed of silica, which deters pests (they cannot penetrate it because it cuts them to pieces). This waste has few traditional uses other than landscaping or animal bedding and unless prohibited, often burned, causing pollution.

Earth is a natural, beautiful, biodegradable, and abundantly available building material. It can be used for Rammed Earth, Compressed Soil Blocks, Cobb, Adobe, Superadobe, and more. Stabilized with cement, earth can provide both exterior and interior, structural and finish walls. It is pest resistant, long lasting and has high thermal mass (not a huge advantage in Central Texas, with our low diurnal temperature swing, but not a drawback, either, and possible a means of regulating moisture in the home). Like straw, it has the advantages of low embodied-energy, minimal impact on natural resources, and is biodegradable when the life of the building is over.

OR 4.11 Wall framing is by the "Optimum Value Engineering" (OVE) or "advanced framing" method (as allowed by Code): employ a minimum of 3 measures:

a. Exterior wall framing at 24" on center

b. Interior wall framing at 24" on center

c. Right-sized headers (designed and constructed for actual load conditions or doubled rim joist in lieu of header

d. Open corner framing (2-stud corners) with drywall clips and ladder blocking

e. No wood wall sheathing (corners excepted

f. Window framing without jack studs

Advanced Framing involves framing exterior and interior walls 24" on center. Placing wood studs on 24" centers (where Code allows) reduces wood use by about 1/3, without a significant reduction in structural strength. The result is reduced impact on forests, as well as reduced cost for stud materials. Secondarily, framing labor and delivery costs will also be reduced. (Note: Advanced Framing is a subset of framing practices called Optimum Value Engineering. See below.)

The extraction, manufacture, transport, and disposal of lumber depletes resources, damages natural habitats, and pollutes air and water. Dimensional lumber depends upon larger trees that require decades to mature. Conventional framing can often be structurally redundant, using wood unnecessarily and reducing space for insulation.

OVE framing techniques provide a means to reduce environmental impacts in the construction of quality, structurally sound, code-approved wood-framed homes. According to the US Department of Energy's Office of Building Technology, advanced framing techniques can save hundreds of dollars in material costs and shave 3 to 5 percent off of labor costs. They reduce annual heating and cooling costs up to 5 percent by maximizing the exterior wall cavity available for insulation installation, creating a more energy-efficient building envelope.

While the system can be applied as a whole package, many of its components can be used independently. Framers unfamiliar with these techniques may need training. In general more planning is needed when using these techniques, but once they are mastered, great savings can ensue. We suggest that builders try some of them and add more over time.

See the following websites for more information and details about OVE wood frame construction:

www.toolbase.org/pdf/techinv/oveadvancedframingtechniques_techspec.pdf

www.nrdc.org/cities/building/rwoodus.asp

4.12 Finger-jointed studs are used for a minimum of 50% of wall construction

The use of engineered, finger-jointed studs saves forests, material, time and money, without compromise of structural strength. Finger-jointed studs are comprised of short pieces of lumber glued together into stud lengths. These studs are straighter, more stable, and stronger than solid-sawn studs. This substantially reduces the need to cull bad studs, normally required with solid-sawn studs.

Structural finger-jointed lumber is manufactured to meet the requirements of two different types of end-use applications. The first category is basically an all-purpose product, indicated by *CERT EXT JNTS* on the grade stamp. The second category is appropriate for use where the primary loading will be in compression parallel-to-grain, indicated by *VERTICAL USE ONLY* on the grade stamp.

Finger-jointed products grade-stamped *CERT EXT JNTS* are intended for all structural applications. This lumber is assembled with a waterproof, exterior-type adhesive. Limitations on knot size and placement near joints are highly restrictive. *CERT EXT JNTS*-stamped products may be used interchangeably with any solid-sawn lumber product of the same species and grades. The lumber may be used as beams, joists, rafters, studs, plates, or in any other exterior or interior framing application.

Products that are grade-stamped *VERTICAL USE ONLY* (previously stamped and known as *STUD USE ONLY*) are appropriate for carrying loads in compression as vertical framing members. *VERTICAL USE ONLY*-stamped finger-jointed lumber is manufactured to meet the performance capabilities of solid sawn, end-loaded bearing members where short-term bending or tension loads from lateral forces such as wind, seismic and impact may be present, but where forces from the conditions of long-term, sustained-bending or tension loading are not present.

4.13 Roof framing system: engineered trusses or materials such as I joists, truss joists, or LVLs (no solid lumber 2x10 or larger)

Due to the dwindling supply of large timber, engineered wood products or non-wood substitutes should be used in place of large-dimension lumber. These products are more consistent in quality than solid lumber. They may be made up of smaller and/or shorter pieces of solid lumber, or from small, fast-growing tree species, or other materials, thus saving our old-growth forests.

Engineered wood products offer many advantages:

- Optimize the use of global wood resources by using only very small trees or fast-growing species
- Use a very high percentage of the tree
- Are more consistent in quality and result in less waste
- Use less material to provide greater strength
- Are made to-order for a given job, which reduces job site waste
- Are less prone to expansion and contraction; engineered trusses less prone to squeaking
- Floor trusses can be constructed to allow easy placement of ductwork, wiring and plumbing
- Roof trusses can be constructed with duct chases

All of the products described below fall into the general category of engineered lumber:

Floor and Roof Trusses
Wood trusses eliminate waste since they are made to order. They reduce the pressure on old growth forests by replacing 2x10s and 2x12s traditionally used for floor joists and roof rafters. Manufacturers have the ability to vary flange sizes, depth of webs, grades and types of timber to meet the desired load constraints and thereby maximize the use of raw material. The open web design also allows excellent access for plumbers, electricians and air-conditioning contractors to design and install services through the floor without cutting or notching.

NOTE: Ensure that ducts chases in trusses line up to allow straight duct runs.

Glulams
Glulams (glued laminated timber) are comprised of wood laminations, or "lams," that are bonded together with strong, waterproof adhesives. Glulam lumber can be milled from a variety of species. Individual "lams" are typically two inches or less in thickness and vary in width depending on the size of the beam. The final products are beams that range in size from 4x8 up to 6x20 and larger. Glulams can be used as beams and girders where standard construction practices would require large dimension timber.

Laminated Veneer Lumber
Laminated veneer lumber (LVL) is made from layers of dried and graded wood veneers bonded together with waterproof adhesive. The grain of each layer of veneer runs in the same direction, rather than cross-lamination which is typical of other engineered wood products such as plywood. The result is a solid and uniform engineered wood product that is sawn to consistent sizes and is virtually free from warping and splitting. LVL is available in various thicknesses and widths and is easily worked in the field using conventional construction tools. LVL typically out-performs conventional lumber and can be used as studs, headers, rim joists, beams, columns, and girders in floor framing and as rafters in roof framing. LVL is also known as structural composite lumber (SCL).

Wood I-Joists and I-Beams
Wood I-joists are comprised of top and bottom flanges of various widths combined with webs of various depths. The flanges resist common bending stresses, and the web provides outstanding shear performance. I-joists can be manufactured using solid sawn lumber or LVL for the flange components and plywood or oriented strand board (OSB) for the web. They can be manufactured to span longer distances than solid lumber and can be purchased in lengths up to 40 feet. Moreover, they are dimensionally stable and do not crown or bow as does solid lumber.

Oriented Strand Board
Oriented strand board (OSB) is a solid panel product manufactured from waterproof heat-cured adhesives and rectangularly shaped wood strands that are arranged in cross-oriented layers, similar to plywood. This results in a structural engineered wood panel that shares many of the strength and performance characteristics of plywood.

Parallel Strand Lumber
Parallel strand lumber (PSL) is manufactured from 2'-8' long, thin wood strands. The strands are generally taken from veneers peeled from the outermost section of the logs, where stronger grain is located. Veneers are dried to and graded for strength before chopping into strands. The strands are then aligned parallel to one another, coated with a waterproof adhesive, then pressed and cured to form a rectangular billet. The product is quite uniform throughout the cross section, and is re-sawn from the manufactured billet to a wide range of sizes. Large members, some approaching sizes common in glulams, are manufactured by assembling strands which have been chopped from sheets of veneer up to 8 feet long. The result is an engineered wood product with considerably higher strength than is available from solid timbers of the same cross section.

Laminated Strand Lumber
Laminated strand lumber (LSL) is manufactured from short (about 12") thin wood strands. The strands are aligned parallel to one another, coated with a waterproof adhesive, then pressed and cured to form a rectangular billet. Like PSL, the product is quite uniform throughout the cross section, and is re-sawn from the manufactured billet to a wide range of sizes.

4.14 A minimum of 50% of framing or sheathing or decking material is SFI-certified engineered products or lumber

SFI—the Sustainable Forestry Initiative--is the certification program of the forestry industry. See: **http://www.sfiprogram.org**. This industry has made steady advances in recent years toward more sustainable forestry practices and 3rd-party certification. It differs substantially from the FSC in regard to its assessment of the amount of remaining old-growth forests. See the document "FSC and SFI Similarities and Differences" on the SFI website.

4.15 A minimum of 50% of framing or sheathing or decking material is FSC-certified engineered products or lumber

FSC-certified wood products are verified by a third party as originating from sustainable, well-managed forests. The Forest Stewardship Council (FSC) is currently recognized as having the most rigorous standards and also the only certification system that provides for chain-of-custody supervision to ensure that products used were derived from certified forests. FSC has developed a set of Principles and Criteria for forest management that are applicable to all FSC-certified forests throughout the world. There are 10 Principles and 57 Criteria that address legal issues, indigenous rights, labor rights, multiple benefits, and environmental impacts surrounding forest management.

Sustainable forestry practices as established by the FSC minimize or eliminate the negative impacts on air, water and soil quality, wildlife, recreation, and forest longevity that are associated with conventional forestry. The use of FSC certified products reduces the negative impacts of conventional forestry practices--such as clear-cutting, monoculture, destruction of recreational areas and wildlife habitat.

Some companies sell both certified and non-certified wood products, or products that have been certified according to different, less stringent environmental standards. To make certain that you get environmentally responsible wood products, be sure to specify FSC-certified wood. Many FSC-certified products are now available at local building supply stores. Others still have to be special ordered.

For further information visit the U.S. FSC website: **www.fscus.org**

4.16 Use of reclaimed materials, such as doors, hardware, flooring: provide list of all products used for this credit in Section 12

Reclaimed materials or products are ones that have previously had a life in one structure or location and are then removed and installed in a new or renovated one, thus reducing the need for virgin resources. These materials and products are often of higher quality than new ones and often are a better fit in a renovation project.

4.17 80% of excess lumber and drywall are recycled/reused (not landfilled); approved documentation required

Lumber and drywall waste from construction sites can be recycled for new uses instead of being sent to a landfill. For example, wood may be find new life in engineered lumber or mulched and used for landscaping and erosion control. The gypsum in drywall can be used as a soil amendment, in the production of cement, and as an ingredient in the manufacture of many types of commercial products. Since gypsum makes up approximately 90% of the weight of a piece of drywall, if the gypsum can be recovered from the drywall, the majority of the material can be recycled.

OR 4.18 Minimum 40%-by-volume of waste is recycled/reused (not landfilled); approved documentation required

OR 4.19 Approved construction waste management plan; documentation required

The purpose of a construction waste plan is to reduce the need for landfills, reduce hauling and its environmental impacts, reduce dumping and storage fees, provide materials for reuse and resources for the manufacture of new products, and save money for the builder and owner.

This plan is ideally included in the specifications, but if this has not been done, the builder can develop a plan and may want to do so with a construction waste management company.

Here are examples of matters a construction waste plan should address:

- Measures taken to reduce on-site waste (e.g. factory-construction of walls)
- Reuse of usable structures and materials, on-site if possible
- Recycling of waste materials for new uses, on-site if possible
- Proper and safe disposal of unusable or hazardous material

Best practice is to use construction waste on site as much as possible. This reduces the problems related to transport and disposal—pollution from vehicle emissions and shortened life of disposal sites. It may also mean finding uses for deconstructed materials in a new structure that are often much higher quality than available new materials.

Trade contractors are available that bring a mulching machine to a site to pulverize organic materials, such as scrap lumber, gypsum board, stone, brick, concrete, roof tiles, for on-site or nearby reuse. This material can be spread around the foundation to keep workers from tracking through mud and for erosion control. It can be used for landscaping, as well. Mulched gypsum provides a soil amendment which loosens the soil, increases water penetration, and reduces stormwater runoff.

To the extent that construction waste cannot be used on-site or on a neighboring site, a plan can be developed for uses off-site, always with the goal of sending as little waste as possible to the landfill. The easiest method is to contract with a construction-waste-management company. Some such companies do not require any job-site sorting—they do it themselves at their own site. They have contacts for selling reusable and recyclable material, thus reducing the cost of this service. They are set up to keep track of what happens to the waste, by volume or by weight, obviating the need for the builder to do this.

4.20 Concrete truck wash-out managed to recycle concrete residue and treat wash-out water

Washout containment systems need to be water-tight to prevent all water and fine concrete material from coming in contact with the ground. Some local waste-management companies may provide a service for containment and recycling. The containment system may be job-built. Builders should consult with their AEGB Representative/Rater to discuss options before implementing a system.

The waste water from concrete washout is alkaline and contains high levels of chromium, which can leach into the ground and contaminate groundwater. If washout facilities allow runoff into storm drains, creeks, and streams, the resulting increase the pH not only harms aquatic life but affects our drinking water supply. Managing concrete washout can prevent this contamination, as well as reduce construction waste by diverting and recycling concrete waste from the landfills. Appropriate steps should be taken to recycle and reuse aggregates salvaged from washout operations, as well as treat the wash-out water to remove contaminants before it is allowed to permeate into storm drains or ground soils. The treatments site should be located for convenient access for the concrete trucks nearby the area where concrete is being poured so that the maximum amount of residue can be treated. The system of treatment should be inspected and serviced frequently to assure components are functioning to completely remove contaminants.

The Construction Waste Management Documentation form provides a means for tracking construction waste. It is available on the Austin Energy Green Building website (See the link: For Building Professionals) or from your AEGB Representative/Rater. On this form, waste materials, their quantities, volume/weight conversion factors and disposal methods are listed.

SECTION 5: INTEGRATED PEST MANAGEMENT

5.01 Sand or mechanical-barrier termite control system is used (or structure is not termite-edible)

Physical barriers, made of materials such as aggregate, stainless-steel mesh or plastic, do the job of termite control without dangerous chemicals, which could harm occupants and ground water. Actually most of the chemicals that are still legal aren't very effective after a short time anyway, so why risk using them?

Stainless-steel-mesh barriers must have correctly sized openings that termites cannot pass through and they must be strong enough not to break. Plastic barriers have a termiticide sandwiched between layers of plastic, but this is not the kind of termiticide used in conventional chemical treatment. All of these methods rely on correct installation and must not be broken over time. A sand barrier requires the correct grain size—one that termites are unable to dig through or move.

When slab foundations first became common, people assumed they would offer better protection against termites but that has not been the case. In fact, subterranean termites like the underside of slabs, are well-protected there, enter the home through tub traps openings, control joints, plumbing and other penetrations, and cannot be easily discovered until they have done their damage. (Termites are now being found farther north, as slabs have become a more accepted foundation type in moderate climate areas). Pier and beam foundations actually make termite detection easier.

5.02 All wood framing is treated with a borate product to a minimum of 3 feet above foundation (or structure is not termite-edible)

The old-fashioned "spray and kill" methods of termite control are dangerous, not only to termites, but also to workers, occupants, the soil, beneficial insects, pets, plants and groundwater.

There are numerous advantages to using borate chemicals on lumber. Although they are highly toxic to wood boring insects and fungi, they exhibit low toxicity to humans and other mammals. Once the wood has been treated and kept dry, the borate protection is extremely long lasting. What's more, the borates do not affect the appearance or workability of the lumber. The borates are non-corrosive to metal fasteners used in lumber, they are odorless, and they are extremely cost effective.

Borate is usually sold in powder form that readily dissolves in water. It should be applied to framing lumber after the house is dried in. The borate solution should be sprayed or brushed on before the lumber is covered over with insulation, drywall, or plastic. If possible, two applications on separate days are preferable to one. Dry, rough lumber absorbs borate chemicals readily. Once the solution is applied to bare lumber, it can soak deeply into the wood. The depth and extent of penetration depends on several things: temperature of the lumber, lumber species and texture, the internal moisture content of the lumber, and the number of applications.

5.03 All exterior wood-to-concrete connections are separated by metal or plastic fasteners/dividers (e.g., posts, deck supports, stair stringers)

If exterior wood comes in direct contact with concrete (especially if it is sunk directly into it), the wood tends to rot quickly. That's because the wood swells and shrinks from rain and humidity changes and can't drain and dry out properly. By separating the wood and concrete with metal or plastic, a barrier is created and the wood has a better chance to dry out. Fasteners designed for this purpose, with air separation and drainage, do the best job. Be certain that wood-to-concrete connections are properly made with metal or plastic spacers. This will reduce chances of wood rot, structural damage, and termite infestation.

5.04 All new plants have trunk, base, or stem located at least 36” from foundation

Extra precaution should be taken to keep landscape plants a safe distance from the foundation and walls of a home. A clear space--devoid of plants, bushes, and trees--around the perimeter of a house allows easy access for homeowner inspection for termite tunnels and removes an easy pathway for termites and other pests to attack the house. Having this clear space is not a guarantee, but it is an aid in having a termite-free home. Homeowners should be informed to maintain this clear zone around their home over time—prune and remove plants as necessary. This will also make it easier for the homeowner to inspect for good drainage away from the home, as well. Keeping plants away also protects siding materials from deterioration.

SECTION 6: THERMAL ENVELOPE AND MOISTURE CONTROL

See “Builder’s Guide to Hot-Humid Climates” + “Water Management” for design and construction guidelines. In Central Texas, make wall system as air-tight as possible but vapor permeable and able to dry to both inside and outside.

6.01 Window U-value of 0.51 or lower

6.02 Glazing has SHGC of 0.30 or lower

See Basic Requirements: #3. Window efficiency

6.03 “Raised-heel” or ”energy” roof trusses

Typical roof construction with standard trusses or cut-in rafters (rafter meets bottom chord at top of wall) does not easily allow sufficient space above the wall for ventilation-air intake and full depth of insulation where the rafter meets the wall. If a larger overhang is desired for shading and protection from rain, the rafter tail obscures the view out the window, especially if the roof is steeply pitched.

With raised heel trusses, the rafter and bottom chord of the truss meet at the outer end of the overhang or rake (not at the top of the wall), so all the above problems are solved. These trusses are cost-effective and installation is no different from conventional pre-fabricated trusses.

Note: this type of truss is not needed in a sealed attic insulated at the rafters.

6.04 Vented attic has continuous ridge and soffit vents (no functioning gable vents)

Continuous ridge and soffit vents provide the best method of cooling a *ventilated attic* in hot weather. They allow the relatively cooler outside air to enter the attic in a continuous path under the entire length of the eave and exit along the entire length of the ridge. This means the whole underside of the roof will be bathed in cooler air. This attic ventilation system exhausts the largest possible volume of air continuously and evenly and is not affected by wind volume or direction. It works naturally, based on the physics of hot air rising, and needs no mechanical help. A cooler attic results in less heat flowing through the attic insulation into the living space on hot summer days, and provides a more congenial space for the cooling equipment and ductwork, if they are located in the attic.

Ridge vents are inexpensive, easy to install, reduce the number of roof penetrations, and are more aesthetically pleasing than gravity vents, since they can be roofed over and are virtually invisible. Some hip-style roofs may not have room for a long continuous ridge vent. With such designs, hip vents or exhaust vents placed as close to the peak as possible are required to augment or replace the ridge vent.

Other types of vents, such as gable vents, gravity vents, and non-continuous soffit vents result in limited and uneven air paths and are more dependent on wind volume and direction. Power attic vents are not recommended because their energy consumption exceeds their overall energy benefit and are seldom repaired if they stop working. Even the use of solar-powered vents is not recommended for the latter reason.

OR

6.05 Closed/sealed attic system: unvented; polyurethane foam-insulation at roof rafters, minimum 5.5” depth (any gas equipment located therein is sealed-combustion)

The rationale for venting attics in the South has been to flush out hot air in summer. However, the dominant heat transfer mechanism in an attic is radiation, which cannot be “flushed” out. This heat slowly passes through insulation on the floor of the attic into the living space. When ductwork is installed in a vented attic, the problem is compounded: heat passes into the conditioned air in the ducts as well, which also ends up in the living space.

To date, we have no evidence that sealed and insulated attics in hot, humid climates trap moisture. In fact, researchers have found that, in this climate, buildings with unvented attics are actually less likely to have condensation and mold than those with vented attics. That's because in our climate most moisture comes from outside, and the foam keeps the attic dry by keeping that moisture out.

In the Austin climate, it makes sense to insulate the attic at the roof plane/rafters (no ventilation provided), bringing the attic space and anything within it inside the thermal enclosure. In most localities, building codes will allow unvented roof assemblies if two conditions are met: there's no vapor barrier between the attic and the home's living space, and the insulation is installed between the rafters with an air-impermeable product--polyurethane spray foam.

An unvented, sealed attic may result in a slight increase in shingle temperature but has not been proven to have an impact on shingle durability. (The same battle with shingle manufacturers was once fought over the use of radiant barrier.) The color of the shingle is more important than venting or non-venting. However, the biggest factor in long-term on shingle durability is ultra-violet radiation, which is the same whether the attic is vented or not.

For a case study of unvented attics in production-built homes see:

www.nrel.gov/docs/fy01osti/30909.pdf#search=%22unvented%20attic%22

6.06 “Total-fill” insulation in walls (e.g. blown cellulose, BIBS, spray foam, SIPs)

Total-fill insulation refers to any type that is blown-in or sprayed that fills all “nooks and crannies” of the wall framing, so there are no visible voids or gaps or compression. Various types of insulation may be applied or installed in this manner. These points also apply to any system which is constructed with the insulation as an integral part of the material or system itself. Such types of insulation installation or wall system greatly reduce flaws in a home’s thermal envelope.

6.07 Insulation has no added urea-formaldehyde

Formaldehyde glues have typically been a common component of fiberglass batt insulation. The glue is used to hold the short fibers together and help maintain batt shape. Since formaldehyde is a known health threat, the reduction of its use will contribute to improved indoor environmental quality and occupant health.

Formaldehyde-free fiberglass insulation is being produced by major manufacturers and is readily available. It is usually distinguishable by its white color. In addition, most other types of insulation, such as cellulose, rock wool, cotton, and foam, do not contain added urea-formaldehyde.

6.08 Wall and attic insulation have average total-recycled-content of 75% minimum

Producing insulation from recycled materials reduces the consumption of virgin resources and the energy used to process them. Cellulose insulation, mostly from recycled newsprint, has become a popular and cost-effective option for insulating attics and exterior walls. Cotton batts made from old clothing and scrap cloth are a resource-friendly option for wall insulation. Both products are treated with borates to increase their resistance to both pests and fire.

6.09 Roofing meets requirements of Energy Star; minimum 10-year warranty

Roof products that meet or exceed a specified solar reflectance, without compromising product quality, performance and longevity, qualify for the Energy Star label.

Energy Star roof standards are not restricted to any particular type of roof product. However, Energy Star expects that, at least initially, metal, single-ply membrane, and roof coating products will be most widely represented.

For Energy Star roof products visit:
www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products

For more energy information about roofing products, see
www.coolroofs.org/documents/September2006ProductDirectory090106.pdf

The Cool Roof Rating Council (CRRC) develops accurate and credible methods for evaluating and labeling the solar reflectance and thermal emittance (radiative properties) of roofing products and to disseminate the information to all interested parties. CRRC recognizes only roofing product radiative property tests performed by properly trained and accredited independent laboratories. CRRC standardizes and assures the quality of the rating process - *they don't establish or enforce performance thresholds.* EPA's Energy Star program is complementary in that it promotes only products meeting certain performance levels but it relies on manufacturer performance claims.

Other “cool” roofing materials may be found in the Lawrence Berkeley Labs (LBL) “Cool Roofing Materials Database”. These roofing materials have been selected for performance, durability, and availability. Some are appropriate only for low-slope and flat roofs. The LBL cool roof list can be found at the following website: http://eande.lbl.gov/coolroof.

6. 10 Roofing is tile or metal

Tile and metal roofing materials out-perform other kinds in regard to keeping a house cooler. Tile does not transfer heat well. Metal, though it can get very hot, cannot hold much heat, and cools quickly in the evening when the sun is no longer striking it. Because these materials are poor heat sinks, they will not be radiating heat to the interior all night long, as composition shingles do. If they are white in color, they offer reflectance as well, for the ideal cooling combination.

In addition, tile and metal roofing materials can be life-time materials, so the homeowner may never have to replace them and the need for virgin materials is reduced. Lifetime labor costs are reduced by up to 60% compared to roofing materials that need replacing every 15 to 25 years and a huge amount of landfill space can be saved. Clay tiles are biodegradable. Metal roofing typically has a high percentage of recycled content and can be recycled over and over again.

A third benefit of tile and metal roofs is that they are well suited as a collecting surface for rainwater harvesting systems. And because of their longevity, they are a better choice for installation of solar thermal collectors and photovoltaic panels.

6.11 Gutters and downspout system directs water away from foundation to landscaping or catchment system

A rain gutter system is an effective way to help protect a home’s walls, windows, doors and foundations from damage due to stormwater run-off from the roof and reduces termite problems. Water and moisture at the foundation and wall system also attract termites. Directing this captured water away from the foundation to the landscaping or a catchment system will put this water to use, saving on water bills as well.

6.12 Blower door test performed results in envelope leakage no greater than 0.40 ACH (air changes per hour)

For good energy-efficiency, the tighter the thermal envelope of a home, the better it is. A blower-door test determines the amount of air infiltration through the thermal envelope. A large fan is attached to the open front door, the home is de-pressurized, and the amount of outside air entering the home—through all the cracks in the envelope—is measured.

The staff at Austin Energy Green Building believes that it is always best to build the tightest-possible structure and to control ventilation through mechanical means.

Air pressure imbalances cause air to leak into or out of a home. Imbalances depend on such factors as wind speed, whether the mechanical system is turned on, and whether pressure imbalances exist inside the home (e.g. if doors are shut to rooms that have no dedicated return air ducts or pressure-relief measures). The rate of leakage depends on the magnitude of the imbalance.

SECTION 7: PLUMBING AND APPLIANCES

7.01 ≥ R-2 insulation of all water lines located outside the thermal envelope and in exterior walls

Plumbing that is located in exterior walls can compromise the integrity of insulation by causing it to be compressed or otherwise reduced in thickness. This is especially true of plumbing drains that have a diameter only slightly less than the depth of a 4" (nominally, 31/2") stud wall. Installation of plumbing also requires boring or notching of the framing members through which they are installed, so it is good to minimize this in exterior walls.

Water supply pipes are also more prone to freezing when placed in exterior walls, especially cold water pipes which are often not insulated. (The City of Austin code requires that *hot* water pipes be covered with at least ½ inch of insulation when installed within walls.) Condensation can also form on cold water pipes if their temperature falls below the dew point, a situation more likely to occur in an exterior wall.

Insulating hot water pipes reduces heat loss and can raise water temperature 2ºF–4ºF hotter than uninsulated pipes can deliver, allowing for a lower water temperature setting on the water heater. The homeowner also won't have to wait as long for hot water when turning on a faucet or showerhead, which helps conserve water.

Insulate all accessible hot water pipes, especially within 3 feet of the water heater. It's also a good idea to insulate the cold water inlet pipes for the first 3 feet. Use quality pipe insulation wrap, or neatly tape strips of fiberglass insulation around the pipes. Pipe sleeves made with polyethylene or neoprene foam are the most commonly used insulation. Match the pipe sleeve's inside diameter to the pipe's outside diameter for a snug fit. Place the pipe sleeve so the seam will be face down on the pipe. Tape, wire, or clamp (with a cable tie) it every foot or two to secure it to the pipe. If you use tape, some recommend using acrylic tape instead of duct tape.

On gas water heaters, keep insulation at least 6 inches from the flue. If pipes are within 8 inches of the flue, the safest choice is to use fiberglass pipe-wrap (at least 1-inch thick) without a facing. Either wire or aluminum foil tape can be used to secure it to the pipe.

7.02 Gas water heater is sealed-combustion/direct vent model

Sealed-combustion water heaters draw combustion air directly from outdoors through a pipe connected to the burner compartment. The best units have both an air intake pipe and an exhaust pipe. The entire combustion process is totally sealed from the interior of the house, avoiding the introduction of combustion by-products, such as carbon monoxide, into the living space. Consequently, sealed-combustion units are safer and typically more efficient than open-combustion units.

Compare this with most residential gas appliances installed in Central Texas, which are open-combustion designs: the combustion chamber and flue are open to the surrounding air and the flame takes combustion air from the space around it. The hot combustion by-products flow up through the appliance

flue and out of the house because they are lighter than the surrounding air. It's very important for this to occur properly, because combustion gases contain carbon monoxide and other noxious and dangerous gases, which can cause health problems (headache, fatigue, respiratory problems) and even death.

In very tight houses, drawing combustion air from the house and passively venting flue gases up the chimney can sometimes result in back-drafting of dangerous combustion gases into the house. This can occur if depressurization occurs inside the house. This could be caused by a gust of wind, poorly constructed flues, leaks in the HVAC duct system, too many exhaust fans running at the same time, or an over-sized range hood in the kitchen.

7.03 Gas water heater is tankless/on-demand

As described by their name, demand / tankless water heaters have no storage tank for hot water. A heating element heats water only when there is a demand for hot water—i.e. when someone turns on a hot water faucet. Since these water heaters have no stand-by losses (heat loss out the walls of the storage tank), they have higher efficiency—typically 10% to 20% higher than storage-tank water heaters. Note that only gas models receive points on the Rating. Gas models have a higher hot water output than electric ones. Look for a model with electronic ignition to eliminate the energy consumed by a continuously burning pilot light.

Tankless models have additional advantages: they take up less space, they can be installed outside in Austin's climate (solving the venting problem) and they last longer because they are less susceptible to mineral scaling. Tankless models have a life-expectancy of 15—25 years, whereas storage models last only 5—15 years, depending in part on how they are maintained.

Whether or not these water heaters save water and energy may depend on hot-water use patterns within the home.

It is important to choose the right tankless water heater for occupant needs, since adequate water flow of a sufficiently high temperature is limited in many models. Large units intended for whole house water heating are usually located centrally in the house. If necessary, more than one unit can be installed in a home, especially if baths, laundry, and kitchen are not well consolidated. In such point-of-use applications, the water heater usually sits in a closet or under a sink.

For more information see the NAHB research center website:

www.toolbase.org/TechInventory/techDetails.aspx?ContentDetailID=599

OR

7.04 Water heater is solar thermal

According to the DOE/Energy Efficiency and Renewable Energy division, solar water heaters can be a cost-effective way to generate hot water for a home. They can be used in any climate, and the fuel they use—sunshine—is free. Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't.

Most solar water heaters require a well-insulated storage tank. Solar storage tanks have an additional outlet and inlet connected to and from the collector. In two-tank systems, the solar water heater preheats water before it enters the conventional water heater. In one-tank systems, the back-up heater is combined with the solar storage in one tank.

Three types of **solar collectors** are used for residential applications:

- **Flat-plate collector**
  Glazed flat-plate collectors are insulated, weatherproofed boxes that contain a dark absorber plate under one or more glass or plastic (polymer) covers. Unglazed flat-plate collectors (usually used for swimming pool water heating) have a dark absorber plate, made of metal or polymer, without a cover or enclosure.
- **Integral collector-storage systems**
  Also known as ICS or *batch* systems, they feature one or more black tanks or tubes in an insulated, glazed box. Cold water first passes through the solar collector, which preheats the water. The water then continues on to the conventional backup water heater, providing a reliable source of hot water. They should be installed only in mild-freeze climates because the outdoor pipes could freeze in severe, cold weather.
- **Evacuated-tube solar collectors**
  They feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin. The fin's coating absorbs solar energy but inhibits radiative heat loss. These collectors are used more frequently for U.S. commercial applications.

There are two types of active solar water heating systems:

- **Direct circulation systems**
  Pumps circulate household water through the collectors and into the home. They work well in climates where it rarely freezes.
- **Indirect circulation systems**
  Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water that then flows into the home. They are popular in climates prone to freezing temperatures.

Passive solar water heating systems are typically less expensive than active systems, but they're usually not as efficient. However, passive systems can be more reliable and may last longer. There are two basic types of passive systems:

- **Integral collector-storage passive systems**
  These work best in areas where temperatures rarely fall below freezing. They also work well in households with significant need for hot water both day and night.
- **Thermosyphon systems**
  Water flows through the system when warm water rises as cooler water sinks. The collector must be installed below the storage tank so that warm water will rise into the tank. These systems are reliable, but contractors must pay careful attention to the roof design because of the heavy storage tank. They are usually more expensive than integral collector-storage passive systems.

Solar hot water systems should be designed with a solar collection area of 10-15 square feet and 20-30 gallons of storage per person. In central Texas, collectors should be placed facing south and tilted at a 30-degree angle for optimal results. Water-saving faucets and showerheads are recommended to reduce hot-water needs.

Austin Energy offers rebates for installation of solar thermal hot water systems for existing homes that use electric resistant water heaters, as well as for new homes. For information on the rebate:

http://www.austinenergy.com/Energy%20Efficiency/Programs/Rebates/Solar%20Rebates/Solar%20Water%20Heater/index.htm

For more information see the DOE/EERE and NREL websites:

www.eere.energy.gov/consumer/your_home/electricity/index.cfm/mytopic=1285

www.nrel.gov/learning/re_solar_hot_water.html

7.05 Push-button on-demand hot-water recirculation system (not continuously operating pump system)

A huge amount of water gets wasted when we let water run down the drain while waiting for it to get hot. The typical home wastes between 7,000--14,000 gallons per year for this reason. This raises utility bills for both water and energy, not to mention wasting the money, time, equipment and materials used to clean and get that water to the home, heat it, and carry it away in the sewage system. This problem is growing due to the increase in the size of homes, the increase in the size of water pipes, and the increase in the number of fixtures requiring hot water. Aside from the cost of this wasted water, it is annoying to wait for hot water.

An on-demand hot-water recirculation system can significantly reduce wasted water. By running a return line from the last tap on the hot water supply line back to the water heater and installing a small circulating pump, hot water is circulated in the supply line and is quickly available when the faucet is turned on. The direction of flow moves from the water heater through the hot water supply line, through the return line, through the recirculating pump, and then back to the water heater.

This system is user-activated by a button so *hot water is only circulated when needed*. A thermo-sensor in the pipe deactivates circulation when hot water is no longer needed. It's not necessary to have this device on every tap, but it's a good idea for taps that are most remote from the water heater, especially showers. Recirculation pumps tied to a motion sensor or light switch are not advised, since someone might enter the bathroom without wanting hot water.

Note--here are some other factors that affect the amount of water wasted in the wait for hot water:

- Pipe size—the bigger the pipe, the more water will have to be evacuated before hot water arrives. The system should be designed for the smallest size allowed by code.
- Amount of insulation surrounding the pipe—the better the insulation, the less heat will be lost to the pipe itself. Note that the City of Austin requires a minimum of ½" pipe insulation, or ¾" in attics if above the insulation level.
- Distribution design—preferable to more common systems (radial, manifold, parallel pipe or trunk and branch), a half-loop type, with a demand recirculation system, can bring hot water quickly to the tap. All fixtures are on the "supply" portion of the loop, with the "return" length approximately equal to the supply length. Since the fixtures are located on only half of the loop, the pipe size can be reduced. The thermo-sensor to turn off the pump is located after the last fixture, so it is not necessary to heat the second half of the loop. This type of system can be piped with copper, CPVC or PEX.

7.06 Toilet is dual flush or HET (high efficiency toilet) from current City of Austin Water Conservation Program Rebate Toilets list

Dual-flush toilets, long popular in Australia, Western Europe, and East Asia, offer two flush options: a standard flush for solid wastes and a lower-volume flush for liquid wastes and paper. Typical products use 1.6 gallons at the full flush and 0.8-0.9 gallons at the low flush. One manufacturer estimates that a typical family of four will save approximately 7,000 gallons of water per year with this toilet, compared with a standard 1.6 gallon-per-flush toilet. In terms of flush performance, the toilet successfully removes 800 grams of test media at full flush, based on standardized tests.

High-efficiency toilets include pressure-assisted and vacuum-assisted models. Under the tank lid of a pressure assisted toilet there is an inner tank which is completely sealed. When water is fed from the water line, the air inside the tank gets compressed. When the toilet is flushed, instead of just falling by the force of gravity, the water is forced out with the pressure of the compressed air. This pressurized stream of water cleans all the waste from the bowl much more efficiently than the water from gravity toilets. Vacuum-assisted toilets have a vacuum chamber inside the tank that works like a siphon to pull air out of the trap below the bowl so that it can quickly fill with water to clear waste.

7.06 Toilet is ADA model from current CoA toilet list (at least one)

The two standards set forth by the Americans with Disabilities Act that apply to residential toilets are the height to the top of the seat and the location of the flush controls. The top of the seat must be at least 17 inches and no more than 19 inches above the floor. The flush controls cannot be mounted above 36 inches from the floor and must be mounted on the "wide," or unobstructed, side of the toilet. Toilets listed on the CoA toilet rebate list that are available meeting the ADA compliance requirements will have a model number listed as “ADA (17”) Bowl: [model number]”.

7.08 All shower heads have maximum flow of 2.0 gallons per minute; no more than one shower head per shower or tub

A great deal of water is wasted by shower heads with high flow rates. The challenge is to find low-flow models that give a satisfactory shower to the user, but models that give high satisfaction do exist.

There are two types of low-flow shower heads: aerating and non-aerating.

Aerating - mixes air into the water stream. This maintains steady pressure so the flow has an even, full shower spray. Because air is mixed in with the water, the water temperature can cool down a bit towards the floor of the shower. Aerating shower heads are the most popular type of low-flow shower head.

Non-aerating - air is not mixed into the water stream. This maintains temperature well and delivers a strong spray. The water flow pulses with non-aerating shower heads, giving more of a massaging-showerhead effect.

For more information see **www.h2ouse.net.**

7.09 Clothes washer from current WashWise list of the City of Austin Water Conservation WashWise list

The City of Austin Water Conservation Program maintains a list of high-efficiency clothes washers. Due to availability of water and the costs to treat it, the City’s Water Conservation Program offers rebates on the listed models. Some manufacturers offer rebates, as well.

The list includes both top-loading and horizontal-loading models, but typically the horizontal-type (horizontal axis) has some added advantages: they rate very high in both water- and energy-savings (they use on average 40% less water and 50% less energy than typical top-loading washers); they clean by a rotating basket, not agitation, so they are gentler on clothes; they need very little detergent; and because the door is gasketed, they do not add humidity to the home’s interior.

City of Austin high efficiency clothes washer list: **www.ci.austin.tx.us/watercon/sfwasher.htm**

SECTION 8: MECHANICAL

8.01 Cooling tonnage does not exceed 5 tons

OR 8.02 Cooling tonnage does not exceed 4 tons
OR 8.03 Cooling tonnage does not exceed 3 tons
OR 8.04 Cooling tonnage does not exceed 2 tons.

If tonnage is less than 2, write in amount in Section 12)

The square footage of living space per ton of cooling is a good indicator of climate-appropriate design. A well-designed 3,000-square-foot house may require no more cooling than an inappropriately designed 1,000-sq. ft. house. For example, the 3,000 house might have very little wall area and very little unprotected glass facing west, while the 1,000 house might have a lot.

(Of course, cooling tonnage is not the only measure of “greenness”, since the larger house will require much more material. Even if the larger home has fewer occupants than the smaller home, studies show they typically use more water and energy.)

8.05 Whole house, ductless, mini-split heating and cooling system

Long common in other parts of the world, ductless mini-split heat pumps are becoming a popular choice for homes in the U.S., especially for smaller homes (for which the smallest split systems are too large) or those in which a ducted forced-air system would be impractical. While cooling-only models are available, heat pump models, which both heat and cool, are more practical for Central Texas' mild winters which don't require much supplemental heat for a home.

Like standard cooling systems, mini-splits have two main components: an outdoor compressor/ condenser, and an indoor air-handling unit. But unlike standard systems, which distribute cooled or heated air throughout the house via ducts, mini-splits distribute *refrigerant* to air handlers that are located in each room or area to be cooled.

Mini splits come in a wide range of sizes and capacities, with one-to eight air handlers operating off of a single compressor/condenser, making them suitable for a single room or an entire house. Depending upon the manufacturer, air handlers can be hung on a wall, recessed in or suspended from a ceiling, or concealed in a chase. Most use a remote control to make it easier to program the air handler when it's positioned in an elevated location.

Several features of mini-splits make them more energy-efficient than conventional ducted systems. Because each air handler can be set independently of the others, a house can be zoned room-by-room. Some mini-splits rely upon variable-speed fans and compressors to precisely respond to demands for heating and cooling. Energy losses through duct leakage, a major concern with ducted systems, are nonexistent. Mini-splits are available with seasonal energy-efficiency ratings (SEER) up to 21.

For types of construction where there is no or limited space for ducts, a mini-split may be the only option. The lineset (refrigerant lines, condensate tube and power/controller wires) from the air handler to the compressor/condenser generally requires only a three-inch hole for installation.

While window units and PTACs (packaged terminal air conditioners) are also ductless, they are generally not recommended due to their lower efficiency (10 to 12 SEER) and higher noise levels. Most require installation in a window or through a substantial opening in an exterior wall.

8.06 Variable-speed air handler and minimum 600 sq. ft. /ton of cooling

Variable-speed air handlers are desirable for their ability to meet both normal demand (most hours of the cooling season) and abnormal demand (unusually hot times or an above-average occupant load), as well as their superior ability to dehumidify.

Electrically commutated motors (ECMs) for powering fans/blowers are becoming more common in residential air handlers. Electronic controllers automatically change the fan motor speed and the amount of air flow to match heating and cooling requirements. This unique feature of speed variability helps ensure compressor reliability, proper system capacity and airflow distribution through the duct system. Because the motor only runs at a speed that meets required air flow, it can also reduce electric consumption.

ECMs are a necessity for zoned systems, where dampers shut off airflow to one or more rooms in a house. The controller can sense the resulting increase in pressure within the system and lower the speed of the fan motor accordingly. They can also facilitate humidity removal by delivering less air flow across the evaporator coil.

When mechanical ventilation (a requirement for tightly-built houses) is incorporated into the heating and cooling system, ECMs can be used to move just enough air through the system to satisfy ventilation requirements.

NOTE: Some mechanical contractors use installation of ECMs as a rationale to oversize an HVAC system. ECMs allow a system to be sized more closely to heating and cooling requirements, so oversizing the system would be wasteful and inefficient. Points are given for installation of an ECM only for systems serving 600 square feet or more per ton of cooling capacity.

8.07 Variable-capacity compressor and minimum 600 sq. ft./ton of cooling

Variable capacity, dual-stage, or dual capacity compressors can achieve greater efficiency by tailoring refrigerant delivery to meet partial cooling needs. Variable capacity is usually accomplished via inductive control of the compressor motors. While this system is fairly common in ductless mini split systems, it is only now being introduced in the ducted split systems that common in the US or Canada.

More common are systems using either a two-stage compressor or two compressors, one smaller and the other larger. When the system starts, it first operates at the smaller capacity. If the thermostat set point cannot be reached at the smaller capacity, the second stage (or larger compressor) is brought into operation. In other words, only the capacity needed to lower the temperature of the house is utilized.

This type of system can also be used to reduce humidity levels when cooling is not needed. The smaller compressor capacity, coupled with a lower fan speed, dehumidifies with reduced power consumption. When properly sized to heating and cooling loads, dehumidification can be improved as part of the cooling cycle.

NOTE: Some contractors may want to oversize a dual stage system because of its ability to operate at reduced capacity. Superior dehumidification occurs only when the system is properly sized, and an oversized dual stage system will have the same type of comfort problems as a single-speed system and will increase peak electricity demand. Points are given for installation of multi-stage systems serving 600 square feet or more per ton of cooling capacity.

8.08 Ground-source heat pump

Ground-source or geothermal heat pumps are different from traditional air source heat pump units in that there is no outside condensing unit. Instead of rejecting heat from the cooling cycle to the air, the heat is rejected to the earth or water through buried or submerged piping. The indoor unit is the same as other heat-pump equipment.

Ground-source heat pumps take advantage of the near-constant temperatures that exist underground or in the deeper waters of lakes. In the summer, heat is removed from the house and transferred to the earth or water, which is at a lower temperature. In the winter, the process is reversed, with the heat pump extracting heat and then transferring it into the conditioned space.

These systems are energy efficient in both heating and cooling when compared to conventional (air) heat pumps, but the initial cost is greater. Ground source heat pumps can achieve efficiency ratings as high as 28 SEER, producing energy savings of 25-50% over air source heat pump units and up to 75% better than electric resistance heating. Ground source heat pumps are a good solution in locations where electric rates are high and steps to reduce cooling loads (better windows, more insulation, reflective roofing) have been taken.

Different types of installations include:

- **Trench**— Trenches for the tubing, often hundreds of feet long, require a lot of surface area, but may be the only option in hard to drill areas. Refrigerant is sent through closed spirals of tubing and back to the indoor unit.
- **Deep Well** — Wells are drilled (usually one per ton of cooling) and refrigerant is sent through closed, deep pipes and back into the unit. Requires less land area than the trench installation, but drilling the wells may be more costly than trenching.
- **Water source** — An open system where water is pumped into a deep well and drawn out of an adjacent well. Prohibited in many areas due to concern over potential for groundwater contamination.
- **Lake Source**—If a large private body of water is nearby, it can be the most economical ways to reject heat. Closed tubes are extended to the bottom of the lake and back.

All of these systems require careful calculations to ensure the length of pipe run will reject enough heat to operate the unit efficiently.

8.09 Gas furnace is sealed combustion/direct vent model (CoA requirement if located in “sealed” attic)

Sealed-combustion furnaces draw combustion-air directly from outdoors through pipes or tubes connected to sealed-burner compartments. The best units have both an air intake pipe and an exhaust pipe. The entire combustion process is totally sealed from the interior of the house, avoiding the introduction of combustion by-products into the living space. Consequently, sealed-combustion units are safer and usually more efficient than open-combustion units. They get all the air they need for the flame to burn from outside the home, not from the air in the living space. They prevent dangerous and noxious gases, such as carbon monoxide, from entering the home, in case of a drop in air pressure.

Compare this with most residential gas appliances installed in Central Texas, which are open-combustion designs: the combustion chamber and flue are open to the surrounding air and the flame takes combustion air from the space around it. The hot combustion by-products flow up through the appliance flue and out of the house because they are lighter than the surrounding air. It’s very important for this to occur properly, because combustion gases contain carbon monoxide and other noxious and dangerous gases, which can cause health problems (headache, fatigue, respiratory problems) and even death. Combustion gases may back-draft into the living space, however, if depressurization occurs inside the house. This could be caused by a gust of wind, poorly constructed flues, leaks in the HVAC duct system, too many exhaust fans running at the same time, etc.

8.10 Hydronic space heat supplied by gas water heater or is solar-assisted

A gas-fueled, combination (“combo”) hydronic space-and-water heating system uses a water heater as a heat source for a forced-air heating system. Hot water from the water heater circulates through a heat exchanger in an air-handler, where a blower moves the heated air into a standard duct system to supply warm air to the supply registers.

This system saves space, since no furnace is necessary. It also avoids combustion gases that are produced by a gas fired furnace. More than one air handler can be connected to a single water heater if a zoned system is desired.

Note that the water heater must be sized for the heat load of the house (not the desired hot-water amount) and a minimum recovery-efficiency of 76% is required. Models with recovery-efficiency ratings of up to 90% are available. The higher the recovery-efficiency and energy factor, the lower the utility bills will be for the homeowner.

Hydronic systems can also be connected to solar thermal collectors, providing space heating as well as domestic hot water. Both the heating requirements of the living space and hot water requirements must be calculated to determine the correct size/number of the solar collectors and the appropriate storage capacity. Gas or electric back-up water heating will be necessary for periods of persistent low temperatures or cloudy conditions.

8.11 Sheet metal plenum and main trunk lines; any flex-duct take-offs are no longer than 10 feet

An air-delivery system of a sheet-metal plenum and main trunk lines with short flex-duct runs (no longer than 10’) will result in good air-flow, more even temperatures from room to room, and greater energy-efficiency. This will help improve total system efficiency.

As handy as flex-duct is to install, it was not designed for long duct runs, due to its corrugated, high-friction interior surface and consequent reduced airflow. It was designed for very short turns that would be difficult or not cost-effective to fabricate from metal.

Main trunk lines should be used to avoid the “octopus” effect. If too many sections of flex duct are run directly from a small plenum, airflow will not be equal among them. Some will receive more air than necessary and some will receive too little.

8.12 Air-tight supply buckets/boots (ductboard or pre-fabricated)

The 2006 IECC code requirements for HVAC duct system joints and seams requires that they "shall be made substantially airtight by means of tapes, mastics, gasketing or other approved closure systems". Air-tight supply buckets or supply boots are available ready-made that meet this requirement by using snap rail flanges. This improved boot design is available either uninsulated or wrapped with an R-6 EPS cover.

Supply buckets fabricated from ductboard can be made fairly leak-proof, since they have a minimum of seams that can be sealed with mastic or approved tape. Care should be exercised to avoid damaging the outer surface of unlined ductboard – small holes or scrapes can allow supply air to escape.

8.13 Ceiling registers are curved-blade type located high on walls or in ceiling

Supply registers can have a substantial impact upon the amount of air delivered to a room and how that air is distributed. Ceiling registers with curved blades can reduce noise and increase air flow, and they redirect air for a better throw into the room – registers with flat blade deflect the air, reducing flow. The builder should ensure that the size, location and type of the register are matched to the air flow requirements for each room.

Registers should be located either in the ceiling or high on a wall so as to distribute air across the room, not down toward occupants.

8.14 Ductwork system is masked/sealed at supplies and returns during construction

In most residential construction, the ducts are installed after the structure is framed, but before drywall, paints, and other components are installed. If the openings in the ductwork are not sealed, dust and other contaminants common during the construction process can settle in them. These contaminants, if deposited on the blower and coil, reducing system efficiency. Dust in the ducts can also contribute to the growth of mold and dust mites.

All ducts should be sealed at the supplies and returns until the rest of the mechanical system is installed and work in the interior of the house is substantially complete.

8.15 HVAC filter: $\geq$ 4" pleated-media, or electronic (not electrostatic); easily accessed (HVAC system designed for filter type)

The filter is an important part of the heating, ventilating, and air conditioning (HVAC) system. A good filter protects the evaporator coils, blower fan, and ducts from becoming covered with dust, pollen and other particulates that can significantly decrease the HVAC unit efficiency and shorten its life. A good filter can improve the quality of conditioned indoor air for the occupants, as well.

Standard woven-fiberglass panel filters provide no improvement in indoor air quality and only minimal protection for the HVAC equipment. They are ineffective at protecting the HVAC equipment (the fan motor and heating/cooling coil) and they do not remove indoor dust and air pollutants that irritate people. Such filters are rated <1 on the MERV scale (Minimum Efficiency Reporting Value). (The MERV system rates filters on a scale of 1 to 20, 20 being the most effective at removing contaminants.) Since these fiberglass filters can only screen out very large particles, such as pollen and dust mites, they are not recommended, in spite of their low price.

A pleated-media filter is reasonably effective at doing these two jobs for a modest price and is therefore a far superior choice for the cost. A 4-inch filter typically lasts at least six months in most households, especially one without pets. People who get twice-a-year HVAC maintenance (a good idea) can have the technician take care of the filter and they never have to bother with it themselves. They are about 5--10 times more efficient than standard woven-fiberglass filters, mainly depending on the thickness installed

(20%—75% efficiency range on a dust-spot test and 6 - 12 on the MERV). An electronic (not electrostatic filter) is also acceptable (dust spot efficiency of 90%).

Due to its substantial impact on airflow, the filter must function properly with the mechanical system. In new homes, it should be possible to get good filtering and proper airflow at the same time. More efficient filters may require a more powerful blower.

Electronic filters use high voltage to charge particles in the return-air stream. They are the most efficient kind of filter (90% "dust spot" rating) and restrict air flow only minimally. However, they are very expensive, use electricity, and must be well-maintained. They are the best filter for people with severe allergy problems but may not be practical for other people.

Another choice for people suffering from allergies is a HEPA (high efficiency particulate arresting) filter. It is made of ultra-fine glass fibers pressed into a paper-like material, which is folded in pleats to maximize surface area, thereby improving air flow and increasing the apparent thickness of the filter medium relative to the particle's angle of attack. The principle means by which HEPA filters stop particles is simply through impact. As a particle tries to penetrate the filter it runs into a fiber and remains there because of the attraction between positively-charged and negatively-charged materials.

Note: we do not recommend electrostatic filters (even though they have the virtue of being reusable and of not restricting air flow) because they are not very efficient. Ozone generators are not recommended because ozone is a powerful oxidant and can damage lung tissue.

***Note: The mechanical system must be designed for the filter used because filters affect airflow*.** Also, location of filters is also an important part of design: they should be located for easy maintenance.

8.16 Mechanical ventilation with damper brings outside air into return-air plenum

Improvement in building materials and construction techniques produces tighter houses, which means some degree of mechanical ventilation is desirable to maintain indoor air quality. The amount of mechanical ventilation required depends on a number of factors: size of the house, number of occupants, rate of natural infiltration (tightness), amount/types of indoor pollutants, and climatic conditions.

In the past, ASHRAE 62.2 called for a combined natural infiltration/mechanical ventilation rate of .35 ACH (air changes/hour). For example, if a house with an interior volume of 13,050ft^3 (1450ft^2 with 9 foot ceilings) has an infiltration rate of .2 ACH - or 43.5cfm - it would require additional continuous mechanical ventilation of 33cfm for a total rate of 76.5cfm to meet the .35 ACH benchmark.

The current standard for ventilation, ASHRAE 62.2-2004, sets a ventilation rate based on the square footage of the house and estimated number of occupants (number of bedrooms + 1), resulting in a ventilation rate for smaller houses that is similar to the prior standard, but generally lower for larger houses. It is up to the builder and mechanical contractor to determine the natural infiltration rate and what amount of mechanical ventilation is required using the following formula:

$Q_{fan} = 0.01A_{floor} + 7.5(N_{br}+1)$
where
Q_{fan} = fan flow rate in cubic feet per minute (cfm)
A_{floor} = floor area in square feet (ft^2)
N_{br} = number of bedrooms; not to be less than one

Keep in mind that the above formula includes a default credit for ventilation provided by infiltration of 2cfm/100ft^2 of occupiable floor space. For example, if the 1450ft^2 house in the example above had three bedrooms, then *.01 x 1450 + 7.5 x 4* = 44.5cfm continuous ventilation. When added to the default infiltration of 29cfm (2cfm/100ft^2), the resulting total ventilation rate is 73.5cfm, very close to 76.5cfm of the old ASHRAE 62.2. A house with an infiltration rate of less than 2cfm/100ft^2 would need more mechanical ventilation; a house with infiltration greater than 2cfm/100ft^2, less mechanical ventilation.

Fresh outside air can be added in a controlled manner to the air distribution components of the heating and cooling system by use of an outside-air intake-duct. When connected to the return air plenum, a fresh-air duct allows outside air to be mixed with the house air when the heating or cooling system is operating. A timer can be added to introduce fresh air into the home periodically (e.g. every twenty minutes) when the heating and cooling system is not operating. A balancing damper controls the flow of fresh air into the system.

Certain thermostats can also accommodate control of mechanical ventilation systems. In some cases, they will prevent ventilation when outdoor temperatures are too high or low, or outdoor humidity is excessive.

Note: ASHRAE 62.2-2004 sets a maximum whole-house mechanical net exhaust flow of 7.5 cfm per 100 ft^2. Some integrated ventilation systems take into account exhaust fan operation and can adjust the operation of ventilation fans accordingly so as to not exceed the maximum rate. Care should also be taken to temporarily reduce ventilation rates when the outdoor temperature/humidity is extremely high.

8.17 Stand-alone hygrometer; OR thermostat has integral hygrometer or humidistat

A hygrometer measures both temperature and relative humidity. Although it doesn't "do" anything, it serves as a powerful tool to help occupants better understand and operate their home.

A thermostat with an integral humidistat can allow certain cooling equipment to maintain a desired relative humidity. This is especially valuable in the spring and autumn when humidity is high but the temperature moderate, causing the system to "short cycle" and turn off before moisture in the air has had a chance to condense on the evaporator coil located inside the house. Humidistats are usually combined with variable-speed air handlers (see 8.06). When set to dehumidify, the air handler operates at a lower airflow which allows the evaporator coil to reach a lower temperature more quickly.

Humidity control is important in Central Texas homes since high humidity conditions that foster mold and mildew growth consistently occur year-round. Poor construction methods and over-sized cooling systems exacerbate this problem. The source cannot be easily eliminated, so mechanical ventilation and dehumidification are often the best solutions.

8.18 Energy Star Programmable thermostat

A thermostat, in its simplest form, must be manually adjusted to change the indoor air temperature. Programmable thermostats can be pre-programmed to adjust temperature automatically, according to occupants' lifestyle, and thus have the potential to reduce monthly heating and cooling bills by up to 10%.

All ENERGY STAR qualified programmable thermostats perform one or more of the following energy control functions:

- Store and repeat multiple daily settings, including a "hold" feature that allows users to temporarily override automatic settings without deleting programs (For example, programming can be adjusted to maximize savings during a vacation or extended absence)

- Store four or more temperature settings a day, including separate weekday and weekend programs, each with up to four customized temperature settings—two for occupied, "in use" periods and two for energy-saving periods when the house is unoccupied or occupants are asleep
- Adjust heating or cooling turn-on times as the outside temperatures change

Other desirable features include:

- An advanced recovery feature that can be programmed to reach the desired temperature at a specific time in a way that minimizes system run-time and auxiliary heat use
- Ability to maintain room temperature within 2 degrees Fahrenheit of desired temperature Digital, backlit displays
- Touch pad screen programming
- Voice and/or phone programming
- Hold/Vacation features
- Indicators which tell you when its time to change air filters
- Indicators that signal malfunctioning of heating/cooling systems
- Adaptive Recovery/ Smart Recovery features - control features that senses the amount of time it will take to reach the next set-point temperature, and reach desired temperatures by the set time

Homeowners need to be instructed on how to use their programmable thermostat.

8.19 Air distribution system leakage no greater than 5%

Air-distribution system leakage no greater than 10% as verified by a direct duct-pressure test performed by approved 3rd party, is required by the City of Austin energy code for all homes permitted since January 1, 2008 and for homes in any location rated under the AEGB program. Leakage of no greater than 5% represents a substantial improvement over that requirement.

Air leakage is more difficult to identify than water leaking from pipes, but the problems created by it may be just as serious. These problems may include loss of conditioned air, infiltration of unconditioned outside air, unbalanced supply-air flow, backdrafting of combustion gases from gas appliances, and introduction of dust, pollen, and mold into living spaces.

HVAC system leakage testing and repair can improve cooling equipment efficiency, operating conditions, and indoor air quality in a home in four ways:

1. **The quality of workmanship can be evaluated.** When leaking supply air ducts are located in an attic, for example, the conditioned air leaks out into the attic and is eventually vented to the outside without ever reaching a living space. It is obviously inefficient and costly to condition air only to have it leak to places where it is not needed. Good test results can assure the homeowner that conditioned air is being delivered to actual living space and not unintentionally to locations outside the home's thermal envelope.
2. **Air pressure imbalances in a home may be discovered.** When the indoor air pressure is negative, for example, the house can draw in hot, humid outdoor air, and also from the attic, crawl space, basement or garage. In addition, gases can be drawn into the living space from flues and chimneys. This is called backdrafting and can occur when fireplaces, gas furnaces and gas water heaters are being used or operated.
3. **Health and safety risks can be assessed.** Sealing leaks in return-air ducts stops pollutants from being drawn into the home from the attic (insulation fibers, dust), crawl space (moisture, pesticides, mold and mildew spores, animal residue, insulation fibers, dust), and the garage (car exhaust, carbon monoxide, chemical fumes, dust).
4. **A smaller capacity and less costly cooling unit may be installed.** A person performing Manual J calculations (see above) can now rely on correct duct installation and therefore won't be tempted to over-size the equipment.

The duct leakage test is typically performed by the 3rd party home performance testing company when construction is complete. It is good practice, however, for the mechanical contractor to test at the rough stage to be sure he is on track to pass the final 3rd party test. This is particularly critical if ductwork will not be accessible later on (e.g. it is located in a furred down or house is 2-story with ductwork in the floor between). A final test at completion is always needed, however, since damage may occur at a later time during construction.

Builders should be sure that their agreement with their mechanical contractor states that testing will be done, and that the mechanical contractor is responsible for workmanship that meets the Rating standard.

SECTION 9: ELECTRICAL

9.01 Ceiling fans in all main rooms and bedrooms (not required in dining areas)

Air moving over the skin increases the evaporation rate of moisture on the skin, which has a cooling effect. A person exposed to moving air will be comfortable at a temperature four to five degrees higher than if he is in still air. The thermostat can be raised several degrees, thus saving on expensive air-conditioning. Ceiling fans are a low-cost way of making people more comfortable in hot weather. A ceiling fan costs about the same to run as a 100-watt incandescent bulb.

Ceiling fan blade spans range from 29 to 54 inches. To determine which size you need, measure the room where the ceiling fan will be installed and follow these guidelines:

Room Dimensions	Suggested Fan Size
Up to 75 ft^2	29 - 36"
76 - 144 ft^2	36 - 42"
144 - 225 ft^2	44"
225 - 400 ft^2	50 - 54"

Energy Star-qualified ceiling fans provide more energy savings with improved motors and blade designs, and light kits. Ceiling fan/light combination units that have earned the Energy Star designation are about 50% more efficient than conventional fan/light units. This can save $15-$20 per year on utility bills, plus any additional cooling or heating savings that may be gained when fans are operated properly.

9.02 Whole-house fan with insulated cover

A whole-house fan (also known as an attic fan) can reduce the need for mechanical cooling when properly used. Opening windows and running the whole-house fan whenever the outdoor temperature is lower than the indoor temperature and relative humidity is not too high will help cool the house.

When a whole-house fan is installed in an attic, care must be taken to ensure that enough ventilation pathways are present in the attic to exhaust the air out. Determining the amount of airflow in cubic feet per minute (cfm) that the whole house fan should provide involves a simple calculation. Multiply the total gross square footage of the house (include upstairs area) by the ceiling height (typically 8 feet). Select a fan that delivers between one half to one times that amount of cfm at 0.1" static pressure. For example, a 25'x40', one-story home is 1,000 square feet and would need an 8 x 1,000 x 0.5 = 4,000 cfm fan or better. One manufacturer offers a two-speed unit that delivers 4,500 cfm at the high setting (240 watts) and 3,200 cfm at low (120 watts); this unit should be adequate.

A removable, insulated cover should also be installed for use when the fan is not on. If an insulated cover is not used, conditioned air will escape from the living spaces through the fan opening. Because the louvers are leaky, a cover should be purchased or constructed to seal and insulate this opening during the seasons when the fan is not in operation. The cover can be installed from the attic side if attic access is easily available or from the house side. Both covers could be included in excessively hot or cold climates. Homeowners must remember to remove cover(s) before operating the fan and to replace cover(s) during seasons when the fan is not in use.

Homeowners should be informed that the fan must be used in conjunction with open windows. Closing windows in unused rooms will create higher velocity air movement in occupied rooms. They should also be told that during times of high humidity, it’s better to use the central cooling system, which dehumidifies the interior air, rather than the whole-house fan, which will draw in outside humid air.

Note: do not install a whole-house fan if attic is sealed (not ventilated).

9.03 Bathroom exhaust-fans connected to timer or humidistat (recommended sone rating ≤1)

Whether a bathroom fan is connected to the light switch or is independently switched, the occupant typically turns off both at the same time, before the fan has had time to exhaust excess humidity (this typically requires a run-time of about 20 minutes.. Separating these functions and connecting the fan to a timer or humidistat will do a much better job of reducing excess humidity.

Ideally, a fan exhausts enough air to get rid of the excess humidity without making so much noise that no one wants to turn it on in the first place. After the correct CFM rating is selected (see above) the sone (sound) rating should be selected. (One sone is equivalent to the sound of a quiet refrigerator in a quiet kitchen.) Typically, the sone level is measured at maximum CFM (speed). However, some newer products are also being tested at normal CFM (speed) settings to provide consumers with typical sound level information. Installing a fan with a sone rating no greater than 1.0 increases the likelihood that the occupants will use it. A combination of a more powerful fan motor and a larger turbine (fan blade) results in a quieter fan.

Installation quality is equally important to having a quiet fan, however. The duct should be right-sized for the fan, as short as possible, taut and well supported, and have no kinks or compression (just like HVAC ductwork). Although in-line fans that mount in the attic, not in the ceiling, are the quietest, they are not recommended because they tend to exhaust so much air, they can easily depressurize the house. This causes an increase in air infiltration and risk of backdrafting from gas-appliance.

9.04 Recessed-can lighting fixtures installed do not break through the thermal enclosure OR no recessed-can fixtures are installed

Research shows that recessed can lights (even air-sealed IC-AT type) in insulated ceilings are one of the largest sources of air loss in homes because they usually puncture and compromise the thermal envelope.

If a home has a sealed attic (polyurethane foam at the rafters) can lights are acceptable. They are also acceptable in the first-floor ceiling of a 2-story home. Otherwise they must be omitted for these points to count.

9.05 ENERGY STAR Advanced Lighting Package (ALP) requirements met

An ENERGY STAR Advanced Lighting Package includes only lighting fixtures and ceiling fan products that are rated for compliance according to EPA/DOE's stringent requirements aimed at maximizing efficiency and energy bill savings. The ALP designation apaplies to lighting packages that consist of a minimum of 60% ENERGY STAR-qualified hard-wired fixtures and 100% ENERGY STAR qualified ceiling fans. ENERGY STAR-qualified recessed downlights, ceiling fan light kits and ventilation fans with lighting may also be counted toward the fixture requirement. Certain fixtures are required to use non-screw based technologies for sustained savings so that CFL or LED bulbs cannot be replaced by standard screw-in incandescent bulbs.

9.06 A minimum of five items from the following list are Energy Star qualified: appliances, light fixtures/luminaries, ceiling fans, and/or ventilation fans

ENERGY STAR-qualified appliances incorporate advanced technologies that use 10–50% less energy and water than standard models. The money saved on utility bills can more than make up for the cost of a more expensive but more efficient ENERGY STAR model. A helpful website for identifying the *most* efficient dishwashers and other appliances is **www.aceee.org**.

The average dishwasher uses 8 -12 gallons of water when set on its normal cycle. Though electricity or gas is used to run the machine, about 80% of the energy consumed by the dishwasher is used to heat the water. Decreased water usage can save hundreds of dollars over the lifetime of a machine. Some dishwashers have options to allow the adjustment of the machine's settings to reflect the size of the load and how dirty the dishes are. This can also lower the water use and therefore the energy bills. An efficient dishwasher typically consumes less water and energy than washing by hand under a running faucet.

ENERGY STAR-labeled dishwashers are at least 25% better than the federal water and energy requirements set for dishwashers. A list of these appliances and other information on efficient appliances can be found at the ENERGY STAR web site. Although Energy Star does not measure water efficiency, Energy-Star-rated dishwashers typically use 30-50% less water.

Check out these websites: **www.epa.gov/WaterSense/**

www.energystar.gov/index.cfm?c=dishwash.pr_dishwashers

ENERGY STAR qualified ceiling fans use improved motors and blade designs. Ceiling fan/light combination units that have earned the Energy Star are about 50% more efficient than conventional fan/light units.

ENERGY STAR qualified kitchen range hoods, bathroom and utility fans, and inline fans provide energy savings and are significantly quieter than standard models. Qualified ventilation fans that include lighting use 70% less energy on average than standard models, saving $120 in electricity costs over the life of the fan. These fans high performance motors and improved blade design, providing better performance and longer life and are more than fifty percent quieter than standard models.

9.07 A minimum of 90% of lamps/bulbs are Energy Star-compliant

Lighting fixtures that have earned the Energy Star designation combine high performance, attractive design, and highest levels of energy-efficiency, so they save energy, save money on utility bills and help protect the environment. Energy Star fixtures accommodate bulbs that have a minimum life of 10,000 hours. This means that with regular use (i.e., four hours per day), you won't need to change the bulb for at least seven years. All Energy Star-qualified light fixtures carry a two year warranty - double the industry standard. They also have a color rendition index (CRI) of 82 or higher, so the colors they illuminate look true and natural. Qualified fixtures can now be found at most home centers, lighting showrooms, and specialty stores. Look for qualified fixtures for the following applications: torchieres, under and over cabinets in the kitchen, ceiling-mounted, wall sconces, suspended fixtures and outdoor lighting, including motion sensor fixtures.

9.08 Exterior light fixtures are designed to reduce up-lighting / light pollution, or locations are shielded from above

Exterior light fixtures, which allow light to shine above the horizontal plane, create light pollution and rob people of being able to see the night sky. Furthermore, they frequently cause annoying “light trespass” on to neighboring property, and are often a safety hazard because they produce a blinding glare.

An obvious result of all this wasted light is the huge waste of the energy required to produce it. The International Dark-Sky Association estimated in 1996 that the cost of energy spilled upward into the night sky was nearly 1.5 billion dollars per year in the U.S. alone. The cost of energy wasted in light trespass was not calculated. The costs of power production and the resulting pollution are borne by the whole community.

Attractive, appropriate light fixtures that prevent up-lighting are now readily available. Fixtures that reduce light trespass as well are also available. Wattage of the lamps/bulbs should be as low as possible to reduce glare, promote safety and prevent energy waste. The eye adapts very quickly to low light levels at night.

The International Dark-Sky Association (IDA) provides objective, third-party certification for luminaires that minimize glare, reduce light trespass, and don’t pollute the night sky. For a modest fee, IDA will evaluate the photometric data of any luminaire submitted by its manufacturer. When the fixture is approved, the manufacturer receives a certificate and the Fixture Seal of Approval. Manufacturers may use the FSA seal to promote and advertise their IDA-Approved™ Dark Sky Friendly products. For a directory of lighting fixtures approved by the International Dark Sky Association see: www.darksky.org/fixtures/.

Note: to earn the points of this measure, it is not necessary to install IDA-approved fixtures.

9.09 All exterior lighting has motion detectors with photocell controllers or is solar-powered

Outdoor lighting that is fluorescent, motion detector, or photocell-controlled will reduce energy costs to the homeowner and provide security or landscape lighting when it is needed.

Fluorescent lighting is much more energy-efficient than incandescent lighting. For example, a 27-watt fluorescent lamp will produce the same amount of light as a 100-watt incandescent and will last ten times longer, on average. This reduces both the cost of operating the lighting and the replacement costs. Exterior light fixtures are often hard to reach—another good reason to install a long-lasting lamp.

Motion-detector lighting provides security lighting when someone enters the field of the motion detector. This type of security lighting is far more effective than constantly illuminating security lighting, since people tend to ignore an unchanging environment. It also saves energy by having the light on only when it is needed. This is convenient for the occupant needing to find the keyhole at night, and makes him/her feel safer. Motion-detector lighting should be equipped with a photocell. Photocells sense ambient light and only turn on when ambient light falls below a certain level.

Solar-powered outdoor lighting fixtures use photovoltaic cells to produce electricity directly from sunlight.

9.10 Central vacuum system; exhausts to the outside

Central vacuum systems offer numerous advantages in terms of improved indoor air quality, reduced energy usage, and reduced landfill waste. When installed with exhaust air to the outside, many pollutants are removed from the indoor living space. Additionally, several central vacuum power units offer the following environmentally friendly advantages:

- Made of recyclable steel, reducing the impact on landfills
- Require no paper bags or filters reducing the impact on forests and landfills
- Longer life - less impact on landfills than traditional vacuum cleaners
- Built-in dust pan to encourage sweeping dust to the pan, which means the central vacuum runs less, thus conserving energy
- Turbine powerheads run from the airflow of the central vacuum instead of from electricity, so they further reduce the amount of energy used

9.11 Solar photovoltaic (PV) power system installed: 1.5 kW minimum

9.12 Solar photovoltaic (PV) power system installed: 3.0 kW minimum (at least 1.5 kW in addition to 9.10)

Solar electric photovoltaic panels turn a home into its own power plant. Although it is not yet practical for a home connected to an electric grid to have a solar PV array large enough to meet its entire need for electricity, a small array provides an excellent supplement.

However, it makes sense to install PVs only after insuring that the home is built to a high standard of energy-efficiency. Otherwise the PVs would be like lipstick on a pig (or *hog*, to be more apt).

A photovoltaic (PV) or solar cell is the basic building block of a PV (or solar electric) system. An individual PV cell is usually quite small, typically producing about 1 or 2 watts of power. To boost the power output of PV cells, we connect them together to form larger units called modules. Modules, in turn, can be connected to form even larger units called arrays, which can be interconnected to produce more power, and so on. In this way, we can build PV systems able to meet almost any electric power need, whether small or large.

The most common array design uses flat-plate PV modules or panels. These panels can either be fixed in place or allowed to track the movement of the sun. They respond to sunlight that is either direct or diffuse. Even in clear skies, the diffuse component of sunlight accounts for between 10% and 20% of the total solar radiation on a horizontal surface. On partly sunny days, up to 50% of that radiation is diffuse. And on cloudy days, 100% of the radiation is diffuse.

It is the law in the State of Texas that an electric provider must buy back excess electricity produced by a home or building. Some electric service providers try to discourage the installation of grid-tied systems by making the process difficult and costly.

Within the Austin Energy service grid, this is not a problem, however. Homes may have PVs installed to supply energy to the home or to the centralized grid when the PV power exceeds the homeowner's need for electricity. The interface between the home-produced power and the grid can be metered so that when power produced by the PVs is sent into the grid, the meter will run backwards and the homeowner's utility bill will be credited. When power is needed from the grid, the meter will run forward and the utility bill will be charged. The monthly utility bill will therefore be the cost for the home's "net energy use" – total power provided by Austin Energy minus the unneeded power the home's PV system sent back to the electric grid.

To encourage the implementation of solar technology, Austin Energy offers rebates to its qualifying electric customers to help offset the cost of a solar photovoltaic electric system or solar-thermal hot water system. One of the highest in the country, this rebate level will pay between 45-75% of the cost of installation of a solar system. For example, the cost of installation of a 1-kilowatt (1,000 watts) solar system, the smallest considered practical, is expected to cost between $6,000 and $10,000. The Austin Energy rebate will pay approximately $4,000 toward the installation.

For more information about how PV systems work, visit the DOE Energy Efficiency and Renewable Energy website:www1.eere.energy.gov/solar/photovoltaics.html

For more information about the Austin Energy solar rebate program visit:

www.austinenergy.com/Energy%20Efficiency/Programs/Rebates/Solar%20Rebates/index.htm

SECTION 10: INTERIOR CONSTRUCTION AND FINISHES

10.01 Interior moulding is finger-jointed or MDF

10.02 OR Interior moulding is locally milled local species; made from agricultural waste product; or is FSC-certified wood

Such materials have many environmental and other advantages. The doors/cabinet faces/trim made of wood from local species keeps local money in the local economy, as well as saving the additional expense and pollution that would be incurred if the products were shipped long distances.

Engineered trim is designed to do its job properly and use resources efficiently at the same time. It may be made up of smaller pieces of lumber or from small, fast-growing tree species, thus saving our old-growth forests.

FSC-certified (Forest Stewardship Council) wood means that the lumber has been taken from a certified, sustainably harvested forest that is well managed to preserve wildlife, plant life, water, soil, and the health of the forest for future generations.

10.03 Cabinet boxes, doors, drawers + adhesives: a) meet E1; or b) CARB Phase 1; or have no added urea-formaldehyde

Since formaldehyde is a known threat to health, reducing its use in building products is a prudent thing to do. Formaldehyde is a common component of typical cabinet materials, such as interior plywood, most medium-density fiberboards (MDF), and particleboard. Materials that meet the E1 standard (in effect in most European countries as well as others that have adopted an equivalent standard) have formaldehyde emissions no greater than 0.1 parts per million. Materials meeting this standard are usually so marked on their labeling. If there is any question as to whether a material meets the standard, contact the manufacturer.

CARB Phase 1: In April 2007 California adopted limits on formaldehyde for panel materials that are similar to the E1 standard. (The California standard relies on the ASTM E-1333-1996 testing protocol, which differs from the European protocol.) The initial phase of standard takes effect in January 2009.

See **http://www.arb.ca.gov/toxics/compwood/compwood.htm**

Examples of materials that do not contain added formaldehyde are solid wood, metal, glass, and "formaldehyde-free" MDF panels. In regard to these MDF materials, that means that no formaldehydes have been added during manufacture. Very low levels of formaldehyde may occur naturally in the wood itself.

10.04 At least 75% of all cabinet faces are locally milled local species; or FSC-certified wood

10.05 At least 75% of all doors are locally milled local species; or FSC-certified wood

See 10. 2 above.

10.06 Structural floor is the finish floor for a minimum of 50% of all floor area (e.g. exposed concrete, single-layer wood)

When the finish floor of a home is also the structural floor, materials and installation labor can be cut substantially, significantly reducing overall material needs and costs.

Exposed concrete floors are extremely durable, easy to clean and maintain, and are very desirable in today's marketplace. They may be colored with low-toxin pigments, scored, and finished in patterns, for great, aesthetic appeal. As an added bonus, they also provide an energy benefit, due to the ideal ground temperature in Central Texas.

Single layer wood flooring (no sub-floor) usually consists of tongue-and-groove 2x solid lumber. Since construction-grade lumber is usually used for this purpose, it is less expensive than flooring-grade wood laid over a sub-floor (and saves the cost of the sub-floor) and can be very aesthetically appealing. Since both sides of the lumber can be exposed, it can be installed to serve as the finish ceiling of the lower story of a two-story house, an even more material-conserving and beautiful technique. Note, however, that this application does not provide sound protection, and since no wiring or other "guts" can be run in the ceiling, careful planning is required to find other locations for them.

10.07 Finish flooring is durable material for minimum of 50% of all floor area (e.g. ceramic tile, concrete, wood)

OR

10.08 Flooring is 100% durable material

When floors are made of the durable materials listed above, they require less maintenance, less frequent replacement (in some cases, they never need replacing) and contribute to a healthier indoor environment, for both the installers and occupants. They are easier to clean and do not harbor dust mites, as carpet does.

NOTE: Although soft vinyl flooring (sheet vinyl) has some of these same benefits, it is does not qualify for these points, due to our efforts to reduce the use of fossil-fuel and chlorine-based materials, with their associated health and environmental risks. Superior substitutes are readily available, such as true linoleum. Vinyl composition tile currently remains on the acceptable list because it does not contain plasticizers--chlorine-based compounds that increase health risks and environmental burdens.

10.09 Flooring is rapidly renewable or reused material for a minimum of 25% of all floor area (e.g. cork, wool)

Rapidly renewable materials can be replenished quickly and have minimal negative environmental impacts. Examples of such materials are cork, linoleum, bamboo, and carpeting of sisal, sea grass, jute, and wool.

- Cork can be safely harvested from cork trees every nine years. It provides acoustic and thermal insulation, is resilient (if dented, returns to its shape), is air and water-tight, termite and rot-resistant, and provides a pleasant cushion underfoot. It is no longer made with urea-formaldehyde binders.
- Linoleum (made from linseed oil, wood flour, cork flour and ground limestone) is extremely durable and resilient (good point load, so very resistant to high heels), naturally anti-static and anti-bacterial (therefore popular in hospitals), resistant to oil and many solvents, and has low flammability. Do not confuse it with vinyl.
- Bamboo is harvested about every six years and is as hard as maple, but is more stable in conditions of changing humidity (as is common in our climate) than hardwoods. Buyers should look for products which do not contain added formaldehyde in glues and finishes.
- Wool carpet naturally resists dirt and stains, reduces the problem of static electricity, is flame resistant, and will far outlast synthetic carpets because of its natural resilience (the fiber is shaped in a coil and can spring back many more times than synthetic fiber). Most other natural carpet materials are also resilient, and resistant to staining, dirt, and static-electricity.

Bear in mind that many of these materials are sourced in far-away locations that substantially increase their embodied energy by the time they get to the job-site.

10.10 Carpet, carpet padding or flooring adhesives have the CRI Green Label

The Carpet and Rug Institute has established a labeling program to identify carpet, carpet padding and flooring adhesives, which have been tested by an independent laboratory and met certain criteria for low emissions of harmful chemicals. (See **http://www.carpet-rug.org/drill_down_2.cfm?page=8&sub=4**) Products are re-tested quarterly to monitor continued compliance. The current criteria, based on a maximum emission factor measured in mg/m^2 hr are as follows:

Carpet	
Total VOCs	0.50
4-PC (4-phenylcyclohexene)	0.05
Formaldehyde	0.05
Styrene	0.40
Carpet padding/cushion	
Total VOCs	1.00
BHT (butylated hydroxytoluene)	0.30
Formaldehyde	0.05
4-PC	0.05
Adhesives	
Total VOCs	10.00
Formaldehyde	0.05
2-Ethyl-1-Hexanol	3.00

10.11 Interior wall and ceiling paint has maximum VOC level of 10 grams per liter

See Basic Requirements. The more we can reduce VOC levels in our indoor environment, the less health risk occupants will face. The lowest level paints are particularly recommended for remodeling work if occupants remain in the home while work is being done.

10.12 All doors have lever handles

Lever door handles are much easier to turn than knobs. People with a hand impairment from illness or injury will have a much easier time using doors with lever handles. Since they can be operated with a push of the elbow, they are more convenient for someone with his hands full, as well.

10.13 Grab bars installed in tub and/or shower of at least one bathroom

Grab bars make tubs and showers safer for all users.

Many people associate grab bars with the elderly, and not wanting to put themselves in that category, don't want to consider installing these bars. But even able-bodied people have accidents in slippery tubs and showers—e.g., they may be distracted by shaving or they may be stiff and sore from overdoing their exercise program. They may be temporarily disabled from an accident or operation.

Fortunately there are styles to suit every décor now, so one doesn't have to settle for "hospital" style.

10.14 Carbon monoxide detector installed (may be combined with smoke detector)

Today's houses are built very tight to be energy-efficient, so maintaining a healthy indoor environment is becoming an increasing concern, especially in homes with gas appliances (see H17). A carbon monoxide detector can be a helpful tool to protect occupants from the dangers of combustion appliances.

Only a few gas appliances are made with sealed-combustion chambers, and installation of available ones (some furnaces, water heaters and fireplaces) is not yet common in the Austin area, due to unfamiliarity and higher cost. For these reasons, it is wise to install a carbon monoxide detector. Two-story and spread-out one-story homes may need more than one.

SECTION 11: SITEWORK AND LANDSCAPING

See Grow Green for information on appropriate, water-wise landscaping for Central Texas

11.01 Permanent erosion and storm-water control measures (such as piped drainage system, berms and swales)

New developments are required to construct stormwater detention, retention and/or water quality ponds to reduce flow and clean the water from rain events.

Individual homesites can be designed to do the same thing and recycle rainwater without the use of cisterns. Swales and berms can direct the sheet flow of rainwater to depressed areas where it slowly percolates back into the soil. Another way to use stormwater on the landscape is to create a rain garden with native plants (http://www.ci.austin.tx.us/growgreen/raingardenplants.htm) that thrive in occasional wet and dry conditions.

11.02 Decking material of raised porch/deck is recycled-plastic/composite lumber

Wood composite and plastic lumber are manufactured with up to 100% recycled materials, sometimes including a large percentage of post-consumer products. They are durable, waterproof, and pest resistant.

11.03 Existing natural vegetation is retained on at least 50% of pervious cover area

Existing natural vegetation has proven itself able to thrive on the site without added water or fertilizers. Keeping this vegetation intact will eliminate the homeowner's need for landscape maintenance, the use of pesticides and fertilizers, and will reduce water bills. It will also help preserve existing wildlife on the site. Taking the lessons that nature provides us about our soil, water, and sun will give us clues to the types of plants to put into re-planting areas.

Some of this vegetation may be native to our area and some of it may just be well-adapted* for our conditions. For additional information on *native vegetation* go the Lady Bird Johnson Wildflower Center at http://www.wildflower.org/collections/collection.php?collection=TX_central or see *Native and Adapted Landscape Plants* http://www.ci.austin.tx.us/growgreen/pg_pdfs.htm from the City of Austin Grow Green Program.

*Many well-adapted plants are highly invasive and should be avoided.

11.04 No turfgrass installed or *planned*

"Planned" means that the entire site is landscaped with something other than turf (for example, hardscape areas, mulched sections, a groundcover named on 11.06 approved lists). This does not mean that the builder has provided no landscaping, leaving that to the homeowner, who will then likely install turfgrass!

OR

11.05 Turfgrass/lawn does not exceed 50% of pervious cover area

Turfgrass lawns are popular for their beauty and for being a pleasant surface for recreational activities. Most varieties require huge amounts of water to thrive in our climate, however. Omitting turfgrass entirely from a home's landscape, or reducing the amount planted, eliminates or reduces the need for water, fertilizer, pesticides, cutting time and costs. Many other kinds of vegetation, with fewer negative environmental impacts, are available for attractive landscaping.

11.06 Existing vegetation substantially retained; OR all new plants from Grow Green list AND turfgrass area installed ≤ 2,000 sq.ft.

11.07 Turfgrass/lawn in full sun is AEGB-approved low-water variety (common Bermudagrass, zoysia japonica, buffalo)

Austin's blazing sun takes a heavy toll on most varieties of turf grass. A number of low-water varieties are available, however, that thrive better in sunny areas. They typically have these advantages:

- Drought-tolerance
- Heat and cold-tolerance
- Establish quickly
- Need very little fertilizer
- Need very little watering
- Insect, disease, and fungus-resistant

Common Bermuda grass requires 1/5 of the water commonly required by St. Augustine grass. Buffalo grass is the most water-conserving type of grass for Central Texas. It grows slowly and seldom needs mowing (maybe only twice in a season). (609 Buffalo Grass will thrive in shadier areas as well: it needs only 5-6 hours of sun per day.)

Here is a list of acceptable grasses for the Austin area. Please note that this list may change as more research is done and new grasses are developed. For more information about grass choices, contact your Austin Energy Green Building Representative/Rater.

Benefits of Suitable Grasses	Buffalograss	Bermudagrass	Zoysiagrass Japonica Sp. Only	St. Augustine
Available as seed	Common, Top Gun	Common only	Limited, sources on the Web	No
Available as sod or plugs	Prairie, 609, Stampede (dwarf)	419 Tifway, Tifway, Tifway II, Tifdwarf, Tifgreen	Palisades, El Toro, JaMur, Cavalier, Crowne	Common, Floratam, Raleigh, Palmetto
Green Building allowable growing conditions	Minimum 6 hours of sun per day	Minimum 6 hours of sun per day	Full sun or part shade	NO FULL SUN Shady areas only
Drought tolerance	Excellent	Good	Good	Fair
Insect problems	Minimal	Chiggers, Bermuda mites	Grub worms	Chinch bugs Grub worms
Weed problems	Nutgrass, Bermudagrass invades easily if you mow & watered! Will not discourage weeds until established.	Nutgrass, broad-leafed weeds, crabgrass, dallisgrass, others.	Some weeds possible, but good cultural practices discourage weeds.	Broad-leafed weeds, crabgrass, nutgrass (not noticeable), others.
Disease problems	Occasional fungal diseases	Occasional fungal diseases	Fungal diseases	Fungal, viral diseases

Note: water use is not the only criteria for turfgrass choice. Some grasses will take more wear and tear, some are more susceptible to weed invasion or disease, some are more invasive, etc.

See the Water Conservation Program website for more information: www.cityofaustin.org/watercon.

11.08 Newly installed turfgrass areas have at least 6" of soil containing 25% compost (e.g., Dillo Dirt, http://www.ci.austin.tx.us/water/dillo.htm); OR no turfgrass installed or planned

See Basic Requirements #14.

11.09 Trees are protected with fencing at the drip line; or a tree protection plan prepared by professional arborist is followed

Trees add value to our entire community because of their beauty, their cooling effect, and contribution to health. Each large shade tree cleans the air by absorbing carbon dioxide. It cleans up the pollution created by a typical car that drives 11,000 miles per year. It gives off enough oxygen to fulfill the needs of a family of four. It reduces the temperature around it through shade and transpiration by about 10^{o}. In addition, trees help reduce the "heat-island effect" in cities. Heat islands develop as vegetation and its cooling effects are lost and replaced by heat-absorbing materials, such as asphalt and concrete. These higher temperatures result in *increased* demand for air-conditioning, which requires *increased* energy production, which *increases* greenhouse gasses (which *increase* global warming), and ground-level ozone, which *increases* threats to human health. For the individual homeowner trees increase property value, as well.

Some large specimen trees have historic value. Trees provide important symbolic links with the past. If a living tree is associated with important events, the tree takes on historical values unrelated to aesthetics or usefulness. For example, a community would normally value a tree that shaded the deliberations of the community's founders. In Austin, a good example is Treaty Oak. Aside from specific events, old trees may be regarded as important simply because they have lived through eras with which we have few other connections.

Placing protective fencing at the drip line of the tree will greatly improve the chances that a mature tree will survive the construction process. In Central Texas, where there is often very little soil, the feeder roots of trees may spread out horizontally from the trunk as much as 2.5 times more than the height of the tree. When protective fences are placed too close to the trunk, trucks, equipment and even foot traffic can compact the soil above the root system. That prevents the tree from getting enough water and oxygen to thrive and can permanently damage the roots. It may take several years for this damage to become apparent, but by that time it may be too late to save the tree. A fence at the drip line is not ideal protection, but provides a simple rule-of-thumb.

It is far better to engage the services of a professional arborist. An arborist can prepare a detailed tree protection plan, which includes correct tree protection measures for a given site and tree, dedicated construction-traffic access, mulching, pruning, a replanting plan, etc. Following these practices will greatly increase the chances of maintaining healthy trees, thus increasing the value of the property.

11.10 Rainwater Harvesting: 110-600 gallons storage

11.11 OR Rainwater Harvesting: 601-2000 gallons storage

11.12 OR Rainwater Harvesting: 2001 or more gallons storage

Rainwater harvesting is an old idea that is popular again. The future of our region depends, in part, on innovative approaches to water supply. In Central Texas, as in many parts of the world, sources for potable water are diminishing. On building sites with no municipal water supply, rainwater harvesting may be an especially appealing option, since wells are expensive and the water quality is often very poor. Due to its high mineral content, well water often has an unpleasant taste, stains plumbing fixtures and teeth, degrades water lines, and can damage appliances.

Harvesting rainwater is a great way to get high-quality water with the following benefits:

- Soft water (good for hair, skin and plants)
- Chlorine-free,
- Tastes good,
- Won't stain plumbing fixtures
- Lengthens appliance lifespan (no mineral scaling)
- Plants grow better
- Reduces water bills
- Reduces the burden on a municipal water system
- Obviates the need for a well when no municipal supply is available
- Helps control storm-water runoff

In Central Texas, with a yearly average rainfall of 32 inches, almost 45,000 gallons of water falls on a 2,500 square-foot roof. Obviously, rainwater harvesting is potentially a viable method to achieve sustainability with regard to water resources. Many old homesteads and farms had rainwater cisterns as their main source of drinking water.

The basic concept of harvesting rainwater is simple. Rainwater is typically collected from the roofs of buildings. It flows by gravity through gutters and downspouts into a storage tank. From the tank it can be used in the landscape as is, or be filtered and treated to become a source of high-quality drinking water. Since most of our rainfall occurs in large storm events, the ability to store collected rainwater is paramount. Farmers and ranchers know the value of stored water as evidenced by today's major sources for large water tanks— fence, ranch, and feed stores. But, garden and nursery retailers sell smaller rain barrels and the City of Austin Water Conservation Program offers 75-gallon barrels at a subsidized cost.

All of the components for rainwater harvesting can be found in the plumbing section of area retailers. A typical system replaces metal downspouts with solvent-welded PVC piping. By making the downspouts watertight, water can be carried by gravity to a storage tank. Several downspouts can be joined together into one larger main pipe leading to the tank. This main pipe is usually buried below ground and breaks the surface again at the side of the tank. An inlet to the tank is installed as high as possible to maximize storage capacity. The inlet can be on the side or the top of the tank. Just remember, the solid PVC piping system (downspouts) at the building must be at least 6 inches (preferable 18 inches) above the highest piping at the tank. This will allow the tank to fill, as the pressure of the water will work like a "P" trap under a sink. The water will equalize and flow into the tank. This "P" trap part of the system also must have an outlet installed to allow water to drain out for maintenance and to prevent freezing.

For more information visit the following websites:

City of Austin
www.ci.austin.tx.us/watercon/ Click on 'Outdoor Uses' and then on 'Rainwater Harvesting'
State of Texas Water Development Board
www.twdb.state.tx.us/assistance/conservation/Alternative_technologies/Rainwater_Harvesting/Rain.asp

11.13 Rainwater is sole source of indoor water

Homesites where a centralized potable water source is not available have traditionally depended on well water. When more development occurs in the area, wells may have to be deepened. In some areas, the well water is not suitable for drinking without considerable processing. Rainwater is an excellent alternative with costs similar to drilling and outfitting a well. When a dependable water provider services a site with piped water, rainwater harvesting for potable uses is seldom an economical alternative.

■ SECTION 12.0 Additions and Innovations

The advancement of building science and development of better practices and new materials is occurring at a rapid pace. Builders, architects and designers sometimes incorporate features, materials, or technology that is not covered by the items in the preceding sections. Please confer with your Representative/Rater to discuss what measures may be included and points earned in this Section.