Administrative Procedures for the City of Santa Fe
Residential Green Building Code (RGBC)

1. PURPOSE

The purpose of these administrative procedures is to establish procedures for the City of Santa Fe (herein "City") staff, boards, commissions or committees, the Governing Body and any agent of the City to implement and administer the Residential Green Building Code (RGBC).

2. SCOPE

This document and its attachment (the "administrative procedures") set forth responsibilities, procedures, standards for administrative actions necessary to implement the RGBC ordinance, which include but are not limited to the following:

2.1 Submitting and reviewing applicable residential building permit requests and determining compliance with the provisions of RGBC for all new single family units.

2.2 Reviewing and approving Residential Green Building Code checklists (herein called "RGBC checklists") with building permit applicants to ensure compliance with the RGBC ordinance and these administrative procedures.

2.3 Monitoring the performance of building permit holders subject to such checklists, these administrative procedures (herein, collectively called "the permit holder") and taking appropriate action in the event of noncompliance.

3. RESPONSIBILITY FOR ADMINISTRATION

3.1 **Land Use Department** – This city department or its agent shall be responsible for the following functions with regard to administration of the RGBC ordinance and these administrative procedures (herein, collectively called "RGBC") set forth below.

3.1.1 Administering all functions of RGBC except for those which are specifically described as the responsibilities of other city departments and providing overall coordination among city departments.

3.1.2 Providing forms, information, technical assistance and certifications with regard to compliance with the RGBC ordinance.

3.1.3 Approving proposed RGBC checklists for complying with RGBC from an applicant.

3.1.4 Monitoring compliance with RGBC checklists.

3.1.5 Determining when sanctions for noncompliance should be invoked, and requesting the city manager to direct that appropriate city departments take appropriate action.

3.1.6 Performing other functions as required by RGBC.

3.1.7 Performing other functions not specifically described in the RGBC ordinance or these administrative procedures, but essential for successful administration of RGBC and within the powers and abilities of the department.

3.1.8 Ensuring the proceeds of fees for getting a worse index than the required HERS index are directed to the appropriate City trust fund.

3.2 **Staff** – Administration of the RGBC shall be delegated to a Green Code Building Administrator or other staff in the Land Use Department. The staff shall be responsible for the day-to-day administration of the department's responsibilities, and shall specifically be responsible for:

3.2.1 Assuring that monitoring of compliance with RGBC checklists takes place, and in the event of noncompliance, requesting that the city manager request action by appropriate departments with regard to the department's responsibilities for administering RGBC.

3.2.2 Coordinating, training and monitoring the department's staff and any appropriate agent of the department with regard to the department's or agent's responsibilities for administering RGBC.

3.2.3 Performing other duties as described in the RGBC ordinance or these administrative procedures.

3.2.4 Requiring that applicants prepare RGBC checklists as part of all new single family residential building permit and submit them to the Green Building Code Administrator Department.

3.2.5 Where applicable and upon the City Manager's instruction, invoking sanctions for non-compliance with agreements, upon the request of the Land Use Department.

3.2.6 Performing other functions described as the responsibility of the Land Use Department in the RGBC ordinance or these administrative procedures.

3.3 **City Attorney's Office** – This office or its agent shall be responsible for the following functions with regard to administration of SFHP:

3.3.1 Providing legal assistance when requested by the Land Use Department, Public Utilities Department or City Manager.

3.3.2 Assisting in the interpretation of RGBC checklist items when there is a disagreement.

3.3.3 When requested by the City Manager or Governing Body, pursuing such legal actions as may be necessary to enforce checklists, if such actions are permitted by common law, state statutes, any ordinance and/or any agreement.

3.4 **Green Building Mediation Team** - A Green Building Mediation team including a HERS rater, residential building contractor and Building Codes Expert shall be constituted to try and reach an agreement when a conflict arising between the Green Building Codes Administration and a Permit Applicant or Permit Holder.

3.5 **Governing Body** – The Governing Body shall be responsible for reviewing, and approving or denying, appeals of decisions of city departments or commissions with respect to RGBC requirements.

4. APPLICABILITY

4.1 **Developments and Actions Subject to RGBC** – Except as provided in this paragraph, RGBC applies to any applications for new single-family residential construction.

4.1.1 The RGBC applies to new construction

4.1.2 It shall be the responsibility of the applicant to determine the applicability of RGBC to the proposed single-family residential building permit and comply with the requirements of RGBC.

5. DEFINITIONS

Applicant means a property owner or agent of a property owner who submits a development request to the city which is subject to any SFHP requirements, or any successor in title that is subject to SFHP requirements.

City means the city of Santa Fe or its agent.

City Attorney's Office means the City Attorney's Office of the City of Santa Fe, its agent or successor.

City Code means Santa Fe City Code 1987 (SFCC 1987).

Land Use Department means the Land Use Department of the city, its agent or successor.

RGBC means the Residential Green Building Code

RGBC Checklist means a checklist filed with the City by a building permit applicant for a new single-family residence.

6. RGBC CHECKLISTS

Following are standards and procedures for preparation, review and approval of RGBC checklists:

6.1 **Requirement for RGBC Checklists** – RGBC checklists shall be required by the City for all new single-family residential building permits. RGBC checklists shall be approved by the Housing and Community Development Department prior to issuance of the building permit.

6.2 **Scope and Content of RGBC Checklists** – RGBC checklists shall include all of the following:

6.2.1 A completed proposed checklist showing all checklist items and associated points the permit applicant is agreeing to comply that meet the requirements of the permit application.

6.2.2 The permit applicant's requirements for providing the City or its agent with verification of compliance with the RGBC checklist.

6.2.3 Provisions granting access to the City or its agent to inspect records and construction sites.

6.3 **Other Terms that Apply to all RGBC Checklists** – The following terms and conditions shall apply to all RGBC checklists.

6.3.1 The City's obligation to give notice in writing and in a timely fashion of violations including what actions are needed to correct the violation and time frame for compliance.

6.3.2 The City's right to impose sanctions or take other actions after notice of violation has been given and not complied with.

6.3.3 The expiration date of the checklist shall be the same as for the building permit.

6.3.4 Development incentives to be granted by the city in consideration of the applicant's agreement to construct or create SFHP units.

6.3.5 The name of the qualified organization or organizations that has been engaged to provide HERS rating services, including confirming the projected HERS index and thermal bypass inspection..

6.3.6 Other terms and conditions necessary to implement the requirements of the SFHP with regard to the subject development.

6.4 **Submission of RGBC Checklists** – A RGBC checklist shall be submitted with any new single-family residential building permit request to the City.

6.5 **Review of RGBC Proposals** – After submittal, each RGBC checklist shall be reviewed by the Green Building Code Administrator or their designee. After review, the Green Building Code Administrator shall take one of two actions with regard to a RGBC checklist:

6.5.1 Approve the RGBC checklist if the checklist meets RGBC requirements.

6.5.2 Disapprove the RGBC checklist and refer it back to the applicant if it does not meet RGBC requirements. In this case, the Green Building Codes Administrator shall make written comments regarding the checklist's deficiencies.

6.6 **Re-submittal of RGBC Checklists After Disapproval** -- If a RGBC checklist has been disapproved, an applicant may resubmit revised checklists until the checklist is compliant with the RGBC..

6.7 **Appeals** – A permit applicant or holder may appeal actions of the City with regard to RGBC as follows:

6.7.1 An applicant may appeal if:

a. The permit applicant believes that City staff misinterpreted the RGBC requirements in disapproving the RGBC checklist, and the checklist as written conforms to RGBC requirements; or

b. The permit applicant is aggrieved by any other action of the City with regard to RGBC.

6.7.2 All such appeals shall be made on forms provided by the Housing and Community Development Department, and must be accompanied by a description of the City action which is being appealed and the grounds for appeal. If the applicant is appealing staff disapproval of a RGBC checklist, the appeal must be accompanied by:

a. A proposed RGBC checklist that has been disapproved by staff; and

b. Staff comments on the RGBC checklist, including the reasons for disapproval of the checklist.

6.7.3 Appeals of staff decisions shall be heard by a Green Building Code Mediation Team. If resolution cannot be found, the appeal will then be heard by the Governing Body.

6.7.4 If a RGBC checklist is subject to appeal, the outcome of the appeal process may determine whether the permit applicant is entitled to certain incentives. In this case, the permit applicant may choose one of the following options with regard to continued processing of the building permit:

a. Processing may be suspended until the appeal is heard and decided.

b. Processing may be continued. In this case, the permit applicant may determine whether to incorporate into his or her checklist any building permit incentives which are subject to the outcome of the appeal.

6.8 **Approval of Building Permits Subject to RGBC** – No building permits subject to RGBC requirements may be approved by City Staff unless a RGBC checklist has been approved in compliance with the RGBC by the Land Use Department or appealed. Such RGBC checklist presented by the permit applicant shall correspond to the building permit as approved by City.

6.9 **Execution of RGBC Checklists** – After the RGBC checklist has been approved by the Green Building Codes Administrator. The checklist shall be filed in the Land Use Department and monitored as implemented.

6.10 **Noncompliance with Checklists** – It shall be unlawful for any building permit holder subject to RGBC to violate any provision of or fail to comply with any of the requirements of RGBC or a the approved RGBC agreement. Whenever the city finds that a building permit holder has violated or is violating a requirement of the RGBC or of a RGBC checklist, the city shall issue a written notice of violation. The notice of violation shall:

6.10.1 Set forth the specific violation found;

6.10.2 Establish a specific and reasonable period of time for the correction of the violation found;

6.10.3 State that failure to comply with the notice may result in the following sanctions, depending upon which is deemed most effective and appropriate considering the nature of the noncompliance:

a. Issuing stop work orders

b. Revoking building permits

c. Withholding or revoking certificates of occupancy

6.10.4 The notice shall be hand delivered to the building permit holder or mailed registered mail, return receipt requested to the address listed on the building permit.

6.10.5 The Notice shall inform the permit holder that he may request a hearing prior to any sanction being imposed.

6.11 **Non-Compliance Hearings** – In the event that a property owner notified of a violation requests a hearing, the hearing shall be conducted by the director of the Land Use Department after giving notice to the person requesting the hearing.

6.11.1 All parties shall be allowed to respond and present evidence and argument on all issues involved.

6.11.2 A record of the hearing shall be made

6.11.3 Findings of fact shall be based exclusively on the evidence presented and on matters officially noticed

6.11.4 Notice of the final decision shall be in writing and hand delivered to the permit holder or mailed registered mail, return receipt requested to the last-known address.

6.11.5 Decisions by the director of the Land Use Department shall be final and may be appealed in district court.

6.12 **Legal Action and Potential Fines** – If a property owner fails to comply with, the final decision of the director of the Land Use Department, the Land Use Department shall notify the City Manager of the non-compliance and request that applicable sanctions be imposed.

7. SEPARABILITY

The provisions of these administrative procedures are separable and the invalidity of any part of these provisions shell not affect the validity of the rest of these provisions.

8. USER'S GUIDE

The User's Guide provides additional information on each checklist item. The User's Guide shall be used in the administration of the checklist and to inform how conflicts are resolved. The User's Guide follows:

RESIDENTIAL GREEN BUILDING CODE USERS GUIDE

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Chapter 5
LOT DESIGN, PREPARATION, AND DEVELOPMENT

501.1 Lot: the lot is selected to minimize environmental impact by one or more of the following:

(1) An infill site is selected

Intent:
Building on an infill site **(vacant or underutilized lots of land, served by existing roads, mass transit, power lines, sewer and water)** can effectively conserve resources (e.g., infrastructure) and preserve open space that could be lost from "green field" development.

Additional Information / How to Implement:
Infill areas are vacant or underutilized lots of land, served by existing physical installations such as roads, power lines, sewer and water, and other infrastructure.

Resources:

- Policy Link, Equitable Development Toolkit, Infill Incentives, http://www.policylink.org/EDTK/Infill/.

- Northeast-Midwest Institute and Congress for the New Urbanism, *Strategies for Successful Infill Development* (2001), http://www.nemw.org/infillbook.htm.

(2) A Greyfield or an EPA-recognized brownfield lot is selected

Intent:
(Greyfield is any site previously developed with at least 50% of the surface area covered with impervious material). Redevelopment of a Greyfield site can provide an efficient use of land and infrastructure. Greyfield redevelopment allows for the preservation of open space and wildlife habitat in the midst of growth. Remediation of a Brownfield results in the environmental restoration of a polluted site, a transformation that makes an abandoned site habitable. Like Greyfield and infill development, Brownfield development provides an efficient use of land and infrastructure while allowing for the preservation of open space and wildlife habitat in the midst of growth.

Additional Information / How to Implement:
Within these guidelines, a Greyfield is defined as "any site previously developed with at least 50% of the surface area covered with impervious material." The development of a Greyfield site can be daunting, but local or national incentives may exist to reward those builders who go through the process. Incentives may include the elimination of development related fees, contribution from the local government in the development of off-site improvements, and tax breaks. For more information, contact the Congress for the New Urbanism, Urban Land Institute, American Planning Association, or the International Council of Shopping Centers.

The U.S. Environmental Protection Agency (EPA) characterizes Brownfields as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant." The EPA estimates that there are 450,000 such sites around the country. Grants, loans, and training are available

through the EPA's Brownfield Initiative to assist builders and developers in the remediation and development of Brownfield sites.

Resources:

- Congress for the New Urbanism, www.cnu.org.
- Urban Land Institute, www.uli.org.
- American Planning Association, www.planning.org.
- Congress for the New Urbanism Publications http://www.cnu.org/resources/publications
- U.S. Environmental Protection Agency, Brownfields and Land Revitalization: http://www.epa.gov/Brownfields/index.html
- U.S. Environmental Protection Agency has introduced two Web-based tools to give the public additional access to information about Brownfield properties and cleanup efforts. The tools allow residents to locate Brownfields in their area and provide access to information about cleanup grants. - www.epa.gov/brownfields/bfwhere.htm

501.2 Mass Transportation: A range of mass transportation choices are promoted by one or more of the following:

(1) A lot is selected within one-half mile (805 m) of pedestrian access to a mass transit system or within five miles (8046 m) of a mass transit station with provisions for parking.

(2) Walkways, street crossings, and entrances designed to promote pedestrian activity are provided. New buildings are connected to existing sidewalks and areas of development.

(3) A lot is selected within one-half mile (805 m) of six or more community resources [e.g., recreational facilities (such as pools, tennis courts, basketball courts), parks, grocery store, post office, place of worship, community center, daycare center, bank, school, restaurant, medical/dental office, Laundromat/dry cleaner).

Intent:

Use of mass transit lowers the greenhouse gas emissions and other environmental impacts of using private gas-powered vehicles for transportation. By making the access to public transit easy and safe residents will be encouraged to consider this means of transportation when it suits their needs. Other ways to reduce greenhouse gas emissions from transportation is to select a site that is within walking distance of important community resources such as those listed in the item.

Additional Information / How to Implement:

Select a site close to an existing public transit stop and/or community services and design pedestrian access towards public transit stops and/or community services..

Resources:

American Public Transit Assocition www.apta.com

503 Lot Design
Minimize environmental impacts; protect, restore, and enhance the natural features and environmental quality of the site.

503.1 Natural Resources: Natural resources are conserved by the following;

(4) Approved training in tree and other natural resource protection is provided for the onsite supervisor.

Intent:
Construction activities can be very damaging to trees and other vegetation that is planned to be retained. Some of the impacts may not appear until several years later, reducing the benefits of maintaining that established vegetation. By providing training to the on-site supervisor on how to avoid this kind of damage the benefits can be preserved.

Additional Information / How to Implement:
Training should conform to the requirements of appropriate professional organizations such as those listed under resources below. Courses are available at local institutions including the Santa Fe Area Home Builders Association and the Santa Fe Community College.

Resources:
- American Society of Consulting Arborists, http://www.asca-consultants.org/why.html.
- American Society of Landscape Architects, http://www.asla.org
- International Society of Arboriculture, http://www.isa-arbor.com/home.aspx.
- Society of American Foresters, http://www.safnet.org/certifiedforester/.
- Article on preserving trees during construction: http://www.umass.edu/bmatwt/publications/articles/preserving_trees_during_construction.html

503.5 Landscape Plan: A landscape plan is developed to limit water and energy use while preserving or enhancing the natural environment:

(2) Vegetation and trees are selected that are native or regionally appropriate for local growing conditions.

(3) A percentage of cool season turf areas are limited.

(a) 0 percent

(4) Plants with similar watering needs are grouped (hydrozoning).

(5) Species and locations for tree planting are identified that will provide summer shading of streets, parking areas, and buildings to moderate temperatures when trees reach maturity.

Intent:
Landscaping water use accounts for approximately 50% of a home's total water needs. Conservation of this valuable resource through such techniques as hydrozoning, reducing turf area, and selecting regionally appropriate plants is a key component to responsible building. Thoughtful selection and placement of plants can also reduce heating/cooling loads of a home, provide habitat for native fauna, and minimize the heat-island effect of developments.

Additional Information / How to Implement:
Select landscaping materials and vegetation to fit site conditions. Regionally appropriate plants are hardy plants that can withstand local water and temperature conditions such as freeze, heat, drought, and rain. Regionally appropriate plants will also not be overly prolific or invasive, and will be able to coexist with other native plants over time. Other benefits of landscaping with native plants: minimizes maintenance (reduces emissions of equipment); fosters wildlife habitat.

When planning for the revegetation of a site, consider the multiple services that natural areas can provide: natural habitat, storm water processing, shading, wind break, etc. Trees that shade the streets can keep a neighborhood cool while also increasing the neighborhood's attractiveness. Properly selected plants can be grouped to serve as a bioretention zone. Deciduous trees allow the sun's rays through in winter and provide shade in the summer. Evergreens can provide an effective windbreak. Careful selection and integration of trees and vegetation can reduce a developer's initial costs while providing value to a development/neighborhood later. When planting trees, several factors should be taken into account such as the value of shading (trees shading asphalt will mitigate a site's temperature more than trees shading landscaped areas), maintaining a safe distance from the house (especially in areas prone to natural disasters), ultimate tree size, etc.

Developers may wish to consider enforcing guidelines for the protection of onsite vegetation. Some developers even fine builders for damage to areas designated for protection.

If grinding and scattering cleared plants, care should be taken to grind only regionally appropriate plants. Grinding of invasive species can increase their propagation and result in the ultimate destruction of native species.

One of the best ways to reduce energy consumption is through passive solar design of a home – using orientation, overhangs, fenestration, etc. Landscaping to reduce energy consumption is only part of the whole effort.

It is good practice to limit ratio of turf area to total landscaped area due to maintenance requirements of turf versus native plants and regionally appropriate trees and vegetation. In some areas, there may be restrictions on the percentage of turf that the front yard must contain. Research has shown that homeowners are comfortable with having as little as 50% of the front yard composed of turf. Fewer regulations are imposed on turf-to-landscaping ratio in the backyard, so good gains might be made more easily there. For research on turf and landscape of front yard with native species, see: Nassauer, Joan. 1995. *Messy Ecosystems, Orderly Frames.* Landscape Journal, 14 (2), 161-170.

In areas with low annual rainfall, one way to account for water usage is through the development and implementation of a water budget. Below is Built Green Colorado's Water Budgeting information.

Water Budgeting

Description

Calculate the water needs of irrigated landscapes based on plant types, land area and irrigation system efficiency. Use the calculated water budget to apply water according to the needs of the plants and manage irrigation. Overall property water budgets can be developed to include both indoor and outdoor water requirements.

Basic Practice Guidelines

A. The landscape design process should incorporate a general outdoor annual water budget to be used as a guideline for irrigation design and long-term landscape management. The water budget should be developed by the landscape architect or designer as part of the plant selection and grouping process (turf, trees, shrubs, ground covers, etc.).

B. The irrigation maintenance process should be based on calculation of a monthly and annual water budget for existing sites.

C. Calculate the site landscape water budget by summing the water requirements calculated for each hydrozone of the landscape using either of these general formulas:

Approach #1, when Reference ET is known:

$$\text{Water Budget} = \frac{(ET_o)(K_c)(LA)(0.623)}{IE}$$

Water Budget = Water Needed for Plants (gallons per year)
ET_o = Reference evapotranspiration (inches per year) for bluegrass in your area
K_c = Crop coefficient for plant type (See Appendix E for more information.)
LA = Landscaped Area (square feet)
0.623 = Conversion Factor (to gallons per square foot)
IE = Irrigation Efficiency (varies based on irrigation system)

Approach #2, when Reference ET is not known:

Water Budget = Land Area (sq. ft.) x Estimated Plant Water Use (gallons/sq. ft.)
Where: Estimated Plant Water Use = Estimated water use in gallons/sq. ft. for the metro-Denver Front Range area. For other areas, water use estimates may need to be increased or decreased based on climate and location characteristics. Water use estimates may also be increased or decreased based on climate and location characteristics. Water use estimates may also be reduced when more efficient irrigation systems such as drip irrigation are used.

Example Using Both Water Budgeting Approaches:

For purposes of a simple example, assume that 70% of a 5,000 sq. ft. of a northern Front Range landscape is Kentucky bluegrass irrigated with a properly designed automatic irrigation system with an 80% irrigation efficiency reported by the irrigation contractor. The remaining 30% of the landscape is "low to very low" water use plants irrigated with a drip irrigation system with a 90% irrigation efficiency reported by the irrigation contractor. The seasonal reference ET value for this northern Front Range location is 26.69 inches for cool season grass mowed at 5 inches. For the turf area, a crop coefficient (Kc) of 0.9 is applied to represent a nice quality Kentucky bluegrass lawn mowed at a 3-inch height. The "low to very low" water use plants require about 25% of reference ET, so the resulting water budget for the landscape would be:

Water for Turf Area = [(26.69"*0.9)*3500 sq.ft.*0.623]/0.8= 65,472 gal/yr

+ Water for Other Area = [(26.69"*0.25)*1500 sq.ft.*0.623]/0.9 = 6,928 gal/yr

Total Landscape Water Requirement = 72,400 gal/yr

This example results in an average water requirement of about 14.5 gallons/sq. ft. of irrigated area.

Using Approach #2, one would assume the 3,500 sq. ft. of bluegrass would use about 18-20 gal/sq. ft./yr and the 1,500 sq. ft. of low water plants would require about 5 gal/sq. ft., resulting in the following calculation:

19 gal/sq. ft. * 3,500 sq. ft. = 66,500 gal/yr
+ 5 gal/sq. ft. * 1,500 sq. ft. = 7,500 gal/yr

Total Landscape Water Requirement = 74,000 gal/yr, or about 14.8 gallons/sq. ft. of irrigated area.

D. The water budget provides the annual irrigation that the site needs in order to thrive in addition to natural precipitation. The annual water budget assumes a normal year of natural precipitation (14 inches of annual precipitation for the Front Range area). In either wetter or drier years, the water budget will need to be adjusted.

E. The rate at which plants lose water to the surrounding air is called evapotranspiration (ET). Temperature, humidity, wind and light all influence the ET rate. When watering, it is only necessary to replace the amount of water that has been lost due to ET.

F. In order for water budgets to be accurate, it is necessary to provide accurate information on factors such as crop coefficients. See the GreenCO web site (www.greenco.org) and Appendix E for recommended crop coefficients to be used in calculating water budgets.

G. It should be noted that the ET_0 (reference ET) in the water budget equation does not reflect that Kentucky bluegrass can be attractive and viable at much lower ET rates and can be very drought tolerant. For properly established turf, the actual irrigation water needs of turf can vary, depending on desired appearance.

H. The water budget does not apply to the initial establishment period for plantings, which can vary from 2-4 weeks for annuals to several growing seasons, depending on plant type and the timing of planting. One year is typical for many perennials and shrubs to become established.

I. Water features, outdoor pool(s), and/or any other outdoor water uses should be included in the water budget.

J. If a property manager/landscaper knows the water budget for each month, he/she can compare actual use to the site water budget and adjust irrigation practices accordingly. Excessive water use may also be attributed to irrigation system deficiencies, which should be corrected.

K. Evapotranspiration (ET) or "smart" irrigation controllers can facilitate landscape irrigation according to the needs of the plants (and therefore the water budget).

   1. Low water-use plants don't automatically save water (they are easily and, frequently, over-watered). Using a "smart" controller can insure the proper irrigation is applied to low water-use plants.

   2. High water-use plants (such as turf) don't automatically waste water. They are also often over-watered. Using a "smart" controller can insure the proper irrigation is applied to high water-use plants.

L. Often the retrofitting of poor irrigation systems and the use of "smart" controllers will provide a payback in saved water. To calculate the payback time, use the water budget to measure how much water is actually needed, versus how much has historically been used, along with local water rates and irrigation system cost.

M. GreenCO provides a simple water budget calculator on its Website at www.greenco.org. Green Industry professionals can use this calculator with customers to demonstrate that water budgeting is a manageable approach to understanding water needs for a given property and adjusting watering practices accordingly.

Regional or Industry Considerations/Adaptations

A. Water budgets can be used by water utilities to determine how much water is needed versus how much the utility sells or has.

B. Water budgets can be used by water utilities to determine how much water they need versus how much they sell or have. The difference is how much water could be saved, or how much more water needs to be purchased.

C. Water budgeting approaches adopted by utilities typically include ET-based irrigation scheduling combined with tiered pricing for increasing water usage. Tiered pricing, by gradually increasing the price of water as consumption rises, provides incentive to conserve. At the time of this manual's publication, this approach had been adopted in other water-limited states such as California and Arizona. See Centennial Water and Sanitation District in Highlands Ranch, Colorado, for information on their program http://www.highlandsranch.org

D. Colorado's Water Efficient Landscape Design Model Ordinance (see www.dola.state.co.us/smartgrowth/) is based on water-budgeting with a goal of 15 gallons/square foot/year of water required for a landscaped area.

E. Check the GreenCO Website (www.greenco.org) for more information on water budgeting techniques.

Key References

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California Department of Water Resources. 1993. Model Water Efficient Landscape Ordinance. Website: http://www.owue.water.ca.gov/landscape/ord/ord.cfm.

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Colorado State University Cooperative Extension Drought Task Force. 2004. Website: www.drought.colostate.edu/.

Design Studios West, Inc.; J.M. Knopf; HydroSystems KDI, Inc.; The Restoration Group, Inc.; and G. A. White. 2004. *WaterWise Landscaping Best Practice Manual: A Companion Guide to Water Efficient Landscape Design.* Website: www.dola.state.co.us/smartgrowth/. Denver, CO: Colorado Department of Local Affairs, Office of Smart Growth.

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McStain Neighborhoods. 2003. *Water Conservation Standards for Common Areas and Open Space Landscapes.* Boulder, CO: McStain Neighborhoods.

Mecham, B. 2004. *Scheduling Methods* Using ET as a Management Tool. http://www.ncwcd.org/ims/ims_info/scheduli.pdf. Loveland, CO: Northern Colorado Water Conservancy District.

Northern Colorado Water Conservancy District. 2004. Turfgrass Irrigation Management Program. http://www.ncwcd.org/ims/scheduler.asp. Loveland, CO: Northern Colorado Water Conservancy District.

Slack, E. 2001. Case History: Irrigation on a Water Budget, *Irrigation Business and Technology*, March/April. (www.irrigation.org).

Resources:

- Center for Plant Conservation, http://www.mobot.org/CPC/.

- Lady Bird Johnson Wildflower Center, Native Plant Information Network National Suppliers Directory, http://www.wildflower2.org/NPIN/Suppliers/suppliers.html.

- New England Wildflower Society, Native Plant Societies of the United States and Canada, http://www.newfs.org/nps.htm.
- NAHB Research Center Inc., *Onsite Grinding of Residential Construction Debris: The Indiana Grinder Pilot*, February 1999.

504 Lot Construction

504.2 Trees and Vegetation: Designated trees and vegetation are preserved by one or more of the following:

(1) Fencing or equivalent is installed to protect trees and other vegetation

(2) Trenching, significant changes in grade, and compaction of soil and critical root zones in "tree save" areas are avoided.

Intent:
To protect trees and vegetation that are meant to be preserved after construction. The benefits of maintaining existing established vegetation will be preserved.

Additional Information/How to Implement:
Fencing or other means of restricting access to protected areas is installed and maintained during the course of construction. Grading activities are not done in areas where existing vegetation is planned to be preserved. If such activities is planned adjacent or very near to existing vegetation then fencing or some other means of reducing the potential for inadvertent impact is employed.

505 Innovative Practices

505.1 Driveways and Parking Area: Driveways or parking areas are shared. Waivers or variances from local development regulations are obtained to implement such practices, as applicable. In a multi-unit project, parking capacity is not to exceed the local minimum requirements.

Intent:
Percolation through soil is one of the most effective means for filtering pollutants carried by storm water. By minimizing impervious surfaces builders can reduce harmful pollutants carried off site while safely and effectively managing much of their storm water load onsite.

Additional Information/How to Implement:
Obtain any necessary agreements and permits and design driveway and parking areas compactly.

Resources:
Betty Rushton, Southwest Florida Water Management District, *Low Impact Parking Lot Design Reduces Runoff and Pollutant Loads: Annual Report #1,* Brooksville, Florida, 1999.

505.4 Select a small lot to promote density and public transit and reduce sprawl

(1) Infill site of less than 6000 square feet OR

(2) Infill site of less than 5000 square feet OR

(3) Infill site of less than 4000 square feet OR

(4) Infill site of less than 3000 square feet

Intent:
To encourage using less land and to encourage careful planning of the site and building. To encourage the use of empty lots in established neighborhoods where there are existing services and utilities.

Additional Information/How to Implement

Select a lot that is less than one of the square feet listed or, if the site is greater and the zoning allows, subdivide into smaller lots.

Chapter 6
RESOURCE EFFICIENCY

Although existing green builder programs provide good information for builders to emphasize the long-term advantages and savings of more durable, lower-maintenance products, there is currently no standardized method to assess the durability of residential construction materials or systems or to define "low maintenance." A possible approach that green home building program administrators can use at this time in is to give credit for extended warranties on materials and workmanship. The person choosing the building product should consider using manufacturer claims, warranty duration, third-party certifications and sources such as *GreenSpec Directory*, and Life-Cycle Assessment (LCA) tools that are under development as proxies to identify "low maintenance" or "durable" materials during the purchasing process.) (A note regarding defining "low maintenance" materials: For certain types of building products, the buyer could be on the lookout for materials that have below average maintenance needs compared to other products in that same material category (e.g., composite decking or treated lumber).

601 Quality of Construction Materials and Waste

601.1. Conditioned Floor Area; Conditioned floor area, as defined by ICC IRC and calculated in accordance with NAHBRC Z765, is limited. Dwelling unit size is to be calculated in accordance with NAHBRC Z765. Only the conditioned floor area for stories above grade plane is to be included in the calculation.

(1) less than or equal to 1,000 square feet (93 m^2)
(2) less than or equal to 1,500 square feet (139 m^2)
(3) less than or equal to 2,000 square feet (186 m^2)
(4) less than or equal to 2,500 square feet (232 m^2)

Intent:
Larger homes typically use more construction materials than smaller homes. Therefore, efficient compactly designed homes have a smaller greenhouse gas impact that larger homes and are encouraged.

Additional Information / How to Implement:
Use the NAHBRC Z765 to determine the conditioned floor area of the proposed residence. Consider using compact design methods to reduce the floor area while meeting the building's programmatic needs.

Resources:

- Use the newly-modified American National Standards Institute (ANSI) Z765-2003 to calculate square footage. Available from the NAHB Research Center Bookstore - http://www.nahbrc.org/tertiaryR.asp?TrackID=&CategoryID=1652&DocumentID=2636

- Oikos®, *Small, Efficient and Beautiful*, 17 Space Design Tips. http://oikos.com/esb/52/smallefficient.html

- There are many resources available to help a builder create efficient home floor plans. For example, Sarah Susanka's *Not So Big House* series of books can assist in home design.

The Not So Big House (The Taunton Press, 1998); *Creating the Not So Big House* (The Taunton Press, 2000).

- GreenBuilder, *Sustainable Building Sourcebook,* http://www.greenbuilder.com/sourcebook/

- Environmental Building News and BuildingGreen.com, *GreenSpec Directory* http://www.greensage.com/BOOKS/GreenSpecs.html

601.2. Material Usage: Building-code-compliant structural systems or advanced framing are implemented that optimize materials usage.

Intent:
Advanced Framing or Optimum Value Engineering refer to framing techniques that reduce the amount of materials used to build a home while maintaining the structural integrity of the home. An optimum value engineered assembly tends to use less energy for space conditioning because the omitted (and redundant) structural components can be displaced with insulation. Accordingly, the user will note that some advanced framing techniques receive points for both

Additional Information / How to Implement:
Advanced framing elements can be applied independently, or adopted in the entirety, depending upon the specific requirement(s) of the project. Framers unfamiliar with the techniques may need training, and the initial use of these techniques may temporarily slow down framing operations. In general, more planning is needed to implement these elements.

In addition to the advanced framing techniques described below for wood, homes with steel framing can incorporate similar techniques using advanced framing techniques, including 24" o.c. spacing for steel floors and walls, described in the HUDUSER's *Prescriptive Method for Residential Cold-Formed Steel Framing* (see Resources section of this line item for additional information).

Some of the benefits of advanced framing include:

- Reduced first cost (3 to 5% of framing cost)

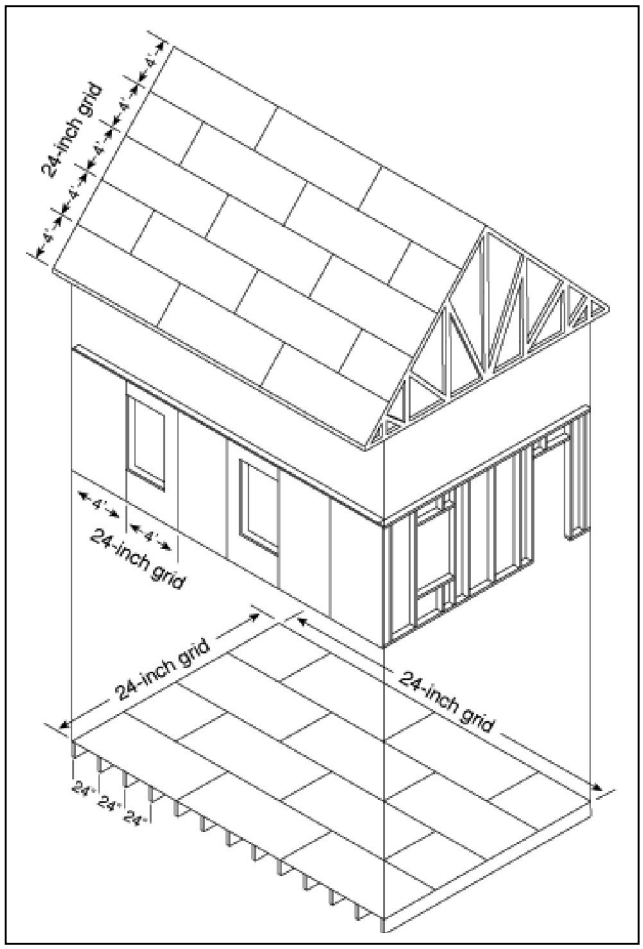
- Improved energy efficiency (2 to 5% per year)

- Improved resource efficiency (less wood consumption and waste)

Advanced framing uses engineering principles to minimize material usage while meeting model building code structural performance requirements.
The following list covers different principles that form an advanced framing system.

(1) 24" OC Framing

Details: Wall and floor framing spacing can often be engineered for 19.2" (1/5 of an 8-foot sheet) or 24" on center (1/4 of an 8-foot sheet). Roof framing that utilizes trusses is most frequently spaced at 24". This strategy can be combined with *modular layout and single top plate* for added economy, but can also be used independently



Installation: Installation should be in accordance with manufacturer's specifications and model building code prescriptive methods. Bracing and fastening schedules and sheathing thickness requirements increase with framing spacing.

Careful spacing of window and door openings will maximize the economy of wider spacing. Designs that are built repeatedly should include wall framing layout drawings to guide the framing crew. When first implementing advanced framing elements, crews are likely to be slowed down until they become more familiar with the method.

Benefits/Costs: Approximately one-third of the lumber can be eliminated from the wall and floor framing of a value-engineered house, over walls and floors spaced 16 inches on center. Floor joists may need to be deeper for wider spans, but the reduction in lumber required for the building usually offsets the price increase from having larger floor joists. The need for thicker deck sheathing will also offset a portion of the savings. A careful analysis or a trial prototype is needed to determine whether the wider spans make economic sense for a particular plan. In general, simpler plans designed on a two-foot module are much more likely to result in savings with 24" on center framing than are complex plans with odd dimensions and many small offsets. However, resource savings will occur regardless of economic savings.

Wider stud spacing contributes to energy efficiency by reducing the amount of lumber in a wall cavity. Since more insulation and less lumber is used, and since insulation has a higher R-value than lumber, increasing stud spacing increases the overall R-value of the wall system. Limitations: Floor decking, wall cladding, roof sheathing and interior finish material (such as gypsum wall board) need to be sized to span the added dimension without undesirable deflection. If floor joists are chosen that have wide flanges, this will reduce the clear span of the floor decking. Material fastening schedules and sheathing thicknesses become more stringent when wider spans are employed, which may affect quantities, installation time, and cost of accessories.

One-half-inch thick gypsum board will deflect somewhat more over 24" framing than 16" framing, although it is commonly used. An alternative would be to use half-inch "anti-sag" or 5/8" gypsum board.

Some manufacturers do not make insulation batts for 19.2" on center framing. Therefore, using this spacing in an insulated wall assembly may require changing type or brand of insulation.

In some markets, there is a perception that wide-spaced framing is a mark of inferior construction. Attention to all of the details of assembly, including fastening and bracing schedules, will assure that the system performs well.

Code/Regulatory: Model codes allow bearing walls framed with 2x4 studs spaced 24" on center or single top plates on bearing walls within defined structural guidelines. Designs in high-wind zones or with tall walls may not allow 24 inch on-center spacing.

(2) Single top-plate – exterior and bearing walls

Details: Single top plates are typically incorporated with advanced framing designs that include 24" on center framing. By stacking the wall and roof framing, it is possible to use a single top plate because the top plate merely transfers compressive vertical loads to the stud below. Steel plates or straps are used to maintain continuity of the plate in the absence of a second, overlapping plate.

Installation: Temporary bracing is needed to steady and plumb newly erected walls. As with all light frame structures, temporary bracing should be left in place until the floor and, or roof is completed to permanently brace the structure.

Benefits/Costs: In a 28' x 40' two-story house, the savings by eliminating second top plates in bearing and non-bearing walls is equivalent to eliminating about 35 studs. Because one plate is omitted, the amount of wall insulation is increased, slightly improving energy performance.

Limitations: May not work on homes in high-wind or earthquake zones. Requires purchasing a longer stud.

Code/Regulatory: Meets model codes in some designs, but is more likely than other OVE practices to raise questions from building officials.

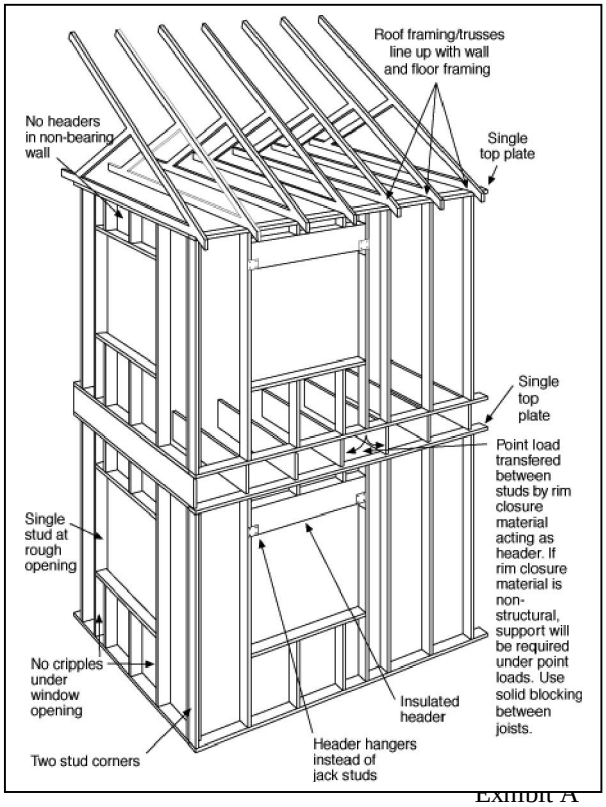
(3) Single top-plate – interior non-bearing partitions

Details: Any non-bearing partition can be built with a single top plate.

Installation: Bracing is needed to steady and plumb recently erected walls. This bracing should be left in place until the floor or roof above the walls is completed, tying the structure together.

Benefits/Costs: Savings depend on the design's linear feet of non-bearing walls. In a 2,200 sq. ft. home, the equivalent of 2 or 3 dozen studs are likely to be saved on interior walls.

Limitations: If used along with a normal double plate on bearing and exterior walls, two lengths of wall studs are required on the job, which could be confusing.



Code/Regulatory: Meets codes, but is more likely than other OVE techniques to inspire questions from the building official.

(3) Right-sized header or insulated box headers

Details: Instead of sizing all headers in bearing walls to accommodate the greatest load case, size each header for its actual load and span using the appropriate wood species. Also consider the benefit of using a deeper, single-ply, and engineered wood header.
If the tedium of framing different header depths to uniform head heights at openings is daunting, use insulated box headers that facilitate load transfer above openings and use fewer resources than 2-ply solid sawn members. Typically, a boxed header design consists of a top and bottom 2x4 on the flat, some end and interior cripples and a plywood face on one or two sides. The hollows in the header interior allow insulation to be added.

Installation: Headers of various sizes require framers to pay attention to plans and customize openings. An alternative would be to site-fabricate and insulate box headers of a consistent depth and install these in lieu of dimensional or engineered wood headers.

Benefits/Costs: Material cost and usage economies must be balanced against the chance of installing the wrong sized header and slowing down the framing process by making opening head framing inconsistent. Similarly, material economies associated with fabricating box headers of consistent depth will be offset by labor involved with fabricating these on site. The need to have an additional material, insulation, on hand at the rough frame stage makes the bill of materials more complex.
Reducing the use of large-dimensioned lumber is environmentally desirable.

Limitations: Without thoughtful implementation, right sizing headers could result in uneven window and door head heights. The practice requires cutting different sized cripples over headers.

Code/Regulatory: Model building codes include prescriptive methods for sizing headers and girders, as well as sizing and constructing box headers.

(5) No headers in non-bearing partitions

Details: Although it is obvious that headers are not needed in non-bearing partitions, it is not always obvious which partitions are load bearing and which are not. Thus, framers often put headers over every opening to be safe. Eliminating these headers saves both material and labor.

Installation: If a method of identifying the bearing walls versus the non-bearing partitions is included on the plans, the layout framer can determine which openings need headers. For instance, solid blue walls can denote bearing and uncolored walls would be non bearing.

Benefits/Costs: Saves material and labor cost, and conserves resources by reducing the use of wide dimension lumber.

Limitations: None.

Code/Regulatory: Model codes do not prescribe headers in non-bearing locations, although it may be necessary to demonstrate to the inspector that a partition is non-bearing.

(6) Ladders at perpendicular wall intersections

Details: Use flat horizontal blocking between studs to secure a perpendicular wall rather than solid vertical framing. (With 24" on center wall framing, three 22-1/2" scrap pieces are set at 24" on center vertically to replace two studs.)

Installation: Cutting and nailing three pieces of blocking requires approximately the same labor as installing two studs.

Benefits/Costs: Less lumber is used, and scrap pieces can be used for blocking. The horizontal blocking stiffens the wall junction. Most important, insulation in the exterior wall can be installed continuously behind the ladder frame.

Limitations: Blocking should be set so that it does not conflict with light switches and outlets.

Code/Regulatory: The system has no impact on model codes.

(7) Two-stud exterior corner framing or equivalent

Details: Only two studs are needed at an outside building corner, one at the end of each intersecting wall end. Any additional framing is needed only to support the gypsum board at the inside corner. Gypsum can be supported either with a flat stud, to leave an open-ended cavity at the corner; or with drywall clips, thus eliminating the need for a third stud.

Installation: If using a third stud for gypsum board backing, the extra stud can be a 2x4, even if the wall is composed of 2x6 studs.

Benefits/Costs: With a two-stud corner, one stud is eliminated. In all cases, the open cavity at the corner can be insulated along with the wall, eliminating the need for the framer to insulate a closed cavity before the sheathing goes on.

Limitations: Drywall clips are unfamiliar to some builders and subcontractors. Exterior corner trim or cladding may result in being secured to the sheathing only and not to the stud.

Code/Regulatory: More studs may be required at corners in high-wind or earthquake zone construction.
Availability: Drywall clips are readily available.

(8) Doubling the rim joist in lieu of header

Details: In thick wall construction, 5 ½” or greater actual wall dimension, it is possible to have the floor system rim board act as the header, or one member of a 2-ply girder or header assembly, at the door or window openings located below that member.

Installation: The joists that frame into this structural member will be shorter than other joists if the design requires a two-ply member to carry the span across the opening. Multiple-member headers should be properly fastened to assure load sharing.

Benefits/Costs: Some labor may be saved in framing the header, but extra labor and thought is involved in fitting perpendicular joists inside the two-ply assembly and framing the opening

height down. The concept works best for long spans where the extra depth of the member or additional height of the opening is needed. The design is also an efficient method for use above openings in foundations.

Limitations: If the rim joist is intended to act along with the extra member (or by itself), it must be continuous across the opening.

Code/Regulatory: This is an unusual technique and may inspire questions from the inspector.

Resources:

- NAHB Research Center, *Advanced Framing Techniques: Optimum Value Engineering,* http://www.nahbrc.org/tertiaryR.asp?TrackID=&DocumentID=2021&CategoryID=70.

- HUDUSER, *Prescriptive Method for Residential Cold-Formed Steel Framing*, http://www.huduser.org/publications/destech/pm2.html

- Building American, DOE, *Optimum Value Engineering Best Practices,* (September, 2002), http://www.ibacos.com/pubs/OptimumValueEngineering.pdf.

- DOE, *Advanced Framing for Walls and Ceilings,* http://www.energy.state.or.us/code/respub/res10.pdf

- International Code Conference, *2003 International Residential Code*®, Panel Box Headers, Table R602.7.2, pg. 123, and Fig. R602.7.2, pg. 124.

- *Reduce Framing Costs with Advanced Framing Techniques*, U.S. EPA: http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/BuilderGuide3D.pdf

- *Advanced Framing Fact Sheet*, U.S. DOE: http://www.toolbase.org/docs/MainNav/WoodFrameConstruction/3949_advancedwallframing1.pdf

- Advanced framing: http://www.buildingscience.com/housesthatwork/advancedframing/default.htm

- *Cost Effective Homebuilding: A Design and Construction Handbook*, 1994, NAHB Research Center, available for purchase at: http://www.nahbrc.org/tertiaryR.asp?TrackID=&DocumentID=2584&CategoryID=917

601.5 Prefabricated components: Pre-cut or pre-assembled components, or panelized or precast assemblies are utilized for a minimum of 90 percent for the following system or building:

(1) floor system
(2) wall system
(3) roof system
(4) modular construction for the entire building located above grade
(5) manufactured home construction for the entire building located above grade

Intent:
Utilizing materials that do not require additional resources and/or onsite assembly optimizes plant manufacturing efficiencies and offers protection from the elements. Less time (site impact) and resources are spent onsite.

Additional Information / How to Implement:
For Option A, the builder would receive 3 points for using a flooring package, 3 points for a roof framing package, or 6 points for using both.

Precut material packages – A precut floor or roof package can be bundled and shipped for sequencing of use in layout and covered to minimize exposure to the elements. Pieces are marked by location on a layout plan that is provided on the blueprint or with the package. Package delivery can be scheduled for just-in-time delivery to minimize site disturbance. Not having to cut or calculate the position of the components of the floor system speeds assembly, eliminates onsite waste, and saves labor. Contractor-focused lumberyards and component manufacturers that supply engineered wood will have the resources to provide this value-added service. Another resource is building material supply dealers who supply steel stud framing packages.

Pre-manufactured component packages – Open-web floor or roof truss packages also benefit from the efficiencies listed above for precut material packages. Because building components can be engineered with 2x4 and 2x6 lumber to perform as capably as wide dimension lumber, components present an opportunity to reduce the resources in a home. Often, the reduced amount of board feet of lumber in the component facilitates easier handling because of the reduced weight.

Panelized construction – Open wall panels, manufactured in a factory, benefit from efficient purchasing and use of materials, automated cutting and fastening methods, and assembly in an environment that is protected from the elements. Panels are custom manufactured and delivered to meet the builder's schedule. A layout plan aids the carpenter in assembling the walls on site. Using panels can save several days in the critical path of assembly and speed the process of "closing-in" the home.

Modular construction – entire sections of the home are constructed and transported to the site. Modular housing goes further in reducing waste on site, since the unit is delivered to the site 70 to 85% finished. Modules are moved onto a site-built foundation, connected, repaired at common junctions, and tied in to utilities. Homes can be made ready for move-in within one week.

Resources:
- NAHB, Building Systems Council, *Fast Facts: Systems-Built Housing,* http://www.nahb.org/generic.aspx?sectionID=455&genericContentID=10216 and www.buildingsystems.org

- U.S. HUD, *Builders' Guide to Residential Steel Floors*, http:www.huduser.org/Publications/PDF/steelfloor.pdf

601.6 Stacked Stories: Stories above grade are stacked, such as in 1 ½-story, 20story, or greater structures. The area of the upper floor is a minimum of 50 percent of the area of the story below, based on areas with a minimum ceiling height of 7 feet (2134 mm).

(1) first stacked story
(2) for each additional stacked story

Intent:
Fewer building materials and resources are used to build the same square footage when some of the building is stacked. The foundation and roof are smaller and energy is distributed more efficiently.

Additional Information/How to Implement:
Design the building to utilize multiple stories consistent with local building code. Arrange critical functions on the ground level, including one bedroom and bath that are designed for maximum accessibility, to create a floor plan that maximizes both the ability to age-in-place and to take advantage of the resource efficiencies of stacked buildings.

Resources:

- Use the newly-modified American National Standards Institute (ANSI) Z765-2003 to calculate square footage. Available from the NAHB Research Center Bookstore - http://www.nahbrc.org/tertiaryR.asp?TrackID=&CategoryID=1652&DocumentID=2636

- Oikos®, *Small, Efficient and Beautiful*, 17 Space Design Tips. http://oikos.com/esb/52/smallefficient.html

- There are many resources available to help a builder create efficient home floor plans. For example, Sarah Susanka's *Not So Big House* series of books can assist in home design. *The Not So Big House* (The Taunton Press, 1998); *Creating the Not So Big House* (The Taunton Press, 2000).

- GreenBuilder, *Sustainable Building Sourcebook,* http://www.greenbuilder.com/sourcebook/

- Environmental Building News and BuildingGreen.com, *GreenSpec Directory* http://www.greensage.com/BOOKS/GreenSpecs.html

601.7 Site-applied Finishing Materials: Building materials or assemblies are utilized that do no require additional site-applied material for finishing.
(1) 90 percent or more of the installed building material or assembly listed below:
(2) 50 percent to less than 90 percent of the installed building material or assembly listed below:
(a) pigmented, stamped, decorative, or final finish concrete or masonry
(e) Use no trim on doors and windows counting both interior and exterior and both sides of internal doors.

Intent:
To reduce the amount of materials used.

Additional Information / How to Implement:
Santa Fe style with its use of bull nose detailing inherently minimizes the amount of trim material used in construction. This technique is used both on the interior and the exterior of buildings and for interior doors as well.

601.9 Above Grade Wall Systems: One or more of the following above grade wall systems that provide sufficient structural characteristics are used for a minimum of 75 percent of the gross exterior wall area of the building or 30 percent of interior and exterior wall areas combined.

(1) adobe or compressed earth block
(2) concrete and/or masonry
(4) rammed earth

Intent:
To increase thermal storage of home by increasing the thermal capacity of the structure.

Additional Information/How to Implement:
Thermal mass in the interior of the home when in the sun path through a window stores energy and re-emits it in the winter (or re-absorbs it in the summer). Calculate the total area of walls that are in or enclosing the building's thermal envelope and calculate the percentage that is comprised of the materials listed above.

601.9.1 Use earth from site (80% of the soil used) to make adobes, compressed earch block or rammed earth material used building.

Intent:
To reduce the imbedded energy and greenhouse gas emissions associated with the use of adobes or rammed earth. The energy required to transport these heavy materials from remote locations where they are made for sale is avoided when the materials on the site are used to construct the materials.

Additional Information/How to Implement:
Assess the soil make up to determine if it has the component mix of sand, clay and organic material necessary to make the materials. Up to 20 percent of material can be brought from off-site (such as additional clay material if the soil is insufficient) to take advantage of this item.

602 Enhanced Durability and Reduce Maintenance

Intent:
Building designs, material choices and installation techniques should seek to minimize the effects of degradation and weathering, enhance life expectancy of the assembly, and lessen maintenance needs.

Additional Information / How to Implement:
Durability may be defined as the ability of a material, product, or building to maintain its intended function for its intended life-expectancy with intended levels of maintenance in intended conditions of use.

Fortunately, many of the best practices intended to improve durability require little more than good judgment and a basic knowledge of the factors that affect building durability. A thorough review of resource publications will provide a solid foundation for addressing durability during the stages of construction.

Resources:

- NAHB Research Center for PATH, *Durability by Design*, http://www.huduser.org/publications/destech/durdesign.html

- Canadian Architect, *Measures of Sustainability*, http://www.cdnarchitect.com/asf/perspectives_sustainibility/measures_of_sustainablity/measures_of_sustainablity_durability.htm

- The Residential Moisture Management Network is working on addressing issues related to moisture management in homes, http://www.rmmn.org/

- Installation details for wood framed construction that will minimize moisture intrusion into the building envelope can be found at http://www.buildabetterhome.org. Publications on foundations, roofs and walls can be downloaded by going to each of those sections under the "builder tips" and then clicking on "get the brochure."

602.1 Exterior Doors: Entries at exterior door assemblies, inclusive of site lights, are covered by once of the following methods to protect the building from the effects of precipitation and solar radiation. A projection factor of 0,375 minimum is provided.

(a) installing a porch roof or awning
(b) extending the roof overhang
(c) recessing the exterior door

(1) main entrance door
(2) additional covered door assemblies

Intent:
A roof over an entry to a home sheds precipitation and sunlight from the opening, protecting door finish and penetration of moisture around jambs, trim and threshold, thereby minimizing the need for maintenance of these areas. Roofs over entries are convenient for the occupant during foul weather and are an architectural feature that can enhance a home's visual appeal and provide an outdoor living space.

Additional Information / How to Implement:
Designs should include a roof or recessed front opening of a depth equal to or greater than the recommended roof overhang for the region.

602.2 Roof Overhangs: Fixed permanent roof overhangs, including portals, based on inches of rainfall in Table 602.2, are provided over a minimum of 90 percent of exterior walls for sloped roofs or portals that cover 50% or more of the wall area for flat roofed buildings to protect the building envelope.

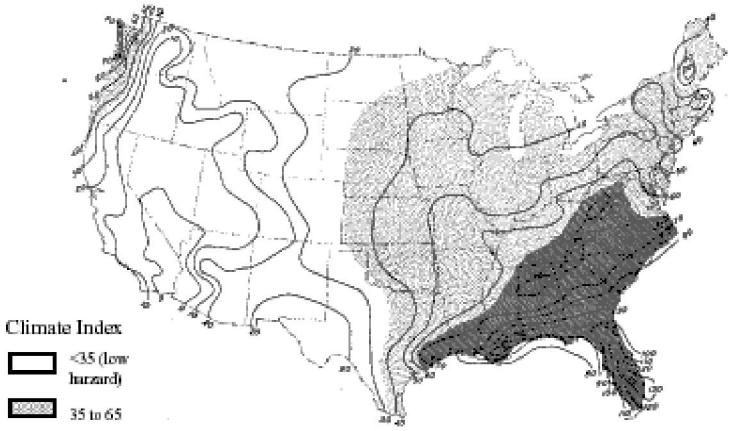
Intent:
Protect the building envelope and enhance the home's durability through the use of overhangs. Use overhangs to shade windows from summer heat gain.

Additional Information / How to Implement:
The following table presents the recommended roof eave and rake overhangs for the climate:

Resources:
NAHB Research Center for PATH, *Durability by Design*, http://www.huduser.org/publications/destech/durdesign.html

602.4 Drip edge is installed at eave and gable roof edges.

Intent:
The drip edge directs roof runoff water into the gutters and away from the fascia and roof sheathing.



Additional Information / How to Implement:
Drip edge is an inexpensive accessory that can be included in the roofer's scope of work and roofing material package.
Resources:

- Truini, Joseph, *This Old House*, Roof Runoff Remedy, http://www.thisoldhouse.com/toh/knowhow/solutions/article/0,16417,193154,00.html

602.7 Termite Barrier: Continuous physical foundation termite barrier used with or without low toxicity treatment is installed in accordance with Figure 6(3).

602.7.1 Additional points for continuous physical foundation termite barrier using no toxic treatment installed in accordance with Figure 6(3).

Intent:
Providing a low- or non-chemical termite obstruction offers a long-term solution to termite infestation avoidance.

Additional Information / How to Implement:
IRC Fig. R 301.2(6) has a *Termite Infestation Probability Map* of the United States delineating the country into different zones of infestation levels; heavy, moderate-to-heavy, etc. The local HBA may offer information on the regional probability of termite infestation in consultation with local cooperative extension service and other termite experts.
Using a foundation termite shield is only one way a builder can effectively combat termite infestation. Following is a breakdown of the homebuilding process and a list of the tactics that can be used in an environmentally-aware fashion to accomplish termite resistance.

I. Site.

A. Selection - termites dislike dry conditions. Choose a site that is well-drained and ventilated.

B. Sanitation - the majority of termites that infest homes live underground and food (cellulose in the form of wood, paper, leaves, etc.) stored underground may lead termites

to a house. When preparing a site for construction, don't bury vegetation and construction debris. After foundation construction, don't include wood scraps in the backfill.

C. Landscaping - Keep homes dry. Slope finish grade away from the house. Keep plantings well away from homes. Roots act as underground bridges through chemical or physical termite barriers. Plants such as shrubs and trees can prevent ventilation to the home and prevent drying after precipitation events.

II. Design

A. Layout - Keep houses dry. Ensure that wood elements are stopped at least 8" above finish grade. Termites can form hills or tubes that extend from the soil to food. Greater clearance between ground and wood elements prevents this situation and allows more time for detection should termites use tubes to reach above-ground food sources. Keep untreated wood away from contact with concrete. Concrete is a good conductor of water and untreated wood in contact with concrete may decay or attract termites.

B. Thermal - Termites love moisture and moisture comes from many sources. Proper design of the exterior envelope will prevent condensation from occurring.

C. Materials - Areas of the home that are particularly susceptible to moisture, like shower and bath surrounds should not be detailed with cellulose materials. Penetrations through the foundation, walls, and roof are all vulnerable to moisture intrusion and care should be taken to minimize these penetrations. To protect against foundation penetrations, consider using one of new physical barriers in the marketplace. Termiticides bonded between a polymer fabric and a stainless steel mesh small enough to keep out termites are some of the innovations available.

III. Construction Process

A. Material Storage - Keep moisture sensitive materials dry and don't incorporate compromised products into the house. Arrange to have materials delivered as close to the time of installation as practical.

B. Flashing - Penetrations through the exterior envelope are particularly vulnerable to moisture intrusion. Properly flash and seal all penetrations to prevent moisture accumulation.

IV. Post Construction

A. Owner Education - Inform homeowners about the value of dry homes and practices they can perform to keep the house free of termites and decay. Describe prevention features of the home and how these features can become compromised.

B. Termite Control - Should termites need subsequent control, consider targeted poisons such as baits.

<u>Resources:</u>

- Canadian Wood Council, *Termite Control and Wood-Frame Buildings: Slab and Foundation Details,* http://www.cwc.ca/publications/building_performance/termites/structural.php

- NAHB Research Center, *Termite Baiting*
  http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1402&DocumentID=2153

- University of Kentucky Entomology, *Termite Baits: A Guide for Homeowners,*
  http://www.uky.edu/Agriculture/Entomology/entfacts/struct/ef639.htm

- Termiticide fabric and mesh manufacturers, http://www.impasse.com/ and http://www.termi-mesh.com/

602.11 Foundation Waterproofing: Enhanced foundation waterproofing is installed where waterproofing is required by code: (Note: Some coatings are not compatible with exterior foam insulation.)

(1) rubberized coating, or
(2) drainage mat

Intent:
To keep moisture out of the foundation by providing a waterproof exterior coating or engineered exterior drainage plane.

Additional Information / How to Implement:
Foundation coatings that are required by the model building codes help prevent moisture from penetrating the foundation. A number of products are available to provide a more permanent barrier to moisture at the exterior of the foundation.

Resources:
ToolBase Services, *Foundation Drainage Panels,*
http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2063&CategoryID=1010

602.12 Flashing details are shown on plans and flashing is installed at all of the following locations, as applibable:

(1) around exterior fenestrations, skylights and doors
(2) roof valleys
(3) deck/balcony to building intersections
(4) at roof-to-wall intersections and at roof-to-chimney intersections
(5) a drip cap is provided above windows and doors that are not flashed or protected in accordance with Section 602.1

Intent:
To specify and call out the details of systems integration on the blueprints rather than leaving them to the half dozen or so specialists who perform installation of adjacent materials on the jobsite. All junctions of dissimilar material and flashing details are to be shown on plans.

Additional Information / How to Implement:
Product manufacturer's installation guides and association best practices details are good sources for the correct detailing of systems.

Resources:
- Brick, http://www.gobrick.com/html/frmset_thnt.htm

- Masonry products, www.ncma.org.

- Various, http://pix.nrel.gov:8020/BASIS/nich/www/bapublic/SDF

- Windows and doors, http://pix.nrel.gov:8020/BASIS/nich/www/bapublic/SDF

- Wood, http://apacad.org/

- *EEBA Water Management Guide* - http://www.eeba.org/mall/water.asp - This guide presents a variety of recommendations for minimizing water intrusion into homes. These recommendations are not intended to apply to every conceivable situation but are intended to illustrate principles.

603 Reused or salvaged materials

603.1 Reuse of Existing Building: Existing buildings and structures are reused, modified, or deconstructed in lieu of demolition.

Intent:
Construction activities may comprise as much as 40% of all raw materials extracted from the earth. At the same time, construction, remodeling, and deconstruction are blamed for generating 136 million tons of waste annually. Some waste material can easily be refitted back into a structure. The action would decrease both material use and waste. In addition, unneeded transportation costs associated with hauling could be eliminated.

Additional Information / How to Implement:
Develop and implement a plan to use materials prudently, regardless of their origination.

Resources:
- Inform, Inc., *Community Waste Prevention Toolkit: Construction and Demolition Fact Sheet*, http://www.informinc.org/fact_CWPconstruction.php#basics

- Government of Hawaii, *Minimizing Construction and Demolition Waste,* http://www.hawaii.gov/health/environmental/waste/sw/pdf/constdem.pdf

- California Integrated Waste Management Board (CIWMB), http://www.ciwmb.ca.gov

- CIWMB, *Recycled-Content Product Directory*, http://www.ciwmb.ca.gov/RCP/Product.asp?VW=CSI&CATID=269

- NAHB Research Center, ToolBase Services, *Construction Waste Management,* http://www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=34

- Whole Building Design Guide, *Construction Waste Management Database,* http://www.wbdg.org/ccbref/cwm.php

- Washington State Department of General Administration, Construction Waste Management Guide, http://www.ga.wa.gov/EAS/CWM/ContractorsGuide.doc

603.3 Scrap Materials: Facilitation for sorting and reuse of scrap building material (e.g., provide a central storage area or dedicated bins).

Intent:
To use scrap materials in lieu of cutting up new materials into smaller pieces. This reduced the amount of total material used to build the home.

Additional Information/How to Implement:
Design the sorting and reuse area in such a way as to make it easy to find pieces of sufficient size for the purpose. If using this scrap material proves difficult it is less likely that workers will take the time to dig through a disorganized pile but rather start with a new piece of whatever kind of building material they need.

605 Recycled construction waste

Recycling waste materials is driven by market conditions at the local level throughout which recycling markets and tipping fees vary greatly.

605.1 Construction Waste and Management Plan: A construction waste management plan is developed, posted at the jobsite, and implemented with a goal of recycling or salvaging a minimum of 50 percent (by weight) of construction and land-clearing waste.

Intent:
Create a C & D waste management plan that sets goals to recycle or salvage a minimum of 50% (by weight) of construction, demolition, and land clearing waste.

Additional Information / How to Implement:
A C & D plan can be a simple spreadsheet that covers the materials used or de-constructed on site and the plan for reusing them onsite, or recycling them. If recycling, include the name of the hauler, destination, and approximate quantities. A sample plan can be obtained from the City of Oxnard, CA in the Resources.

Resources:
City of Oxnard (CA), *C & D Solid Waste Management and Recycling Plan,* http://www.ci.oxnard.ca.us/pubworks/refuse/worksheets/c_dplan.pdf

- NAHB Research Center, Inc., Residential Construction Waste information, http://www.epa.gov/epaoswer/non-hw/debris/mgmt.htm

- U.S. Environmental Protection Agency Solid Waste and Emergency Response, Building Savings, Strategies for Waste Reduction of Construction and Demolition Debris from Buildings (EPA-530-F-00-001) (June 2000), http://www.epa.gov/osw

- Institute for Local Self-Reliance. http://www.ilsr.org/recycling/buildingdebris.pdf.

607 Resource-efficient materials

607.1 Resource-Efficient Material: Products containing fewer materials are used to achieve the same end-use requirements as conventional products, including but not limited to: (3 points awarded for each material)

(2) engineered wood or engineered steel products

(3) roof or floor trusses

Intent:
Minimize the resources consumed by and environmental impact of building a house.

Additional Information / How to Implement:
Points: A project must use resource efficient materials for at least two different types of components to receive the three points.
When specifying materials, consider the amount of resources going into the product and whether other alternatives are available. Examples are specifying hollow brick that meets the requirements of ASTM C 652 and is made from less material than face brick that meets ASTM C 216. Appearance and durability requirements are identical. Or, specifying engineered wood products, e.g., I-joists that use 35% less fiber material than solid-sawn products.
Caveat: even though engineered products can reduce the amount of feedstock used in a product, e.g., wood fiber in I-joists, more energy or binders may be needed to create the final product. While this may be the case, our intent is to reduce the core source of material going into the product's creation.

Resources:

- DOE's Energy Efficiency and Renewable Energy, *Energy and Environmental Guidelines for Construction,* http://www.eere.energy.gov/buildings/info/design/construction.html#construction

610 Innovative practices

610.2 Universal Design: For future resource efficiency. One point per universal design element (see User's Guide) maximum of 6 points.

Intent:
Reduce the chances of a structure undergoing future remodeling if the mobility of the occupants changes.

Additional Information / How to Implement:
Elements of Universal Design include:

1. no stairs required to enter the home
2. no stairs required to get to all necessary rooms within the home
3. room in one bathroom for a wheelchair
4. bars in one bathroom for the toilet
5. bars in one bathroom for the tub or shower
6. lever-type faucets in the bathroom or kitchen,
7. flat threshold at one entrance (preferably the main entrance)
8. or other element appropriate to the home

610.3 Modular Building Dimensions. Frame structures or structures made with modular units are designed on 16- or 24-inch dimensions.

Intent:

Use of standard or modular dimentions in layout will reduce waste by not having to cut materials.

Additional Information / How to Implement:
Modular dimensioning it was adopted in the late 1960s and is widely used. Adherence to modular dimensioning can reduce waste of material on the job site.

- One side of a door and window opening located at regular 16" or 24" stud positions.
- Modular window sizes used, with both side studs located at a normal 16" or 24" stud positions
- Building dimension in the direction parallel to the primary joist span is evenly divisible by 4 feet.
- Building dimension in the director perpendicular to the primary joist span is evenly divisible by 2 feet.

Building to a 2' module and using 24" on-center wall and floor framing will maximize framing materials resource efficiency and cost savings. Few homes can be entirely confined to a rigid module because typical dimensions such as the width of a tub or corridor are not in two-foot modules. To maximize savings, window sizes, and placement should be coordinated with the two-foot module.

Resources:
NAHB Research Center, PATH technological list, *Advanced Framing Techniques: Optimum Value Engineering (OVE.*
http://www.toolbase.org/tertiary.asp?TrackID=&DocumentID=2021&CategoryID=70

610.4 Use structural vigas, beams, or posts (from less than 300 miles away) (does not apply to decorative vigas)

Intent:
To make the home building process more environmentally acceptable by minimizing transportation and processing costs and using materials that are common in the local region.

Additional Information / How to Implement:
Supply documentation from supplier indicating where the materials were harvested and distance from that location to Santa Fe.

610.5 Structural insulated panels (SIPs) used for the exterior:
(1) walls
(2) roof

Intent:
Using SIPs reduces the lumber used to frame the home. In addition, SIPs eliminate thermal bridging, reducing energy demands to heat and cool the home.

Additional Information/How to Implement:
Specify SIPs for walls and or roof for the exterior building envelope. Ensure that sufficient insulation is provided to meet the local building code requirements. This may require addition of insulation which can be achieved through attaching rigid insulation to the outside on top of the SIPs.

610.6 Drainage from canales is done in accordance with all of the following

(1) Waterproof the foundation behind the splash area and extending 3 feet in both directions.

(2) Install an impermeable liner in splash area under canale.

(3) Liner or other collector guides water away from structure sloping a minimum of 6 inches over 6 feet for a minimum of 6 feet away from structure.

Intent:

To reduce the impact of water splashing back onto the wall and seeping down to the foundation.

Additional Information/How to Implement:

All three items must be implemented to get these points. These three actions taken together, can significantly reduce building material degradation and eventual leakage associated with the water that is concentrated by canales. When water falls from a canale it can splash back onto the exterior wall surface and collect below the canale, especially if there is no mechanism to direct the water away from the structure.

Chapter 7
ENERGY EFFICIENCY

701 Minimum Energy Efficiency Requirements

701.1 Mandatory Requirements: New buildings must comply with Section 702 (Performance Path)

701.4.3 Insulation and Air Sealing
701.4.3.1 General. Insulation and air sealing is inspected by an approved third party and a report verifying compliance is provided to the City's Inspection Division and is in accordance with the following:

(1) Insulation. Insulation is installed in accordance with the manufacturer's instructions or local code, as applicable. (Mandatory)
(2) Shafts (duct shaft, piping shaft/penetrations, flue shaft). Openings to unconditioned space are fully sealed with solid blocking or flashing and any remaining gaps are sealed with caulk or foam. Fire-rated collars and caulking are installed where required. (Mandatory)

701.4.3.2 Floors, foundations, and crawlspaces: These items are inspected by an approved third party and a report verifying compliance is provided to the City's Inspection Division.

(1) Floors. (including insulated floors above garages and cantilevered floors) (Mandatory)
(a) Insulation is installed to maintain permanent contact with the underside of the subfloor decking, enveloping any attached ductwork within the thermal envelope without compression or air gaps in the insulation. This practice does not apply to ducts or other mechanical equipment that is adjacent to the underside of the subfloor.
(b) Batt and loose-fill insulation is held in place by permanent attachments or systems in accordance with the manufacturer's instructions.
(2) Crawlspace. Where insulated, crawlspace wall insulation is permanently attached to the walls. Exposed earth in unvented crawlspaces is covered with continuous vapor retarder with overlapping joints that are taped or masticed. (Mandatory)

701.4.3.3 Walls: These items are inspected by an approved third party and a report verifying compliance is provided to the City's Inspection Division.

(1) Windows and Doors. Caulking, gasketing, adhesive flashing tape, foam sealant, or weatherstripping is installed forming a complete air barrier (Mandatory)
(2) Band joists and rim joists. Band and rim joists are insulated and air sealed. (Mandatory)
(3) Between foundation and sill plate bottom plate
(a) Sill sealer or other material that will expand and contract is installed between foundation and sill plate. (Mandatory)
(b) Caulk or the equivalent is installed to seal the bottom plate of exterior walls. (Mandatory)
(4) Skylights and knee walls. Skylight shafts and knee walls are insulated to the same level as the exterior walls. (Mandatory)

(5) Exterior architectural features. Code required building envelope insulation and air sealing are not disrupted at exterior architectural features such as stairs and decks. (Mandatory)

701.4.3.4 Ceilings and attics. These items are inspected by an approved third party and a report verifying compliance is provided to the City's Inspection Division.

(1) Attic access (except unvented attics). Attic access, knee wall door, or drop-down stair is covered with insulation and gasketed. Knee wall door is an insulated unit or is covered with insulation. (Mandatory)

(2) Recessed lighting. Recessed light fixtures that penetrate the thermal envelope are airtight, IC-rated, and sealed with gasket, caulk or foam.

(3) Eave vents. Where ceiling/attic assemblies or designs have eave vents, baffles or other means are implemented to minimize air movement into or under the insulation. (Mandatory)

Intent:

When building an energy efficient home, it is equally or more important to prevent air infiltration as it is to provide a high R-value wall system. Air can pass through very small cracks, resulting in energy loss and condensation, so it is necessary to be very detail-oriented when it comes to air sealing. Attention to these details is important to make sure the Blower Door test comes in at the projected rate and that any thermal by-pass is reduced.

Housewrap Installation from oikos.com

Additional Information / How to Implement:

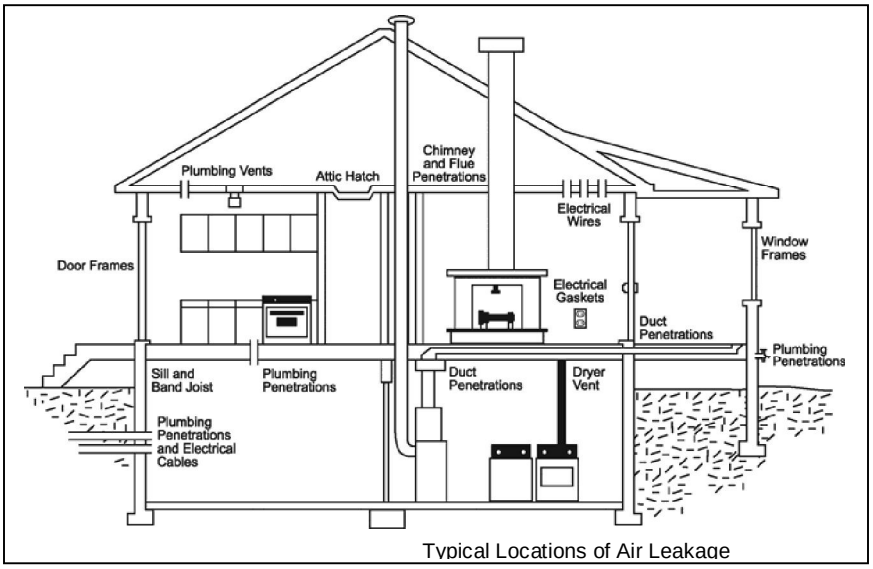
Air leakage can account for as much as 20-30% of energy loss through the building envelope. Although insulation reduces energy loss , air infiltration can compromise the efficiency of a building because it brings conditioned air directly outdoors (or outdoor air inside), bypassing the insulation. In addition, it not only carries heated (or cooled) air to the outdoors, but may also create moisture problems as water vapor in the air moves from a warmer to colder location and condenses. Use the list below to make sure that you seal the nooks and crannies where air may escape.

To perform air sealing, use a variety of materials such as caulk, foam, and gasket materials. It has been proven that “chinking” with fiberglass insulation does not prevent airflow. Low-expanding foams should be used around windows and doors so that the frame doesn’t bind—a common complaint with first-generation, high-expanding foam products. Other details that can help reduce air leaking include:

- Sill sealer between foundation and sill plate.
- Caulk bottom plate of exterior walls.

- Air seal band joist cavities between floors.
- Ensure air barrier continuity at all framed cavities such as air chases, soffits, coffered or dropped ceilings, and behind tub/shower units on exterior walls.
- Caulk/foam all electrical, plumbing, heating penetrations between floors (including attic, basement, crawl space, and garage) and to exterior
- Block and seal cantilevered floors and kneewalls.
- Weatherstrip attic hatches, kneewall doors.
- Insulate, caulk, or foam between window/door jambs and framing.
- If installing recessed lights in ceilings adjacent to unconditioned space, use rated, air-tight Type IC housings.
- Caulk/foam HVAC register boots to subfloor or drywall that penetrate the building envelope.
- If a fireplace is installed, install a gas fireplace that is sealed combustion or a wood-burning fireplace with gasketed doors.

Air Sealing Details



Typical Locations of Air Leakage

Also see Section 5.2.2 under the Indoor Environmental Quality section for more information about mechanical ventilation options.

In conjunction with implementing an air sealing package, also consider a means of providing fresh air to the home. This may be operable windows if the homeowner will use them, but often an automatic mechanical means of introducing fresh air may be the most reliable way to ensure adequate ventilation. Controlled ventilation that is carefully designed and installed provides a more consistent rate of air exchange compared to simply building a leaky structure. A tight building envelope with an intentional means of introducing outdoor air enhances energy efficiency, comfort, and indoor air quality.

Resources:

- *Advanced Air Sealing* (book available for viewing online): http://oikos.com/library/airsealing/index.html

- U.S. DOE's fact sheet, *Airtight Drywall Approach* (no diagrams), http://www.eere.energy.gov/consumerinfo/fact sheets/bd8.html

- Southface Energy Institute's fact sheet, *Airtight Drywall Approach* (contains diagrams), http://www.southface.org/web/resources&services/publications/fact sheets/24ada_drywal.pdf

702 Performance Path

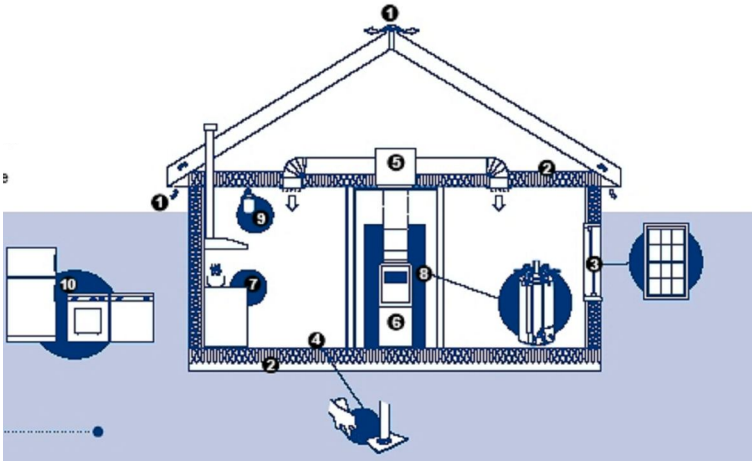
702.2 Energy cost performance levels. Energy efficiency features are implemented to achieve energy cost performance that exceeds the ICC IECC by the following. A documented analysis using software in accordance with ICC IECC, Section 404, or ICC IECC Section 506.2 through 506.5, applied as defined in the ICC IECC, is required. A projected Home Energy Rating System, or equivalent, rating in the form of an ES 2.5 report, or equivalent, shall be provided to submit for permit and a report of the confirmed rating also in the form of an ES 2.5 report, or equivalent shall be provided to the City of Santa Fe's Inspection Division. (Mandatory)

Intent:
To establish a minimum energy threshold for all homes. A HERS index is a whole systems approach in designing and building an energy efficient home. Key concepts are *integrated* and *comprehensive*. To have a measured evaluation of how much energy the building is expected to use to operate that can be fairly used to compare one residence to another. It also ensures that the overall energy use in the City is predictable to assist in the City's efforts to reduce greenhouse gas emissions in accordance with the U.S. Mayor's Agreement on Climate Change.

Additional Information / How to Implement:
A Home Energy Rating System (HERS) measures the energy that would be used by the home as compared to a model home of the same size. Since it is a comparison to a model it is an index (rather than the more common reference of a score). Therefore an index of 100 means that the home being analyzed would use 100% of the energy that the model home would and a home with an index of 70 would use 70% of the energy that the model home would. Therefore, the lower the index, the more energy efficient the home.

Prior to having a HERS rater, REScheck, available free for download, can be used to assist the designer to select appropriate energy saving methods and materials such as examining the effect of different levels of insulation, window U-values and SHGC factors, and space conditioning equipment efficiencies to identify a cost-effective system for your project. Once the HERS rater enters the design into REMRATE, a more complete software package available only to certified HERS raters, the results may vary from those obtained by RESCHECK. It is only the results of REMRATE that are accepted by the City of Santa Fe for purposes of obtaining a building permit.

Pay attention to multiple facets related to energy efficiency during the design and construction process. For instance, rather than simply focusing on individual decisions related to energy efficiency, such as the R-value of attic insulation, consider the implications of each choice on the performance of the whole house. Balance the cost and performance of each component of the home system, such as a well-insulated building envelope (foundation, walls, and attic); windows recommended for the climate by experts such as the Efficient Windows Collaborative, the Department of Energy, and/or local energy professionals; a thorough and carefully-implemented air sealing package; climate-appropriate heating and cooling equipment that balances efficiency with cost effectiveness; sealed ductwork kept within the conditioned space; and efficient water heating equipment and distribution. Moisture and indoor environmental quality are closely related factors that are affected by energy efficiency measures.



Courtesy of Southface Institute; developed with funding from the U.S. Department of Energy

Improve Energy Efficiency Throughout the House

1. Provide roof/attic ventilation
2. Install adequate insulation with no gaps or compressed areas.
3. Specify efficient windows; consider window orientation.
4. Seal all penetrations.
5. Locate all ducts within conditioned space; ensure all ducts are sealed with mastic.
6. Size heating and cooling equipment; choose efficient models.
7. Provide controlled ventilation.
8. Install efficient water heating.
9. Specify efficient lighting for fixtures used more than 4 hours per day.
10. Choose efficient appliances.

Resources:

- Residential Energy Savings Network (RESNET) http://www.natresnet.org/
- *Home Energy Checklist* (EEBA) http://www.eeba.org/technology/publications/hec/default.htm
- *Whole House Energy Checklist* (U.S. DOE fact sheet), http://www.southface.org/web/resources&services/publications/technical_bulletins/WH-Energy%20Checklist%20GO-10099-766.pdf
- *Energy Efficiency Pays* (U.S. DOE fact sheet), http://www.southface.org/web/resources&services/publications/technical_bulletins/EEP-Efficiency_pays%2099-746.pdf
- *Considerations for Building a More Energy Efficient Home*, NAHB Research Center fact sheet. Available at http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1809&DocumentID=4168
- *REScheck* is a free software tool that can be downloaded at http://www.energycodes.gov/rescheck/.
- American Council for an Energy-Efficient Economy's list of most energy efficient appliances http://www.aceee.org/consumerguide/mostenef.htm
- http://www.energystar.gov for a list of equipment meeting ENERGY STAR standards
- *Gas Appliance Manufacturer's Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment.* http://www.gamanet.org

- *REScheck* - REScheck, available for free download at: http://www.energycodes.gov/rescheck/

- *International Energy Conservation Code* (IECC) 2003. Available from the International Code Council, http://www.iccsafe.org

702.2 Better HERS Index than Required. For each two (2) whole HERS index points below the required HERS index.

Intent:
To give credit for lowering the energy usage of the building below the required level of the code.

Additional Information / How to Implement:
At time of permit application not all of the points will be allocated to having a lower than required HERS index. This is to accommodate differences that sometimes arise between the projected HERS index and the confirmed HERS index which is given after construction. However, all points will be awarded once the confirmed HERS index is submitted and will be reflected on the posting given prior to Certificate of Occupancy.

704 Additional Practices

704.2 Lighting and appliances

704.2.1 Hard-wired lighting is in accordance with one of the following:
(1) A minimum of 50 percent of the bulbs in the hard-wired light fixtures, qualify as ENERGY STAR or equivalent.
(2) A minimum of 50 percent of the total hard-wired lighting fixtures qualify as ENERGY STAR or equivalent.

Intent:
To reduce the energy requirements to light the home while maintaining adequate lighting.

Additional Information/How to Implement:
Select ENERGY STAR fixtures and/or light bulbs, such as compact fluorescents (SFL) or Light Emitting Diodes (LED).

704.2.2 The number of recessed lighting fixtures that penetrate the thermal envelope are less than 1 per 400 square feet (37.16 m2) of total conditioned floor area and are in accordance with Section 701.4.3.4(2).

Intent:
To eliminate energy losses associated with inadequate insulation above, and air infiltration through, light fixtures in insulated ceilings.

Additional Information / How to Implement:
Although there are recessed light fixtures rated for insulation contact, they still carry an energy penalty because of reduced insulation thickness in the ceiling above the fixture and/or air leakage around the housing. To completely avoid this energy penalty, do not install recessed

lights in an insulated ceiling. Bulkheads or dropped soffits can permit the installation of recessed lights in insulated ceilings. Be sure that there is a continuous air barrier at the top of the bulkhead or the original ceiling. The preferred method is to install drywall (or other finish material) on the ceiling prior to constructing the bulkhead.

704.2.4 Tubular daylighting device (TDD) or a skylight with sealed, insulated, low E glass is installed in rooms without windows.

Intent:
To reduce the need for artificial lighting by providing natural light when available.

Additional Information / How to Implement:
Tubular skylights provide natural lighting to interior spaces while minimizing the inherent energy losses of standard skylights. Tubular skylights have a smaller diameter roof penetration than most skylights and have an additional layer of insulating glazing at the ceiling level.

Resources:
Tubular Skylights (NAHB Research Center technology fact sheet)
http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1282&DocumentID=2024.

704.2.5 ENERGY STAR or equivalent appliance(s) are installed
(1) refrigerator
(2) dishwasher
(3) washing machine

704.2.6 Induction cooktop is installed

Intent;
To reduce energy demand of household appliances.

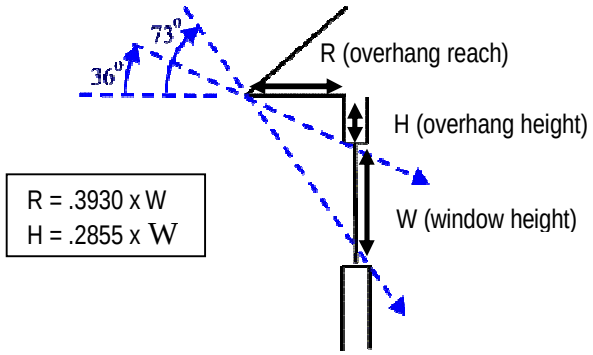
Additional Information/How to Implement:
Select appliances that use less energy to perform the same task such as ENERGY STAR rated appliances or an induction stove top.

704.3 Renewable Energy and Solar Heating and Cooling

704.3.1 Solar Space Heating and Cooling

704.3.1.1 Sun-tempered design. Building orientation, sizing of glazing, and design of overhangs are in accordance with the following:
(1) Long side (or one side if of equal length) of the building faces within 20° of true south.
(2) Vertical glazing area on the south face is between 5 and 7 percent of the gross conditioned floor area [also see Section 704.3.1.1(8)] if no mass is present or up to 12% if mass is present.
(3) Vertical glazing area on the west face is less than 2 percent of the gross conditioned floor area and glazing is Energy Star compliant or equivalent.
(4) Vertical glazing area on the east face is less than 4 percent of the gross conditioned floor area and the glazing is Energy Star compliant or equivalent.
(5) Vertical glazing area in the north face is less than 4 percent of the gross conditioned floor area and the glazing is Energy Star compliant or equivalent.

(6) Skylights, where installed, are in accordance with the following:
(a) Shades and insulated wells are used, and all glazing is ENERGY STAR compliant or equivalent.
(b) horizontal skylights are less than 0.5% of finished ceiling area or less than 1.5% finished ceiling area if thermal performanfce is enhanved by means such as reflectors or translucent insulation.
(c) sloped skylights located on slopes facing within 20 degrees of true south are less than 0.5 percent of the finished ceiling area or less than 1.5% of finished ceiling area if thermal performance is enhanced by means such as reflectors or translucent insulation.
(7) Overhangs designed or adjustable canopies or awnings or trellises provide shading on south-facing glass in accordance with the diagram below.



(8) The south face windows have a SHGC of 0.40 or higher
(9) Return air or transfer grilles/ducts are in accordance with Section 704.4.5.

704.3.1.2 Automated solar protection with sensor or timer is installed to provide shading for all widows in the sun path.

Intent:
To reduce the amount of non-renewable energy required to heat and cool a home through design features which permit solar heat gains and minimize the potential for overheating.

Additional Information / How to Implement:
The Sustainable Buildings Industry Council provides the most concise and clear-cut guidance on sun-tempered design. The design rules of thumb cited above will provide some solar benefit and prevent overheating in most climates. The diagram above is designed for Santa Fe to maximize the solar gain in the winter and minimize the solar gain in the summer.

Resources:
- Green Building Guidelines – Meeting the Demand for Low-Energy, Resource-Efficient Homes, Chapter 2A: Renewable Energy: Solar and Other Renewables, Sustainable Buildings Industry Council.

- *Passive Solar Design Strategies, Guidelines for Home Building*, Sustainable Building Industries Council, http://www.psic.org.

- *Passive Solar Design* (NAHB Research Center fact sheet) http://www.toolbase.org/docs/MainNav/Energy/3944_passivesolardesign.pdf
- More detailed design guidance for climate-specific passive solar design is available from the Sustainable Building Industry Council , 1331 H Street NW, Suite 1000, Washington, DC 20005; Phone: (202) 628-7400; www.sbicouncil.org.

704.3.1.3 Passive cooling design features are in accordance with three or more of the following:

(1) Exterior shading is provided on east and west windows using one or a combination of the following:

(a) Vine-covered trellises with the vegetation separated a minimum of 1 foot (305 mm) from face of building

(b) awnings or louvers designed to shade the windows

(c) covered porches or portals

(d) attached or detached conditioned/unconditioned enclosed space that provides full shade of east and west windows (e.g., detached garage, shed, or building)

(2) Overhangs are installed to provide shading on south-facing glazing in accordance with Section 704.3.1.1(7).

(3) Windows and/or venting skylights are located to facilitate cross ventilation.

(5) Internal exposed thermal mass is a minimum of three inches (76 mm) in thickness or 30 pounds of water per square foot of glazing. Thermal mass consists of concrete, brick, and/or tile that are fully adhered to a masonry base or other masonry material and is in accordance with one or a combination of the following:

(a) A minimum of 1 square foot (0.09 m2) of exposed thermal mass of floor per 3 square feet (2.8 m2) of gross finished floor area.

(b) A minimum of 3 square feet (2.8 m2) of exposed thermal mass in interior walls or elements per square foot (0.09 m2) of gross finished floor area.

Intent:
To reduce non-renewable energy required for space cooling in the home by mitigating solar heat gain and using design features that promote natural ventilation.

Additional Information / How to Implement:
Natural features, landscaping, and architectural features can help cool a home naturally and/or reduce unwanted solar gains that increase cooling load. The charts below provide guidance on the length of overhangs to achieve desired shading of south-facing glass for different latitudes in the country.

Shading of east and west windows is difficult to achieve with a fixed overhang because the sun is low in the sky when shading is typically desired. Moveable awnings or louvers allow the flexibility to shade windows during certain times of the day or year. In cooling-dominated climates, a covered porch may be a good solution on the west side of the home to mitigate unwanted solar heat gain.

Resources:
- *Passive Solar Heating and Cooling: Natural Cooling*, Arizona Solar Center fact sheet, http://www.azsolarcenter.com/technology/pas-3.html

- *Cooling Your Home Naturally*, (U.S. DOE fact sheet) http://www.eere.energy.gov/consumerinfo/pdfs/coolhome.pdf

- *Passive Solar Design Strategies*, Guidelines for Home Building, Sustainable Building Industries Council, www.psic.org.

704.3.1.4 Passive Solar Heating Design. In addition to the sun-tempered design in Section 704.3.1.1, all of the following are implemented:

(1) Additional glazing, no greater than12 percent, is permitted on the south wall. This additional glazing is in accordance with the requirements of Section 704.3.1.1.

(2) Additional thermal mass for any room with south-facing glazing of more than 7 percent of the finished floor area is provided in accordance with the following:

(a) Thermal mass is solid and a minimum of 3 inches (76 mm) in thickness. Where two thermal mass material are layered together (e.g., ceramic tile on concrete base) to achieve the appropriate thickness, they are fully adhered to (touching) each other.

(b) Thermal mass directly exposed to sunlight is provided in accordance with the following minimum ratios:

(i) Above latitude 35 degrees: 5 square feet (0.465 m2) of thermal mass for every 1 square foot (0.0929 m2) of south-facing glazing or 30 pounds of water.

(c) Thermal mass not directly exposed to sunlight is permitted to be used to achieve thermal mass requirements of Section 704.3.1.4(2) based on a ratio of 40 square feet (3.72 m2) of thermal mass for every 1 square foot (0.0929 m2) of south-facing glazing.

(3) In addition to return air or transfer grilles/ducts required by Section 704.3.1.1, provisions for forced airflow to adjoining areas are implemented as needed.

Intent:
To reduce the amount of non-renewable energy required to heat a home by taking advantage of the sun's energy through passive design features that collect desirable solar heat gain and mitigate unwanted solar heat gain.

Additional Information / How to Implement:
In most regions of the country having a winter heating load, homes can be designed such that a portion of this load can be satisfied by solar gains. As south facing glass is increased to obtain greater solar benefit, thermal mass must be provided to store excess heat gain, prevent overheating, and moderate heat delivery to the home. Properly sized thermal mass (typically in the form of masonry materials such as tile floors and brick walls, or water) absorbs heat while the sun strikes it and releases that heat slowly once the sun has gone down. Designing a truly passive solar home requires careful calculation of solar gain, thermal storage capacity, and hourly outdoor winter conditions. Obtain the Passive Solar Design Guidelines (see Resource) for your climate as well as the other references cited below if you intend to build a passive solar home. It is also advisable to consult a design professional with background and experience in passive solar design.

Resources:

- *Green Building Guidelines – Meeting the Demand for Low-Energy, Resource*-Efficient Homes, Chapter 2A: Renewable Energy: Solar and Other Renewables, Sustainable Buildings Industry Council.

- Sustainable Building Industry Council Passive Solar Design Guidelines, available at http://ww.sbicouncil.org

704.3.2 Solar Thermal Systems: A solar thermal system is installed in accordance with one of the following: (points can be taken for either 704.3.2.1 or 704.3.2.2 but not both)

704.3.2.1 Solar Domestic Water Heating: SRCC (Solar Rating & Certification Corporation) OG 300 rated, or equivalent, solar domestic water heating system is installed. Solar Energy Factor (SEF as defined by SRCC) is in accordance with Table 704.3.2.1 (Note: A custom-designed system qualifies for points if a mechanical engineer certified the SEF)

Intent:
To reduce non-renewable energy use for domestic water heating.

Additional Information / How to Implement:
Solar collectors that preheat water for domestic use are often cost effective. However, solar water heaters must be designed and installed properly to operate to their maximum potential for many years. Solar water heater designs are generally climate specific, primarily with regards to freeze protection. Consult a knowledgeable local installer to design the system, select equipment, and carefully install the system. Use the references below for a basic understanding of the types of systems available and the estimated performance in your climate. Use the ratings published by the SRCC (see Resources) to determine the solar fraction provided by the system you select.

Resources:

- For a list of Solar Rating and Certification Corporation's certified solar water heating systems, see www.solar-rating.org

- *Solar Water Heaters* (NAHB Research Center technology fact sheet), http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2136&CategoryID=68

- Database of State Incentives for Renewable Energy, www.dsireusa.org

704.3.2.2 Solar Domestic Water and Space Heater: SRCC (Solar Rating and Certification Corporation) OG 300 rated, or equivalent, solar collector thermal performance rating water and space heating system is installed. Manufacturer's specifications, SRCC OG 300 rating, and SEF for either gas or electric (or equivalent ratings) for solar water heating system and space heating system installed in building. Point calculation: Use the SRCC OG 100 rating for category C, Clear Day (note that the number provided in the tables at http://www.solar-rating.org is given in 1000 BTUs) and round down to the nearest whole number.

Intent:
To reduce the amount of fossil fuel needed to heat the residence by use of active solar space heating systems.

Additional Information / How to Implement:
There are several ways of using solar energy for space heating. Heat from solar panels can be used in any way that hot water from a boiler us used. Examples are: hot water base board, in floor radiant, hydronic to forced air.

Resources:
The New Mexico Solar Energy Association: www.nmsea.org

704.3.3 Additional Renewable Energy Options

704.3.3.1 Photovoltaic panels are installed on the property

704.3.3.2 Other on-site renewable energy source is installed (e.g., wind energy, on-site micro-hydro power.

Intent:
To supply a portion of a household's electricity needs by renewable energy sources. To reduce peak electricity demand of the home. Peak electricity demand can necessitate power companies to operate peak generation equipment which, because it is operated for a short time, generally is less efficient than non-peak power production.

Additional Information / How to Implement:
As demand for electricity increases and costs to build additional generating capacity continue to escalate, renewable energy sources such as photovoltaic and wind power become more attractive and more cost effective to consumers and utilities. Local generation of electricity by the sun and wind is a viable option in most regions of the country. Costs of smaller (2 kW to 8 kW) photovoltaic systems are about $8-$9 per watt and, in some states like New York, California, and New Jersey, incentives are available which bring the cost even lower. Net metering—in which excess electricity produced at a residence causes the electric meter to spin backwards—may also be available in your area. Net metering effectively credits the customer full retail value for electricity sent back to the utility and greatly improves the economics of residential solar electric power production.

Resources:
- http://www.dsireusa.org - provides information about areas offering incentives that promote renewable energy and information about net metering rules.

704.4 Ducts

704.4.2 Space heating is provided by a system that does not include air ducts

704.4.3 Space cooling is provided by a system that does not include air ducts

Intent:
Leakage from a duct system, even when well sealed, reducing the efficiency of the system. These leaks often increase over time as the sealants dry or are compromised if equipment shifts. By providing a heating or cooling system that does not include air ducts in its delvery these inefficiencies can be avoided.

Additional Information/How to Implement:
Select a heating and/or cooling system that does not include air ducts such as radiant heat and cooling or other similar system.

704.4.4 Ductwork is in accordance with all of the following:

(2) Heating and cooling ducts and mechanical equipment are installed within the conditioned building space.

(3) Ductwork is not installed in exterior walls.

704.4.5 Return ducts or transfer grilles are installed in every room with an exterior door. This practice does not apply to kitchens, closets, and pantries.

Intent:
The possibility of duct leakage to unconditioned space is significantly reduced by avoiding placement of ducts in areas listed. Also, to prevent pressure imbalances that may occur when there are central return(s) and interior doors are closed. Pressure imbalances can lead to inadequate airflow to a room which can create uncomfortable conditions.

Additional Information / How to Implement:
Panned joists or stud cavities should be avoided because they can rarely be effectively sealed. When cavities are used as returns, air may be pulled from unintended locations in the home and create unwanted pressure imbalances that may compound energy loss. When cavities are used as supplies, the volume of delivered air may be inadequate and, because these areas may be dusty and dirty, *Indoor Environmental Quality* issues may result.

Methods for keeping ductwork in the conditioned envelope include extending the thermal boundary by insulating the foundation walls, insulating the attic at the roof, or installing ductwork beneath an insulated ceiling and enclosing it with bulkheads.

With improved window technology and air sealing practices, there is less need to supply warm air along exterior walls—a common practice in older homes that needed airflow near windows to prevent condensation on poorly insulating windows and to keep occupants warm near drafty windows. In tightly sealed and well-insulated homes, heating or cooling registers can be located near the interior, thereby minimizing duct length and eliminating any need to run ductwork in outside walls. This not only reduces duct leakage to the exterior but also eliminates the need to reduce insulation in those wall cavities.

Supply and return registers located in every room and sized according to industry standards provide the best assurance that airflow to each room is balanced. However, having supply and return vents in each room increases the installation cost of a forced air heating or cooling system. Common practice is to locate a single central return on each floor of the home. This method pulls return air from all areas of the home in most cases, but return airflow is restricted when doors are closed. Doors cannot be undercut sufficiently to provide an adequate path for air flow. When return air flow is restricted from a particular room, that area becomes pressurized and air leakage to the outdoors increases. Other areas of the home may become depressurized causing the opposite effect, i.e., outdoor air is drawn through cracks and crevices. Transfer grilles in interior walls are a cost effective compromise to ensuring that all rooms have adequate supply and return airflow.

Resources:

- *A Builder's Guide to Placement of Ducts and HVAC Equipment in Conditioned Space*, 2000, NAHB Research Center. Available to purchase at http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2570&CategoryID=110

- ACCA Manual D® Residential Duct Systems

704.5 HVAC Design and Installation

704.5.3 Performance of the heating and/or cooling system is verified by the HVAC contractor in accordance with all of the following that apply and provide a signed checklist to the City of Santa Fe Inspection Division:

(1) All start-up procedures are performed in accordance with the manufacturer's instructions
(2) Refrigerant charge verified by super-heat and/or sub-cooling method
(3) Burner set to fire at input level listed on nameplate
(4) Air handler setting/fan speed is set in accordance with manufacturer's instructions.
(5) Total air flow within 10% of design flow
(6) Total external system static does not exceed equipment capability at rated airflow.

Intent:
Verification of performance provides a final assurance that the system has been designed, installed, and commissioned as intended. Items can easily be overlooked during a busy construction schedule – even given the most conscientious approach.

Additional Information / How to Implement:
Ask your HVAC contractor to carefully follow the startup procedure outlined in the equipment literature. Ask for a checklist of the recommended startup procedure.

Resources:

- North American Technician Excellence. Operates a certification program for HVAC technicians. Maintains a database of certified technicians at http://www.natex.org/ or by calling 877-420-NATE.

- Manufacturer's Website or printed installation instructions.

704.6 Insulation and Performance Verification

704.6.1 Third-party on-site inspection is conducted to verify compliance with all of the following, as applicable. Minimum of two inspections are performed. One inspection after insulation is installed and prior to being covered, and another inspection upon completion of the project. Where multiple buildings or dwelling units of the same model are built by the same builder, a representative sample inspection of a minimum of 15 percent of the buildings or dwelling units is permitted.

(1) Ducts are installed in accordance with the ICC, IRC or IMC and ducts are sealed.
(2) Building envelope air sealing is installed
(3) Insulation is installed in accordance with Section 703.1.2

(4) Windows, skylights, and doors are flashed, caulked, and sealed in accordance with manufacturer's recommendations and in accordance with Section 703.2.1.

Intent:
To ensure maximum effectiveness of insulation in the building

Additional Information/How to Implement:
This item must be done by a qualified professional who will verify all elements listed. Be sure to contact this person early in the construction process and keep them apprised of the construction process so they can conduct their inspections in a timely manner.

704.6.2 Third-party testing in conducted to verify performance.

704.6.2.1 Building envelope leakage rate is demonstrated by blower door test. Inaddition to the test, the following practices are required:

(2) Fossel fuel furnace and water heater is sealed combustion or power vented in accordance with Section 901.1

(4) The maximum leakage rate is in accordance with:

(a) 5 ACH50
(b) 4 ACH50
(c) 3 ACH50
(d) 2 ACH50
(e) 1 ACH50

Intent:
To increase efficiency of the homes ventilation system to reduce energy use.

Additional Information/How to Implement:
Ensure that any fossel fuel furnace and/or water heater is specified to be either a sealed combustion unit or power vented.

705 Innovative Practices

705.1 Energy Consupmtion Control. A whole building or whole dwelling unit device is installed that controls or monitors energy consumption

(1) Programmable conmmunicating thermostat (Not applicable to radiant systems that don't use a solar hydronic system)

(2) Energy-monitoring device

(3) Energy management control system

Intent:
By allowing the home occupant to track their energy usage it will make the occupant more conscious of their energy use and encourage them to conserve more.

Additional Information / How to Implement:
Several manufacturers have developed smart meter technology. The meter should be located where it can be easily seen by the building occupants.

Resources:
Paper on the effects of motivating people to conserve energy through smart metering: www.epa.gov/solar/documents/stateforum/01_22_08/background.pdf.

705.3 Use a more energy efficient system for cooling the house than refrigerated air conditioning.

(1) Use whole house fan with insulation on flaps and the side walls have the same r-value as the exterior walls.

Intent:
To reduce the energy used to cool the home.

Additional Information/How to Implement:
Whole house fans use less energy to cool the home than does refrigerated air conditioning. However, to reduce possible energy loss at the fan installation location, specify a fan that has insulation on the flaps and construct the side walls to have the same R-value as the exterior walls.

705.4 Lighting. Install all interior lighting fixtures within the conditioned envelope of the building, e.g., housing does not penetrate insulated ceiling.

Intent:
To eliminate energy losses associated with inadequate insulation above, and air infiltration through, light fixture in insulated ceilings.

Additional Information/How to Implement:
Although there are recessed light fixtures rated for insulation contact, they still carry an energy penalty because of reduced insulation thickness in the ceiling avove the fixture and/or air leakage around the housing. To completely avoid this energy penalty, do not install recessed lights in an insulated ceiling. Bulkheads or dropped soffits can permit the installation of recessed lights in insulated ceilings. Be sure that there is a continuous air barrierat the top of the bulkhead or the original ceiling. The preferred method os to install drywall (or other finish material) on the ceiling prior to constructing the bulkhead.

705.5 Skylights are less than 0.8% of the square footage of the conditioned area of the house. Final calculations based on installed skylights shall be provided at the time of Final Green Building Inspection.

Intent:
To reduce heat loss in the winter and excessive heat gain in the summer associated with skylights

Additional Information/How to Implement:
Calculate the entire area of the conditioned space, including multiple floors, and calculate the percentage of that number represented by any skylights to determine if this items applies.

705.6 Install device(s) on all skylights to improve their efficiency such as aerogel panels.

Intent:
Aerogel panels were developed to reduce the energy loss through skylights while maintaining most of the lighting benefit they provide. This item is intended to reduce the energy loss of skylights through innovative approaches to increasing their insulation qualities.

Additional Information/How to Implement:
Either purchase a skylight that has aerogel panels or equivalent incorporated into their design or add them as an after market product.

705.7 Reduce phantom loads with outlets tied to switches at room entries or comparable method

Intent:
To reduce the overall electrical usage of the home by eliminating phantom loads.

Additional Information / How to Implement:
Phantom loads are electric loads which continually draw electricity even when the appliance is no being used. Such loads include any appliance that can be operated with a remote control and any charger for electronic equipment. By tying these loads to switches at room entries, you can also use them to turn on floor or table lamps from the door as well. Be sure that there are outlets that are not controlled with switches for use with appliances that need continual electricity such as refrigerators and clocks. (Note: If there is a dimmer device such an outlet, it may adversely effect some appliances such as vacuums).

705.8 Construction site personnel has taken an approved thermal bypass inspection (TBI) class.

Intent:
Nearly every trade working in construction can impact the thermal bypass characteristics of the home. Having construction personnel on the site with knowledge of thermal bypass can avoid inadvertent impacts to the thermal bypass characteristics, improving the energy performance of the home.

Additional Information / How to Implement:
Thermal bypass classes have been given at both the Santa Fe Community College and the Santa Fe Area Home Builders Association. Obtain copies of certificates of completion of these classes and supply to the City of Santa Fe for worksite personnel.

UNDERSTANDING HVAC SYSTEM DESIGN ISSUES[1]

When designing a comfort system, it is not adequate to merely produce a heat loss and heat gain estimate. Much more is involved in the proper design and installation of a comfort system. Heat loss and heat gain estimates are part of a design procedure that flows from system selection decisions, the actual load calculations, to equipment selection procedures, to placement and selection of air distribution hardware, to duct routing and airway sizing.

Documents such as ACCA *Manual RS* provide valuable information about zoning, system concepts, equipment capability and design procedures. It is strongly recommended that system designers be familiar with the material in Manual RS.

Manual J or equivalent load calculations affect every aspect of the system design procedure. The calculations must be as accurate as possible.

- Equipment capacity that matches the size of the applied heating and cooling loads will deliver comfort, efficiency and reliability over the entire range of operating conditions.
- Heating and cooling loads determine the total air delivery requirement (blower CFM) and the air flow requirement for each room (room CFM). This airflow information is then used to select supply air outlets and to size the duct runs.
- Load information also is used to estimate purchased energy requirements and to estimate annual operating cost. In this regard, the energy and operating cost estimates will only be as accurate as the load estimate.

    - The design concept must be suitable for the application:
        - Contemporary architecture tends to produce dwellings that require a zoned system and/or variable capacity equipment.
        - Custom homes that feature a large amount of architectural glass that provides a panoramic view or architectural theme may not have internal shade, or the shading device may be completely open when the room is occupied. In such cases, the performance of the glass (U-value and solar heat gain coefficient) has a significant effect on comfort, equipment size and energy use. If there is a large amount of South glass, cooling may be required during cold weather. These dwellings must be carefully zoned and may require year-around cooling.
        - People may be uncomfortable when bathed by sunlight pouring through a window. During cold nights or cold overcast days, radiation from the occupant's skin to cold glass surfaces may cause discomfort

    - External overhangs or some type of internal shading device are desirable because they provide comfort for the occupants (overhangs provide shade without interfering with the view).

***Manual S* (or equivalent) and Manufacturer's Data to Select Equipment**

In general, the effective capacity of heating and cooling equipment shall, as closely as possible, match the load when the equipment is subjected to design conditions. For instance, *Manual S* explains how to use *Manual J* output and manufacturer performance data to obtain this result. *Manual S* also provides guidelines pertaining to the acceptable amount of excess capacity and manipulating heat pump balance points.

[1] Information provided by the Air Conditioning Contractors of America (ACCA)

***ACCA Manual T* (or equivalent) and Manufacturer's Data to Select Supply Outlets and Return Grilles**

Supply outlets (grilles and registers) shall be the appropriate style and size for the application and shall be in an appropriate location for the application.

- Supply outlets shall not produce objectionable noise. Design guides and manufacturers' information establish limits for face velocity.
- Supply outlets shall provide the appropriate throw for the installed location. Floor outlets shall throw the supply air to the ceiling; ceiling outlets shall throw the supply air to the wall, etc. Size depends on product performance, the supply CFM value and the face velocity limitation.
- Never blow supply air directly into the occupied zone. Occupants will complain about drafts.
- Floor outlets that blow air straight up the exposed wall are best for cold-climate heating; and if properly selected, adequate for cooling.
- Ceiling outlets are best for cooling, but will not warm slab or exposed floors during the winter.
- If high sidewall outlets are used for cooling, supply air shall not drop into the occupied zone during cooling. These devices will not warm slab or exposed floors during the winter.
- The relation between supply CFM, throw, face velocity and drop is established by manufacturer performance data. Performance is very sensitive to size and devices that appear to be generally similar can have substantially different performance characteristics.
- A low resistance return path shall be provided for every room that receives supply air - a wall opening with no door, a transfer grille or a ducted return. Door undercuts are not acceptable).
- Return grilles shall be the correct size for the grille flow rate. Filter grilles have a lower face velocity than plain grilles.
- The location of the return grille does not affect room air patterns which are controlled by the supply outlets and will not have a significant affect on pockets of stagnate air. Low returns do "pull" warm air down to the floor and high returns do not "pull" cool air up into the occupied zone.

***Manual D* (or equivalent) to Size the Duct Runs**

The resistance (inches water gauge of static pressure) of the longest circulation path (longest supply run plus longest return run) shall be compatible with the performance of the blower that is supplied with the heating-cooling equipment. Airway sizes that are compatible with the blower performance shall be increased if airflow velocity creates a potential noise problem. All systems shall have adequate provision for balancing airflow.

- The length of the longest circulation path and the available static pressure determine the friction rate used for airway sizing.
- The length of the circulation path includes the straight runs and the equivalent length of the fittings along the path. One fitting can add from 5 feet to more than 60 feet to the length of the path.
- External static pressure is determined from the equipment manufacturer's blower performance data, preferably for medium-speed operation.
- The available static pressure equals the external static pressure minus the pressure drop through all the air-side devices in the circulation path. Refer to blower table footnotes and manufacturer pressure drop data for devices that were not in place when blower performance was laboratory-tested by the equipment manufacturer.
- Accessory or after-market filters (or any device) that produce a substantial increase in system resistance shall not be installed if the blower cannot accommodate the increased

resistance by speed change. An arbitrary increase in system resistance may cause low airflow to rooms, a high temperature rise across a furnace heat exchanger, or low suction pressure at the cooling coil.

- The room heat loss and heat gain estimate (*Manual J or equivalent)* and the heating and cooling factors (Manual D or equivalent) determine the design value for room airflow.
- Airway size is determined by sectional flow rate and the design friction rate value.
- The friction chart or duct slide rule used for airway sizing shall be technically correct for the type of duct material.
- Airway velocities shall not exceed specified design limits.
- Branch (runout) ducts shall be equipped with a hand damper (for balancing).

Related Comfort Conditioning System Design Considerations:

Impacts of Incorrectly Sized Heating and Cooling Equipment

- The obvious problem with significantly undersized equipment is that it will not maintain the desired set-point temperature when a passing weather system imposes a design load on the heating and cooling equipment. However, slightly undersized cooling equipment -- by a margin of 10 percent or less -- may actually provide more comfort at a lower cost.

- Oversized equipment causes short-cycles, marginalizes part-load temperature control, creates pockets of stagnate air (unless the blower operates continuously) and degrades humidity control during the cooling season (more information on this subject is provided below). Oversized equipment also requires larger duct runs, increases installed cost, increases operating cost, increases the installed load on the utility grid and causes unnecessary stress on the machinery.

Humidity Control During the Cooling Season:

- Sensible and latent cooling loads are imposed on dwellings located in climates that have a substantial amount of moisture in the outdoor air during the cooling season (wet-coil climates). When the summer design condition occurs, properly sized equipment will operate continuously or almost continuously, both loads will be completely neutralized, and the occupants will be comfortable. But, the design condition only occurs for a few dozen hours per season.

- Reduced latent capacity at part load will cause the indoor humidity to drift above the design value, which is acceptable, providing the relative humidity stays below 60 percent. The possibility for experiencing comfort problems at part load conditions is minimized by observing the following guidelines:
  - Use outdoor design conditions recommended by design manual, providing a code or regulation does not specify a different set of conditions.
  - Use the default indoor design conditions recommended by design manual, unless a code or regulation specifies a different set of conditions.

- Some climates are too dry to produce a latent load on the indoor coil. In this case, the indoor humidity depends on the moisture content of the outdoor air, the infiltration rate and the amount of moisture generated by the occupants. If the outdoor air is very dry, these factors will combine to produce an indoor relative humidity that is less than 50 percent and it could

even be lower than 40 percent. But, if the relative humidity stays above 30 percent, the indoor air condition will be in the comfort zone.

Humidity Control During the Heating Season

During the heating season, very cold weather can produce discomfort. Dry-air causes a sensation of coolness, a desire to increase the thermostat set point, problems with static electricity and dry sinuses. Adding a humidifier to the heating system moderates these problems, but if a humidifier is installed, it must not produce a visible or concealed condensation problem. (See the unabridged version of *Manual J* for more information on this subject).

Part Load Days More Important than Design Load Days

As a group, homeowners are overly concerned with extreme weather conditions that occur for a few hours per season and uninformed about the significance of the part-load conditions that occur for thousands of hours per season. This lack of understanding pressures contractors to install oversized equipment. This results in systems that are more expensive to install, less efficient, less comfortable for a majority of the season and less reliable. In addition, the oversized equipment produces an unnecessary load on the electric and gas distribution systems. The solution to this problem is consumer education. Section 10-4 of Manual RS provides more information on this subject.

Chapter 8
WATER EFFICIENCY

Water Use General Resources:

- All aspects of water conservation:
- www.awwa.org/waterwiser/

801 Indoor and Outdoor Water Use

801.1.1 Indoor hot water usage is reduced by one of the following practices:

(1) All hot water plumbing fixtures in both the kitchen and bathrooms are 32 feet (9,754 mm) or less in length from the water heater and is sized in accordance with the code for the specified application OR

(2) All hot water plumbing fixtures in both the kitchen and bathrooms is 24 feet (7,315 mm) or less from the water heater and is sized in accordance with the code for the specified application OR

(4) Pipe runs exceeding 32 feet (9,754 mm) from the Water heater to fixture locations are aided by:

(a) tankless water heater is installed at point of use and is served only by cold water or a solar assisted system OR

(b) on-demand hot water recirculation system is installed with a water temperature sensor turn-off located at the fixture furthest from the water heater.

Intent:

Reduce water waste by using technologies that provide hot water at the tap with a minimal wait time and using a minimal amount of water. Also, minimizing the distance between the hot water heater and major hot water uses reduces the total amount of plumbing pipe installed. This helps reduce the amount of conductive heat loss from the pipe, reduces the amount of time it takes for hot water to reach baths, the laundry area, and the kitchen (helping to conserve water), and reduces the amount of hot water left standing in pipes after a draw (which helps save energy). It has an added benefit of resource efficiency from using less piping material.

Additional Information / How to Implement:

Place a water heater at the point of use or install a hot water recirculation device that is controlled by the user or an automatic device (e.g., timer or thermostat) to minimize or eliminate the waiting period for hot water at faucets. In order to save both energy and water, recirculating systems should be controlled by the user at the time of use rather than circulating hot water through the piping system continuously. Typically, in this type of controlled system, a switch or a push button located near a fixture activates a small pump that begins circulating hot water when there is demand for it.

To reduce pipe run distance between the water heater and bathrooms and kitchens the first step is to locate those areas in close proximity to one another when designing a home. Once baths, kitchens, and laundry rooms are "clustered" or "stacked," the water heater can be located to maximize efficient delivery. The effective implementation of this line item offers material and labor savings during construction as well as water and energy savings throughout the life of the home.

Resources:

- Demand Hot Water Heater fact sheet:
  http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1318&DocumentID=3206

- Hot Water Recirculation Systems fact sheet:
  http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1436&DocumentID=2130

- "An Energy-Saving Product That's Actually Convenient?" Energy Design Update, July, 1997, pg. 8. This article reviews one hot water recirculation product.

- DOE Technology Fact Sheet – Water Heating
  www.eere.energy.gov/buildings/info/documents/pdfs/26465.pdf

801.2 Water-Conserving Appliances. ENERGY STAR or equivalent water-conserving appliances are installed.

(1) dishwasher
(2) washing machine OR
(3) washing machine with a water factor of 6.0 or less

Intent:
Reduce water consumption by selecting water-efficient major household appliances.

Additional Information / How to Implement:
The ENERGY STAR label identifies appliances that are at least 20% more energy efficient than other appliances of similar size and model and use less water than their standard counterparts. An ENERGY STAR washing machine uses approximately 20 gallons of water per load compared to 40 gallons for standard models. The machine also removes more water during the spin cycle, reducing drying time. ENERGY STAR washing machines are available in both top and front loading models. An ENERGY STAR dishwasher uses about 40% less water than conventional models. The ENERGY STAR label takes much of the guesswork out of selecting energy efficient appliances and equipment, making the selection process easier for builders and homeowners.

Resources:

- List of ENERGY STAR -rated appliances:
  www.energystar.gov/index.cfm?c=appliances.pr_appliances

- Vertical Axis (Top Loading) Energy-Saving Clothes Washers:
  www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1280&DocumentID=2004

- Energy Efficient Appliances, DOE Technology Factsheet:
  www.toolbase.org/Docs/MainNav/Energy/4070_doe_energyefficientappliances.pdf?TrackID=&CategoryID=1280&DocumentID=4070

- *"Dishing Out Dollars," Consumer Reports,* March, 1998, pg. 37. A comprehensive review of energy and water-efficient dishwashers.

804.1 Showerheads. Showerheads are in accordance with the following:

(1) The total showerhead flow rate at any point in time in each shower compartment is 1.6 to less than 2.5 gpm. The total flow rate is tested at 80 psi

(552 kPa) in accordance with ASME A112.18.1. Showers are equipped with an automatic compensating valve that complies with ASSE 1016 or ASME A112.18.1 and specifically designed to provide thermal shock and scald protection at the flow rate of the showerhead. Documentation of fixture flow rate must be provided at final plumbing inspection.
(2) All showerheads meet the requirements of 801.4(1). In addition, all showerheads are in compliance with either 801.4(2)(a) or 801.4(2)(b). Documentation of fixture flow rate must be provided at final plumbing inspection.
(a) 2.0 to less than 2.5 gpm
(b) 1.6 to less than 2.0 gpm
(3) Manual shower shutoff

Intent:
Save water by installing low-flow showerheads.

Additional Information / How to Implement:
Low-flow showerheads conserve water by cutting the water flow through the showerhead to levels below the federal minimum standards for showerhead flow rate.

Resources:
- PATH Technology Inventory: *Low Flow Plumbing Fixtures*
  www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1316&DocumentID=2135

- Plumbing materials and supplies: www.plumbingworld.com

801.5 Fuacets

8701.5.1 Water-efficient lavatory faucets with 1.5 gpm (5.68 L/m) or less maximum flow rate when tested at 60 psi (414 kPa) in accordance with ASME A112.18.1 are installed and documentation of flow rate must be provided at plumbing final inspection:
(1) a bathroom
(2) all lavatory faucets

Intent:
Save water by installing aerators that cut flow to levels below the federal minimum standards for faucet flow rate.

Additional Information / How to Implement:
Aerators are a water saving device. Installing aerators in faucets conserves water by restricting the water flow at the faucet outlet. Aerators can be simply screwed into most conventional faucets.

Resources:
- PATH Technology Inventory: *Low Flow Plumbing Fixtures*
  www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1316&DocumentID=2135

801.5.2 Pedal activated faucet is installed to enable intermittent on/off operation

Intent:
Reduce water waste by installing a faucet control that allows the user, via a (typically) hands-free method, to turn water on and off without changing the temperature.

Additional Information / How to Implement:
Pedal-activated faucets are water saving devices that allow the individual to use their feet to control the faucet. This system conserves water by reducing the duration of a water flow event.

Resources:
- U.S. DOE, Greening Federal Facilities, Showers, Faucets and Drinking Fountains http://www.eere.energy.gov/femp/pdfs/29267-6.3.pdf

801.6 Water Closets and Urinals. Water closets and urinals are in accordance with the following and if the gallons per flush rate is not printed on the fixture then documentation of the flush rate must be provided at the plumbing final inspection:

(2) A water closet is installed with an effective flush volume of 1.28 gallons (4.85 L) or less when tested in accordance with ASME A112.19.2 (all water closets) and ASME A112.19.14 (all dual flush water closets), and is in accordance with EPA WaterSense Tank-Type High-Efficiency Toilet.

(3) A urinal is installed with a flush volume of 0.5 gallons (1.9 L) or less when tested in accordance with ASME A112.19.2.

(4) All water closets and all urinals are in accordance with Section 801.6(2) or Section 801.6(3), as applicable.

Intent:
Reduce water use associated with toilet flushing.

Additional Information / How to Implement:
Several manufacturers offer toilets that use even less water than the federally mandated 1.6 gallons per flush while still performing reliably. Power-assist toilets accomplish this with a small, electrically-powered pump and use either 1.0 or 1.4 gallons per flush depending upon liquid or solid waste. These models require a receptacle near the toilet and have a button on top that allows the user to select the desired flow. One manufacturer estimates water savings of about 2,000 gallons per year with the power-assist toilet. Other new gravity-fed models use as little as 0.8 to 1.4 gallons per flush and maintain quiet operation. Most of these models are set to a particular flow rate at installation but this setting can be adjusted later if desired.

Resources:
- EPA, *Low Flow Toilets*: www.epa.gov/owm/water-efficiency/toilets.htm

- Arizona Cooperative Extension: http://www.sahra.arizona.edu/programs/water_cons/home/bathroom_toilet.htm#3

801,7 Irrigation systems

801.7.1 A low-volume irrigation system is installed.

(2) drip irrigation OR

(3) bubblers OR

(4) drip emitters OR

(5) soaker hose
(6) subsurface irrigation

801.7.2 Irrigation system is in accordance with both of the following:
(1) designed by a professional in accordance with EPA WaterSense requirements or equivalent
(2) Installed in accordance with EPA WaterSense program, or equivalent.

Intent:
Minimize water use associated with outdoor water use by installing irrigation systems that offer the most effective and efficient delivery method.

Additional Information / How to Implement:
Drip irrigation systems provide water directly to root systems where it is most needed, making drip irrigation more efficient than spray systems. Water run-off and evaporation are minimized with drip irrigation systems. Drip systems are the preferred irrigation method in the desert regions of the United States, but are also recommended in any region where lawns and bedding areas require supplemental watering during the growing season.

Resources:
- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, http://www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf

- *Landscaping Irrigation Systems*, H2ouse.org., the California Urban Water Conservation Council, http://www.h2ouse.org/tour/details/element_action_contents.cfm?elementID=68BAD0B5-0C95-4AE8-8EC6EC8D76A4CBE1&actionID=BD9DA9D3-0CFA-4F05-B3CBFEC63E2EEE57&roomID=F80B1F87-C00D-498C-9C1F1E5BE9D04637

801.7.3 Irrigation system is zoned separately for areas with different watering needs (hydrozoning).

Intent:
Control irrigation to areas having different irrigation individually.

Additional Information / How to Implement:
Turf and bedding areas have different irrigation needs based on the various types of grasses and vegetation planted in those areas. Zoned irrigation systems allow for distributed control of the flow of water to each individual turf or bedding area. Zoned systems can conserve water by providing irrigation on a selective basis since most plants require 25% to 50% less water than lawns.

Resources:
- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, http://www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf

- *Landscaping Irrigation Systems*, H2ouse.org., the California Urban Water Conservation Council, http://www.h2ouse.org/tour/details/element_action_contents.cfm?elementID=68BAD0B5-

0C95-4AE8-8EC6EC8D76A4CBE1&actionID=BD9DA9D3-0CFA-4F05-B3CBFEC63E2EEE57&roomID=F80B1F87-C00D-498C-9C1F1E5BE9D04637

801.7.4 The irrigation system(s) is controlled by a smart controller.

(1) Evapotranspiration (ET) based irrigation controller with a rain sensor

(2) Soil moisture sensor based irrigation controller

(3) No irrigation is installed and a landscape plan is developed in accordance with Section 503.5, as applicable.

Intent:
Conserve water by providing irrigation on an "as needed" basis.

Additional Information / How to Implement:
The portion of household water used outdoors varies by climate, but can be up to 60% of all household water use. Currently, most irrigation systems are controlled by automatic timers. The systems operate at a particular time each day regardless of whether it has rained recently. Often, assessing the need for watering by visual observation or surface conditions can be difficult since watering needs are based on conditions at the roots. The recommended method for irrigation control is to use moisture sensors that activate irrigation based on soil moisture content. This not only saves water but also provides the optimum conditions for the turf grass or plants in question since over-watering can be as detrimental to healthy plant growth as insufficient water. Computer-based controls use historical local weather data to project anticipated weather patterns and time outdoor watering accordingly.

Resources:

- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, http://www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf

- University of Nebraska drought monitoring site by U.S. state, http://drought.unl.edu/dm/monitor.html

- *Soil type and classification*, Association of American State Geologists, http://www.kgs.ukans.edu/AASG/AASG.html

801.8 Rainwater Collection and Distribution. Rainwater collection and distribution is provided in an active system.

(1) Rainwater is collected and used

(a) 1 gallon per square foot for 100% of roofed area is collected and at least 60% of the roof area is collected.

(b) 1 gallon per square foot for 75% of roofed area is collected and at least 50% of the roof area is collected.

(c) 1 gallon per square foot for 50% of roofed area is collected and at least 40% of the roof area is collected.

(2) Rainwater is distributed using a renewable energy source or gravity.

(3) Rainwater that is collected in (1) above is used in an irrigation system as described in 801.7.1

Intent:
Reduce water needs for irrigation by collecting and using rainwater and to reduce domestic potable water demand while not adding energy demand (minimum capacity of 200 gallons).

Additional Information / How to Implement:
Rainwater that is collected in a collection system for later distribution to water landscaping reducing the demand for domestic potable water for that use. Collecting rainwater keeps rainwater onsite, thus lowering the impact on storm water collection and conveyance systems and helping to replenish aquifers. However, if the system is designed to require pumping that is powered by conventional energy sources, there are associated greenhouse gas emissions. Therefore, points are given for this item if either gravity or a renewable energy source used to distribute the collected rainwater into the landscaping. To meet the intent of this item there needs to be at least 200 gallons of storage capacity in the system to qualify for the points.

Resources:

- PATH Technology Inventory, *Rainwater Harvesting*: www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1315&DocumentID=2129

- *Harvesting Rainwater for Landscape Use*: http://ag.arizona.edu/pubs/water/az1052/harvest.html

802 Innovative Practices

802.1 Gray Water. Gray water, as specified in ICC IRC, Appendix O, is separated and re-used as permitted by local code.

(2) irrigation from reclaimed or recycling water on-site

Intent:
Reduce total household water consumption by reusing greywater, i.e., water generated from the laundry, showers, and sinks.

Additional Information / How to Implement:
Greywater reuse is the process of recycling laundry, shower, and sink water for non-potable uses. Greywater is typically used to irrigate lawns, trees, shrubs and vegetation and can also be used to flush toilets. Reusing greywater can significantly reduce total household water consumption.

Resources:

- PATH Technology Inventory: http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2137&CategoryID=1002

- Greywater: www.greywater.com/

- Arizona Department of Environmental Quality, *Using Gray Water at Home*: www.deq.co.pima.az.us/water/Water%20PDFs/graywater.pdf

802.2 Composting or Waterless Toilets and/or Urinals. Composting or waterless toilets and/or urinals are in accordance with the following:

(2) Composting or waterless toilet and/or urinal is installed

(3) All toilets and urinals are in accordance with Section 802.2(2)

Intent:
Eliminate water use associated with toilet flushing by installing composting or waterless toilets.

Additional Information / How to Implement:
Composting or waterless toilets do not use water.

Resources

- EPA, Technology Fact Sheet, *Composting Toilets*: http://www.epa.gov/owm/mtb/comp.pdf
- Sustainable Building Sourcebook, *Composting Toilets*: http://www.greenbuilder.com/sourcebook/CompostToilet.html
- What is a composting toilet? http://www.oikos.com/library/compostingtoilet/
- Composting Toilets: http://www.compostingtoilet.org/

802.3 Automatic Shutoff Water Devices. One of the following automatic shut-off water supply devices is installed. Where a fire sprinkler system is present, installer is to ensure that device will not interfere with the operation of the fire sprinkler system.

(1) excess water flow shutoff
(2) leak detection system.

Intent:
To minimize the loss of potable water when a leak in the water system occurs.

Additional Information / How to Implement:
Both of these systems are designed to limit water loss during a leak or break in the water system.

802.4 A real-time water use meter device is installed where the home occupant can easily see and monitor the home's water use like a KopyKap.

Intent:
By allowing the home occupant to track their water usage it will make the occupant more conscious of their energy use and encourage them to conserve more.

Additional Information / How to Implement:
The meter should be located where it can be easily seen by building occupants.

802.5 Recirculating water pump is triggered by either a motion sensor or is switch activated

Intent:
By having the recirculating pump triggered only when it is needed the amount of energy both for pumping and water heating will be reduced.

Additional Information/How to Implement:
Having the pump switch activated will be the most efficient. People may enter bathrooms and kitchens without the need for hot water each time. Motion sensors cannot distinguish between entries that will use hot water and those that don't.

Chapter 9
INDOOR ENVIRONMENTAL QUALITY

General Resources

- The Sustainable Building Sourcebook, http://www.greenbuilder.com
- The Healthy House Institute, http://www.hhinst.com
- For Volatile Organic Compounds, http://www.concretenetwork.com/concrete/finished_basements/a_word_about_vocs.htm
- For Building Material Emissions Study, http://www.ciwmb.ca.gov/Publications/GreenBuilding/43303015.doc
- For spot ventilation, see the fact sheet *Spot Ventilation—source control to improve indoor air quality* http://www.toolbase.org/Docs/MainNav/Energy/3947_spotventilation1.pdf?TrackID=&CategoryID=1004&DocumentID=3947 (Sept 2004)
- EPA. *A Guide to Indoor Air Quality*, http://www.epa.gov/iaq/pubs/insidest.html (Sept 2004)
- *Mold in Residential Buildings*, http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1554&DocumentID=2944 (Sept 2004)

901 Pollutant Source Control

901.1 Space and Water Heating Options

901.1.1 Natural draft space heating or water heating equipment is not located in conditioned spaces, including conditioned crawlspaces. Natural draft equipment is permitted to be installed within the conditioned spaces if located in a mechanical room that has an outdoor air source, and is otherwise sealed and insulated to separate it from the conditioned space(s).

Intent:
To minimize the potential for air contamination due to incomplete combustion in appliances.

Additional Information / How to Implement:
This applies to natural gas or propane appliances. locating natural draft appliances outside of the conditioned space limits the potential for any incomplete combustion to release pollutants into the home.

901.1.2 Air handling equipment or return ducts are not located in the garage, unless placed in isolated, air sealed mechanical rooms with an outside air source.

Intent:
To minimize pollutants entering into the system from leaks in the ductwork or other parts. Installing combustion appliances in an isolated space, such as in a combustion closet, can minimize the concern that combustion by-products could be drawn into the home.

Additional Information / How to Implement:
Locate air handing equipment to avoid the potential for sources of air pollutants entering the system should leaks appear.

A combustion closet is an area sealed off from the conditioned space. Insulate and seal all walls and the ceiling, install a solid door with weather stripping and a sufficient threshold, and extend ducts outside the building envelope to provide combustion and ventilation air.
Alternatives include installing direct vent or mechanical/induced draft equipment (see 5.1.a-b) or installing electric equipment.

Resources:

- Efficiency and Renewable Energy, U.S. Department of Energy. *Combustion Equipment Safety: Provide Safe Installation for Combustion Appliances*. Page 3, Combustion Closet Design chapter

901.1.3 The following combustion space heating and water heating equipment is installed within conditioned space:

(1) Direct vent (sealed combustion) furnace or boiler

(2) Water heater

(a) power vent water heater

(b) direct vent (sealed combustion) water heater

Intent:
There are concerns that exhaust vents (bathroom, kitchen, etc.) can depressurize a tight home and cause by-products of combustion from appliances to be drawn into the home. If installing combustion space and water heating appliances, minimize the back drafting potential by choosing direct vent (sealed combustion) or mechanical/induced draft (power-vented) equipment. All space and water heating appliances must meet these criteria to receive points.

Note: Points can be obtained for this guideline by mixing equipment types. For instance, direct vent space heating equipment and an induced draft water heater can be installed and receive credit.

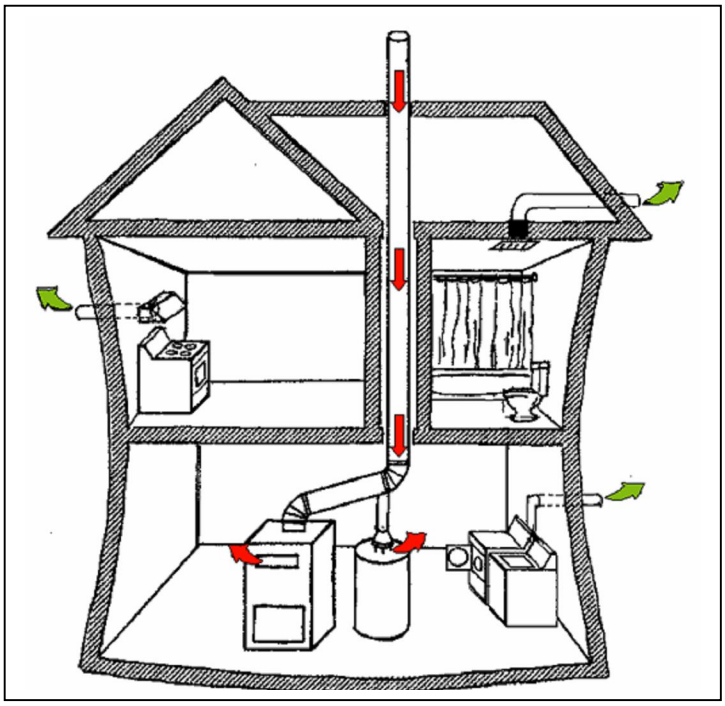
Additional Information / How to Implement:
Combustion appliance manufacturers offer equipment with various means of exhausting by-products:

1. Unvented equipment (a.k.a., ventless, vent-free) where by-products are exhausted into the home;

2. Natural draft equipment (a.k.a., atmospherically vented) where environmental pressure and temperature differences cause by-products to be drawn up a chimney which is directly connected to the equipment;

3. Mechanical draft equipment (a.k.a., induced draft, power vented) where by-products are exhausted through a vent due to pressure differences created by a fan, blower, or ejector located in the vent, or

4. Direct vent equipment where all combustion takes place in a sealed chamber. Combustion air is drawn directly from the outdoors into the chamber. Products of combustion are then vented directly outdoors. Direct vent space heating equipment also has an energy benefit as compared to natural draft or mechanical draft equipment. The Annual Fuel Utilization Efficiency (AFUE) of direct vent equipment is typically above 85%.



Direct vent water heaters remain quite expensive. Mechanically vented or electric water heaters may be the most practical option for many builders wishing to comply with this guideline. Some local codes may require an outdoor source of combustion air for mechanical draft equipment.

An alternative to direct vent equipment includes isolating combustion equipment from the conditioned space such as constructing a combustion closet (see 5.1.2).

<u>Resources:</u>

- Koontz, M.D., N.L. Nagda. *Depressurization-Induced Backdrafting and Spillage: Implications of Results from North American Field Studies.* ASHRAE Winter Meeting; January 12–16, 2002, Atlantic City, New Jersey. AC-02-3-2. Atlanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., 2002.

- National Fire Protection Association, *American Gas Association. National Fuel Gas Code*. 2002 Edition. NFPA 54-2002. ANSI Z2223.1-2002. Section G2406 (303) Appliance Location

- American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. *ASHRAE Standard 62-1989*

- Lstiburek, J., *Builder's Guide: Hot-Dry & Mixed-Dry Climates*. Westford, MA: Building Science Corporation, September 2000.
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- Lstiburek, J., *Builder's Guide: Hot-Humid Climates*. Westford, MA: Building Science Corporation, January 2002.

- Lstiburek, J., *Builder's Guide: Hot-Humid Climates*. Westford, MA: Building Science Corporation, February 2002.

- http://www.epa.gov/iaq/homes/ Search for: “Preventing Problems with Combustion Equipment” and “What You Should Know About Combustion Appliances and Indoor Air Pollution”

901.1.4 The following electric equipment is installed:
(1) Heat pump air handler in unconditioned space
(2) Heat pump air handler in conditioned space

Intent:
To reduce indoor air quality impacts by use of heat pumps instead of combustion-type equipment.

Additional Information/How to Implement:
Heat pumps do not use a combustion process to function, eliminating the risk of indoor air pollutionts associated with combustion appliances. Select or specify a heat pump air handler.

901.2 Fireplaces and Fuel-Burning Appliances: Fireplaces and fuel-buring appliances (except cooking appliances, clothes dryers, water heaters, and furnaces) located in conditioned spaces are in accordance with the following:

901.2.1 Fireplaces and natural draft fuel-burning appliances are code compliant, vented to the outdoors, and have adequate combustion and ventilation air provided to minimize spillage or back-drafting, in accordance with the following, as applicable.
(2) Solid fuel-burning appliances are in accordance with the following requirements:
(a) All wood-burning fireplaces are equipped with gasketed doors designed to operate with the doors closed, outside combustion air, and a means is provided for sealing the flue to minimize interior air (heat) loss when not in operation.
(b) Factory-built, wood-burning fireplaces are in accordance with the certification requirements of UL 127 and are EPA certified.
(c) Wood stove and fireplace inserts, as defined in UL 1482 Section 3.8, are in accordance with the certification requirements of UL 1482 and are in accordance with the emission requirements of the EPA Certification and the State of Washington WAC 173-433-100(3).
(d) Pellet (biomass) stoves and furnaces are in accordance with the requirements of ASTM E 1509 or are EPA certified.
(e) Masonry heaters are in accordance with the definitions in ASTM E1602 and ICC IBC, Section 2112.1.

901.2.2 Fireplaces, woodstoves, pellet stoves, or masonry heaters are not installed.

Intent:
Direct vent sealed combustion gas fireplaces, or sealed wood burning fireplaces, and sealed woodstoves minimize the risk of smoke and combustion by-products backdrafting into the home. Outdoor air is also supplied directly to the combustion chamber so that indoor air is not required for combustion.

Additional Information / How to Implement:
Fireplaces typically come in:

- Wood burning (uses room air for combustion, and exhausts up a chimney)

- Vented gas (uses room air for combustion, exhausts through vent or chimney),

- Direct vent gas (a.k.a., "sealed combustion," outdoor combustion air provided directly to sealed combustion chamber,, exhausts through vent or chimney), or

- Vent free gas (uses room air for combustion, and exhausts to room).

When installing a wood burning stove or fireplace, make sure it is sealed with a gasketed door. Recognize that a wood-burning fireplace is only about 10 to 30 efficient. Consider specifying an EPA-certified wood stove which have efficiencies of around 69 to 78 percent. EPA-certified woodstoves and gas appliances minimize outdoor air pollution.

Direct vent fireplaces (a.k.a., sealed combustion) are more energy efficient than wood fireplaces and atmospherically-vented gas fireplaces. They use outside air for combustion and exhaust directly to the outside. Like vented gas fireplaces, they typically use a heat exchanger to circulate warm air through the room but keep combustion air separate from room air.

Resources:

- U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Consumer Energy Information: EREC Reference Briefs. *Air Pollution from Wood-Burning Appliances and Fireplaces* http://www.eere.energy.gov/consumerinfo/factsheets/ja3.html.

- Hearth, Patio, and Barbecue Association (HPBA). http://hpba.org

- HPBA fact sheet on EPA-certified wood burning http://www.hpba.org/communications/FactSheets/Fact03-EPAWoodBurn3.pdf

- HPBA fact sheet *Wood Burning Fireplaces* http://www.hpba.org/communications/FactSheets/WoodBurningFireplace.pdf

- HPBA fact sheet, *Gas Fireplaces* http://www.hpba.org/communications/FactSheets/GasFireplace.pdf

- National Fireplace Institute. http://nficertified.org. Find a certified installer. NFI Certification identifies those individuals who have passed an exam based on the knowledge needed to properly plan and install hearth products and their venting systems.

- U.S. EPA Compliance Monitoring, *Woodstoves*: http://www.epa.gov/compliance/monitoring/programs/woodstoves

- For fireplace venting options, http://www.fireplacenow.com/_content_/VentingOptions.htm (Sept 2004)

901.3 Garages. Garages are in accordance with the following:

(1) Attached garage

(b) A continuous air barrier is provided between walls and ceilings separating the garage space from the conditioned living spaces.

(c) For one- and two-family dwelling units, a 100 cfm (47 L/s) or greater ducted, or 70 cfm (33 L/s) or greater unducted wall exhaust fan is installed and vented to the outdoors, designed and installed for continuous operation, or has controls (e.g., motion detectors, pressure switches) that activate operation for a minimum of 1 hour when either human passage door or roll-up automatic doors are operated. For ducted exhaust fans, the fan airflow rating and duct sizing are in accordance with Appendix A.

(2) A carport is installed, the garage is detached from the building, or no garage is installed.

Intent:
To reduce risk of automobile exhaust from entering into the residence.

Additional Information / How to Implement
For attached garages ensure that the continuous air barrier between the walls and ceiling separating the garage space is not penetrated thereby preventing pollutants from the garage entering the home.

902 pollutant Control

902.1 Spot ventilation

902.1.1 Spot ventilation is in accordance with the following:

(1) Bathrooms are vented to the outdoors. The minimum ventilation rate is 50 cfm (23.6 L/s) for intermittent operation or 20 cfm (9.4 L/s) for continuous operation in bathrooms.

(3) Kitchen exhaust units and/or range hoods are ducted to the outdoors and hava a minimum ventilation rate of 100 cfm (47.2 L/s) for intermittent operation or 25 cfm (11.8 L/s) for continuous operation.

902.1.2 Bathroom and/or laundry exhaust fan is provided with an automatic timer, motion sensor and/or humidistat:

(1) for first device

(2) for each additional device

Intent:
To improve indoor air quality by exhausting sources of indoor air contamination to the exterior.

Additional Information / How to Implement:
The ventilation rate for all ventilation fans is provided by the manufacturer. Chose products that meet one or more of the flow rates listed above. These systems must be exhausted to the outdoors, and not into an attic or other interior space, in order to take the points.

902.1.4 Exhaust fans are ENERGY STAR, as applicable.

(1) ENERGY STAR, or equivalent, fans

(2) ENERGY STAR, or equivalent, fans operating at or below 1 sone

Intent:
To reduce improve the indoor air quality through the use of exhaust fans while minimizing the energy used for those fans.

Additional Information/How to Implement:
Select or specify ENERGY STAR or equivalent fans. If the exhaust requirements of the home can be met using fans that operate at or below 1 sone.

902.2 Building ventilation system

902.2.1 Once of the following whole building ventilation systems is implemented and is in accordance with the following formula: CFM fajn flow continuous – (heated square footage X .01) + (7.5 (number of bedrooms + 1)). Note: Note: Continuous flow rate can also be achieved, for example, by two fans continuous at half the rate or by doubling the fan flow over half the time, with a timer. (Mandatory)

(1) exhaust or supply fan(s) ready for continuous operation and with appropriately labeled controls

(2) balanced exhaust and supply fanswith supply intakes located inj accordance with the manufacturer's guidelines so as to not introduce polluted air back into the building

(3) heat-recovery ventilator installed with balanced exhaust and supply fans with supply intakes located in accordance with the manufacturer's guidelines so as to not introduce polluted air back into the building

(4) energy-recovery ventilator installed with balanced exhaust and supply fans with supply intakes located in accordance with the manufacturer's guidelines so as to not introduce polluted air back into the building

Intent:
Provide small amount of background ventilation to ensure that indoor air is exchanged at a consistent and adequate rate.

Additional Information / How to Implement:
It is advantageous from an indoor environmental quality perspective and for energy efficiency purposes and comfort to construct a tight building envelope. Air infiltration not only contributes to energy loss but can also cause mold problems if warmer air condenses when it reaches a cooler surface as it moves through a wall cavity. However, a very tight building shell can create the need for an intentional means of introducing fresh air into the living space. Introducing outdoor air into the home in a controlled manner has both an energy and IEQ advantage. Exhaust or Supply Fan: Kitchen or bath exhaust fans can be part of a whole-house ventilation strategy in cold climates by controlling fans with timers or humidistats. As air is exhausted from the home, the negative pressure created pulls in outdoor air from nooks and crannies in the building envelope. The practice is not recommended in warm, humid climates because humid, outdoor air traveling through a wall cavity can create moisture problems. In these climates, supply-only ventilation is preferable. For supply-only ventilation, locate the ducts carefully since cold or hot outdoor air can create comfort issues.

Balanced Exhaust and Supply Fan: Balanced ventilation does not contribute to pressure imbalances between indoors and out. As air is exhausted by one (or more) fans, fresh air is introduced by another. One option for balanced ventilation is to use bath fans for the exhaust and to install a small duct from outside to the return side of the air handler on a central heating or cooling system. Controls and timers are then used to operate the fans and air handler simultaneously or as desired. Outdoor air can also be supplied directly to the home with a separate fan, but take care in locating the ducts so that comfort is not compromised.

Heat or Energy Recovery Ventilators: These systems are also a form of balanced ventilation. In addition to supplying fresh air and exhausting stale air, they precondition the incoming air to some degree. Heat recovery ventilators exchange sensible heat while energy recovery ventilators transfer moisture to some extent as well. Thus, in a humid climate, some moisture from the incoming air is transferred to the exhaust stream. Energy recovery ventilators are not dehumidifiers; they transfer moisture from one air stream to another. For severely humid climates, one should consider a dehumidifying ventilator. Typically, heat recovery ventilators are recommended for cold climates and energy recovery ventilators for hot climates. However, if dry indoor air is a potential issue in a heating dominated climate, an energy recovery ventilator may be preferred.

See also Section 3.3.1B under the Energy Efficiency section.

Resources:

- American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. ASHRAE Standard 62-1989

902.2.2 Ventilation airflow is tested to achieve the design fan airflow at point of exhaust in accordance with Section 902.2.1by a qualified third party and a report provided to the City of Santa Fe Inspection Division

Intent:
To ensure all exhaust flows are operating as designed.

Additional Information / How to Implement:
If ductwork is not properly sized and installed, fan flow may be restricted and fans may not exhaust air at their rated capacity. For example, a fan rated at 50 CFM may only exhaust 35 CFM if duct runs are extremely long or if ductwork is kinked during installation. Without adequate fan capacity, moisture may not be adequately removed. Properly size ducts in accordance with the manufacturer's recommendation for duct diameter and maximum duct length. Fans should perform within 10% of their rated capacity. After installation, visually inspect the duct length, look for crimped or damaged ducts, check for missing parts, and ensure that connections are secure. A more accurate method of checking fan air flow is to use a flow hood or pilot tube and manometer. Ask the installer about methods of checking air flow.

Resources:

- ACCA Manual D http://www.cmhc-schl.gc.ca/en/burema/gesein/abhose/abhose_ce17.cfm

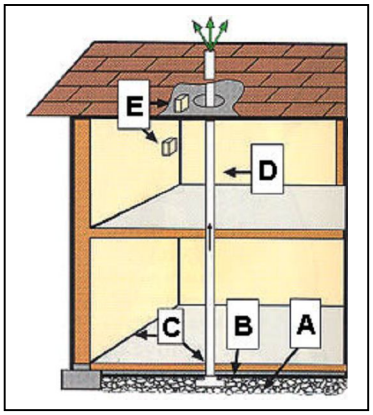
- Flow hood equipment - http://www.energyconservatory.com/products/products1.htm

902.3 Radon control. Radon control measures are in accordance with ICC IRC Appendix F (Mandatory Item)

(1) Buildings located in Zone 1 (Santa Fe)

(a) a passive radon system is installed with an electric supply to be able to add a fan in the future if needed.

(b) an active system is installed



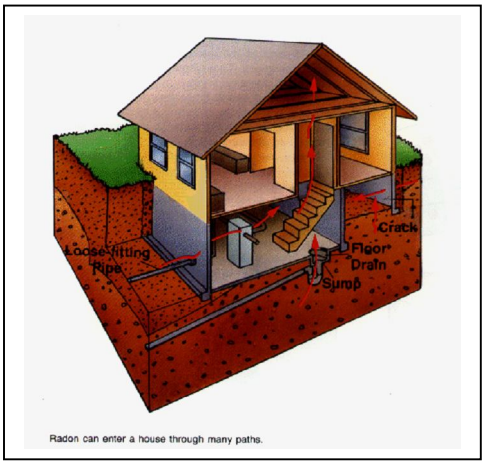
Intent:
Prevent radon gas from entering the home.

Additional Information / How to Implement:

Text and graphic in table from: http://www.epa.gov/radon/construc.html
A. Gas Permeable Layer This layer is placed beneath the slab or flooring system to allow the soil gas to move freely underneath the house. In many cases, the material used is a 4-inch layer of clean gravel.
B. Plastic Sheeting Plastic sheeting is placed on top of the gas permeable layer and under the slab to help prevent the soil gas from entering the home. In crawlspaces, the sheeting is placed over the crawlspace floor.
C. Sealing and Caulking All openings in the concrete foundation floor are sealed to reduce soil gas entry into the home.
D. Vent Pipe A 3- or 4-inch gas-tight or PVC pipe (commonly used for plumbing) runs from the gas permeable layer through the house to the roof to safely vent radon and other soil gases above the house.
E. Junction Box An electrical junction box is installed in case an electric venting fan is needed later.

Radon is a naturally occurring gas spontaneously produced from the decay of radium. Radon levels can vary between outdoor air, indoor air, soil, and ground water. Radon is a carcinogen that can enter through voids in a homes foundation and become trapped inside. Radon gas can easily be directed outside of the home with a few basic construction designs.

Note that in areas designated as high radon areas, special considerations should be taken to treat well water. Simple water treatments are available. For more information, call EPA's Drinking Water Hotline at (800) 426-4791 or visit www.epa.gov/safewater/radon.html If your water comes from a private well, you can also contact your state radon office



Resources:

- 2003 IRC page 559
- HBA: Use radioactivity maps from USGS, state geological surveys, colleges/universities to better know the dangerous radon zones in your area. http://energy.cr.usgs.gov/radon/georadon/4.html
- EPA's map of radon zones by county http://www.epa.gov/radon/zonemap.html
- HBA: EPA also recommends contacting your state radon representative. EPA has a list of contacts on their Website at: http://www.epa.gov/iaq/whereyoulive.html
- http://www.epa.gov/radon/
- *Radon Resistant New Construction* - http://www.epa.gov/radon/construc.html

- 2000 IRC, page 564, *Radon-resistant construction details for four foundation types*.

- For Radon remediation, check http://www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1174

902.4.1 Mask HVAC outlets during construction and vacuum ducts, boots, and grilles, and replace filter if necessary, before turning on central heating/cooling system. HVAC may be run once the thermal envelope is completed during cold weather if run with filters and if cleaned after construction is complete.

Intent:
When possible, do not operate ducted HVAC equipment during construction.
Remove dust and dirt from supply and return ducts before putting the equipment into operation to minimize airborne pollutants.

Additional Information / How to Implement:
Tightly cover openings with materials such as cardboard and tape, especially during tasks that create significant dust such as drywall or floor sanding. It is not necessary to professionally clean ducts in order to comply with this guideline. Rather, use a shop vacuum to remove dust and debris close to the openings.

902.5 Central vacuum system. Central vacuum system is installed and vented to the outside.

Intent:
To remove dust and allergens from the living space that might otherwise be re-emitted from a stand-alone vacuum.

Additional Information / How to Implement:
Install well sealed piping at frame stage and have power source in garage for vacuum systems.

Resources:
Install well sealed piping at frame state and have power source in garage for vacuum system.

902.6 Living space contaminants. The living space is sealed to prevent unwanted contaminants and third-party verified.

(1) Attic access, knee wall door, or drop down stair is caulked, gasketed, or otherwise sealed. (Mandatory)

(2) All penetrations (e.g., top plates, HVAC register boots, recessed can lights) are sealed in the following areas: (Mandatory)

(a) attic/ceiling

(b) wall

(c) floors

Intent:
To reduce contaminants in the living space through effective sealing.

Additional Information/How to Implement:

Contaminants from outside the home can infiltrate into the living space through gaps in sealing of the exterior envelope of the home. By adequately sealing the exterior envelope through caulking and gasketing penetrations through it the risk of outside contaminants entering the home is minimized.

903 Moisture Management: Vapor, Rainwater, Plumbing, HVAC)

Intent:
Reduce risk of moisture accumulation which can lead to deterioration of building products and potential mold problems.

Additional Information / How to Implement:
See Resources section.

Resources:
- Lstiburek J., and J. Carmody, *Moisture Control Handbook, Principles and Practices for Residential and Small Commercial Buildings*, Wiley, 1996.

903.5 Plumbing

903.5.1 Plumbing supply distribution lines are not installed horizontally in exterior wall cavities.

Intent:
Reduce the potential for condensation on supply pipes by keeping pipes in conditioned space (where pipes are not exposed to large temperature and humidity differentials). Also reduces the consequences of a potential plumbing leak—which could lead to wetting of structural members, insulation, and interior finishes.

Additional Information / How to Implement:
Try to cluster bathrooms and other hot water uses, e.g., "stacked" bathrooms, to minimize the need for running supply lines on exterior walls. Water supply lines can be run through duct chases (designed for keeping ducts in conditioned space). When piping must be located in exterior walls, insulation should be placed between the exterior sheathing and the pipe, but not between the pipe and the interior wall (to prevent freezing).

Resources:
- *Builder's Guide to Placement of Ducts and HVAC Equipment in Conditioned Space*, 2000, NAHB Research Center. Available at http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2570&CategoryID=110

- Lewis, Bill. *Preventing Frozen Water Pipes*. http://homerepair.about.com/cs/plumbing/a/frozen_pipes_b3.htm (Sept 2004)

903.5.2 Cold water pipes in unconditioned spaces are insulated to a minimum of R-4 with tape insulation or other covering that adequately prevents condensation.

903.5.3 Plumbing is not installed in unconditioned spaces

Intent:

Reduce the potential for condensation on cold water supply pipes located in unconditioned space by insulating the pipes. This guideline has more relevance in hot, humid climates where piping is more likely to be located in an unconditioned area. Cold water piping installed in crawl spaces can pose a condensation problem in colder regions during the summer months.

Additional Information / How to Implement:
Foam insulation for insulating pipes is readily available and easy to install.

(photo from energyoutlet.com, http://energyoutlet.com/res/ducts/insulating-480.gif)

Resources:

- *Preventing and Thawing Frozen Pipes*. http://www.prepare.org/basic/frozen.htm (Sept 2004)

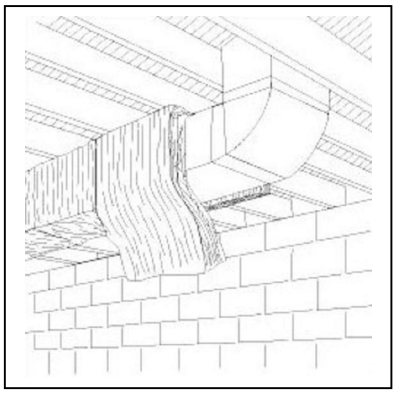
- Do It Yourself. http://www.diynet.com/diy/diy_kits/article/0,2019,DIY_13787_2275412,00.html (Sept 2004)

903.6 Duct Insulation. All HVAC ducts, plenums, and trunks in unconditioned attics, basements, and crawl spaces are sealed with UL 181 tape or mastic and insulated to a minimum of R-6. Outdoor air supplies to ventilation systems are sealed with UL181 tape or mastic and insulated to a minimum of R-6.

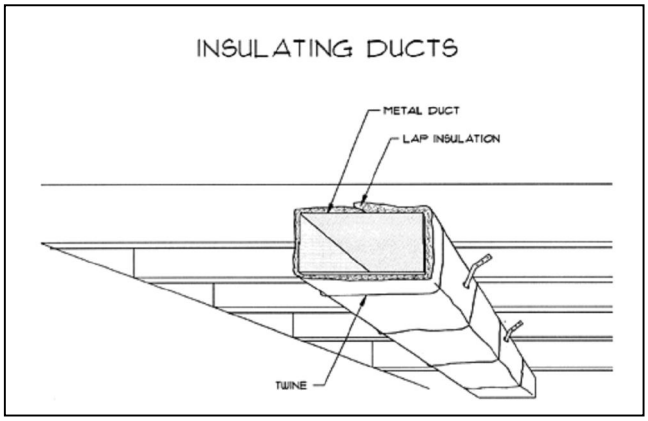
(1) Insulated to a minimum of R-6.
(2) Insulated to a minimum of R-8

Intent:
To prevent condensation on the outside of cold HVAC ducts located in unconditioned basements and crawlspaces that can lead to moisture problems in those areas.

Additional Information / How to Implement:
After sealing ductwork, use spray foam or wrap a flexible insulation product (e.g., reflective insulation, fiberglass batts) around metal supply ducts, plenums and trunks in basements and crawlspaces. Do not use flexible ductwork in crawlspaces, as it can be an entry point into the home for vermin.



http://www.mme.state.va.us/de/energybook/hbchap5.html



http://www.mme.state.va.us/de/energybook/hbchap5.html

Resources:

- Energy Outlet information on duct sealing, available at http://www.energyoutlet.com/res/ducts/insulating.html

- *Crawlspace Condensation* by Home Energy Magazine Online http://hem.dis.anl.gov/eehem/01/010304.html (Sept 2004)

- *Insulating Ducts for Efficiency.* http://www.bobvila.com/ArticleLibrary/Subject/HVAC/Insulation/InsulatingDucts.html (Sept 2004)

904 Innovative Practices

904.4 Use non PVC materials for water supply lines including the service to the house

Intent:
To reduce the pollution associated with the manufacture of PVC materials.

Additional Information / How to Implement:
Use copper with lead-free solder or cross-linked polyethylene for water pipes. The manufacture of PVC materials, including pipes and other construction materials, contributes a greater amount of pollution than other alternative materials.

904.5 Use no carpet or vinyl flooring

Intent:
To reduce indoor air contaminants due to off gassing and reduce air pollution in general and to reduce the amount of allergens in the home that get trapped in carpet fibers.

Additional Information / How to Implement:
Both carpet and vinyl flooring result in pollution during their manufacture and off-gas into the home after installation. Using either the floor slab as the flooring material or wood products with low-VOC finishes are less polluting alternatives.

Chapter 10
OPERATION, MAINTENANCE, AND BUILDING OWNER EDUCATION

Ensure that homeowners are aware of the green features of their new home, know how to operate and maintain the home to achieve the highest level of environmental performance, and have a resource for warranty issues.

1001 A building owners manual is provided that includes the following, as available and applicable.

(1) A green building program certificate or completion document (Mandatory)

(2) List of green building features (can include the national green building checklist). (Mandatory)

(3) Product manufacturer's manuals or product data sheet for installed major equipment, fixtures, and appliances, including any alternative energy systems. If product data sheet is in the building owner's manual, manufacturer's manual may be attached to the appliance in lieu of inclusion in the building owner's manual. (Mandatory)

(4) Information on local recycling programs.

(5) Information on local utility or other energy provider program that purchase a portion of energy from renewable energy providers.

(6) Explanation of the benefits of using energy-efficient lighting systems [e.g., compact fluorescent light bulbs, light emitting diodes (LED)] in high-usage areas.

(7) A list of practices to conserve water and energy.

(8) Local public transportation options.

(9) A diagram showing the location safety valves and controls for major house systems. (Mandatory)

(10) Where frost-protected shallow foundations are used, owner is informed of precautions including:

- **(a) instructions to not remove or damage insulation when modifying landscaping.**
- **(b) providing heat to the building as required by the ICC IRC or UMC**
- **(c) keeping base materials beneath and around the building free from moisture caused by broken water pipes or other water sources.**

(11) A list of local service providers that offer regularly scheduled service and maintenance contracts to ensure proper performance of equipment and the structure (e.g., HVAC, water-heating equipment, sealants, caulks, gutter and downspout system, shower and/or tub surrounds, irrigation system).

(12) A photo record of framing with the utilities installed. Photos are taken prior to installing insulation, clearly labeled, and included as part of the building owner's manual.

(13) Maintenance checklist.

(14) List of common hazardous materials often used around the building and instructions for proper handling and disposal of these materials.

(15) Information on organic pest control, fertilizers, deicers, and cleaning products.

(16) Information on native landscape materials and/or those that have low-water requirements.

(17) Information on methods of maintaining the building's relative humidity in the range of 30 percent to 60 percent.

(18) Instructions for inspecting the building for termite infestation.

(19) Instructions for maintaining gutters and downspouts and importance of diverting water a minimum of 5 feet away from foundation.

(20) A narrative detailing the importance of maintenance and operation in retaining the attributes of a green-built building.

(21) Information regarding cost effective window treatments

(22) Information about protecting the home from fire danger

(23) Instructions for maintaining solar systems employed in the home (only available if solar systems are employed in the home) (Mandatory)

(24) Provide homeowner with information about mulching and composting

Intent:
Help home owners to "live green" in their green built home.

Additional Information / How to Implement:
Gather information for homeowners from local and national resources (see Resources). Include information about the green features of the home as well as tips for living in the home with less impact on the environment. Ask your local Green Building program if they offer a sample Green Homeowners' Manual.

Resources:

- Fannie Mae's, *Home Performance Power: Fannie Mae's Guide to Buying and Maintaining a Green Home.* For a copy, call Fannie Mae's Consumer Resource Center at 1-800-7FANNIE (1-800-732-6643).

- NAHB's *Your New Home and How To Take Care of It.*

- *The National Home Maintenance Manual,* by California Building Standards.

- Your local HBA's Green Building Program office. List of local Green Building Programs at http://www.toolbase.org (click on "Green Building")

- Various manufacturers

- City, county, or township recycling information

- U.S. DOE's Green Power Network: http://www.eere.energy.gov/greenpower/

- Lighting energy savings calculator at http://www.goodmart.com/light_bulb_energy_saving_calculator.aspx

- Water saving tips at http://www.h2ouse.org/. Energy Saving tips: http://www.eere.energy.gov/consumerinfo/energy_savers/ and http://www.aceee.org/consumerguide/chklst.htm

- Metropolitan area, city, county, township, or private public transit information (usually listed in the front matter of the phone book)

- *Homeowner's Manual—At last, an owner's manual for your new home*. By CMHC. http://www.cmhc-schl.gc.ca/en/bureho/buho/buho_002.cfm (Sept 2004)

- National Environmental Services Center, http://www.nesc.wvu.edu/nsfc/NewReleases/nsfc_NR_11_14_03.htm (Sept 2004)

- Community Associations Institute, http://www.caionline.org/about/homeowner_education.cfm (Sept 2004)

- Massachusetts Housing Partnership, http://www.mhp.net/homeownership/education.php (Sept 2004)

- How-To Publications by Family Resource Management, College of Agriculture & Home Economics. http://www.cahe.nmsu.edu/pubs/_g/ (Sept 2004)

- Papolos, Janice. *The Virgin Homeowner: The Essential Guide to Owning, Maintaining, and Surviving Your Home*, Penguin Books. ISBN: 0140274766.

- For earthquake safety. http://www.seismic.ca.gov/pub/CSSC_2002-04_HOG.pdf (Sept 2004)

- For fire prevention http://www.ofm.gov.on.ca/english/FirePrevention/FireSmart%20Communities/pdf/User%20guide.pdf (Sept 2004)

- For soil-lead hazard. http://www.epa.gov/region01/leadsafe/pdf/chapter8.pdf (Sept 2004)

- For septic system by University of Minnesota Extension Service. http://www.extension.umn.edu/distribution/naturalresources/DD6651.html (Sept 2004)

- For pest control and pesticide safety, http://pep.wsu.edu/psp/scripts/documents.asp?qryType=new, and http://scholar.lib.vt.edu/ejournals/JPSE/v5/v5hipkinsra2.pdf (Sept 2004)

- For HVAC. http://www.healthgoods.com/Education/Healthy_Home_Information/Space_Heating_and_Cooling/sizing_heat_and_ac.htm (Sept 2004)

- Home*a*Syst, *An Environmental Risk-Assessment Guide for the Home, Healthy Home Tool*, available at http://www.uwex.edu/homeasyst/

- Local Green Building Checklist, or other documents

- EPA document: http://www.epa.gov/epaoswer/non-hw/househld/hhw.htm

- Check with the local or state environmental or solid waste agency to see if there is a hazardous waste drop-off day. Local recycling information may cover hazardous wastes. County or state may have Cooperative Extension fact sheets geared toward your municipality (see, for example, http://www.epa.gov/grtlakes/seahome/housewaste/src/open.htm)

- Local Cooperative Extension office should have printed information. Also, organic-based lawn services, such as NaturaLawn, usually have printed information.

- County or state Cooperative Extension publications

- Cooperative Extension publications for information about termite tubes, where to look for them, and what they look like. See, for example, http://www.uky.edu/Agriculture/Entomology/entfacts/struct/ef604.htm

1002 Training of Building Owners on Operation and Maintenance for One- and Two-Family Dwellings and Multi-Unit Buildings

1002.1 Training of building owners. Building owners/occupants are familiarized with the green building goals and strategies implemented and the impacts of the occupant's practices on costs of operating the building. Training is provided to the responsible party(ies) regarding all building operation and control systems. Systems include, but are not limited to, the following:

(1) HVAC filters or boiler maintenance
(2) Thermostat operation and programming
(3) Lighting controls
(4) Appliances and settings
(5) Water heating settings
(6) fan controls
(7) the irrigation system
(8) catchment system maintenance

(9) all other equipment

Intent:
During the walk through, demonstrate how to control of all the mechanical systems in the home. Demonstrate how to use all controls such as thermostats, lighting controls and fan controls.

Additional Information / How to Implement:
During the walk through, demonstrate how to control all of the mechanical systems in the home. Demonstrate how to use all controls such as thermostats, lighting controls and fan controls.

Resources:

- National Association of Home Builders, *Your New Home and How to Take Care of* It. Washington, DC: BuilderBooks, 2001, 60 pages.

- Provide homeowners these pages and pages of tips on maintenance to help keep their new home performing at its peak. In the back there are pages on which to note maintenance dates and remarks.

- http://www.builderbooks.com

- 800-223-2665

- Manuals from manufacturers for reference.

1004 Innovative Practices

1004.2 Translate homeowner documents into Spanish and provide both to homeowner.

Intent:
To provide the greatest chance that the homeowner's manual will be accessible to future homeowners.

Additional Information / How to Implement:
Many Santa Feans speak and read Spanish as a first language. Even if the original home owners first language is English, there is a potential that subsequent owners first language will be Spanish. Therefore, by providing the manual in both languages, it increases the likelihood that it will be effectively used and understood.