Energy Checklist

Energy Efficient Construction

Building an energy efficient home requires dozens of decisions by home designers, builders, and subcontractors. Many decisions affect the cost of construction and the profitability of the project. While energy efficiency requires careful planning and attention to details throughout the construction process, it offers substantial benefits to building professionals:

- fewer callbacks due to drywall cracks, nail pops, moisture damage, and other problems
- reduced liability from failure to comply with building, fire, and energy codes
- enhanced design and construction flexibility due to smaller and more simple mechanical systems
- increased markets due to energy efficient mortgages and other incentives
- greater customer satisfaction because of improved comfort, less noise, reduced maintenance, increased durability, and lower operating costs
- recognition as a professional dedicated to quality and protecting the environment

House As A System

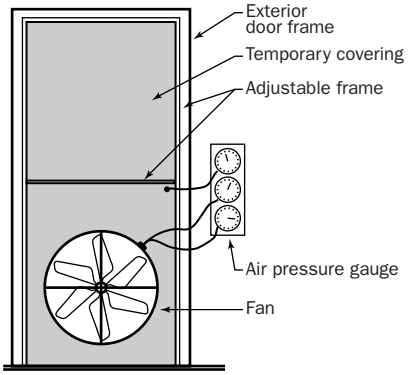
Successful design and construction professionals follow a "systems" approach to improving the energy efficiency of their homes. A systems approach considers the interaction between the site, building envelope, mechanical systems, occupants, and other factors. The systems approach recognizes that features of one component of the house can greatly affect others.

For example, energy efficient windows cost more than standard products. However, energy efficient windows reduce heating and cooling needs, which reduces the size of the mechanical systems. The reduction in size saves money on the purchase and installation cost of the mechanical equipment which pays for the better windows.

Home design and construction has changed dramatically over the past 20 years. Most builders realize that today's homes have tighter envelopes, increased insulation levels, and higher efficiency mechanical systems and appliances. However, many building professionals do not realize that these improvements have not tapped the full potential for saving energy. When approached piecemeal and without consistency, some of these improvements can endanger the health, safety, and durability of the building.

For example, the increased insulation of today's homes slows heat flow, but also reduces the ability of the building envelope to dry. If the envelope is not thoroughly sealed against air leaks, moisture laden air can enter and cause problems.

Tighter homes means less infiltration of cold, dry outdoor air. Whereas many standard homes experience excessive dryness in winter and require a humidifier, tighter homes may have excess humidity and need controlled ventilation.



Testing the airtightness of a home using a variable speed fan called a blower door can help ensure that airsealing work is effective. Blower door testing is required by many energy efficiency certification programs. The test can usually be performed in less than an hour for simple floor plans and may be offered by utilities, weatherization agencies, and energy service companies.

Air Barrier

Air leakage can account for over 50% of a home's heating and cooling costs, and contribute to problems with moisture, noise, dust, and entry of pollutants, insects, and rodents. Commonly used sheet materials, such as drywall, sheathing, and decking, are effective at stopping air leakage. The key is to seal all holes and seams between sheet materials to create a continuous air barrier.

Many homes have large gaps in the sheet goods. These gaps are often hidden from view: under the bath tub, above dropped soffits for kitchen cabinets, or in mechanical room closets. Avoiding these gaps is inexpensive during construction. The key is to identify problem areas in the design process, assign the responsibility for sealing the holes, then check to ensure the airsealing was done effectively.

The first priority to airsealing should be no big holes in the sheet materials that form the air barrier.

Airsealing does not usually require expensive materials or special construction skills. Many affordable housing programs rely on volunteer labor. However, airsealing must be done throughout the construction process: during framing, prior to insulating and installation of interior finish materials, after installation of fixtures, and as a part of final punch-out. The materials that form the air barrier must be designed to provide a seal that will last the life of the home or be easily re-applied by the home owner.

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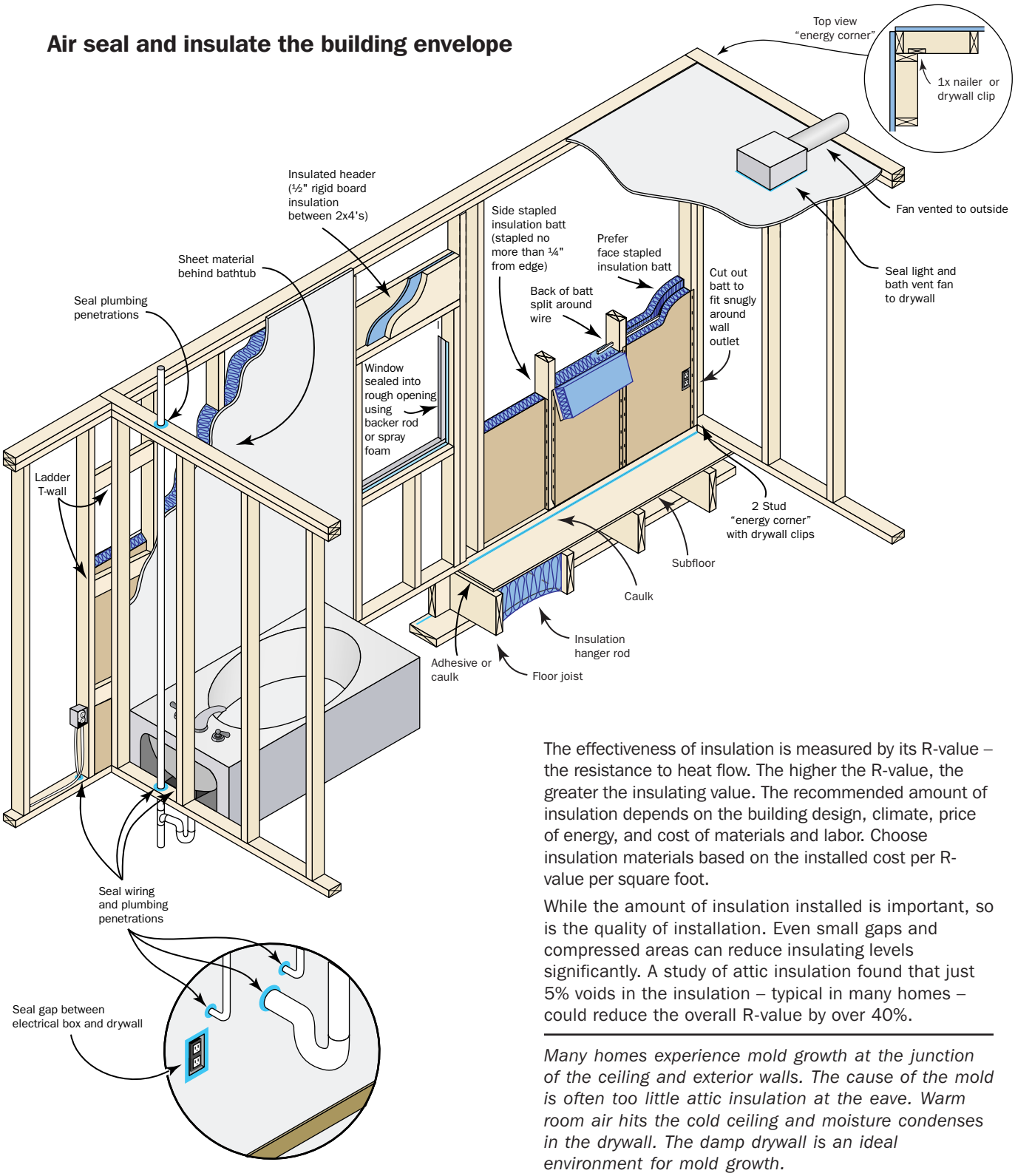
Air seal and insulate the building envelope



Insulation Barrier

Insulation reduces heat flow through the building envelope. Gaps in insulation waste energy and can lead to condensation which can damage building materials and cause growth of molds, dust mites, and other biological contaminants.

The effectiveness of insulation is measured by its R-value – the resistance to heat flow. The higher the R-value, the greater the insulating value. The recommended amount of insulation depends on the building design, climate, price of energy, and cost of materials and labor. Choose insulation materials based on the installed cost per R-value per square foot.

While the amount of insulation installed is important, so is the quality of installation. Even small gaps and compressed areas can reduce insulating levels significantly. A study of attic insulation found that just 5% voids in the insulation – typical in many homes – could reduce the overall R-value by over 40%.

Many homes experience mold growth at the junction of the ceiling and exterior walls. The cause of the mold is often too little attic insulation at the eave. Warm room air hits the cold ceiling and moisture condenses in the drywall. The damp drywall is an ideal environment for mold growth.

It is important to seal air leaks before insulating. Commonly used insulation materials, such as batt and loose-fill products, do not stop air leakage. As air leaks through these materials, it lowers the R-value. For most affordable home designs, materials other than insulation will form the air barrier. There are some insulation

Check List for Energy Efficient Construction

An energy checklist helps ensure a systems approach. The details will vary according to climate, site, house design, materials selection, and other factors. The following checklist is for a home built in a temperate climate with an unconditioned crawl space, atmospheric combustion appliances, and kitchen and bath fans for ventilation.

Foundation

- ☐ Grade slopes minimum of 5% from foundation
- ☐ Install 6 mil plastic ground cover in crawl space; overlap and seal seams (if required)
- ☐ Provide radon vent stack
- ☐ Close crawl space vents

Air sealing

Before drywall is installed:

- ☐ Seal bottom plate of exterior walls during construction
- ☐ Seal inside edge of bottom plate after exterior walls are erected
- ☐ Air seal behind bathtub before setting and after insulation is installed using plastic, drywall, or other sheet material
- ☐ Seal windows and exterior doors into rough opening using spray foam or backer rod (recommended)
- ☐ Seal wiring, plumbing, and HVAC penetrations at top and bottom plates, ceilings, and floors

After drywall is installed:

- ☐ Seal bathtub drain penetration after installation and before floor insulation installed
- ☐ Seal plumbing pipes and electrical boxes (e.g., receptacles, switches, lights, and circuit breaker box) to drywall
- ☐ Seal bathroom ventilation fan to drywall
- ☐ Seal attic bypasses and chases (e.g., open partition walls, dropped ceilings, and duct and flue chases)
- ☐ Caulk, glue or gasket drywall
- ☐ Seal duct boots to floor or drywall
- ☐ Verify that the HVAC contractor has sealed return and supply duct connections (mastic required)
- ☐ Seal exterior penetrations (e.g., porch light fixtures, outside outlets, and phone and electric service holes)
- ☐ Seal gaps around whole house fan frame (backer rod, tape or spray foam preferred)
- ☐ Fabricate whole house fan cover using rigid foam insulation, contact paper, and Velcro®
- ☐ Weatherstrip attic access hatch cover

Insulation

- ☐ Use insulation hangers (rods) placed every 12 inches to hold floor insulation in place
- ☐ Use energy efficient framing (e.g., energy corners, T-walls, insulated headers) to improve coverage
- ☐ Carefully staple kraft paper facing of wall insulation batts to side of stud or front (preferred) to avoid compressing batts
- ☐ Cut wall insulation batts to fit around wiring, wall outlets, and plumbing
- ☐ Install soffit dams and rafter baffles to provide clearance for soffit ventilation
- ☐ Insulate attic access hatch cover or construct cover for attic stairs from rigid foam insulation

Sheathing

- ☐ Repair and replace any deficiencies in the rigid foam insulation
- ☐ Tape or caulk sheathing seams or install housewrap
  - Cover and seal housewrap to top and bottom plates and sills
  - Overlap and caulk or tape seams
  - Seal all cuts and openings
  - Use plastic capped nails and staples to mechanically hold housewrap to house

HVAC combustion closet

- ☐ If using a gas furnace or water heater, isolate equipment closet from conditioned space
  - Insulate and seal combustion closet walls
  - Install solid (non-louvered) door with weatherstripping and threshold
  - Seal all gas and water line penetrations through equipment closet
  - Provide inlet air for combustion

Water heater

- ☐ Insulate water heater with jacket
- ☐ Install heat traps (check valve or inverted loop) on both hot and cold water pipes
- ☐ Insulate all hot water piping in closet and first two feet of cold water pipe
- ☐ Insulate water pipes in crawl space for freeze protection

products, such as rigid form sheathings and spray-in-place materials, that can reduce air leakage and insulate.

Moisture

Controlling moisture is critical to maintaining the durability of a building as well as the health of its occupants. When moisture condenses it can damage finish materials, reduce the R-value of insulation, and lead to decay. High moisture levels are necessary for the growth of molds and dust mites which can endanger human health.

Ground water is a common cause of moisture problems in homes. Ensure proper drainage around the home—usually slope grade a minimum of 5% away from the foundation. Cover bare earth under crawl spaces with a ground cover. Provide a capillary break under slabs.

Problems can also originate from moisture-laden air leaking into the building envelope. Airsealing the envelope not only saves energy but can reduce these moisture problems. Moisture can diffuse through permeable building materials, such as drywall. Vapor barriers may be recommended in some climates to control diffusion of water vapor.

The activities of the home owner, such as respiration, cooking, bathing, and cleaning, generates moisture. In energy efficient homes, it is important to provide for controlled ventilation to remove this moisture.

Heating & Cooling

Fuel choice

The choice of energy source for heating and cooling, equipment is an important factor in determining cost. Compare operating costs for all available fuel types. Do not let short term incentives dictate an expensive energy source.

Equipment size

Energy efficient homes require less heating and cooling than standard homes. Therefore, smaller mechanical systems can be installed which saves the builder money. It is common for mechanical systems to be oversized which increases installation costs, wastes energy, and reduces comfort and moisture control. Properly sized equipment will last longer, provide greater comfort, reduce noise, and save home owners money. Require that equipment be sized using *Manual J* or similar procedure.

Equipment efficiency

High efficiency equipment costs more than standard models reducing equipment size through energy improvements to the building envelope offsets this extra cost.

AFUE (annual fuel utilization efficiency)—measures the efficiency of furnaces. Units range from a low of 78% to mid-efficiency of 82% to high-efficiency of over 92%. AFUE does not measure the electrical consumption of the furnace blower. An inefficient blower can waste hundreds of dollars over its life. Use the manufacturer's data sheets to compare blower efficiency as well as AFUE.

HSPF (heating season performance factor)—measures the efficiency of an electric heat pump in heating mode. Units range from a low of 6.8 to mid-efficiency of 7.2 to high-efficiency of 8.0.

SEER (seasonal energy efficiency ratio)—measures the cooling efficiency of an air conditioner or heat pump. Units range from a low of 10 to mid-efficiency of 12 to high-efficiency of over 13.

Reducing the size of heating and cooling equipment can help pay for energy improvements to the building envelope. Require Manual J calculation of equipment size.

Water Heating

The cost of water heating can be as great as for heating or cooling. Fuel cost is often the prime consideration for water heating. The right choice can save home owners several hundred dollars each year on energy bills.

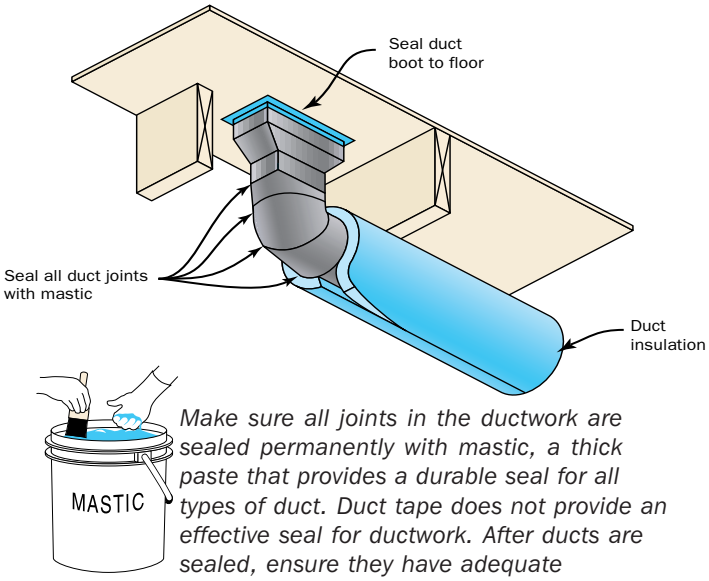
High efficiency water heaters typically pay for their extra cost in energy savings within a few years. Increase savings with simple conservation measures, such as a temperature setting of 120ºF, anti-convection loops in hot and cold lines, and tank insulation.

Avoid locating atmospheric combustion water heaters within the conditioned space. Specify power vented models.

Ventilation

Houses need controlled ventilation. In simple designs, spot ventilation provided by bath and kitchen fans may be adequate. For more detailed designs and severe climates, other ventilation options may be appropriate.

Ductwork is sealed and insulated



Make sure all joints in the ductwork are sealed permanently with mastic, a thick paste that provides a durable seal for all types of duct. Duct tape does not provide an effective seal for ductwork. After ducts are sealed, ensure they have adequate insulation – R-5 or better.

Ductwork

Many homes rely on forced-air distribution of conditioned air through ductwork. Studies show that air leakage from poorly sealed ductwork can waste over 30% of a home's heating and cooling energy. Duct leakage can also create pressure imbalances in a home which endanger health and safety.

The best solution to cutting energy losses from ductwork is to locate the ducts inside the conditioned space of the home. For example, many affordable home designs provide for ductwork in an airtight plenum located at the ceiling of an interior hallway. Air is distributed to individual rooms from registers mounted high on interior walls of adjoining rooms.

If ducts cannot be located in conditioned space, then it is critical to properly seal and insulate them. The 1995 Model Energy Code mandates that all ductwork be sealed with mastic—a thick paste that provides a durable seal for all types of ductwork. Duct tape does not provide a lasting seal for ducts and should not be used. The code also sets minimum duct insulation levels based on climate.

Duct leakage can cause pressure imbalances which can draw in outside air and cause backdrafting of combustion appliances. Seal connections with mastic.