THE HIGH PERFORMANCE HOME

MANUAL

This document, along with the detailed drawings, is presented to offer our clients a roadmap in developing an "High Performance" home. This is not necessarily a "Green" home and does not take into consideration air-quality. It focuses on resource efficiency, energy efficiency, water conservation, and "providing for the future"; all of which are a part of a “green” home design, but not exhaustive. In some instances, we have provided “preferred” options as well as less costly means of attaining a near "High Performance" home.

IMPORTANT: It is important to note that this information (these parameters) and the related detailed drawings are specifically for homes that are to be built in Southwest Texas (primarily the "hill country" type climate). The Climate Zone is three (3).

Site Design Features:

- Heat Mitigation:
    a. Shade hardscape (drives, walks, etc.) with shade trees or such.
    b. Utilize turf pavers for drive and/or walks, patios, etc.

Resource Efficiency:

- Drip edge (eaves and gables):
    a. Minimizes wicking and water distribution off roof material, decking, and fascia.
- Roof Water Discharge:
    a. Provide gutters and downspout system with splash blocks (or such) to carry water a minimum of five feet from foundation (or utilize water harvesting system – see below).
- Finish Grade:
    a. Provide a minimum fall of six inches for each ten feet from edge of building.
- Flashing (galvanized metal):
    a. Flash roof valleys.
    b. Flash deck/balcony to building intersections.
    c. Flash at roof-to-wall intersections and roof-to-chimney intersections.
    d. Provide a drip cap above windows and doors that are not flashed or protected by coverings like pent roofs or are recessed in the exterior wall at least 24 inches.
- Roofing:
    a. Composition: Consider Energy Star®”Cool Roofing”. This can reduce heating and cooling costs as much as 20% by reflecting solar heat gain.

b. Metal roof: Develop a vented space between the metal "skin" and the roof decking (and moisture membrane) by using slotted metal furring strips horizontally 16" o.c. (verify spacing with roofing manufacturer.

- Advanced Framing Techniques:
    a. See our framing details for certain types of construction, namely wood or metal stud framing (e.g. as follows). The purpose of this item is to conserve materials.
        1. Staggered stud walls.
        2. Raised plate to enhance and simplify the venting of the attic space.
        3. Raised heel truss to enhance and simplify the venting of the attic space.
        4. Pre-fabricated truss system(s).
        5. Have the contractor and the framing sub-contractor to jointly prepare a framing plan and material list. Assuming they are sufficiently sophisticated trades, this will save you material.

Energy Efficiency:

- Appliances:
    a. All appliances shall meet or exceed Energy Star® rating. These appliances shall include but not be limited to refrigerators, ovens, ranges, dishwashers, clothes washers, dryers, ice makers, beverage coolers, etc.
- Building Systems:
    a. Framing: See detailed drawings concerning the various enhanced framing techniques.
        1. Staggered stud wall *
        2. Raised plate *
        3. Engineered trussed (not shown)

        *Purpose is to develop a structure that will enable an advanced insulation system and enhanced ventilation. Raised plate is designed to prevent insulation filling up air cavity, omit need for baffles and prevent air flow below insulation.

    b. Sheathing: OSB (oriented structural board or plywood; as specified by engineer.
    c. Moisture membrane: Tyvek© or equal.
    d. Flashing of windows and exterior doors: Tyvek© tape (see manufacture's detailed application of said flashing tape.
    e. Roof decking: Tech Shield © (foil back, face down toward attic floor).
    f. Venting (see detailed drawings also):
        1. Soffit: utilize a continuously perforated product, like Hardi Soffit panel.
        2. Ridge vent: continuous (see detailed drawings).
        3. Gable vent: Sizing—Minimum of one inch for each 500 square feet of attic. (If, for some reason, air does not flow by natural convection, use a solar powered vent fan.)

- Fenestration:
    a. Windows and exterior doors:
        1. Must be NFRC-certified (National Fenestration Registration Council) or equivalent, relating to their "*U-Factor*" and "*SHGC*".

           The **U-Factor** is an energy efficiency term measuring the rate of *thermal transmission (*or heat loss). The lower the number, the better (less heat loss).

           The **SHGC** is the *Solar Heat Gain Coefficient*. It is the ration relating the amount of heat gain. The lower the number is, the better the resistance to heat gain.

           Maximum coefficients: (Climate Zone 3) **

	U-Factor	SHGC
Windows and exterior doors	.35	.30
Skylights and "TDD" *	.35	.35

           * TDD = Tubular Daylighting Device
           ** Climate zone (see IECC, www.iccsafe.org)

        2. Window glazing must be "southern" low-e dual pane, insulated.

- Air-Conditioning and Heating:
    a. Sizing of system: Must be according to heating and cooling loads calculated using *ACCA* (Air-Conditioning Contractors of America) **Manual J**, or equivalent.
    b. Utilization of a **two-stage** heat pump unit is recommended for many situations.
    c. Also, we recommend zoning for multi-story structures or wings of homes that will be used infrequently or occasionally.
    d. Ducting system:
        1. To be designed per *ACCA* **Manual D** or equivalent.
        2. We highly recommend that every bedroom, den, study, or such (with doors) have a separate distribution and return air duct system.
        3. Ducts shall be sealed with tape complying with **UL-181**, mastic, gaskets, or an approved system as required by the **ICC IRC**, section M1601.3.1 or ICC IMC, section 603.9 to reduce leakage.
        4. Duct insulation shall be a minimum per **IEC** (International Energy Code).
    e. Geo-thermal, if cost effective, is worthy of consideration.
    f. Solar heating with photo plastic cell panels is not recommended at this time unless electricity is not available to the site.
    g. SEER rating: (Heat pump)
       Climate Zone 3 = *SEER* – 15 to 17
       EER – 12.5

h. Third party testing may be utilized to verify contractor's installation:
    1. Balanced system: The air flow at each supply and return register shall be within 25 % of design flow.
    2. Total air flow shall be within 10 % of design flow.
    3. Building leakage rate: Minimum 2-ACH-50.
    4. Duct system, including air handlers and register boots tested at a 0.1 inch w.g. (25 Pa) shall have a maximum leakage as a percent of system design flow rate of 6 %.

i. Thermostat: We recommend a programmable thermostat that includes humidity monitoring and management.

- Air Sealing: (Air and Thermal Barrier)
    a. This is one of the most important, most abused, and least expensive energy saving item if applied correctly. It often requires one to check and re-check the application in order to ensure its effectiveness. (See drawings for correct application.)

    However, if a spray foam insulation is utilized, this process is not necessary, since the foam typically seals the gaps and penetrations. The air permeance of the spray foam to provide this seal must be 0.02 L/s-m² or less @ 75 Pa.

    b. Methods of sealing:
        1. Non-expandable spray foam (Latex)
        2. Dupont Weatherization sealant (preferred)
        3. Bottom (toe plate) seal tape

    c. What to seal: (see drawings)
        1. **After framing**, but prior to sheathing (see drawings):
            - Framing "T": Spray foam and fill the cavity.
            - Framing corners: Spray foam and fill the cavity.
            - Headers: Utilize spaced headers and fill gaps with foam, or build headers with foam board between members.
        2. **Prior to applying wallboard** (ceiling board) and after electrical rough-in and plumbing top out:
        Toe plate:
            - Foam all penetrations in toe plate. (If a toe plate [sill plate] seal is not used during framing, this gap between the toe (bottom) plate and foundation must be sealed.) It would not be wrong to foam seal it regardless (or Dupont weatherization seal).

        Top plate: Seal all penetrations:
            - Electrical conductor holes
            - Plumbing pipe penetrations
            - Framing gaps (butt joints) of top plate

Sheathing:

- Sheathing butt joints (seal from inside)
- Penetrations (i.e. exterior duplex outlets, wall lights, water faucets, etc)

Studs:

- Holes between stud bays (i.e. electrical or plumbing)
- Any other penetrations

3. **After wallboard** and ceiling board has been installed, air-conditioning ducts penetrations have been made. (see drawings)
    - Ceiling: (Seal around)
        - Recessed light boxes
        - J-boxes (lights, etc.)
        - Air-conditioning returns and distribution duct penetrations
        - Any other penetrations
    - Skylights and other such penetrations
    - Attic stairs

- Moisture Control:

  There are a number of potential moisture penetrations problems:

  a. Walls: House wraps are very helpful in preventing moisture penetration from the outside environment into the wall cavity. The following are recommended (pursuant to the application) to cover the sheathing:
     1. Wood siding, cement fiber board, hardboard siding (we never recommended this product) - use Tyvek® DrainWrap behind these veneer products.
     2. Stucco – use Tyvek® StuccoWrap behind this veneer product.
     3. Stone and/or brick - use Tyvek® HouseWrap with a water drainage product (spacer between masonry and Tyvek membrane which prevents water from being dammed by mortar build-up).
     4. Flashing - Tyvek® Tape according to manufacturer's instructions (window manufacture and Dupont – see www.dupont.com/tyvek).
        - Windows
        - Doors
        - Base flashing for masonry veneers
        - Skylights
- Insulation: (Air and Thermal Barrier)
  a. Installation
     1. Installation "grade" (per **NGBS**) preferably "1"; minimum "2".
     2. Installed according to manufacturer's instructions (or industry standard).

3. Wall cavities shall be enclosed on all (6) six sides and is in substantial contact with the sheathing.
4. See Attached.

b. Types of insulation:
    1. Walls (conventional*):
        - Blow-in (not batts) fiberglass insulation R:22 min.
        - Spray or rigid foam insulation – must have permeance of 0.02 L/s-m² or less at 75 Pa. Further, said material must fill the cavity (leaving no voids). * Other wall systems that satisfy this would include ICF (Insulated Concrete Forms), SIPS (Structural Insulated Panels) which utilize EPS (Extruded Poly-Styrene) material and provide their own air barrier.
    2. Attic floor:
        - Most cost effective insulation is blown-in fiberglass – min R-38. Other substitutes are cellulose (treated for insect abuse).
        - An alternate fiberglass installation would be two layers of R-19 fiberglass batts each layer laid perpendicular to the other. The shortcoming to this is the affect that the roof bracing will interrupt the installation, therefore, leaving gaps.
        - Reportedly the foam insulation in an unclosed situation can be a fire hazard. There also reportedly is a fire retardant that reduces this problem. Not sure of this effectiveness; however, some bio-foams could be utilized in this application.
    3. Attic ceiling:
        - For Southwest Texas, we recommend a vented attic with a radiant barrier surface on the face down side of the roof decking; therefore, we do <u>not</u> recommend insulating the attic ceiling (see “Radiant Barriers” below).
    4. Special items:
        - Attic openings: Seal with a gasket and insulate using rigid foam insulation.
        - Fireplace openings: Utilize glass doors that seal tight and uses outside make-up air.
    5. Miscellaneous items:
        - Take special precautions to properly insulate the area behind a pre-fab tub/shower. Once the unit is installed, it is difficult to insulate and seal properly.
        - Knee walls should receive foil backed sheathing with the foil facing the attic.
    6. Air-conditioning ducts:
        - Preferred = R - 8 minimum
        - Satisfactory = R - 6 minimum

- Radiant Barrier:
    a. Roof Decks:
        1. The preferred system for dealing with thermal heat gain in the attic is the Dupont "Tyvek" AtticWrap – under decking without foil.
        2. The alternate product is a foil backed sheathing (i.e. TechShield).
    b. Knee walls (including such as skylight tunnels):
        Radiant barrier sheathing with foil toward attic.

- Lighting:
    a. All light fixtures shall be Energy Star® approved or equal.
    b. Bulbs:
        1. Efficiency: Bulbs shall provide a minimum of 40 lumens per watt or be solar powered.
        2. Preferred: Utilize LED (Light Emitting Diodes) bulbs where possible.
        3. Secondary will be the use of CFs or Compact Fluorescent bulbs.
        4. In the case of emergency lights, it might be advisable to use halogen or LED. These lights need to shine brightly and quickly. However, the halogen bulbs need to be used only in fixtures that are utilized infrequently.
    c. Occupancy sensors: Utilize occupancy sensors (with adjustable timers) in rooms or locations where one spends a minimal amount of time (i.e. closets, storage rooms, etc.) Lutron makes an occupancy sensor for which the time of occupancy can be adjusted.
    d. Outdoor lighting:
        1. NGBS suggests occupancy sensors or motion sensors to be utilized for outdoor lighting. Assuming we are referring to "Emergency Lights" (flood lights), if the home is in an area where deer are prevalent, these are not a good option. We suggest using only a switch to be conveniently activated when the need arises and only use these fixtures for security lighting.
        2. Decorative light fixtures which one might desire illuminated all night could be controlled (activated and turned off) via a photo-electric cell switch that can be screwed into the light fixture.
        3. Hands-free lighting: There are situations where one would like an area lit as he approaches (i.e. outdoor trash bin). For this lighting, an occupancy sensor activating a LED bulb would be recommended.
    e. Recessed lights: It is advisable to minimize the number of these fixtures. Since the rough-in box penetrates the ceiling board, it is difficult to adequately seal and insulate them.

- Plumbing (energy related):
    a. Water Heaters:

1. Electric – We recommend the "Marathon" by Rheem or equal. It has a fiberglass tank (rust free), polyurethane insulation, polyethylene shell. The efficiency rate is .90 to .94 EFI; recovery rate is 20 GPN @ 90° (www.rheem.com). The energy factor should be a minimum of .95 for 30 to 40 gallons; .94 for 40 to 50 gallons; .92 above.
2. For weekend cabins, out buildings, "wings" of a home that will be seldom utilized, we recommend gas (or propane) fired tank-less water heaters.
3. Natural gas or propane – The propane industry brags that a propane water heater is the most efficient and effective use of propane. The energy factor should be a minimum of .94 (30 to 40 gallons); .62 for 40 to 50 gallons; .60 above.

   The discussion as to which is more energy efficient (cost effective) between electricity and natural gas or propane is in much debate. For now, natural gas if available; however, we do not know what the future holds. We will leave the speculation up to the client.

4. Solar powered and wind powered – We believe that neither of these are yet cost effective and require management and maintenance that the typical homeowner might not appreciate.

b. Plumbing System:
   1. Keep runs for hot water lines 40 ft. or less from water heater to kitchen and bathrooms. (The shorter the distance, the better, 30 ft. preferred.)
   2. Special piping system designs are recommended as follows:
      - Structured-type plumbing with demand controlled hot water loops, in which the volume of water contained in the pipe and fixture fittings downstream of the re-circulating trunk link is a maximum of 4 cups (57.75 cubic inches) or (0.25 gallons) of water, or
      - Engineered parallel piping system (i.e. manifold system) in which the hot water line(s) distance from the water heater to the parallel piping system is less than 15 ft. and the parallel piping to the fixture fittings contain a maximum of 8 cups (0.50 gallons).
      - Central core plumbing system with all plumbing fixture fittings (e.g. faucets, showerheads) located such that the volume of water contained in each pipe run between the water heater and fixture fitting is a maximum of 6 cups (0.38 gallons).
   3. Alternates to runs in excess of 40 ft.:
      When or if hot water pipe runs exceed 40 ft., consider:
      - Utilizing a tank-less water heater at point of use being served by cold water (could be boosted by heat recovery in stored tank or solar system booster).
      - Or, install an on-demand hot water re-circulating system.

4. Water heating energy is considered most efficient when the water lines are installed in the slab vs. the attic in Climate Zone 3.
5. Heat recovery: If the project will utilize an electric water heater and a heat pump air-conditioning system, then one might consider a "Heat Recovery" system which circulates water through the heat pump coils and heats the water. Keep in mind, that this is only effective when the compressor is in operation. It will not heat the water when it is not running.

Water Efficiency:

- Water Conserving Appliances: Washing machines and dishwashers shall be Energy Star® rated (or equivalent) with respect to water conservation, as well as energy conserving. A food disposer is recommended for its water conserving quality.
- Water Conserving Plumbing Fixtures:
    a. Showerheads
    Preferred: 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.

    Good: Showerhead flow rate: 2.0 to less than 2.5 gpm

    Fair: Showerhead flow rate: 1.6 to less than 2.0 gpm

    Note: One (1) gallon per minute = 3.785 liters/minute.

    b. Faucets: Water-efficient lavatory faucets shall be 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.
    c. Water Closets: 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.
    d. Urinals: A urinal shall be installed with a flush volume of 0.5 gallons (1.9 L) or less when tested in accordance with ASME A112.19.2.
    e. Irrigation Systems: For each landscape type there shall be an individual run and all runs shall be low-volume.

    Preferred: The system shall be designed in accordance with EPA (Environmental Protection Agency) WaterSense requirements or equivalent.

Suggestion: Utilize irrigation controller with a rain sensor to measure ET (EvapoTranspiration).

f. Automatic shut off water devices:
    1. Excess water flow shut off, or
    2. Leak detection system

    Note: If a fire sprinkler system is installed, ensure that these devices will not interfere with the system.

g. Grey Water Reclamation: See "***Planning for the Future***" below.
h. Rainwater Harvesting: We highly recommend a rainwater harvesting system for the following uses:
    1. Water closets
    2. Irrigation
    3. Hose bibs and/or
    4. Clothes washing

    Utilizing water harvesting for potable water uses (drinking, showers, and dishwashing) as well as non-potable uses first requires a large volume of storage tanks. It also involves a rather sophisticated mechanical system for managing the sanitation of the water. Most will not want to spend their time doing so. The exception, naturally is where there is no public or private sources of water available.

Planning For the Future:

Some of the below mentioned items (systems) should be strongly considered prior to construction, even if not utilized at this time.

- Grey Water utilization: (See above)

We recommend that one consider a system that would utilize a portion of the grey water that is only, say, from one side of the house (the side which would produce the most volume of waste water - usually the kitchen side). The purpose of this is that grey water systems require a separate drain system for the grey water and for the brown water. In effect, the commodes and kitchen sink have to have their own drain system and cannot be used for secondary use. So to have two systems for the entire house gets rather expensive.

Assuming two drain systems have been developed and you are not ready to utilize the grey water, you will want to tie the grey water system back into the brown water system until you are ready to use this water. At this time a good grey water system will have a filtering system (requires maintenance) and a temporary holding tank (currently the water must be dispensed within 24 hours) into the sun exposed environment. The system therefore needs an

overflow option once the holding tank becomes full. So the system at this point needs to divert waste into the brown water system.

Note: At this time systems for filtering water for even commode usage is not feasible for residential use. It is not cost effective.

- Separate Light Panel with a transfer switch:
  If the lights circuits (and perhaps refrigerator) can be separated from the power, it could serve several different uses:
  a. Emergency generator (natural gas or propane fueled): The contractor will need to provide a receptacle for the generator plug and a transfer switch that will transfer from public power to generator power.
  b. Low Voltage, LED lighting system: As LED light bulbs decline in price, one will be able to utilize a LED lighting system powered by a **low-voltage** system. A transfer switch installed during construction would make this transition easier when needed.
  c. Solar or Wind power: Neither of these is cost effective at this time; however, could become so in the future. You might consider providing a transfer switch to accommodate future battery source of fuel for the lighting.
- Rainwater Harvesting:
  (also see "Water Efficiency: f" above)

  Think ahead of how you desire to utilize the harvested rainwater. Even if it will not now be developed at the time of initial construction, it is wise to prepare the plumbing system during construction to receive the water from the harvested water storage tank. If the water is to be utilized for irrigation (and/or hose bibs) then this needs to have a separate line with a valve that can switch back and forth between public (or well) water to harvested water.
  a. If also to be used for commode usage, we recommend a modified manifold system that would have three options:
     1. Hose bibs (and irrigation)
     2. Commode
     3. Other (the remainder of the system)
  b. If the system will be utilized for potable water in addition to the other, then only a transfer valve will be needed.
  c. If the system will utilize the potable water in addition to one of the other options, then as mentioned above, separate systems with transfer valves will be required.
  d. Underground PVC piping should be installed under walks, driveways, etc. to enable easier future installation of a harvesting system. Tank locations (and quantity) shall be established up front (during construction). Typically the water harvesting tank should be 75 ft. away from a septic system.
- Whole House Fan:

Consider a whole house fan. One must utilize non-air-conditioned air movement in order for the whole house fan to be of benefit. Things to consider:

a. Location. Usually near center of the house.
b. The fan should be located remotely from its penetration through the ceiling; and perhaps a bend in the duct between the two. The purpose is to reduce noise.
c. The louvered vent must seal very well.
d. Assuming there is a vented attic, exhausting the air could force the hot air in the attic to move out replacing it with cooler air. (Some fire codes might have a problem with this).

SYLLABUS:

ACH=Air Changes per hour (ACH at 50 Pa) ,measurement of a building's airthightness.
Pa=Pascal (pressure measurment
IEC = International Energy Code
NGBS = National Green Building Standard - 2008
ICF = Insulated Concrete Forms
SIPS = Structural Insulated Panels
EPS = Extruded Poly-Styrene
LED = Light Emitting Diodes
ASSE = American Society of Safety Engineers
ASME = American Society of Mechanical Engineers
EPA = Environmental Protection Agency
NFRC = National Fenestration Registration Council
SHGC = Solar Heat Gain Coefficient
TDD = Tubular Daylighting Device
ET = evapotranspiration
Gpm=Gallons per minute