

ENERGY EFFICIENT HOUSING APPLICATION GUIDELINES

Requirements for Nebraska Energy Efficient Housing Application
New Home Construction (for Pre-Sold Homes)
Revised 4-1-2018

This is an optional, beyond code program. Home buyers are under no obligation to participate. Home buyers that do comply with these guidelines, and stay within the requirements of the program, will be eligible for low interest construction and long term financing, and may expect significant energy savings for the life of the home. Savings can be expected to exceed the savings of home built to meet current energy codes and ENERGY STAR®.



Be reminded, that to remain eligible,
you may not file for a building permit,
you may not start construction,
you may not dig a hole for a basement or do other dirt work, and
you may not pour any part of a foundation or foundation walls,
until after the Energy Office has reviewed and approved
your application, plans, and all other submitted documents.

This portion of the Dollar and Energy Saving Loan Program is made available as part of an ongoing effort to reduce energy use and dependence on foreign oil by promoting the advancement of the most efficient and innovative products and building techniques available today. This portion of the program promotes homes that incorporate the most advanced, efficient, and innovative measures in a home's building envelope, heating ventilating & air conditioning (HVAC) systems, and advanced air sealing techniques in the envelope and ductwork.

The 2015 International Energy Conservation Code (IECC) allows homes to show compliance by meeting an ERI score of 55. Considering the ERI score is similar to a HERS score, it is estimated that homeowners will save 18% to 34% of the utility cost of a comparable home built to the 2015 IECC.

Because the program requires the homeowner to build a better home, there will be an increase in the cost of the home, and thus the mortgage payment. However, the monthly mortgage cost increase is balanced by a decrease in the monthly utility costs from the energy savings the program provides. With the reduction in interest, the monthly cost for a homeowner to purchase this home will be much less. Even though the homeowner is purchasing a home designed to be more efficient, and probably more marketable, the cost is much less.

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***Short Reading** – While the number of pages in this document may seem daunting, this entire document is built around the Required & Recommended Minimums that are listed in pages 7 through 13. Reading the Required & Recommended Minimums will give a person an idea of how a home built to these standards might vary from another, perhaps more common, home. Reading the “Possible Examples to Help Reach the Required HERS Score and Other Useful Building Design Information” that starts on page 29 provides some explanation for some of this documents requirements and recommendations and other useful information.

Of course the Where Do I Start section, pages 3 and 4, should be your next read. Where Do I Start is a brief overview of what steps might be taken during the design and approval process, and final HERS rating.

Many of the listed requirements are nothing more than Energy Code, or ENERGY STAR requirements that are reiterated to ensure compliance with those programs. Other requirements, like minimum window U-values, minimum ceiling and wall R-values, minimum amounts of pin based fluorescent or LED lighting, certain ENERGY STAR appliances, and some HVAC requirements are beyond code. The beyond code items are what lower your utility bills far beyond those of a code built home.

The Drawing/Design Requirements, and Drawing Format, which start on Page 14, have slowly developed over the life of the program. These have come about due to discrepancies that have been noted on the hundreds of drawings that have been submitted and reviewed. These sections are required to maintain quality and consistency in the plans that are submitted, and more importantly, to ensure the contractor(s) can easily read and follow the final set of building plans, and in doing so, build a home that meets the requirements of the program.

The Required Drawing Notes, which start on page 21, are notes that must appear on your house plans. We require these notes in an attempt to ensure that the required minimums of the program are met.

The Initial Submittal Documents on Page 5 are a shopping list of documents that must be included when you submit your application. This page also includes the required HERS ratings. Page 6 contains information about possible changes, and submittal requirements once the home is built.

Pages 25 through 28 contain information for your HERS rating and HVAC contractor to ensure that ratings and load sizing is performed according to minimum code and program requirements.

Where Do I Start?

Step One: Read through the Required Minimums, Pages 7 through 13, and decide if these are features you want included in the home you build. If so, this program may be right for you.

Step Two: Find a Designer, Architect, or Builder, provide them with a copy of these guidelines, and complete a set of building plans. All of the requirements listed here, must be incorporated into your plans. (If there are questions during the design, the designer should feel free to call the Energy Office with questions) (Architects AND Engineers are required on homes 10,000 square feet and over with the area of the garage being included only when over three stalls. See page 14 for details.)

In this stage of your design, it is too early to determine your exact mechanical equipment. Although you should have an idea of what type of heating and cooling system you want to use, and that should be shown on your plans, i.e. A/C & Furnace, Air Source Heat Pump, Geothermal, etc.

Your Designer may also be telling you that the requirements of this document will cost you more money. Your Designer is correct. Your Designer is also incorrect.

Yes, the cost of the home is going to go up, we know that. But remember, the cost of your utilities will be going down, as well as your mortgage payment. Explain to your Designer that the sum of the lower interest mortgage plus your lower utilities will both be much less using this program, as compared to not using it.

Too often, the home buyer only looks at the price tag on a home. Ironically, that price tag is never realized by the home buyer. What is real to the home buyer are the monthly bills they pay after the home is purchased, and those include the mortgage payment and the utility bill. The total cost of the mortgage plus the utility bill will be less using this program. In addition, the mortgage will end, but the utility savings will go on for the life of the home.

Once you are certain of the shape of your home, and all of the building requirements listed in this document have been incorporated into your plans, you will move on to the next step and enlist the aid of a Certified Home Energy Rater (HERS rater).

If you are planning to include roof mounted solar, you may want to consult with a solar contractor at this point to get ideas on roof pitch and south facing area needed for the best solar performance, so that this is incorporated into your plans at this stage.

Step Three: Take a copy of your plans to a HERS rater. Certified HERS raters can be found on the Residential Energy Services Network (RESNET) web site, www.resnet.us. The HERS rater will take the dimensions and properties of your home design, input the home into their rating software, and determine if your home meets this program's required HERS score. If your home doesn't meet program requirements, you will need to adjust the design. You may need to upgrade the insulation levels, use more efficient windows, use less windows, use more efficient appliances, or increase the number of pin based fluorescent or LED lights. Your HERS rater can change variables in their rating software to help you determine what you need to do. If you are planning to include Solar or Wind as part of your design, the HERS rater can also determine the proper size for these guidelines. At this stage a rough idea of the size you need can be determined, but precise sizing will come at a later stage of the design.

It is important to note, that after this phase of your home design, your house plans, the size and shape, can no longer change without costing you money and time. If you change the shape or size of the home, you will need to come back to this step and start over. Changes will require your rater to make changes to the rating, costing them additional time. The price your rater charges will likely increase if you make changes. Your move-in date is also extended when you make changes.

Note that the HERS score is not the only requirement. These guidelines also have minimums that must all be met.

Where Do I Start? (cont'd)

Step Four: You now have a home that meets the HERS score requirements of the program, and you need to work out some details. Size the floor joists, and have your HERS rater input the correct size of rim and band joists. Have your Designer lay out the floor joists in your plans so your Heating Ventilation and Air Conditioning (HVAC) contractor can locate where he will run his ductwork.

Step Five: Take a copy of your plans to your HVAC contractor. Your HVAC contractor will input the details of your plans into their sizing software and size the HVAC equipment and ductwork for your home. Your HVAC contractor will need to give the final details of the equipment and ductwork to your Designer. Your Designer will need to show the ductwork and equipment on your plans.

It is important that your HVAC contractor makes correct load and duct calculation. Sizing will be reviewed, and errors will require drawing revisions which will create delays. The HERS rater's software also calculates HVAC equipment size, and the HVAC contractor's size should match.

It is at this stage that your HERS rater can help you to determine the total energy use of the home. This can be used to determine the size of renewable energy equipment, like solar or wind.

Step Six: Design is complete. Now it's time to fill out your application, gather your plans and other supporting documents (see page 5), and submit your application to the Energy Office for review. **REMEMBER**, no building permits, no digging, and no construction until your application is reviewed and approved by the Energy Office!

Up until this point, we have only briefly mentioned your builder. Often times the builder is involved from the start, may have helpful ideas from past experience, and may be a big help with the design and layout of the home. Your builder may even know or provide a good drafter, or Architect. However, that is not a requirement. If you have a home design you like, and know a good drafter, or Architect, and HVAC contractor, and can get your floor joists and other aspects of the home sized, you can come up to the final stages before you select a builder. You will need to select a builder before you submit your application to the Energy Office, as the builder's signature and contact information must be on your application form.

Step Seven: Energy Office review. Your application, plans, and supporting documents, will be reviewed by the Energy Office, along with all other submittals sent to the Energy Office, in the order in which they are received.

The review process simply involves comparing your plans to each of the requirements listed in this document, and determining if each of the requirements listed here have been met. The Energy Office also compares the HERS reports and Manual J load calculations to what is on the drawings to determine if it accurately models your home.

During the review process, if discrepancies are noted a letter will be sent to you, the homeowner, listing items that need to be corrected before approval can be given by the Energy Office. To avoid delays like this, from additional submittals of drawings or forms, it is important that these guidelines, and instructions on the application forms, be followed accurately.

Step Eight: Energy Office approval. Once your plans and applications have been approved, you may use those same plans to apply for a building permit and build your home.

Step Nine: Final HERS rating. Once your home is complete, the HERS rater will do a final rating, and submit copies of the results to the Energy Office. The rater must provide the Energy Office with 10 days notice of the final blower door test, in the event the Energy Office wishes to witness the test. (see page 6 for details for final test and submittal).

INITIAL SUBMITTAL DOCUMENTS:

(Submitted items will not be returned)

- 1. Completed Form M10 with original (not copied) signature(s). – complete all information**
- 2. Completed Form A(s) with original signature(s). – complete all information**
- 3. One set of professional, computer generated house plans, hardcopy – follow All of these guidelines.**
- 4. *AHRI, HVI, and/or EPA equipment efficiency certificate(s) – print single page and include with other submittal documents – do not place on drawings.**
- 5. Documentation showing that the HVAC contractor, Builder, and HERS Rater have completed all required ACCA/ENERGY STAR Version 3 orientation and training – print single web page that shows certification and include with other submittal documents.**
- 6. Manual J load calculation reports, for the “Entire House,” to include the “Worksheet” showing all inputs, and both block, and room loads, and a balanced duct diagram – not needed if using REM sizing.**
- 7. HVAC equipment manufacturer’s expanded performance data – not needed if within sizing requirements using AHRI certificate capacities.**
- 8. Catalog cut sheets for each lighting fixture in the lighting schedule showing base type.**
- 9. ENERGY STAR efficiencies for the Refrigerator (kWh/yr), Clothes Washer (IMEF & kWh/yr), Dish Washer (kWh/yr), and Ceiling Fans (CFM/Watt at medium speed) – print single page from ENERGY STAR web site and include with other submittal documents.**
- 10. Electronic HERS software file (requested only).**
- 11. Hardcopy HERS rating reports***: Building Summary, Equipment Sizing Summary, Air Leakage Report, Home Performance with ENERGY STAR, Home Energy Rating Certificate that shows the design will meet 2009 IECC & ENERGY STAR V3 requirements, and achieve a HERS score, based on HERS rating area*, as outlined in the following chart:**

Area of Home Square Feet**	Required HERS Score without Wind or Solar	Required HERS Score with Wind or Solar***
Less than or equal to 3000 square feet	45	25
Between 3000 and 5000 square feet	40	15
Greater than 5000 square feet	35	10

*To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory, even those that are shown on the ENERGY STAR web site as ENERGY STAR rated.

**Area is measured to the outside of the walls and includes all floor levels, less open areas. The Home Energy Rating System (HERS) ratings are required to use the stated duct leakage and infiltration levels as part of the effort to promote advanced air sealing. The homes must meet the latest ENERGY STAR requirements, and must meet or exceed all requirements listed in these guidelines.

***When wind or solar are used, the home itself must still achieve the score listed “without Wind or Solar.” When wind or solar are used, the HERS rating must be done with and without the solar inputs, and copies of each HERS hardcopy report, with and without solar/wind, must be submitted. Solar or wind size is limited to the HERS estimated annual energy use without solar, times four, divided by 8,760 hours.

GETTING YOUR APPLICATION APPROVED IN A TIMELY MANNER:

When your application is received by the Energy Office, your plans are checked against the requirements listed in this document. Once the plans have been reviewed, the HERS reports, and Manual J load calculations, are checked to see that they represent precisely, the home that is shown on the plans submitted with your application. To ensure a speedy review and approval, make certain each of the requirements listed in these guidelines are clearly reflected on the plans for your home, and that the HERS rater and HVAC contractor input their data according to those plans. Also make certain the application, Form M-10, is filled out completely and legibly, to include a precise location of the new residence. Include precise driving directions and legal description if the new address is not yet known.

REQUIRED SUBMITTALS AFTER NEO APPROVAL OF PLANS:

(Submitted items will not be returned)

You will be notified once your application has been approved by the Nebraska Energy Office (NEO) via a hardcopy approval letter, and email. At that time, no further submittals are required, unless changes are made, until the final HERS rating. Once approved, you are free to build the home according to the approved plans.

CHANGES AFTER NEO APPROVAL:

(Submitted items will not be returned)

Once the application, plans, HERS reports, and Manual J calculations have been reviewed and approved, no further changes may be made to the building envelope. R-values, HVAC equipment, lighting, or other items that would change the energy use of the home may not be changed without further review by the Energy Office.

If you decide you must make changes to your originally submitted plans, you may need to update and resubmit all initial submittal documents that are affected by the change, except for Form M10 and Form(s) A. These revised documents will be reviewed along with all other submittals to the Energy Office, in the order in which they are received. It is also likely that your HERS rater and contractors will need to increase their prices due to delays and added work.

Only submit once you are sure your plans are final.

FINAL SUBMITTAL DOCUMENTS:

(Submitted items will not be returned)

Once your home is built, and the HERS rater has completed the final inspection*, and prior to long term financing under the loan program, the following must be submitted to the Energy Office:

- 1. Final HERS reports**, in hardcopy of: Building Summary, Equipment Sizing Summary, Air Leakage Report, Home Performance with ENERGY STAR, and Home Energy Rating Certificate (HERC), confirming that the home meets 2009 IECC & ENERGY STAR V3 requirements, and has achieved the required HERS score.**
- 2. Completed ENERGY STAR Version 3 Checklists with all associated documentation attached – note that the HVAC contractor’s company name must be shown.**
- 3. Final electronic drawings, in pdf format (emailed or on CD) (requested only).**
- 4. Final electronic REM/Rate file from the HERS rater (emailed or on CD) (requested only).**

*The HERS rater is required to contact the Nebraska Energy Office 10 days prior to final inspection, giving the Energy Office the option and time to arrange to witness the final inspection.

**When wind or solar are used, the HERS rating must be done with and without the solar, and copies of each HERS hardcopy report, with and without solar/wind, must be submitted.

**MANDATORY MINIMUM REQUIREMENTS, RECOMMENDATIONS,
DRAWING REQUIREMENTS and REQUIRED NOTES:**

These mandatory notes and requirements stem from the requirements of ENERGY STAR Version III, latest revision (ES), the 2009 International Energy Conservation Code (IECC), HERS rating or Manual J/S/D calculation input requirements (HERS), and ENERGY STAR and Loan Program (LP) product requirements.

REQUIRED and RECOMMENDED MINIMUMS:

1. Windows, full glass sidelites, and full glass doors shall have an NFRC tested U-value of 0.26 or less and a Solar Heat Gain Coefficient (SHGC) of 0.30 or less. No lite thru 3/4 lite doors and sidelites shall have a U-factor of 0.20 or less and a SHGC of 0.30 or less. Skylights shall have a U-factor of 0.55 or less and a SHGC of 0.30 or less. – (ES, LP)

This does not preclude the use of windows, full lite sidelites, glass doors, or block windows which do not meet the above requirements. Weighted averaging may be used for these items. Showing weighted average U-values must be done using the spreadsheet provided by the Energy Office. When submitting, provide both the electronic Excel spreadsheet & a hardcopy printout (spreadsheet may be emailed). If windows, such as block windows or sidelites, are not NFRC tested, then the default U-value and SHGC in the 2009 IECC must be used. If a window or door product is not NFRC rated, or if a product does not have a default listed in the IECC, the product cannot be used. No lite thru 3/4 lite doors and sidelites, and all skylights must meet listed requirements and are excluded from averaging.

Recommended – ENERGY STAR “Most Efficient” windows with a U-value of 0.20 or less, and window to wall ratios less than 10% to 15%.

2. Required - Minimum ceiling insulation shall be R-38, and must incorporate an energy truss. The energy truss must maintain a minimum 9 inches from the outside top edge of the top plate to the bottom of the ceiling above (R-21 divided by 3.5/inch plus 3 for vent shoot). The 9 inches dimension may be reduced to 6.5 inches when a high density foam with an R-6.5/inch or greater is used above the top plate and out into the attic to a point where the distance from ceiling to roof deck is 9 inches to provide a minimum R-21 where the other insulation begins. The energy truss must be incorporated regardless of attic R-value used. Pay attention to drywall load limits. – (LP, ES)

Recommended - Minimum ceiling insulation to be R-60, and incorporating an energy truss. With the energy truss maintaining a minimum 12 inches from the outside top edge of the top plate to the bottom of the ceiling above. The 12 inches being reduced to 7.5 inches when a high density foam with an R-6.5/inch or greater is used above the entire top plate and out into the attic to a point where the distance from ceiling to roof deck is 12 inches, providing a minimum R-30 where the other insulation begins. The energy truss must be incorporated regardless of attic R-value used. Pay attention to drywall load limits.

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

3. Required – Minimum above grade wall insulation shall be R-20, or R-13 with R-5 continuous insulation board, including corners. Wall cavities must be filled and drywalled. – (LP, ES, IECC)

Recommended - Above grade wall insulation shall be minimum (not average) R-33 for the insulation material only, and does not include R-value from sheathing, drywall, veneer, or any other parts of the wall. This can be obtained using 2 inches of R-12 spray foam with a 3.5 inch R-15 batt, R-27 cavity with R-6 continuous insulation board over sheathing, or R-15 with R-12 continuous insulation board over sheathing, or any other combination (no radiant barriers). Show corner cross sections and details, including depth dimension of insulation and R-values used. Advanced framing must be used. A rain screen is recommended, minimum ½", i.e. "1 by" framing spacer strips between a house wrap or building paper and the exterior cladding, similar to drain plain used in brick construction.

4. Insulation for floors over garages or outside air shall be a minimum R-30 and fill the cavity. Floor insulation must be installed to maintain contact with the floor above. The floor must be covered below the insulation to protect and make permanent that insulation. – (ES)

5. Required – Unheated slab floors, where the top of the slab is 1 foot or less below grade, shall have R-10 minimum insulation from the top of the slab, extending a minimum of 2 ft below, or horizontal to, the bottom of the slab edge. There can be no breaks in the continuity of this insulation – (LP, ES)

Recommended - Unheated slab floors, where the top of the slab is 2 foot or less below grade, shall have R-10 minimum insulation from the top of the slab, extending a minimum of 3 ft below, or horizontal to, the bottom of the slab edge. R-15 and 3 feet required for heated slabs. There can be no breaks in the continuity of this insulation.

6. Minimum foundation walls, including stem or step walls, for conditioned basements and crawl spaces, shall be R-13 framed, or R-10 continuous. Cavities must be filled and walls must be covered with drywall to make permanent and protect the insulation. The drywall does not need to be finished. Draped insulation is not allowed. Stem walls that are above grade, as measured from the top of the slab, are considered above grade walls and must meet above grade wall requirements (see note 3 above). – (LP, ES)

7. Required - Attic access door/cover must provide a minimum R-10 insulation. – (LP, ES)

Recommended - Attic access door/cover must provide a minimum R-30 insulation.

8. Patio slabs, solid decks, porch slabs, and walks adjacent to the home, and driveways must be sloped away from the home at a grade of 1 inch, or more, every four feet. – (ES, IRC 1/50)

9. Backfill must be mechanically tamped to prevent settling, and a minimum 6 inch drop in grade away from the home must be achieved within a distance of 10 feet from the exterior of the home. All areas exterior to the home shall be provided with a natural, above grade drain path away from the home, and having a minimum 5 foot width. Below grade patios, or other below grade areas adjacent to the home, are not allowed. Tamping of back-fill is not required if either: proper drainage can be achieved using non-settling compact soils, as determined by a certified hydrologist, soil scientist, or engineer; OR, the builder has scheduled a site visit to provide in-fill and final grading after settling has occurred (e.g., after the first rainy season). – (ES, IRC 1/20)

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

10. Designers should check that the roof design does not channel large areas of the roof to drain to a single point. If unavoidable, ensure sufficient drainage at valley end point. – (ES)

11. The home shall be designed so that sill plates rest completely on the foundation wall below. Exceptions to this are allowed only when a solution is submitted which bears the stamp of a Nebraska Licensed Professional per the rules and regulations for Engineers and Architects. The final approved envelope shape and design may not be changed without approval. Interior walls may be moved at will, provided the HVAC contractor is consulted and duct work changes are not required – (LP, IRC, IECC)

12. Walls, floors, and stairs between house and garage must include an air BARRIER on the garage side of the wall/floor, and this must be called out on the plans. This can be a 2" layer of closed cell foam applied to the walls, floor, and blocking, w/batt or loose insulation filling the cavities. – (LP, ES).

13. Refrigerator(s), Dishwasher(s), Clothes Washer(s), and Ceiling Fan(s) must be ENERGY STAR rated and listed on the ENERGY STAR web site. It is recommended that "all" appliances be ENERGY STAR and "Most Efficient" rated, but only these four are required. – (LP)

14. All lighting, interior, garage, and exterior, must be either LED, Fluorescent, Metal Halide, or Induction lighting. - (LP)

15. Provide a passive radon abatement system that meets the requirements of the 2009 International Residential Code (IRC), Appendix F. As an example: The passive system must include electrical connections for a possible future active system, i.e. electrical for fan (attic) and sensor(s) (lowest level). The passive system must incorporate minimum 3" nominal fabric wrapped drain tile/pipe within an under slab gas permeable material, that extends around the entire foundation, within 3 feet of the inside of all exterior walls, forming a loop around the entire inside of the foundation, and any central foundation supports which cause a break in the air barrier under the slab. The loop must be connecting either directly, or using a tee and lateral, to a minimum 3" PVC radon abatement riser so that the riser makes one straight run from under the slab, up and through the roof. The radon abatement riser must penetrate the roof, extend a minimum 1 foot above the roof, and be kept a minimum of 10 feet from any inlets, windows, or other openings to the home. Riser may be installed in interior walls or a chase, but NOT in exterior walls. A 6-mil polyethylene sheeting must be installed directly under the slab, with a minimum 1 foot of overlap for any seams. Slab penetrations and joints must be sealed with a polyurethane caulk or equivalent sealant. Sufficient grade must be maintained along the length of the perforated tile/pipe to prevent water from filling low spots and hindering air (radon) circulation. The riser must be clearly marked between each floor and in the attic as "RADON ABATEMENT SYSTEM." In the attic, the riser must have a minimum unobstructed 2 feet of length as measured from the top of ceiling joists to the bottom of the roof trusses. Radon abatement tile/pipe may be incorporated into a sump system. This system may be substituted with any system which meets the requirements of the 2009 IRC, Appendix F. Active abatement systems, while not required, are certainly allowed, but Nebraska State law requires that these must be activated by a licensed radon mitigation business. Since an active system is an added energy use, it is recommended that a passive system be installed first. To ensure the effectiveness of the passive radon system, the occupants of a new home should be provided with written instructions to conduct a short term radon test in the lowest floor of the structure. If the results of such a test are 4.0 pCi/L or greater the passive radon system should be activated by a licensed radon mitigation business. – (LP)

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

16. Sump systems must be fully gasketed and sealed, and may be part of the radon abatement system. See radon abatement requirements in previous item. – (LP, ES)
 17. Hot water shall be provided using either a desuperheater with electric backup and may include a buffer tank, heat pump water heater, or 90% efficiency or better gas. – (LP)
 18. Hot water piping, except for flushing rim sinks, shall be nominal 3/8 inch or smaller individual distribution line per the 2009 International Plumbing Code with manifolds within 5 feet of the hot water heater. If local codes require larger piping, provide a copy of the local code, including footnotes. Recirculating hot water systems are not allowed. – (LP)
 19. HVAC systems shall be balanced using direct returns, transfer grills, or jump ducts. Jump ducts are not allowed in attics, or in floors over unconditioned space, i.e. all ductwork must be “within” the conditioned space. Dropped ceiling soffits are allowed. Dropped subfloors or floor soffits over unconditioned spaces and garages are not allowed. - (LP)
 20. Fabric isolation connectors are required to separate the air handler, or any other source of vibration, from the duct system. This is a code requirement. - (IECC)
 21. Ventilation shall be balanced, using HRV's or ERV's. Bathroom and kitchen exhaust, while certainly allowed, may not be used to meet ventilation requirements, i.e. exhaust only, or supply only ventilation is not allowed. - (LP, ES)
 22. All exhausts are to be vented to outdoors. While it is acceptable to run bathroom, or other exhaust through an ERV or HRV, the final exhaust must be to the outdoors, i.e, you may not terminate exhaust in the attic or any other place except the outdoors. – (ES, LP)
 23. Duct leakage shall be tested by a certified HERS rater, and must be less than 6 CFM-25 per 100 square feet of floor area served. – (LP)
 24. House shall be sealed to a tightness, as measured by a certified HERS rater, to 400 CFM50 plus 100 CFM50 per 1000 square feet of floor area, or less. – (LP)
 25. Ductwork shall be properly sized according to ACCA Manual D for the required air flow, to include proper reductions along the trunk lines and fabric isolation joints at the HVAC equipment and any other sources of vibration. Velocity may not exceed ACCA maximums. – (IECC, LP, ES)
- Recommended - All duct transitions shall be relieved to be maximum 45 degrees for a length equal to the smaller dimension of the duct being connected to. A vertical transition from an air handler to a 10 x 20 trunk line above must have a 45 degree transition into the trunk line that is a minimum 10 inches long. (LP)
26. All ductwork shall be located “within” the conditioned space. Dropped ceiling soffits are allowed. Ductwork is not allowed in floors, subfloors, or floor soffits over unconditioned spaces, to include floors over garages, floors under bay windows or other overhangs, and floors over unconditioned crawls. – (LP)
 27. Wall and floor cavities shall not be used as ducts. Panning is not allowed. – (LP)

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

28. Ground water heat pumps, “pump and dump,” systems must incorporate an injection well. While it is true that water is never lost, eventually returning to the ground, it is important to return the water to the ground after use to maintain ground water levels, as opposed to placing it in the surface water system. – (LP)

29. Zoned single speed HVAC systems are not allowed. Air circulation bypass is not allowed. If zoning is desired, separate systems, or systems with AHRI rated multiple or variable speeds must be used. When using multiple speed or variable speed equipment, the AHRI rated part load may not exceed 125% of the smallest calculated zone load. Open areas to floors above or below a zone are not allowed. A zoned single unit system results in an oversize when the full system provides heating/cooling for a part load zone. Open areas to floors above or below a zone induce one way warm air flow to the zones above, negating the separation of the zone and desired effects of zoning. Air circulation bypass can destroy the efficiency of the unit. The cumulative size of all units is per the block load of the home. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory. – (ES, IECC, LP)

30. Heat pumps having supplementary heat, electric or gas, shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory. – (LP)

31. All duct joints, including drives and cleats and adjusting seams, shall be sealed with tape and/or mastic. Tape and/or mastic shall be UL-181 A or B rated for duct sealing. UL-181 rated tape shall have the ‘UL-181’ shown on the face of the tape. Blank face Foil and Duct tape are NOT acceptable. All ductwork shall be located “within” the conditioned space. Duct leakage shall not exceed 6 CFM-25 total leakage per 100 square foot of conditioned floor space for the area served, as tested by a Certified HERS rater. Ductwork is to be kept “*within*” the building envelope to eliminate energy loss. Dropped ceiling soffits are allowed. Dropped subfloors or floor soffits over unconditioned spaces and garages are not allowed. – (IECC, ES, LP)

32. Heated garages, drives, and other outdoor heating or outdoor cooling are not allowed. This would be an inefficient use of energy. However, an enclosed heated workspace in an attached garage, or an entire garage, may be designed as a conditioned space, but the space must then be considered in the block load calculation for heating and cooling load to determine total overall equipment capacity. This garage area must be included in the calculation to determine the required HERS score. The garage space must use a separate heating and cooling system keeping the garage area separated from the home. Heated detached garages may not be included, as the space would no longer be a part of the home, i.e. it is a separate building. – (LP)

33. Fireplaces, heating stoves, and other fuel fired heating units must be direct venting, taking combustion air from outdoors. Biomass fueled units must be EPA rated with a minimum EPA efficiency of 75%. Gas fireplaces must have a Department of Energy (DOE) Annual Fuel Utilization Efficiency (AFUE) publicly published by the manufacturer. Provide a copy of the EPA stamp for biomass fireplaces, or provide a copy of the manufacturer’s literature or AHRI certificate for gas fireplaces. When multiple fireplaces are used, the lowest efficiency shall be used for the HERS rating. – (LP)

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

34. For ground loop heat pumps, make certain the loop field is designed “not only” according to the size of the geothermal unit, but according to the soil type the loop field is going into. The HVAC contractor is responsible for obtaining a professional well driller that is trained in both the drilling of geothermal wells and the proper design and sizing of a loop field. While it is not a requirement, it is highly recommended that loop fields be designed by an individual certified by the International Ground Source Heat Pump Association (IGSHPA). (IECC, LP)

35. HVAC contractors must have completed all aspects of Quality Assured training to be eligible to install systems under this program. Builders must be ENERGY STAR partners, and must have completed ENERGY STAR Version 3 Orientation. Raters must have completed Version 3 training. All must be listed on either the ENERGY STAR, or ACCA web sites as having completed their required training when the application is received. – (ES, LP)

36. Single speed A/C or Heat Pumps may not exceed the calculated cooling load by more than 15% for A/C units, or 25% for Heat pump units. Per Code, for homes with very small cooling loads, the sizing limit may be exceeded, but under no circumstance by more than the smallest size unit made by the manufacturer. - (IECC, ES)

37. Required - Two speed A/C or Heat Pump part load capacity may not exceed the calculated cooling load by more than 5% for A/C or 10% for Heat Pumps. The efficiency for this equipment will be the average of the AHRI full capacity and low capacity efficiency for the SEER, EER, COP, or HSPF. Per Code, for homes with very small cooling loads, the sizing limit may be exceeded, but under no circumstance by more than the smallest size unit made by the manufacturer. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory. - (IECC, ES)

Recommended - Two speed A/C or Heat Pump part load capacity may not exceed the calculated cooling load. The efficiency for this equipment will be the average of the AHRI full load and part load efficiency for the SEER, EER, COP, or HSPF. Per Code, for homes with very small cooling loads, the sizing limit may be exceeded, but under no circumstance by more than the smallest size unit made by the manufacturer. Units must be currently listed on AHRI. - (IECC, ES)

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

38. For full variable speed equipment, the low end cooling capacity may not exceed 90% of the calculated cooling load. The efficiency for this equipment will be the AHRI low capacity rating for cooling, EER or SEER, and the average of the AHRI full capacity and low capacity for heating, COP, or HSPF. Per Code, for homes with very small cooling loads, the sizing limit may be exceeded, but under no circumstance by more than the smallest size unit made by the manufacturer. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory. Units must be currently listed on AHRI. - (IECC, ES)

Recommended - For full variable speed equipment, the low end cooling capacity may not exceed 75% of the calculated cooling load. The efficiency for this equipment will be the average of the AHRI full load and low end load for the SEER, EER, COP, or HSPF. Per Code, for homes with very small cooling loads, the sizing limit may be exceeded, but under no circumstance by more than the smallest size unit made by the manufacturer. - (IECC, ES)

Recommended - Geothermal heat pumps, air source heat pumps, furnaces and air conditioners, must have the following minimum full load efficiencies: Furnaces 95% AFUE, A/C 13 EER & 16 SEER, ASHP 8.5 HSPF & 12.5 EER & 15 SEER, Geothermal 14 EER & 4.6 COP water loop - 16.2 EER & 3.6 COP ground water – 14.1 EER & 3.3 COP closed loop – 15 EER & 3.5 COP direct expansion. Or, an AHRI tested, ENERGY STAR “Most Efficient” rated unit. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory, even those that are shown on the ENERGY STAR web site as ENERGY STAR rated. – (LP)

39. Total heating capacity must meet Manual S guidelines based on full load capacity. - (IECC, ES)

40. All combustion air must be ducted from outdoors directly to the appliance. - (ES, LP).

41. Part load and variable speed capacity may only be used to meet sizing requirements when the part load capacity is rated and listed with AHRI. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory. – (LP)

42. Radiant hot water floor systems must use heat provided by either a 90% AFUE direct vent combustion gas units, geothermal hydronic or heat pump units, or solar. – (LP)

REQUIRED and RECOMMENDED MINIMUMS (cont'd):

43. Solar or wind is limited to Net-Zero, which will be equal to setting the nameplate rating to the HERS estimated annual energy use, times four, divided by 365 days, divided by 24 hours. - LP

Recommended - Solar or Wind energy is limited to a HERS score of -5 to zero. A schedule for the equipment and ratings must be included on the drawings, to include brand, model, description, and capacity of all major components. When wind or solar is included in the design, the wind/solar design must be firm, and components may “not” be subject to change at a later date. The size of the equipment may not exceed that needed to bring the HERS score to 0 or -5. – (LP)

Recommended - Wind generators must be certified by the Small Wind Certification Council (SWCC) or other National Recognized Testing Laboratory (NRTL) to American Wind Energy Association (AWEA) small wind standards. Rooftop wind is not allowed due to vibration on the home and reduced efficiency from turbulence generated by the home itself. A copy of the cutsheet showing rated output at 15 mph must be submitted. – (LP)

Recommended - Solar panels and associated electrical components must be Underwriters Laboratory (UL) listed. Solar panels must have an STC rating. A copy of the cutsheet for the solar panels which shows the STC and UL ratings must be submitted. - (LP)

Recommended - Solar hot water systems must be listed with the Solar Rating and Certification Corporation (SRCC). A copy of the SRCC OG-300 rating must be included with the submittal. The system must have a SRCC rating of $SF > 0.5$. Hotwater systems must have a current Solar Rating and Certification Corporation (SRCC) OG-300 rating which can be viewed on the SRCC web site. $SF = 1 - (EF/SEF)$, where EF is the energy factor of the water heater, and SEF is the rating shown on the SRCC web site. Use of solar hot water does not reduce the required HERS score. – (LP)

DRAWING/DESIGN REQUIREMENTS & DRAWING FORMAT:

Required for review, for an accurate HERS rating, an accurate Manual J, and as a guide for the contractor to ensure the home is built to meet all program requirements. Drawing formats are required for consistency in what is reviewed.

DRAWING FORMAT:

This program is not designed for quick turnaround, spec type housing, or spec type plans, but for the perspective home owner willing to take the time to develop a complete and thorough set of building plans that are specific to an innovative and energy efficient home they wish to live in and enjoy. Views, notes, and details must be specific to the home. To complete a successful application, without delays caused by discrepancies between documents, resulting in revision and information requests, all parties, the Home Owner, Designer, Home Energy Rater (HERS rater), and HVAC and Building contractors will need to work together. Approval can only be provided if all Information needed by the rater and contractors, and all requirements of these guidelines are clearly reflected on the plans.

Submitted plans and specifications must be:

- 1. Of a professional nature, using standard drafting practices (i.e. scribbled notes, or copies on copies will not be reviewed.)*
- 2. Made using computer aided drafting (CAD), with one hard copy submitted.*
- 3. Specific to the home being reviewed.*
- 4. The final version & used for permitting after review and approval by the Energy Office.*
- 5. Dated and containing revision blocks.*
- 6. Must be page numbered as outlined below.*

- 1. Number all plan pages, using the convention 1 of X, 2 of X, 3 of X, etc., where X is the total number of pages*
- 2. Minimum text size is 3/32nd inch in height (7 point pica).*
- 3. Note and dimension text must be in plain block type font, clear and easy to read.*
- 4. All plan and elevation views, including the duct diagram, must be scaled to a sufficient size to make all text and details clearly discernable. If in doubt, increase the drawing scale or font size. The preferred scale is 1/4, but this is not a requirement. Clarity is a requirement, and will be determined by the reviewer.*
- 5. Paper must be either C (16 to 18 x 24 inch) or D (22 to 24 x 36 inch) size drawing paper.*
- 6. All views and details must be original and specific to the home.*
- 7. All pages must be the same size.*
- 8. Keep all views, notes, and dimensions a minimum of 1 inch from the left side of the drawing page.*
- 9. Staple the drawing set together along the left edge, using a minimum of 3 staples, between 1/4 and 1/2 inch from the left edge.*
- 10. All parts of the plans, the text, dimensions, views, sections, notes, etc., must be easy to read and clearly show the intended design.*
- 11. If a separate set of specifications exist, this must be noted on the first page of the plans, and the specifications must then accompany each set of plans.*
- 12. Homes of 10,000 square feet or more must have an Architect AND Engineer's stamp. Garage area is included in the square footage calculation when the garage is over three stalls. For the purposes of these guidelines, stalls with a side on either the exterior or common wall shall be no wider than 13 feet, and middle stalls with no side wall shall be no wider than 12 feet. No stall shall be longer than 26 feet. Dimensions are measured to the outside of exterior walls and the garage interior of the common wall. Handicap garages may consist of three 9 x 25 foot stalls and two 5 x 25 foot access areas, with dimensions measured from the inside of the walls. These areas include any space used for access and storage. Where local code jurisdictions maintain a stall definition, whether the local requirements are more or less stringent, the local definition shall apply.*

DRAWING/DESIGN REQUIREMENTS:

1. To ensure a speedy and successful review and approval, double check that all aspects of these guidelines are reflected in the plans, prior to submittal.
2. Designers need to work with the HERS rater, Building contractor, HVAC contractor, and most importantly, the Home Owner to ensure all information is included for a complete design.
3. If a separate set of building specifications exist, in addition to the plans, then the plans must contain a clearly visible note on the first page indicating that a separate set of specifications also apply. Separate specifications must be submitted to the Energy Office with the drawings. There can be no discrepancies between information in the specifications and information on the plans. Notes in the specifications do not replace plan notes. The plans are the defining document and must contain all necessary notes and dimensions to complete a HERS rating, a Manual J load calculation, and most importantly, to build the home.
4. Plans submitted for review must be the final home design and may not be marked as “preliminary” or “not for construction.” Drawings and sections must be an honest representation of how the home will be built. Use additional pages as necessary to keep drawings easily readable.
5. As a minimum, the plans must include:
 - a. Four elevation views showing each side of the home,
 - b. Plan views for each floor level,
 - c. A lighting diagram for each floor, including the garage.
 - d. A duct drawing(s) which “very” lightly shows the rooms, floor joists, stairs or other possible duct obstructions in the background, and
 - e. A roofing plan showing ridge and valley lines, direction of drain, and dimensioned soffit overhangs.
6. Break and trim lines and fill that are located around text or dimensions so that the text or dimension is shown clearly and is legible.
7. R-values, U-values, and all other efficiencies must be consistent throughout the plans and specifications. HERS reports and Manual J calculations must reflect the home shown on the plans. Any differences or inaccuracies found in the submitted documents will require revision, re-submittal, and result in delays.
8. Plans must show and include grading, calling out the required 6 inch drop within 10 feet of walls for grading, and 1 inch in 4 feet for solid patios. Show, label, and dimension all concrete patio’s and decks on the plan views. Include the type of patio or deck in the label indicating if the floor is solid or has gaps, i.e. “Standard Gapped Deck” or “Concrete Patio” or “Solid Plastic Deck” or other appropriate label. On the plan views, from the edge of the home, show the 6” drop in grade on the grade line, i.e. with the grade level across the front of the home, as the grade line reaches the edge of the home, show the grade falling away at a 1/20 slope.
9. Show sump pit details. If no sump pit is used, include a note near the required radon note indicating that no sump system is used.

DRAWING/DESIGN REQUIREMENTS (cont'd):

10. Show advanced framing details, and show wall thickness to scale, from inside drywall to exterior cladding. Rain screens are recommended but not required.
11. Show R-values with direct notes and dimension and indicate the locations where they are used. Each plan view must indicate the wall R-values used. Changes in insulation R-value must be dimensioned to show location and labeled to show insulation materials and R-values. – Required for review and for the HERS rater to make an accurate rating.
12. Show and properly label sufficient cross sections, such that all components are shown and noted. Use standard cross section labeling, using arrows on each end of the section line to show the view direction, and placing the letter label next to each arrow. In turn, respectively label each section view accordingly, i.e., Section A-A, Section B-B, etc.
13. The plans must reflect manufacturer's installation instructions. This would include minimum distances between intakes and exhausts, or required vertical and horizontal runs for fireplace chimneys, or minimum duct size for ERV's/HRV's.
14. Provide a window and door schedule showing labels, quantity, rough opening dimensions, NFRC tested U-values and NFRC tested SHGC's. Use the same label for like windows. DO NOT group doors, sidelites, and transoms in one rough opening. Rough openings for doors, sidelites, and transoms must be listed separately. If using a window that is not NFRC tested, the code default U-value must be used and shown on the window/door schedule, and noted as a code default. Show the construction features, i.e. wood frame, double pane, low-e, etc.
15. Label windows, doors, sidelites, and skylights in the elevation views. Labels in the window/door schedule and those in the views must be consistent.
16. In elevation views, include the word "GARAGE" in the label for garage windows and doors. Show and label the door from the house to the garage using hidden (dashed) lines.
17. Show a cross section and details of the energy truss. Provide dimensions showing the required minimum 9" depth available for insulation, the type of insulation material, the R-values attained, the thickness of ceiling drywall used, and the maximum weight allowed by the drywall.
18. Show a cross section for each floor that will be over a garage or outside air. Provide the dimension of the floor joist and area for the insulation. Insulation must be in contact with the floor.
19. Show cross sections of slab floors and slab edge insulation. Show the insulation thickness, the type of insulation, the depth the insulation extends to, the protective cover (drywall) below the insulation, and the R-value. There can be no breaks in the continuity of this insulation.
20. Show cross sections of above grade and foundation walls. Include dimensioned depths available for insulation, drywall, the insulation material, and R-values used.
21. Show details of advanced framing to reduce thermal bridging. Provide corner details and details of intersection of interior and exterior walls, showing the use of advanced framing. Show the framing using proper cross sections to include dimensioned depths available for insulation, the insulation material and R-values used.

DRAWING/DESIGN REQUIREMENTS (cont'd):

22. Show attic access and detail of access door/cover. Show section detail on drawings, with depth dimension for insulation, and insulation material and R-values used.
23. Show section views of each step, coffered, or vaulted ceiling. Show and dimension the areas available for insulation. Show how insulation will be contained at ceiling edges, i.e. knees of the step, and how insulation depth will be maintained at the ceiling edges. Show and dimension the area available for insulation in vaulted ceilings, and at ceiling edges for vaulted ceilings. Call out the insulation material and R-value used.
24. Show details of the required passive radon abatement system, to include any electrical connections provided to change to active. Show the wall or chase used for the radon riser(s) on the plan views, and label the exhaust on the elevation views. Show a dashed line on the foundation plan, in hidden lines, under the slab, locating any perforated pipe that may be around the inside of the foundation and within 3 feet of the inside edge of the foundation wall, and around any central foundation supports which cause a break in the slab. Active abatement systems are also allowed, but are discouraged until after construction to determine if the energy using fan is needed, i.e. passive with accommodations to become active is recommended. Provide installation details and call outs. State law requires that active systems must be designed by a trained and licensed professional.
25. If sump pumps are used, provide a detailed cross section showing complete installation, including manufacturer's installation notes. Show piping and outlet details of a fully gasketed and sealed system. Include the manufacturer and model number. Locate the sump pit on the plan views. If no sump pit is used, make sure this is noted on the drawing.
26. Show and call out gutters and downspout piping that delivers water to natural drains, and at a minimum of 5 foot from the foundation. These are to be shown on the elevation views.
27. Provide cross sections and dimensioned details showing all knee walls (walls behind roofing). Show sufficient details for the HERS rater to calculate the area of each knee wall. Show and dimension on elevation views using hidden (dashed) lines. Show and call out depth of insulation, insulation material and R-value. These can be separate elevation views, specific for the purpose of dimensioning only the knee walls, and using 1/8th scale if clear and easy to read. These can also be shown on the main 1/4 scale elevations. Show and dimension all floor levels.
28. Show cross sections and dimensions required to calculate areas of vaulted, stepped, knee, or other ceiling and wall changes.
29. On the elevation views, dimension the soffit width and distance from the soffit to top of all fenestration rough openings.
30. On the elevation views, indicate the color shade of the shingles being used as light, medium, or dark.

DRAWING/DESIGN REQUIREMENTS (cont'd):

31. A direction indicator must be shown on each drawing page that includes a plan view, with an angle indication of the homes variation from one of the cardinal directions. The indicator must include the letters for North, South, East, and West. See example:

A plot plan with direction indicator and angle indication of the homes deviation from one of the four cardinal directions is preferred,



32. Each elevation view of the home must indicate the direction it faces, to the nearest 45 degrees, i.e. North, South, East, West, Northeast, Northwest, Southeast, or Southwest.

33. Depth of floor joists and vaulted and other ceiling joists must be determined prior to submittal, with cross sections and dimensioned details on the plans to show the depth available for insulation and the R-values used.

34. Show and dimension patio roofing outlines. Show and dimension all roof and patio outlines as dashed on each plan view.

35. Provide a section view of any walls, ceilings, or floors, between the home and an attached garage, which shows the required air barrier separating the home and the garage.

36. Clearly label unconditioned spaces. Note that for this program, an unconditioned space cannot be designed for any type of current or future heating or cooling.

37. Show and dimension floor and ceiling lines behind roofing and awnings. This can be done using dashed or hidden line in the elevation views, or by providing separate elevation views. – The HERS rater must be able to determine area of walls behind roofing, awnings, and soffit overhangs, as these must be input as knee walls.

38. Provide an appliance schedule within or near the lighting schedule. The appliance schedule must show the manufacturer, model numbers, quantity, efficiency and or energy use for the following appliances:

Refrigerator(s) – show kWh/yr,

Dishwasher(s) – show kWh/yr

Clothes Washer(s) – show IMEF and kWh/yr

Ceiling Fan(s) – show CFM/Watt at medium speed

When more than one appliance is used, show the quantity used, but list the kWh/yr used by only one. List different model numbers separately. The HERS rater must add up the total kWh/yr used by all of one type of appliance, like say the refrigerator, for input into the HERS software.

39. Provide a lighting schedule near the lighting diagram(s) which includes labels which match those labels on the lighting diagrams, the name of the manufacturer, model number, type of lighting(LED, Fluorescent, Metal Halide, or Induction), and fixture wattage rating and quantity used. If using more than one of any one particular fixture, list it only once, list the quantity, and use the same label.

DRAWING/DESIGN REQUIREMENTS (cont'd):

40. Provide a Mechanical Schedule near the duct drawing which lists the name of the manufacturers, complete model numbers, capacities, and efficiencies. List the HVAC equipment, ERV's or HRV's, hot water system(s), thermostats, backup heat, exhaust fans, fireplaces, and any other mechanical equipment. For exhaust fans, list the rated air flow capacities, and input power in watts under the efficiency column, i.e. cfm/watt. For HVAC equipment, list both the heating and cooling efficiencies and capacities, and if multiple capacities, then also list the associated multiple efficiencies and capacities. Include a row at the bottom of the mechanical schedule when geothermal is used, and indicate the type of geothermal system, GLHP, WLHP, GWHP, or DX, and include the number of loops and the depth of those loops. Efficiencies for furnaces, heat pumps, and air conditioners must be as listed in the AHRI directory. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory, even those that are shown on the ENERGY STAR web site as ENERGY STAR rated.
41. Show and label all intake and exhaust points for ventilation, exhaust fans, radon, clothes dryers, fireplaces, combustion appliances, and any other envelope penetration, on the elevation views.
42. On the plan views, provide a dimension for each continuous section of exterior wall, i.e. from corner to corner, and in between corners where moving from conditioned to unconditioned space.
43. On the plan views, show and dimension any "exterior" walls on floors above or below the floor being shown, wherever those above or below walls do not follow the same line as the walls on the floor being shown. Show those above and below floors as dashed/hidden lines. This would be for floors that may overhang the floor being shown, or for floors that do not extend to the outside wall of the floor being shown.
44. The duct drawing must show a front and side view of the HVAC unit and its connections to the trunk lines. The trunk lines, front and side view of the HVAC unit, transoms and trunk lines must be to scale. Broken lines on the transoms to connect upper floor trunk lines are acceptable. Branch runs may be shown as weighted lines. The drawing of the HVAC unit must show and call out the fabric vibration connections, furnace filter, humidifier (if used), ERV or HRV, and any other devices that are to be a part of the HVAC system, such as zoning dampers. Show and label all duct sizes and indicate size transition points. Show and label all transfer grills or jump ducts. Show all ventilation ductwork, including bath and kitchen fans, and any chimneys or stacks for fireplaces or furnaces. Indicate if the system will be zoned and show all zoning dampers, or provide a note indicating the system will not be zoned. If zoned provide a diagram of the zones and loads for each zone.
45. Show all ductwork on any given floor on one plan view. That is to say, that if all the ductwork for the basement and first floor are to be installed in or under the first floor joists, it must all be shown on one plan view. Label the registers according to the rooms they go to, the cfm, and if the run is supply or return, i.e. "Bsmnt Bdrm 30 cfm Supply" or "Main Dinette 90 cfm Return" or "2nd Mstr Bed 60 cfm Return." Floor – Room – CFM – Supply or Return.
46. Provide a dimension showing the distance from the garage floor to the adjacent interior floor.
47. When wind or solar are part of the design, provide an equipment schedule which lists the manufacturer, model, description, and capacity of each of the major components of the system. Show the location of the system on either a plot plan, or on the roofing diagram if solar roof mount (rooftop wind is not allowed). Provide footing diagrams and location for ground mounted systems.

DRAWING/DESIGN REQUIREMENTS (cont'd):

48. DO NOT use “cross” hatching to show R-values unless it is in a “cross” section. Label R-values directly using arrows and notes.

49. DO NOT use fill for wall sections, or to show wall thickness.

50. DO NOT use notes such as “unless otherwise noted,” or other like wording. Notes like, “unless otherwise noted”, send reviewers and contractors on a search for something that may, or may not exist, that may or may not be “otherwise noted.” Be specific.

51. DO NOT use notes such as “per the supplier.” If certain suppliers or subcontractors are providing parts of the design, then those suppliers or contractors need to provide their information prior to submitting the application, so that it can be included in the plans.

52. DO NOT show furniture and other non-permanent objects, or any associated dimensions on the construction plans. If desired as part of the design, then these items must be shown on separate pages to avoid clutter. While a full set of drawings and specifications is required for submittal, construction drawing pages showing furniture and other moveable items will not be considered as part of the submittal being reviewed, and may not be used to show the required details. Keep this information separate.

NOTE: All section views must be specific to the home and use standard section call outs locating the view. Generic section views are not to be used and will require revision resulting in delays. R-values are for material only. R-values may not be reduced after initial submittal.

REQUIRED NOTES:

1. One of the following notes must be below each window/door schedule – (LP):

“All windows and doors shall be NFRC tested, except where it is noted in the window/door schedule that the U-value and SHGC are the code default values. NFRC stickers are to be removed by the owner only, and only after inspection by the local Code Official and the HERS rater.”

If all of the windows and doors are to be NFRC tested, then the code default information may be deleted from the note, and the following note used:

“All windows and doors shall be NFRC tested. NFRC stickers are to be removed by the owner only, and only after inspection by the local Code Official and the HERS rater.”

2. The following note must be on each elevation page. - (ES, IRC):

“A minimum 6 inch drop in grade away from the home must be achieved within a distance of 10 feet from the exterior of the home. All areas exterior to the home shall be provided with a natural, above grade drain path away from the home, and having a minimum 5 foot width.”

The note is to be located at one corner of the main elevation view, with an arrow pointing to a grade line that is shown sloping away from the home. Minimum of one note per elevation page.

3. Include the following note for all concrete patios or solid decks - (ES, IRC):

“Maintain a minimum grade of 1 inch in 4 feet away from the home.”

This note is to be located on every plan view with an arrow pointing to the patio or solid deck location. The patio or solid deck outline must also be shown and dimensioned. This note does not apply to decks with gaps between each floor board. For standard decks, with gaps between the floor boards, the requirement for grading would apply below the deck for the soil (6”/10’), or concrete (1”/4’).

4. Include the following note for all floors over garages, outside air, and other unconditioned spaces – (IECC):

“Floor insulation shall be (list material) with an R-value of (list R-value). Insulation must be installed to maintain contact with the floor above. Fill the cavity and cover the underside of the floor with (list the covering type).”

This note is to be located with the cross section for each floor over garage, outside air, or any other floor over unconditioned space. The dimension of the floor cavity must also be shown.

REQUIRED NOTES (cont'd):

5. Include the following note on pages with wall insulation cross section details - (ES, IECC):

“Exterior joints, seams or penetrations in the building envelope, that are sources of air leakage, shall be sealed with durable caulking materials, sealed with gasketing systems, taped or covered with moisture vapor-permeable housewrap.”

6. Include the following note on pages with attic insulation details with arrow pointing to marker – (IECC):

“Install insulation depth markers in attic areas to ensure proper insulation depth, one marker for every 300 square feet, with markers dispersed evenly and facing attic opening.”

7. Include the following note on pages with plan views and section views showing envelope construction details – (LP, HERS):

“The house shall be sealed to a tightness, as measured by a certified HERS rater, to ** CFM50, or less.”

**The calculated CFM50 is: 400 plus 100 for every 1000 square feet of floor area. The floor area is measured to the outside of the walls, not including areas open to the floor below. Stairwells are not areas open to the floor below. Mezzanines adjacent to stairwells, open areas adjacent to balconies, or open areas adjacent to lofts are examples of areas open to the floor below. Double check computer calculations of this area by hand to avoid resubmittal delays.

8. Include the following note near the mechanical schedule – (LP):

“All hot water piping, except to a flushing rim sink, shall be maximum 3/8” nominal diameter individual distribution lines as outlined in the 2009 International Plumbing Code. All hot water piping shall be individually insulated to R-3. Hot water manifolds shall be located within 5 feet of the hot water supply. Recirculating hot water systems are not allowed.”

9. Include one of the following notes/information near the mechanical schedule – (LP, HERS, ES):

“The HVAC system is not zoned.”

Or, if the HVAC system is zoned, then provide a diagram showing the zones and heating and cooling requirements of each zone and provide details on how the HVAC system will be modulated. HVAC bypass is not allowed.

10. Include the following note near the mechanical schedule when a geothermal loop field is used – (LP, IECC):

“Properly size the loop field according to local soil conditions.”

11. Include the following note near the duct drawing – (IECC):

“At least one return air opening is required for every floor level, and one return air opening, jump duct, or transfer grille is required for every room that can be isolated by a door, except bathrooms.”

REQUIRED NOTES (cont'd):

12. Include the following note near the duct drawing – (ES, LP, IECC):

“Duct leakage shall be tested by a certified HERS rater, and must be less than CFM-25.”

**The calculated CFM 25 is 6 times the floor area divided by 100.

13. Include the following note near the duct drawing – (LP, HERS):

“All ductwork shall be located “within” the conditioned space. Ducts are not allowed in floors over garages, floors over unconditioned spaces, or floors over outside air.”

14. Include the following note near the duct drawing – (LP, IECC, ES):

“Ductwork shall be properly sized according to ACCA Manual D for the required air flow, to include proper reductions along the trunk lines, and shall include fabric isolation joints at the HVAC equipment and any other source of vibration.”

15. Include the following note near the duct drawing – (IECC):

“Recommended duct velocities are as follows:

Supply Trunk Lines: 700 fpm rigid duct, or 600 fpm flex duct.

Supply Branch Lines: 600 fpm rigid or flex duct.

Return Trunk Lines: 600 fpm rigid or flex duct.

Return Branch Lines: 400 fpm rigid or flex duct.

Ductwork shall not exceed the following maximum velocities:

Supply Trunk Lines and Branches: 900 fpm rigid duct, or 700 fpm flex duct.

Return Trunk Lines and Branches: 700 fpm rigid duct, or 700 fpm flex duct.

(Check also that these values do not exceed manufacturer’s maximums)”

16. Include the following note near the duct drawing – (IECC):

“Wall and floor cavities shall NOT be used as ducts for either supply or return. Panning is not allowed. Ducts are not allowed in floors over garages, floors over unconditioned spaces, or floors over outside air.”

17. Include the following note near the duct drawing – (IECC, LP):

“Heat pumps having supplementary heat, electric or gas, shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump can meet the heating load.”

18. Include the following note near the duct drawing – (IECC):

“All duct joints, including drives and cleats and adjusting seams, shall be sealed with mastic. Tape and/or mastic shall be UL-181 A or B rated for duct sealing. UL-181 rated tape shall have the ‘UL-181’ shown on the face of the tape. Mastic must be used when connecting metal to metal. Tape may only be used when connecting metal to flex duct. Blank face foil and Duct Tape are NOT acceptable.”

REQUIRED NOTES (cont'd):

19. When a fireplace is used, include the following note near the duct drawing – (IECC, LP).

“Fireplace installation must meet International Residential Code requirements and all other state/local codes and/or regulations. Fireplace must be direct venting taking all combustion air from outdoors”

20. Include the following note near the duct drawing – (IECC, LP).

“Locate primary thermostat away from fireplaces, or other sources of heating or cooling, preferably in rooms without fireplaces and away from registers, direct sunlight, or drafts from open doors.” – LP

21. Include the following note on the foundation plan view. Also provide an arrow pointing to the perforated tile/pipe of the radon abatement system, or pointing to the riser location, with the note on that arrow directing the contractor to this note, i.e. if this were note 3 on your drawing, then the arrow would tell the contractor to “See Note 3.” - (IRC).

“Install a passive radon abatement system which meets the requirements of the International Residential Code (IRC), Appendix F. As an example: Locate minimum 3” nominal fabric wrapped perforated radon abatement tile/pipe within an under slab gas permeable material all along the entire length, and within 3 feet of the inside edge, of all foundation walls, and along any central foundation supports which cause a break in the air barrier under the slab. Install a 6-mil, or 3-mil cross laminated polyethylene air barrier type sheeting directly under the slab, with minimum 1 foot of overlap for any seams. Slab penetrations and joints must be sealed with a polyurethane caulk or equivalent sealant. The perforated tile/pipe must create a loop around the entire inside edge of the home and be connected to a minimum 3” PVC radon abatement riser. Use a tee and lateral to locate the riser so that it makes one straight run from under the slab, up and through the roof. The radon abatement riser must penetrate the roof, extend a minimum 1 foot above the roof, and be kept a minimum of 10 feet from any inlets, windows, or other openings to the home. Riser may be installed in interior walls or a chase, but NOT in exterior walls. Sufficient grade must be maintained along the length of the perforated tile/pipe to prevent water from filling low spots and hindering air (radon) circulation. The riser must be clearly marked between each floor, and in the attic, as “RADON ABATEMENT SYSTEM.” In the attic, the riser must have a minimum unobstructed 2 feet of length as measured from the top of ceiling joists to the bottom of the roof trusses. Radon abatement tile/pipe may be incorporated into a sump system. The system described here and may be substituted with any system which meets the requirements of the 2009 IRC, Appendix F. To ensure the effectiveness of the passive radon system, the occupants of a new home should be provided with written instructions to conduct a short term radon test in the lowest floor of the structure. If the results of such a test are 4.0 pCi/L or greater the passive radon system should be activated by a licensed radon mitigation business. Nebraska State law requires that if a fan is installed to activate a passive radon system the work must be done by a licensed radon mitigation professional.”

22. Discuss with the builder, and include one of the following notes near the edge of each elevation view. (ES).

“Backfill will be tamped.” OR “Builder will return after one full year to backfill any settled areas and repair or replace any associated landscaping.” OR - provide a note that lists the name of the certified hydrologist or soil scientist used and listed the type of soil that will be required as backfill, i.e. “Per Dr. I Am Expert, all backfill shall be Super-Duper brand No-Settle 2000 non settling compact soil.”

HERS REQUIREMENTS:

1. The plans are the defining document and must contain all necessary notes and dimensions to complete a HERS rating, regardless of whether or not a separate set of specifications exist.

If the HERS rater needs to contact the building contractor or design professional for information not on the plans, then that information must be added to the plans. Advise the draftsman to add any needed information to the plans. **To be eligible, a home must achieve a HERS score as indicated.**

2. Input duct leakage as measured cfm 25, zero to outside supply & return, and total rough in test with air handler CFM 25 at 6 x Floor area served (sq. ft. to outside of walls) divided by 100. Input estimated infiltration at 400 CFM 50, plus 100 CFM per 1000 square feet of floor area (sq. ft. measured to outside of walls), post construction tested. The final tested home is required to meet this infiltration level, or less. Heating set point is 70°F, cooling set point is 75°F. Adjust HVAC SHR to 0.85. Set insulation levels as Grade 1, as required to be ENERGY STAR. Input fireplaces as fuel fired unit heaters, using the AFUE efficiency for gas, or the EPA rating less 10% for biomass, and as providing 15% percent of the heat (uncheck the Capacity Weight % load served and manually input 15% for fireplace, weight % for remaining 85%). When multiple fireplaces are used, the lowest efficiency shall be used for the HERS rating. Consider appropriate adjacent window shading. Input wind as solar, area=watts÷300×15, tilt as 12.5, watts and inverter as actual. Do not input radiant barriers. – REM does not consider dust or an air sealing for radiant barriers.

3. Since there is concern that the REM/Rate program might not treat Air Source Heat Pump (ASHP), and Furnace and Air Conditioner (A/C) Efficiencies the same as Geothermal efficiencies, you may input ASHP, Furnaces, and Air Conditioners, as Geothermal units, using the AHRI rated, full capacity EER, and using the following calculations for COP:

For ASHP with electric backup, the COP will be the full load AHRI rated HSPF divided by 3.412 btu/kWh and rounded down to the nearest 10th. For furnaces, the COP will be the AFUE divided by 0.33, which is the average efficiency of electricity that is provided to a home when using generators and the grid, and rounded down to the nearest 10th. For ASHP with furnace backup, use the average of the HSPF and AFUE calculated COP.

As an example, if you have an 8.5 HSPF, 12.5 EER ASHP with a 95% AFUE gas backup furnace, you will calculate the ASHP COP as 8.5 HSPF divided by 3.412 (2.491), and the furnace 95% AFUE (0.95) divided by 0.33 (2.879), and the average of those two is 2.685, and rounded down to the nearest 10th, is 2.6. You now go into REM/Rate and create a Geothermal heat pump with a 12.5 EER and a 2.6 COP

For this same system with electric backup you would use the 12.5 EER and 2.4 COP. For the same furnace with a 13 EER A/C, you would use 13 EER and 2.8 COP.

The efficiencies used will always be the full load efficiencies, and the capacity inputs will always be the largest of the full load capacities. For an ASHP with electric backup, the heating capacity will be the capacity of the electric backup plus half the ASHP capacity. For an ASHP with gas backup, the heating capacity will be the capacity of the furnace.

This option will be in effect until either REM/Rate changes the calculation for ASHP and Furnace/A/C units, or until AHRI changes their standards for the efficiency ratings.

Efficiencies for furnaces, heat pumps, and air conditioners must be as listed in the AHRI directory. To be eligible for this program, furnaces, heat pumps, and air conditioners must be currently listed in the AHRI online directory, even those that are shown on the ENERGY STAR web site as ENERGY STAR rated. DO NOT use efficiencies shown on the ENERGY STAR web site.

NOTE: It should go without saying that this type of HVAC input should be used for this program only! When submitting the homes to your provider, and for ENERGY STAR, you will need to input the HVAC equipment as you normally would for REM/Rate.

HERS REQUIREMENTS (cont'd):

4. Mechanical ventilation must be set at the cfm rate in the HERS "Air Leakage Report". Brand, model, and tested ratings for efficiency for the equipment must be shown on the drawings.
5. **Use of set duct leakage and infiltration rates for the purposes of this program does not remove the liability to properly size the HVAC equipment. State Energy Code and ENERGY STAR requirements both require proper HVAC sizing.**
6. Be reminded that HERS requires that dimensions used be within 1 inch or 1/10th of a foot, but that is for measurements on an existing home. Use exact plan dimensions, be precise and detailed. Do not take shortcuts. Make sure the latest version of REM/Rate is being used.
7. Notes on the plans may use terms like "not to exceed" or "minimum" or "less than." Those phrases are only used as an aid to the builder, giving them a range of products or materials. The phrases do not apply to the HERS reports which must model the home as it is laid out on the plans using worst case scenario. If the plans call out an R-value rating of "not less than 60," then R-60 must be used.
8. Do not forget to input the lighting and appliances. This accounts for about 5 points of the HERS rating. If more than one appliance is used, say two refrigerators, be sure to add the combined kWh/yr. Input pin based LED's as pin based fluorescents.
9. While this is a projected rating, the information must still be easily read during review. Suppress any background labels, such as DRAFT.
10. Check the HVAC contractor's ENERGY STAR checklist for equipment sizing requirements. If the HVAC contractor's checklist does not agree with the HERS Equipment Sizing summary, we may have a problem. If the HVAC contractor shows a smaller load, then that load must be used. If the HVAC contractor shows a larger load, then they must submit a Manual J for review.
11. No credit shall be given for waste water heat exchangers.
12. When Solar or Wind is used, you must submit two sets of the hard copy files. One set with the solar or wind included, and one set without the solar or wind included. NEVER change any aspects of the building when adding the solar or wind.
13. Name rating inputs similar to conventions used on the plans. If the plans show windows with labels A, C, and two F's on the east side of the home with the same depth and overhang, then total the area and name that group "East A-C-2Fs." Descriptive titles will help to speed the review process.
14. **FINAL SUBMITTAL: See page 6, and provide the Energy Office with 10 days prior notice before the final blower door. The Energy Office may attend the final blower door test.**

MANUAL J CALCULATIONS:

1. **The HVAC contractor must submit Manual J load calculations for the block load of the “Entire House.” The submittal must include the “Worksheet” and show both the total and room by room loads and balanced duct diagrams. Floor by floor reports will not be accepted.**

2. **To be eligible for this program, furnaces, heat pumps (air source and geothermal), and air conditioners must be currently listed in the AHRI online directory, even those that are shown on the ENERGY STAR web site as ENERGY STAR rated.**

3. HVAC contractors need to provide copies of Manual J reports that not only show the calculated peak cooling and heating load, but also show the contractor’s inputs. “Short Forms” by themselves are not sufficient. The calculations must be accurate. If errors are found in the Manual J Calculation, the calculation will need to be revised and resubmitted, and this will not only cost the HVAC contractor time and money, but will also delay approval and start of construction for the home owner.

4. Manual J calculations must be based off of Version 8 (MJ8) or later, must use ACCA approved software, must comply with all of the “Do’s and Don’ts” outlined in the text version of Manual J, and must use accurate dimensioning.

5. The HVAC contractor needs to provide the draftsman, or designer, with a duct layout. When using Wrightsoft or other design tools, make certain to link the supplies to the proper returns. Showing a room with a supply of 90 and a return of 60, will not pass approval. The system must balance.

Inputting Manual J components on a room by room basis will greatly facilitate the duct design. Dividing the room loads by the total load gives the fraction of heating and cooling that need to be delivered to each room. Once the total load is known, the equipment is selected, the air flow of the equipment is set according to the calculated SHR, and the airflow is then multiplied by the fraction of heating or cooling required for each room. Ductwork and registers are then sized according to the flow to each room, to have similar velocities, and so as not to exceed the recommended maximum velocity. Trunk lines are sized by starting at the end of each trunk line with the appropriate size for the first two branches and gradually increasing the size of the trunk line as more and more branches are picked up moving back to the air handler, so as not to exceed the recommended maximum velocity. It is also possible to oversize all ducts and simply size all the boots for the proper face velocity, but this will result in excess cost and require more room because of the added duct size. This is also like oversized hot water pipes, it takes longer to fill the ducts with warm or cold air, and longer to get the heat or cool out. Imagine an oversized duct system on a variable speed unit running at a third air flow. With today’s part load equipment, it is best to size both the ducts and the boots for proper air velocity, and that is what is required in this program. Typically a Manual J, S, D, software will do these calculations for the HVAC contractor. For more precise information, consult ACCA Manual D. Do not exceed ACCA Manual D recommended velocities.

Ductwork shall not exceed the following maximum velocities:

Supply Trunk Lines and Branches: 900 fpm rigid duct, or 700 fpm flex duct.

Return Trunk Lines and Branches: 700 fpm rigid duct, or 700 fpm flex duct.

6. To ensure a quick and speedy review for the customer, be precise, detailed, and **Take no shortcuts.** **Size according to what’s on the plans, as opposed to calculating according to some desired size.** **The latter is tell-tale and will result in the submitted Manual J requiring revisions.**

MANUAL J CALCULATIONS (cont'd):

7. Calculated HERS loads from plans are very accurate, as are Manual J calculations. When the HERS inputs and Manual J inputs are the same, the Manual J load calcs are typically a little less than those calculated by the HERS rater. If the Manual J loads exceed those calculated by the HERS rater, there is probably an error in the Manual J or the HERS calculation. Work with the HERS rater and compare inputs.

8. Make certain Windows and doors are input as NFRC rated, using ratings or code defaults shown on the plans. The Manual J calculation must consider overhangs, adjacent shading, U-values, SHGC's, and internal shades. The window HTM's will be checked against a manual calculation.

9. The equipment Sensible Heat Ratio (SHR) used in a Manual J calculation must be set to match the calculated load SHR. In Nebraska, which is relatively dry when compared to a coastal climate, SHR should not be used to size equipment, and is not an excuse to oversize equipment. The SHR is an adjustable feature of all cooling equipment and is adjusted by varying the air flow across the coil (see ACCA Manual S and the manufacturer's expanded performance data). Size the equipment according to the total load calculated in Manual J, and then adjust the air over the coil so that the equipment SHR matches the load SHR.

10. The contractor is responsible for entering data into the load sizing program which matches the equipment, materials, dimensions, etc. called out on the plans. Load calculations with data that does not match the building plans, or those that do not use Manual J default values for design parameters such as indoor and outdoor temps, number of people, miscellaneous loads, etc., will only result in delaying the approval of the customers application until the errors are corrected.

11. The HVAC contractor may only use 2400 btuh as internal gains, unless a calculated custom internal load estimate is submitted. When a custom internal load estimate is submitted, each appliance or item listed on the calculation must also be shown in a schedule on the plans that includes the manufacturer, model number, and rated output. A catalog cut sheet for each item, showing rated output, must be submitted for each listed appliance. The calculation must include the use of the diversity factors shown in Manual J, i.e. an electric range with a total output of 10,000 btuh (3,000 watts or 3 kW), will have an average in use output of 0.25, and a percent used per hour of 0.25, for a total internal gain of, $10,000 \text{ btuh} \times 0.25 \times 0.25 = 625 \text{ btuh}$.

12. For Geothermal Heat Pumps, you must size the loop fields according to the soil type. Equipment size has very little to do with the number of, or depth of the loop field. As an example, while a two ton unit may require 2 loops in good moist soil with appropriate grout, that same two ton unit could require 8 loops in dry clay or sand with a mediocre grout. **Do not use rule of thumb for loop field sizing!** If you, or your well driller, do not have the special training required to properly size a loop field, enlist the aid of an expert who does have this training.

13. If the HVAC contractor needs to contact the building contractor or design professional for information not available on the plans, the HVAC contractor must advise the draftsman of that lack of information, and inform that draftsman, that the plans will need to be revised to include the information. If the plans do not include this information at review, the review process will be delayed by plan revision.

14. *The plans are the defining document and must contain all necessary notes and dimensions to complete a Manual J load calculation, regardless of whether or not a separate set of specifications exist. If you cannot find an input on the plans, once you have found that input, advise the drafter to change the plans to include it.*

POSSIBLE EXAMPLES TO HELP REACH THE REQUIRED HERS SCORE AND OTHER USEFUL BUILDING DESIGN INFORMATION:

The State's current Energy Code is the 2009 International Energy Conservation Code (IECC). A home built to current Energy Code prescriptive standards should obtain a Home Energy Rating System (HERS) score near 60. To reach a HERS score below 50 on most homes, takes nothing more than the addition of a geothermal heat pump. To reach a HERS score below that level will take innovation in design of the building envelope. Design possibilities and combinations used to reach the required HERS score are numerous. Following are examples, provided for information only, as a possible aid for ideas that might be used to reach the required HERS score.

Envelope Example:

1. Foundation walls: Either a 1 inch polyisocyanurate board insulation or 1 inch of high density polyurethane foam behind 2x4@24 framing that is filled with an R-15 batt – (R-22 total).
2. On Grade Slab (any slab 2 feet or less below grade): R-10 slab edge, down 3 feet
3. Rim / Band Joists: 2 inches of blown high density polyurethane (R-14) plus an R-21 batt – (R35).
4. Above Grade Walls: 2x6 above grade walls with a minimum 2 inches of blown high density polyurethane at R-7 per inch with the remainder of the cavity filled with an R-15 batt – (R-29 total), or R-23 blown in cavity with a 1 inch R-6.5 polyisocyanurate exterior foam board insulation (R-29.5 total).
5. Windows: NFRC tested U-value of 0.26 or less and Solar Heat Gain Coefficient of 0.29 or less, Window to Wall Ratio (WWR) $\leq 10\%$. Having a low WWR saves energy, because you have less R-4 windows and more R-30 walls.
6. Doors: NFRC tested U-value of 0.13 or less.
7. Ceiling: 1-1/2 inches of blown in polyurethane R-10 and an additional R-49 blown fiberglass or cellulose – (R-59), or R60 blown in insulation (check drywall weight ratings).
8. Tight construction: Estimated at 400 cfm, plus 50 cfm per 1000 square feet, or tighter, and incorporate operable windows and either an HRV or ERV for ventilation.
9. Lighting: Use either light emitting diodes (LED), compact fluorescents (CFL), T-8 tube type fluorescents, or induction lighting.
10. Appliances: Use ENERGY STAR "Most Efficient" for Clothes Washers, Refrigerators, Dish Washers, and Ceiling Fans. There are ENERGY STAR appliances, and there are ENERGY STAR Most Efficient appliances. Go to the ENERGY STAR web site and search for "Most Efficient." These are the top 10% with regard to efficiency, and it's not just for appliances!

Ceiling Drywall Example:

If the drywall used has insulation load limits of 1.3 pounds per square foot (psf) for ceilings on 24 inch centers and 2.2 psf for ceilings on 16 inch centers, and if the weight of R-60 cellulose at 17.5 inches thickness is 2.1 psf, and the weight of R-60 fiberglass at 22 inches is 1.0 psf, then for R-60 you either use 16 inch centers and cellulose, or 24 inch centers and fiberglass. While this may look like an advantage with fiberglass, the ceiling trusses must also be considered, and using 16 inch centers may allow the use of 2x4's vs 2x6's. Another example might be to use a combination of some level of high density spray foam for sealing, and then topped with either fiberglass or cellulose insulation. Note that this is shown as an example only, and the designer must check the manufacturer's specifications for actual load limits.

POSSIBLE EXAMPLES TO HELP REACH THE REQUIRED HERS SCORE AND OTHER USEFUL BUILDING DESIGN INFORMATION (cont'd):

Double Floor Joists:

For areas of your floor under a fireplace, or perhaps a kitchen island, have your designer check the load limits for the floor joists you're using. Do you need to double the joists in certain areas?

Fireplaces themselves can weigh anywhere from 200 to 700 pounds. And if you would like a nice stone or brick ledge in front of the fireplace, and stone or brick facing around the fireplace, suddenly you can have a 500 to 1000 pound load on your floor that has not been accounted for. Or maybe you want a nice one inch thick granite counter top on your kitchen island, and a sink and garbage disposal, and considering all the piping and electrical also needing support, you may need more than just the minimum floor joists that have been designed only to support a person or light furniture. A 6 inch deep, king size water bed mattress would weigh 1300 pounds. By comparison, the waterbed weight would probably be spread out more, less weight per joist, than a 1000 pound fireplace. Look for things on your plans that are heavy, and ask your designer if they have accounted for the weight.

Foundations and Band Joists Insulation:

When the foundation wall, or band joist is insulated, and codes require that we do this, the freeze point, 32 degrees, will move inside the wall to a point somewhere between the outside surface and inside surface of the insulation. When this happens, moisture vapor in the air will start to condense and accumulate on the inside surface of the rim joist or the foundation wall, just like the frost that can accumulate on a single pane window. Closed cell spray foam in these areas is considered a best practice. Another good practice is to glue foam board on these surfaces, but you must take care to glue all around the outside edge of the foam board to prevent moisture from getting behind the foam board. Both of these practices put the freeze point inside the foam, and stops the moisture vapor in the air from condensing, accumulating, and possibly causing rot or mold. Recent recommendations, or best practices, now recommend a small amount, 1 or 2 inches, of foam on the inside of wall cavities as well, for this same reason.

Mass Walls:

Brick and concrete are not insulators! The R-value of an 8 inch concrete wall will range between R-0.5 to R-1.5. This is very similar to an old single pane windows, R-1. However, brick and concrete have great heat capacities, or thermal mass! They can store lots of heat. The inside wall temperature on a typical wood frame home tends to want to swing with the outdoor temperatures. Brick or concrete walls, or insulated concrete form walls on the other hand, will actually delay the outdoor temperature from reaching the inside surface of the wall because it has a capacity to absorb the heat. While a similar amount of heat, or cold, is seen by each home, brick or concrete will tend to temper that heat, and lower the maximum and minimum temperatures seen by the home. Thermal mass will smooth out the temperature curve your home sees. This tends to even out the load on the heating and cooling system, and lower the maximum load. Thermal mass can also reduce energy use, and can shift energy use away from peak demand times.

HVAC Sizing:

The Energy Code limits the size of heating and cooling equipment (HVAC) to prevent short cycling. Oversized HVAC uses more energy, has less capacity to remove humidity, and fails prematurely, due to short cycling. Oversizing adds up to reduced comfort and increased costs for you, the homeowner.

In just the last few years we are seeing fully variable speed, and multi speed equipment, which allows us to slightly oversize while still maintaining efficiency and comfort. Another option is to use dual units inside the home, with one only running when oversize is desired. In all situations, proper sizing and proper design of ductwork is critical to maintain comfort and efficiency.

POSSIBLE EXAMPLES TO HELP REACH THE REQUIRED HERS SCORE AND OTHER USEFUL BUILDING DESIGN INFORMATION (cont'd):

ERV's and HRV's:

Build it tight and ventilate right. This is considered best practice.

Ventilation can be done using exhaust only, with bathroom or other exhaust fans, or supply only, drawing in fresh air using the furnace fan, or with balanced ventilation from an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV). HRV's and ERV's bring in new air and exchange and conserves both heat and moisture (ERV) or just heat (HRV) from exhausted indoor air.

The problem with the exhaust only approach is that that the air you exhaust must be replaced somehow, and you really don't know where that replacement air is coming into the house. The air coming into the house might not be that good. Supply only systems are better in this sense, because you at least know where the air is coming from. However, both of these systems cause you to expel air that you usually have paid to condition, and replacing that air with air you will need to condition again. The HRV's and ERV's give you fresh air from a location you know, and save you some of the cost you paid to condition the air you are exhausting.

What about clothes dryer exhaust at 250 cfm? Where does the air come from that replaces that? How about kitchen exhaust at 100 cfm or more? Bathroom exhaust at 30 cfm or more?

Ideally, we would have "all" our exhaust connected to HRV's or ERV's. Contractors are already starting to tie bathroom exhausts into the ERV's and HRV's. Are clothes dryers and kitchen exhaust next? With clothes dryers and ERV or HRV could save some of the dryer heat in the winter, but would require a bypass so that the dryer heat would still be exhausted in the summer. We would certainly need to filter air coming from a dryer that we send to an ERV or HRV, and maybe from a kitchen exhaust as well, but a typical furnace filter might accomplish this. Perhaps this is our next step, to have HRV's or ERV's that conserve and control the conditioning in all our exhaust air.

All spray foam is not alike:

Spray foam insulation is expensive, and all foams are not alike. High density spray foam costs are nearly the same as low density spray foams. High density spray foams will have R-values near 7 per inch. Low density foams will have R-values near 3.5 per inch. Know what you're getting.

Equivalent R-value – NO SUCH THING / Radian Barriers – GREAT IN OUTER SPACE:

Some manufacturers will tout "equivalent R-values." Do not be fooled by these ads. Some claim that reduced infiltration is equivalent to R-value. It is not. It is equivalent to reduced infiltration, which, when there is no wind, is zero! A good contractor, with a few tubes of caulk, can make infiltration near zero even when there is a wind! Some radiant barriers claim to stop up to 99% of radiant heat loss, which is great if you live in outer space. Here on earth, conduction and convection are our major heat loss/gain components. Stopping 99% of 1% is only 0.99%! Look for ASTM tested R-values. For R-value information consult the Federal Trade Commission's (FTC) "R-Value Rule." The maximum thermal resistance you can expect from radiant barriers has been tested and is listed in the ASHRAE Handbook of Fundamentals. Note the footnotes in the ASHRAE Handbook state that the values listed are for laboratory conditions, sealed air spaces, and flat and clean surfaces. Even a small amount of dust or moisture on a radiant surface greatly reduces its effectiveness. Imagine dressing in nothing but foil, vs insulated clothes, and walking a few miles to work on a subzero day.

Occupancy Sensors:

As a minimum these should be installed in your bathrooms to turn on lights and fans and turn them off at a set time after you leave. Wouldn't they be nice in your kids' rooms? The first rule of saving energy is to turn it off, and that's what occupancy sensors do.

POSSIBLE EXAMPLES TO HELP REACH THE REQUIRED HERS SCORE AND OTHER USEFUL BUILDING DESIGN INFORMATION (cont'd):

More Building Envelopes to consider:

In the article [*Insight Zeroing In, Net Zero Houses](#), by Joseph W. Lstiburek, Ph.D., P.Eng., Fellow ASHRAE, Building Science recommends the following building practices for Net Zero Homes:

R-5 windows	R-10 slab insulation	R-20 basement insulation
R-40 walls	R-60 roof insulation	Airtightness of 1.5 ach@50 Pa or less
Heat recovery on ventilation	LED lighting everywhere	SEER 18 or more for A/C
HSPF 10 or more for heating	Appliances from the top 10% of ENERGY STAR (Most Efficient)	
AFUE 95% sealed combustion condensing for furnaces, water heaters and boilers.		

(It is estimated that a 2800 square foot home built to these specifications would require a 7.5 kW solar system to reach net zero energy use with a “conserving lifestyle”.)

Or

Consider a foundation wall with a 12 inch top, 8 inches plus a 4 inch brick ledge. Set 2x4 framing 1.5 inches away from the wall. Insulate the interior of this wall with 1.5 inches of high density spray foam between the foundation wall and the framing, and fill the framing cavity with an R-15 batt for an R-24 foundation wall. On top of the foundation wall, set the rim joist inside the brick area plus 2-½ inches for a ½ inch rain screen, or drainage plain, and 2 inches of foam board, and fill the rim joist with 2 inches of high density spray foam with an R-19 batt behind it, or fill the rim with 5 inches of spray foam for an R-42 rim joist. On top of the rim, and again 2-½ inches inside the brick area for the rain screen, or drainage plain, and 2 inch foam board, start with 11/16 sheathing, then a 2x6 wall with cavities filled with 2 inches of high density spray foam followed by an R-15 kraft faced batt for an R-38 wall. Band joists and second floor walls would be the same R-38 to 42 construction. Cover walls, rims and bands with a breathable Tyvek type moisture barrier. Drape 1/4 or 3/8 inch “untreated” sisal ropes down the outside of the wall and across the brick ledge to create weep holes and act as wicks for the drainage plain and also to keep any brick mortar from completely blocking the rain screen or drainage plain (the “untreated” sisal will eventually decay away leaving weep holes and drainage through any mortar that falls into the rain screen/drainage plain). Spray 1” of foam in the attic for sealing purposes and top with insulation to an R-60. Vent the attic. R-20 down 3 feet on any walk out slabs, and slabs less than 4 feet below grade. Use ENERGY STAR Most Efficient Windows and Doors with U-value of 0.20 or less. Use termite caps between foam and wood.

Or

Consider Insulated Concrete Forms all the way to the roof, with 2x4 framing on 24 inch centers set ½ inch inside the ICF, with framing cavities filled with an R-15 batt, for R-35 walls all the way up. Spray 1” of foam in the attic for sealing purposes and top with insulation to an R-60. Vent the attic. R-20 down 3 feet on any walk out slabs, and slabs less than 4 feet below grade. Use ENERGY STAR Most Efficient Windows and Doors with U-value of 0.20 or less. Use termite caps between foam and wood.

Yes! These envelopes cost more. But they also greatly reduced the size of heating and cooling components you have to buy, saving you money, and if you are considering attempting a zero energy, or net zero energy home, these envelopes greatly reduce the amount of solar or wind you need to purchase and rely on, saving you money. Even if you are not considering solar or wind, these envelopes reduce your utility bills, again saving you money. Do they pay for themselves? If not completely, very nearly, but that’s at today’s energy prices. Tomorrow’s energy prices may show a different story.

POSSIBLE EXAMPLES TO HELP REACH THE REQUIRED HERS SCORE AND OTHER USEFUL BUILDING DESIGN INFORMATION (cont'd):

Lighting:

Compact Fluorescent Lights, CFL's, come in all sorts of colors! So do LED's! This isn't necessarily a good thing!

When we go to the store looking for a light bulb, a good recommendation might be to look for bulbs that list the CRI, which is the Color Rendering Index. The CRI is a comparison of the bulbs light to natural sun light. You should also look for the bulbs color temperature, which is an indication of the color of the light. A good neutral color bulb would have a CRI of 84 or higher, and a temperature of around 4000 Kelvin. Higher Kelvin temperatures will give a more blue light, and cooler temperatures tend toward yellow and then red. Direct sunlight is at 4800 Kelvin, a little blue, but this may be a little too blue for your liking. Instant Start, or short start times, are also often desirable.

For tube type fluorescent lighting, you can use the same CRI and color temperature recommendations. Tube type fluorescents can have CRI's in the 90's. It is also recommended to use "low harmonic" and "instant start" electronic ballasts when using tube type fluorescent fixtures.

LED efficiency is very similar to fluorescent efficiency. The big advantage of LED's is the life of the bulbs. Changing bulbs may become a once in a lifetime event with LED's. CRI's and color temperature still apply.

Induction lighting is a type of fluorescent lighting that does not require a spark to start the light. This greatly increases the life of the bulbs. Induction lighting is another big energy saver.

3/8 inch hot water piping:

Shower heads and faucets have been limited to 2.5 gpm and 2.2 gpm respectively. When this was done, maximum pipe size was not limited, and has stayed the same. Recommended maximum pipe velocities are between 5 and 8 fps. Full 2.5 gpm in 3/8 xps copper (smallest I.D. for copper) results in a velocity of 5.8 fps, and in SPS results in a velocity of 4.2 fps. Note that this is considering running nothing but hot water through the shower head. Typically we run our facets mixing some fraction of hot water with some cold water, so the water running in the hot water pipes is some fraction of the 2.5 gpm, or 2.2 gpm limits. The velocity will be the same fraction, and less than max recommended.

Advantage of smaller pipe size: Less water required to fill 3/8 vs 1/2 inch nominal pipe, means less time to hot water in the shower, and less energy loss from storing hot water in the pipes. In the case of XPS, 19% less time to shower, and 19% less hot water in the pipes.

Websites:

Manufacturer's web sites can also be good sources of technical information for your design.

www.buildingscience.com – for best practice information on the building envelope, framing, insulation, roofing, window and door installation, and everything else. This is an excellent site. The information section has tons of free best practice articles dealing with all aspects of residential building.

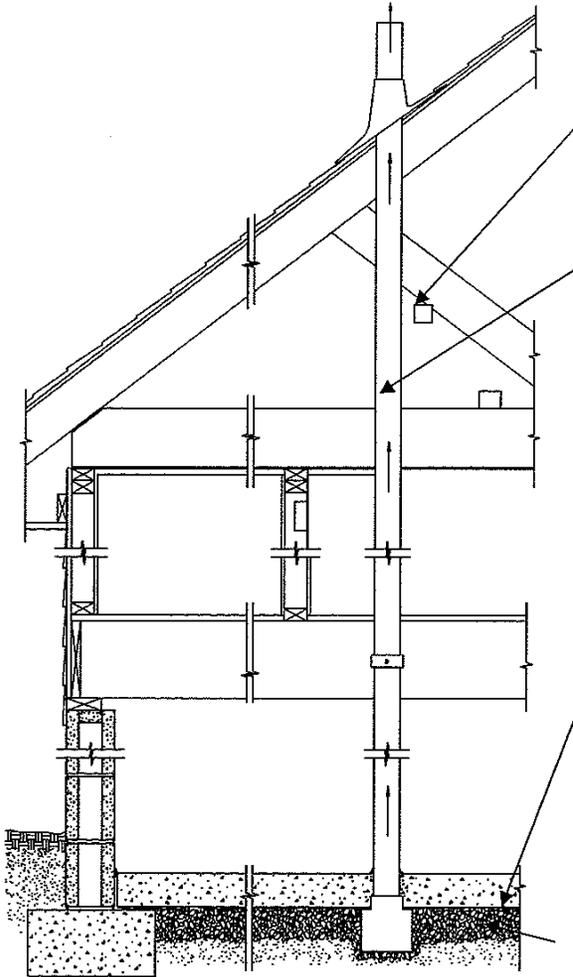
www.energystar.gov – in recent years, ENERGY STAR has developed a new level of efficiency they call "Most Efficient." This rating is similar to the top 10% of products with regard to efficiency. You may need to actually search the ENERGY STAR website for "Most Efficient" but they do have product lists, and they are the best with regard to efficiency! NOTE: For the Nebraska Energy Efficient Housing Loan Program, furnaces, air conditioners, and heat pumps must be currently listed in the AHRI online directory.

http://dhhs.ne.gov/publichealth/Pages/radon_index.aspx - for more information on radon in the State of Nebraska. Also see the radon example on the following page.

www.bulbs.com, www.lighting.phillips.com, www.sylvania.com, and other manufacturer and sales web sites can provide you with additional information on lighting and lighting fixtures. You can use these sites to find information on lighting CRI's and color temperature for bulbs (see "Lighting" above). *NOTE:* Manufacturer information is provided as an example, and for information only, and is not a recommendation of any kind.

POSSIBLE EXAMPLES TO HELP REACH THE REQUIRED HERS SCORE
AND OTHER USEFUL BUILDING DESIGN INFORMATION (cont'd):

MINIMIZE RADON AND SOIL GAS ENTRY INTO HOMES INSTALL A PASSIVE, SUB-SLAB, SOIL GAS VENTILATION SYSTEM



- Install an electrical junction box in the attic to permit the installation of a fan to activate the system, if needed.
- A 3- or 4-inch diameter PVC ventilation pipe vertically through the building floors. The ventilation pipe should have a "T" fitting bedded in the aggregate below the plastic sheeting and should terminate at least 12 inches above the surface of the roof.
- Seal all joints, cracks, or other openings around all penetrations of both exterior and interior surfaces, **below grade**, with an elastomeric sealant to provide an air-tight seal.
- Install 6-mil (or 3-mil cross laminated) polyethylene sheeting material on top of the aggregate material. The sheeting should cover the entire floor area and separate pieces of sheeting should be overlapped at least 12 inches. The sheeting should fit closely around any pipe or other penetrations of the material. Where practical, punctures or tears in the material should be sealed or covered with additional sheeting.
- Install a 4" thick layer of clean, 1/4 to 2-inch size aggregate to create a permeable layer (for soil gas collection below the basement slab) and provide a "*capillary break*" from the soil.

Notes:

1. Label all interior radon vent pipes as a "Radon Reduction System."
2. If the structure will have an interior sump to serve as the outlet point for an interior or exterior drain tile loop, then it should be covered with a gasketed or otherwise sealed lid to retard soil gas entry.

Additional information on building design, construction techniques and good building practices that should be considered as part of a general radon reduction strategy are available from *the Nebraska Radon Program Office* (1-800-334-9491) upon request.

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