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I. Introduction

This document is intended to serve several purposes:

• A guide to the architect who is designing the house and the builder who is building the house.
• An information repository for the homeowners. The amount of information about designing and building a house that we’ve gathered from books, periodicals, Internet web sites, etc. is overwhelming and this document will assist in organizing that information.
• A guide to resources and suppliers for other potential home builders.
• A template for others who are thinking about building a house and are looking for an example on how to organize their data.

Note that this document is dynamic and currently under development and will therefore be changing frequently over the next year. The most recent version publicly available will be online at http://www.bug-soft.com/craigh/house.html.

Note also that an “ideas binder” with photos and clippings is referenced herein and should accompany this document.

A. Goals

We desire to build a house that is energy efficient, fits our lifestyle, is aesthetically pleasing, is durable and is affordable. The objective is to find an acceptable balance between all those desirable but possibly conflicting goals.

1. Energy Efficiency

The house should be as energy efficient as possible although that is not the overriding objective.

According to the Wisconsin Department of Administration, Division of Energy ([DOE]), our lot location is in Degree Day Zone 10. This zone, which includes Dane, Columbia, Dodge, Jefferson, Rock and Green counties, averages 7673 heating degree days (deviations of mean daily temperature below 65˚F) and 465 cooling degree days (deviations of mean daily temperature above 65˚F) per year. This information will be used to determine the baseline level of insulation and heating/cooling requirements for the house. We will then extend these minimum requirements to the level of energy efficiency that we desire and can afford.

We will consider participating in the Wisconsin Energy Star program to verify that the energy efficiency of the house meets our requirements (see [Energy] for more information).

2. Lifestyle

• two person, two dog (Labrador Retrievers) household
• one person commutes to Madison for work, but not on a standard 9-5, M-F basis
• one person works out of the home

3. Aesthetics

The house should fit the building site as naturally as possible and be aesthetically pleasing to the eye. The house interior should be designed for comfort and efficiency of space. The size of the house should be approximately 2000-2300 sq. ft. of living space. In general, we favor the Prairie and Arts & Crafts styles and the use of natural materials where possible.
I. Introduction

4. Durable
The house should be built using quality materials with durability in mind. Recycling and efficient use of resources are honorable goals and the highest form of these goals with respect to house building is to build a house that will greatly outlive its occupants.

5. Affordable
Unfortunately we don’t have a bottomless checking account, so the budget will of course temper the preceding goals.

B. Timeline
The following is an approximate timeline of our design and building process:

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1999 - Nov. 2000</td>
<td>lot search</td>
</tr>
<tr>
<td>November 2000</td>
<td>close on lot</td>
</tr>
<tr>
<td>March 2001</td>
<td>lot topographic survey (completed by Badger Surveying &amp; Mapping Service, LLC)</td>
</tr>
<tr>
<td>March 2001</td>
<td>start design process with architect</td>
</tr>
<tr>
<td>Fall 2001</td>
<td>start building process with builder</td>
</tr>
<tr>
<td>Spring 2002</td>
<td>move in</td>
</tr>
</tbody>
</table>

C. Terminology
Book, periodical or website references appear between braces. For example, [Lyle] refers to The Book of Masonry Stoves: Rediscovering an Old Way of Warming by David Lyle. Full references can be found in section XVIII. References.

Items in italics indicate a title or a reference to a supplier or another section of this document. For example, Viking is a reference to a supplier and XIX.Suppliers is a reference to the suppliers section of this document.

D. Contacts

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   Madison, WI 53703
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   608.251.3836 fax
   linvillearchitects@prodigy.net

3. **Builder**

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   stevegallo@prodigy.net
I. Introduction
II. Siting

A. The “Lot”

The lot is located in the township of Montrose in Dane County in southern Wisconsin. The land consists of approximately 38 acres, of which 27 acres are in farm production. The remaining land consists of forest and road right-of-way.

The legal description of the lot is as follows:

The Southwest 1/4 of the Southeast 1/4 of Section 5, Township 5 North, Range 8 East, in the Town of Montrose, Dane County, Wisconsin, EXCEPT the North 2 acres thereof.

Parcel No: 20-0508-054-9130-5

A topo map of the land is included as Figure 1 on page XX-1.

B. Landscape Orientation

The house should be sited to take advantage of the natural landscape and plant formations of the lot. Landscape formations include the steep slope to the northeast, the woods to the north, east and south and the open field to the west (types of crops, i.e. alfalfa, corn, soybeans, etc., should be taken into consideration). Plant formations are primarily the trees that fall within or near the building envelope. Care should be taken to preserve as many of the viable trees as possible. Trees to the south of the building site may have to be thinned to increase winter solar gain (this may not be part of the initial building process). Refer to the lot topographic survey completed by Badger Surveying & Mapping Service, LLC for more information.

C. Solar Orientation

The house should be sited to provide passive solar gain during the winter. The long axis of the house should be perpendicular to true south, optimally within 15° of true south but minimally within 30°. The majority of windows should be on the southern face of the house although south facing glass area should not exceed 8 to 12% of the total living area unless new high performance units are used and precautions are taken to avoid potential overheating problems. If high performance window units are used the total glass area could be increased to 10% or 15% without increasing the overheating potential ([REED]). Ideally, there should be no windows on the northern side of the house, and 2-4% of the square footage in window area on each of the east and west sides of the house.

The winter and summer solar access angles should be taken into consideration for both siting as well as determining roof overhang lengths. The approximate coordinates of the lot are longitude: 89°34'0" West, latitude: 42°55'53" North. According to the online SunAngle calculator ([SunAngle]), the solar altitude for those coordinates at 12:00 noon on June 21, 2000 (summer solstice) was 70.51° and the solar altitude at 12:00 noon on December 22, 2000 (winter solstice) was 23.63°.

See the Solar Planning section of [REED] for more information on solar orientation.

D. Wind Orientation

The prevailing winds in the area should also be considered when siting the house. According to the The Wisconsin State Climatology Office ([Wind]), the annual average prevailing wind for Madison is
Siting

- 12.4 (miles per hour). See Table 1 on page 6 for a monthly breakdown of prevailing winds. Evergreen trees, vegetation, or earth berms, etc. may be used to shelter the house from winter winds and allow cross-ventilation from summer breezes.

**Table 1: Wisconsin Wind Data**

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Speed</th>
<th>Prevailing Wind</th>
<th>Calm</th>
<th>Peak Gust</th>
<th>Record Gust</th>
<th>Year of Record Gust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>10.5</td>
<td>WNW-11.5</td>
<td>6.0</td>
<td>44.0</td>
<td>NW-58</td>
<td>1978</td>
</tr>
<tr>
<td>Feb</td>
<td>10.4</td>
<td>WNW-12.0</td>
<td>6.9</td>
<td>40.6</td>
<td>NW-62</td>
<td>1987</td>
</tr>
<tr>
<td>Mar</td>
<td>11.3</td>
<td>NW-13.0</td>
<td>6.1</td>
<td>48.0</td>
<td>S-67</td>
<td>1990</td>
</tr>
<tr>
<td>Apr</td>
<td>11.4</td>
<td>S-11.4</td>
<td>6.4</td>
<td>47.7</td>
<td>SW-61</td>
<td>1981</td>
</tr>
<tr>
<td>May</td>
<td>10.1</td>
<td>S-10.4</td>
<td>7.0</td>
<td>47.3</td>
<td>SW-64</td>
<td>1975</td>
</tr>
<tr>
<td>Jun</td>
<td>9.2</td>
<td>S-9.7</td>
<td>8.4</td>
<td>50.7</td>
<td>W-83</td>
<td>1975</td>
</tr>
<tr>
<td>Jul</td>
<td>8.1</td>
<td>S-9.2</td>
<td>9.9</td>
<td>45.7</td>
<td>N-83</td>
<td>1991</td>
</tr>
<tr>
<td>Aug</td>
<td>7.8</td>
<td>S-9.1</td>
<td>11.1</td>
<td>46.7</td>
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<td>1989</td>
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<tr>
<td>Sep</td>
<td>8.6</td>
<td>S-9.8</td>
<td>9.9</td>
<td>40.1</td>
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<td>1985</td>
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<tr>
<td>Oct</td>
<td>9.7</td>
<td>S-10.4</td>
<td>7.8</td>
<td>45.0</td>
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<td>1990</td>
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<tr>
<td>Nov</td>
<td>10.8</td>
<td>S-10.7</td>
<td>5.7</td>
<td>44.4</td>
<td>W-55</td>
<td>1973</td>
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<tr>
<td>Dec</td>
<td>10.4</td>
<td>WNW-11.0</td>
<td>6.0</td>
<td>42.9</td>
<td>NE-58</td>
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<tr>
<td>Annual</td>
<td>9.8</td>
<td>S-12.4</td>
<td>7.6</td>
<td>61.9</td>
<td>W-83</td>
<td>Jun 1975</td>
</tr>
</tbody>
</table>

Notes:
- “Prevailing Wind” refers to the most frequently observed wind speed and direction.
- “Calm” refers to the percent of the hourly observations with no recorded wind.
- “Peak Gust” refers to the mean annual maximum gust.
- “Record Gust” refers to the speed and direction of the maximum gust during the period of record.
- All wind speeds are reported in miles per hour.
III. Exterior

A. Look & Feel

- long low lines
- not too boxy
- large overhangs
- exposed lower level?
- 1 or 2 story?
- banding of different color
- stucco at top, then cedar, then stone on bottom (e.g. a Linville house on Woodland Trail has grey stucco, siding, brick)
- red/orange or black metalwork (iron) rail on patio/porch (see Figure 2 on page XX-2)
- burnt red roof color
- colors (see Figure 3 on page XX-3)

B. Entryway

- covered entrance - partially hidden? (see Figure 4 on page XX-4)

C. Porch/Patio

General design parameters:

- porch vs. patio vs. deck?
- probably prefer screen porch with patio instead of deck
- red/orange or black metalwork (iron) rail on patio/porch (see Figure 2 on page XX-2)

1. Screen Porch

- good views - sunrise/sunset, woods
- enough room for table & chairs (i.e. for eating)
- wood walls & ceiling
- access via kitchen?
- approximately 170 sq. ft. in size

2. Patio

- space for grill
- space for dining
- flagstone or concrete (“orange/red terra cotta”) tiles
- landscaping to attract birds

3. Deck

- wrap around screen porch so faces East, South and West?
- french doors to deck from house?
III. Exterior

D. Garage

- 2-car w/ storage space
- hidden from view as much as possible
- place to hang bikes
- deep like homeowners current garage
- attached or semi-attached
- south facing & sloped for snow melting
- cement slab in front connecting to gravel driveway
- finished room over the garage?

E. Driveway

- gravel (~$4000 for 500 ft.)
- room to turn around at 1st corner & garage?

F. Landscaping

- bark vs. stone around house foundation?
- place for compost bin(s)
- grading as appropriate for water diversion (swale, berm, etc.)
- berms for weather protection?

1. Trees, Bushes, Grasses

- evergreens to contrast with deciduous tress in winter - Black Hills Spruce
- flowering trees and bushes
- trees with red berries in the fall
- fall witch hazel - yellow flowers and seed pods
- serviceberry, hawthorn?, American cranberry bush
- tall grasses
- wildflower/prairie restoration of “front yard” and field taken out of farm production
- minimal grass that needs mowing - keep yard as natural as possible

2. Gardens

- council ring with stone benches (see Figure 5 on page XX-4)
- raised cedar (see gardens in lower left of Figure 3 on page XX-3) vs. concrete perennial beds off of patio/deck
- large stones as bed borders/retaining walls/paths (limestone?)
- vegetable garden

3. Birds

- areas to attract birds that are viewable from the house - birdbath and feeders
- see page 248 in [Minnich] for plantings that will attract birds
III. Exterior

G. Dog Run

- pea gravel, cement or other flooring?
- drainage - dedicated drain or slope away from house
- sheltered by roof overhang and/or side walls
- easy but sheltered access from inside house, preferably via utility room or garage (2 door access for “airlock”)

H. Lighting

- consider HPS (high pressure sodium) lamps for exterior lighting - use seventy per cent less energy than a standard floodlight and last up to eight times as long ([REED])
- minimize light pollution with low spill lighting (no open yard lights)

I. Firewood Storage

- sheltered - most wood stored away from house

J. Shed?

- work area
- garden stuff & storage
IV. Interior

- Prairie/Arts and Crafts style
- use change in ceiling height to divide areas in rooms (e.g. 9 ft. ceiling in public areas, 7-8 ft. in private areas)
- paint - prefer earth tones: green, creamy yellow, brown, grey (no texturing)
- thick wood blinds vs. pleated shades vs. window quilts?
- simple window treatments if any
- tall (6 inch?) baseboards
V. Entry

General design parameters:

- coat closet
- place to sit and remove shoes/boots - built-in bench with storage (see Figure 7 on page XX-6)
- place to put shoes/boots - alcove with rack?
- art glass side panels on door
- half wall and columns (see Figure 7 on page XX-6)
- approximately 80 sq. ft. in size

A. Flooring

- ceramic tile, stone or slate
VI. Utility Room

General design parameters:

• located on main level
• first room entered from garage
• place to sit and remove shoes/boots - built-in bench with storage (see Figure 7 on page XX-6)

A. Size & Layout

• room to iron clothes?
• room to feed dogs and have their water dish accessible
• hidden laundry alternative? (see Figure 8 on page XX-7)
• sliding door to separate from kitchen? (see Figure 8 on page XX-7)
• approximately 120 sq. ft. in size

B. Storage

• closet for coats and hats
• laundry and cleaning supplies
• plant supplies?
• dog food
• dog accessories (leashes, brushes, medications, etc.)
• pull down ironing board?
• shoes & boots

C. Appliances

• front loading clothes washer and dryer
• front mounted controls - can have counter over the top?
• easy access to water valves (inset in wall) to relieve pressure on washer hoses?

D. Flooring

• quarry tile or slate floor
• easy to clean
VII. Kitchen

The kitchen will be part of an open floor plan in combination with the family room and dining room.

General design parameters:

- gourmet level
- plenty of counter-space for food preparation
- access to porch (via french doors?)
- approximately 330 sq. ft. in size

A. Breakfast Area/Nook

A breakfast area with the following characteristics is desired:

- near or within the kitchen for easy access
- in a corner and/or with lowered ceiling (alcove)
- built-in benches (see Figure 9 on page XX-8) and table (see photos in Kitchen section of ideas binder)
- plain wood benches (easy to slide in and out) with storage underneath
- seating for 4 or more
- windows to exterior - eastern exposure
- see [Counts] for more information on breakfast nooks

B. Appliances

All or most large appliances should be professional quality with stainless steel finish.

1. Range

- Viking or similar quality
- freestanding with integrated oven(s)
- 6 or more gas burners or 4+ burners with grill, 36-48” width
- integral shelf
- gas or electric (preferred) oven
- placed in separate alcove (preferred) vs. integral with countertops
- some open counterspace next to range on either side
- ~$5000 with oven (36”)

2. Vent Hood

- sized appropriately to the range
- ducted to outside
- note any requirements for minimum duct length (for sound levels)
- minimal sound levels (exterior mounted fans?)
- no overhead cabinets directly next to vent hood
- integral task lighting?
- ~$1000
VII. Kitchen

3. Ovens
   - two ovens total
   - 1 wall oven and 1 integral with range
   - gas or electric?
   - ~$2000

4. Plate Warming Drawer?
   - ~$1000

5. Microwave
   - built-in or freestanding?
   - above second oven?
   - ~$400

6. Refrigerator
   - Sub-Zero or similar quality
   - 30” (preferred) or 36” width
   - bottom mount freezer
   - ~$5000

7. Dishwasher
   - Asko, Bosch or similar quality
   - stainless steel interior and exterior
   - energy efficient
   - $500 - $1000

8. Garbage Disposal
   - avoid garbage disposal with septic system?

C. Flooring
   - quarry tile, large block, matte finish? (see Figure 10 on page XX-9)
   - bamboo? ($5.40/sq. ft.)
   - birch, cherry, maple (preferred) hardwood or laminate?
   - choices may be limited if radiant floor heating is used

D. Lighting
   - low voltage lighting?
   - all or most lights on dimmers
   - fair number of windows
   - large window over sink that comes all the way down to countertop/backsplash
   - see the article The Well-Lit Kitchen in [FHB_KB2000] for more information
1. Ambient
   - central overhead needed?
   - appropriately placed cans

2. Task
   - overhead lighting for island, range, sinks, countertop work areas, etc.

3. Accent
   - rope lighting above cabinets
   - rope lighting inside cabinets that have glass doors
   - rope lighting under cabinets at kickboard level?

E. Countertops
   - large block granite or tile backsplash behind range?
   - built-in cutting board with curve beyond counter edge (see Figure 11 on page XX-10)
   - honed black granite vs. slate vs. soapstone vs. Fireslate (a combination of portland cement, silica sand and fillers - available from Fireslate)(see Figure 12 on page XX-11)

F. Sinks/Fixtures
   - no rim on sink
   - large single bowl sink vs. 2 bowl sink (1 large & 1 small)
   - small prep sink on island
   - gooseneck or articulated arm faucet?
   - articulated arm faucet near range?
   - sprayer?
   - shop for sinks and faucets as a unit!

G. Storage
   - place for cookbooks - on island shelves? (see Figure 13 on page XX-12)
   - pantry - walk-in vs. pullout shelves? (see the article Designing A Pantry in [FHB_KB2000] for pantry design information)
   - spice storage - drawer insert?
   - appliance garage - corner location
   - deep utensil drawer
   - knife drawer with slots located near cutting board
   - place for small pull-out TV?
   - swing-out susan for pots in corner cabinet (see Figure 13 on page XX-12)
   - pull-out wastebasket/recyclables

H. Office Area
   - desk for phone and computer
VII. Kitchen

- storage for wine information - hanging file drawers?
- “cubby-hole” storage
- cork-board for messages

I. Island

- center island
- butcher block or partial butcher block countertop
- prep sink
- near refrigerator

J. Cabintry

- maple with darker stain or cherry (preferred) with lighter stain (pear)
- simple, flat door style (Shaker?)
- round, silver knobs on doors
- old style drawer pulls
- some leaded or frosted glass doors (see photos in ideas binder for examples)
VIII. Dining Room

The dining room will be part of an open floor plan in combination with the kitchen and family room.

General design parameters:

- quiet calming view
- wallspace to accommodate homeowners travel photos
- music - additional speakers or use family room speakers?
- separate intimate feel

A. Size & Layout

The dining room should be large enough to accommodate the homeowners table, chairs and sideboard with appropriate clearances. Dimensions are as follows

- table w/o leaves: 48” x 72”
- table w/ leaves: 48” x 96”
- chairs: 6 @ 46” x 18” x 20” and 2 @ 46” x 27 3/4” x 20” (HxWxD)
- sideboard: 63” x 45 1/4” x 18” (WxHxD)

The dining room should maintain a separate intimate feel but should not be closed off from the kitchen and family room. The dining room could be separated from kitchen via a snack bar with overhead cabinets or from the family room via a fireplace (see Figure 14 on page XX-13). Overall size should be approximately 200 sq. ft.

B. Look & Feel

- the dining room should match the style of the homeowners dining room furniture described above
- mottled beige wall color called “rose chamois” (see Figure 15 on page XX-14)
- colors to coordinate with fabric on homeowners dining room chairs

C. Flooring

- maple or oak floor w/ area rug?

D. Lighting

- built-in sconce lights and/or chandelier in the prairie style
- good lighting control - separate from kitchen and/or family room

E. Windows

- quiet, calming view - at least visual connection to outside
IX. Family Room

The family room will be part of an open floor plan in combination with the kitchen and dining room.

A. Size & Layout

The size should be approximately 330 sq. ft.

B. Look and Feel

• wall paint: mustard or sage
• wood beams on ceilings
• string course on walls

C. Appliances

1. Television/VCR
   • inside built-in cabinet with doors that close
   • audio switchable to run through stereo speakers?
   • surround-sound components (approx. $1000): decoder/player, 1 center channel speaker, 2 front speakers, 2 surround speakers, 1 subwoofer

2. Stereo
   • shelving to accommodate current components
   • will probably get new speakers: small bookshelf speakers + subwoofer

D. Storage

• built-in bookshelves for photo albums, books, etc.
• built-in CD or record storage vs. storage in pull-out drawers
• put bookshelves or CD storage under windows?
• see Figure 16 on page XX-15 for examples

E. Masonry Heater/Fireplace

• large stone fireplace or masonry heater (see 1. Masonry Heater on page 39)
• tile or terra-cotta on the fireplace?
• centrally located
• wood storage
• for examples see Figure 17, Figure 18, Figure 19 and Figure 20

F. Flooring

• carpet - low cut end shag?
• maple or oak?
• may be determined by heating system (i.e. radiant flooring)
IX. Family Room

G. Furnishings

- large, squared wood couch/chairs w/ upholstery (leather?) on seat/back only (future purchase)
- leather reading chair with footstool

H. Lighting

I. Windows
X. Office

General design issues:

• preferably near main entrance
• separate external entrance?
• lower level or 1st floor preferred, 2nd floor ok
• separate room for noise containment
• should be in “cooler” part of house due to heat generated by computers (may not be very important if zoned AC is used)
• should have minimal direct sun exposure (i.e. no windows to south)
• glass doors to open up space?
• approximately 200 sq. ft. in size

A. Flooring

• suitable for rolling chair
• durable - can stand up to heavy rolling equipment rack
• low static or ESD (electrostatic discharge) surface
• color coordinate with black/light gray computer workstation & rack and purple chair
• consider linoleum, cork, industrial rubber, industrial carpet, low-pile carpet, etc. (see XVII.Flooring on page 47 for more information.)

B. Wiring

• separate electrical circuit(s) (TBD - need to determine current power requirements)
• computer network wiring (Cat 5) in walls (TBD - may not need this if wiring is kept with workstation and wireless network is used)

C. Size

• large enough for current computer workstation & workbench
• room for teak bookcase (TBD - may not need if enough built-ins are provided)

D. Storage

• built-in bookcases
• built-in storage for supplies (e.g. closet)
• shelving sized to accommodate project bins (e.g. Sterilite)

E. Lighting

• windows desirable although computer monitors must be placed appropriately to avoid glare
• ambient overhead lighting - avoid glare problems with computer monitors
XI. Bedrooms

A. Master Bedroom

General design parameters:

• located on upper level
• interesting paint colors - gold tone
• dropped wood border
• lowered ceiling over bed

1 Size & Layout

The master bedroom should be large enough to accommodate the homeowners bed, double dresser with mirror and armoire as well as a chair or bench to be purchased later. Dimensions are as follows:

• queen bed: TBD
• double dresser w/ mirror: TBD
• armoire: TBD
• chair/bench: TBD

Estimated size is approximately 230 sq. ft. not including closet or bath.

The master bedroom should also include a large walk-in closet with shelves for sweaters and shoe racks. Estimated size is 90 sq. ft.

2. Look & Feel

• lowered ceiling and wall color as shown in Figure 21 on page XX-20.

3. Flooring

• carpeting? (see XVII. Flooring on page 47 for more information on floor coverings)

B. Bedroom 2

General design parameters:

• main guest room with new bed, nightstand, dresser (old vs. new?)
• interesting paint color
• approximately 120 sq. ft. in size

1. Flooring

• carpet

C. Bedroom 3

General design parameters:

• futon, old dresser (TBD)
• interesting paint color
• desk (built-in preferable) with room for computer?
XI. Bedrooms

- desk under corner windows (see Figure 21 on page XX-20)
- shelves for books and magazines
- hanging file storage
- area/alcove, possibly covered, for dog crates (if covered, put plants on top)

1. **Size & Layout**

   The 3rd bedroom should be large enough to accommodate the homeowner’s futon and old dresser as well as space for a desk and storage so that the room can serve as a secondary office.

   - futon size: TBD
   - old dresser size: TBD

   The overall size should be approximately 120 sq. ft.

2. **Flooring**

   - carpet
XII. Bathrooms

A. Master Bath

General design parameters:

- 2 sinks
- paint (unless bath has a window, then wall paper ok) - sage color
- quiet ventilation fan (vented to outdoors, not attic)
- not too big - approximately 70 sq. ft. in size

1. Shower
   - easy cleaning shower stall - no tub or whirlpool
   - matte finish tile on shower wall?
   - slate for walls?
   - shower stall without door?

2. Flooring
   - slate vs. ceramic tile (matte finish) vs. linoleum

3. Lighting
   - low voltage lights?

4. Countertops
   - like granite, slate, tile - tumbled or textured

5. Sinks/Fixtures
   - granite vs. solid surface sinks
   - low flow shower head

6. Cabintry
   - cherry vs. maple cabinets?

B. Guest Bath

General design parameters:

- 1 sink
- 2 different paint colors, bring in red/orange color (see Figure 22 on page XX-21)
- patina “cracked” looking wallpaper or is this paint?
- quiet ventilation fan (vented to outdoors, not attic)
- small - approximately 60 sq. ft.

1. Shower
   - integral tub & shower
   - matte finish tile on shower wall?


XII. Bathrooms

2. Flooring
   • slate vs. ceramic tile (matte finish) vs. linoleum

3. Lighting
   • low voltage lights?

4. Countertops

5. Sinks/Fixtures
   • granite vs. solid surface sink
   • low flow shower head

6. Cabintry
   • cherry vs. maple cabinets?

C. 1st Floor Bath

   General design parameters:
   • wallpaper vs. paint?
   • near office/kitchen
   • approximately 25 sq. ft.

1. Flooring
   • slate vs. ceramic tile (matte finish)
   • depends where it is - may continue from another room (wood, laminate, granite?)

2. Lighting
   • low voltage lights?

3. Sinks/Fixtures
   • pedestal sink vs. exposed plumbing with counter only
   • Kohler wood with ceramic bowl?
XIII. Stairs, Halls, Basement, Etc.

A. Stairs, Halls, Etc.

• shelves on stairway and/or landing (see Figure 23 on page XX-22)
• central stair should not be right next to masonry heater (chimney effect)
• space for bike windtrainer
• space for dog beds in corners of upper level hall
• low windows - dogs like to look outside
• colors we like: bedroom alcove colors in Figure 21, wall colors in Figure 24 and Figure 25

B. Basement

General design parameters:

• space for chest freezer
• utility sink
• place to bathe dogs? - drain, hand-held shower nozzle on sink?
• room for shelving homeowners currently own
• general storage area

1. Wine Cellar

• 55° optimal temperature
• 70% optimal relative humidity (need vapor barrier)
• 1000+ bottle capacity (approximately 50 sq. ft. in size)
• prefer passive cooling if at all possible - may require that wine cellar be isolated from the basement slab (i.e. don’t necessarily want the slab under the cellar insulated)
• see [Gold] for more information

2. Root Cellar

• low temperature (varies w/ type of produce)
• high humidity, 80-90% (earth or dirt floor)
• venting desirable (some fruits/vegetables outgas)
• see [Bubel] and [Walton] for more information

3. Workshop

• unfinished basement ok
• room for workbench, ski waxing, etc.
XIII. Stairs, Halls, Basement, Etc.
XIV. Construction

There are seemingly an infinite variety of construction techniques and every builder seems to have their own preferences and biases. After much research, we’ve attempted to list what we feel are some of the important construction parameters in this section. The content of this section will likely change after we start working directly with the builder.

Sources of material for this section include the Gimme Shelter Construction Specifications ([Gimme2] included as an attachment) as well as the other references listed in section XVIII. References under Construction.

A. Foundation

- ground graded (5% or more) away from foundation for water diversion
- exterior drainage at footing level
- sealed sill (closed cell neoprene) - may not be required if vapor barrier is done properly
- insulated on outside?
- poured concrete

1. Framing

- 2x4 construction set 2-3” from interior foundation wall (2” sufficient if foundation is mostly below grade)
- 5 1/2 - 7” BIB (blown in batt) fiberglass (R-4/in.)
- vapor barrier sealed to barrier under basement floor

B. Floors

1. Basement

- cement slab
- insulated and vapor-barrier
- radiant heating?

a. Sump

- sealed sump with radon vent through roof
- sump pump with backup battery if required

2. Interior

- joists vs. engineered joists vs. trusses?
- trusses are very convenient for routing ductwork, wiring, piping, etc. but are normally only used with long runs or high load bearing requirements
- plywood vs. wood subfloor (no OSB!)
- must meet load bearing requirements if in-floor radiant heating (concrete) is used

3. Attic

- 16” minimum blown in cellulose insulation (R60)
- energy heel (12”) truss or similar rafter framing
C. Exterior Walls

1. Framing
   - 2x6 construction, 24” OC
   - 2x2 or 2x4 horizontal strapping (24” OC) on interior side
   - may need window/door jamb extensions due to wall thickness (~$7 more per window from Pella for thick walls)

2. Insulation
   - 7 1/4” BIB (blown in batt) fiberglass (R-4/in.)

3. Sheathing
   - 3/4” shiplap pine (sustainably harvested) vs. plywood
   - regular (i.e. pine) vs. fir plywood

4. Interior Air/Vapor Barrier
   - 6-mil polyethylene minimum
   - minimal number of staples
   - all seams overlapped and taped or sealed with acoustical sealant
   - all seams over solid backing (e.g. studs)
   - placed within the first one-third of the total assembly R-value (measured from the warm side)
   - covered by drywall or plasterboard
   - thin-coat plaster for thermal mass

5. Exterior Air Barrier (housewrap)
   They protect the wall system from the effects of wind, rain and snow. This keeps the insulation and framing components dry while improving the thermal performance by greatly reducing exterior air penetration into the wall. These products are designed to allow water vapor out of the wall system while virtually eliminating air penetration from the exterior. Available as either sheeting applied material (large rolls) or laminated to rigid insulation sheathing, seams need to be sealed with special tapes to work effectively.

6. Penetrations
   - minimize number of penetrations (light switches, outlets, etc.)
   - all penetrations should be sealed (caulked or taped)
   - all electrical outlets should use airtight boxes on exterior walls
   - air/vapor barrier strip around window openings

D. Interior Walls

- 2x4 or 2x6 construction as needed for non-load bearing or load bearing walls
- thin-coat plaster for thermal mass
- insulated for sound-proofing?
E. Windows

- double glazing or double glazing with built-in storms
- low-E, argon filled
- casements and awnings are more efficient in general
- recommended use of awnings is low on south wall or high on north or east walls for venting

F. Doors

1. Exterior Doors
   - insulated (R-10 is good)
   - any glass should be high-performance glazing
   - good weatherstriping to minimize air leakage

2. Patio Doors
   - garden, terrace or french doors are more energy efficient than sliding doors
   - avoid northern exposures and prevailing winds

G. Siding

1. Materials
   a. Aluminum/Steel/Vinyl
      - $2-3 sq. ft. installed
   b. Wood
      - requires maintenance (oil-based stain)
      - seal all 6 sides when installing
      - always use butt joints on wood or cement fiberboard
      - do NOT caulk, seals moisture in!
      - $7-10 sq. ft. installed
   c. Fiber-Cement
      - low maintenance
      - lower insurance rate?
      - e.g. Hardiplank, 50-yr warranty (see James Hardie for more info)
      - $7-10 sq. ft. installed
   d. Stucco (synthetic)
      - may have problems with freeze/thaw cycle
      - don’t install over foam
      - expensive to fix
XIV. Construction

- $10 sq. ft. installed

e. Brick
- $12+ sq. ft. installed

f. Stone
- $15+ sq. ft. installed

H. Roof

1. Ventilation
- For every 300 sq. ft. of ceiling area, there must be 1 sq. ft. of free ventilation area provided by soffit and roof or gable end vents (a 300:1 ratio - 300 sq. m. of ceiling area vented by 1 sq. m. of vent) ([REED])

2. Materials

a. Metal
- preferred
- standing seam galvanized steel can cost $250 a square (100 square feet)
- re-paint every 15-20 years
- see Metal Roofing Alliance ([MRA]) and suppliers under C.Construction Materials on page 55

b. Asphalt
- fiberglass mat (Class A fire rating) or organic mat (Class C fire rating)
- warranty duration: 20, 25, 30 or 40-year (average effective lifespan: 17 years)
- regular shingles might cost from $70-$90 a square (100 square feet) to as much as $120-$250 a square for a high-end, quality product
- see the article [Asphalt] for more information

i. Advantages
Available in a wide range of types, colors, and patterns, asphalt shingles are by far the most popular residential roofing material. Under most conditions asphalt shingles perform satisfactorily. Laminated shingles can dramatically enhance the building's appearance, especially those with higher roof pitches. Can be applied over one layer of flat existing asphalt shingles, but reroofing directly over sheathing is best. Relatively economical material with low first costs, compared to other materials. Easily installed.

ii. Disadvantages
Confusing claims and warranties, and the proliferation of material types and specifications, make it difficult to compare and evaluate different manufacturers' products. Com-
peting products are not necessarily equal, and warranties, specifications, and testing data should be carefully examined and compared. Some asphalt shingle products may perform unsatisfactorily, especially in hot, arid climates where thermal shock conditions (high heat with rapid cooling from thunderstorms) occur. Roofs may darken or stain from excessive moisture or humid conditions. Being a product of nonrenewable fossil materials, asphalt shingles are not the best choice from a sustainability standpoint.

c. Other

- concrete, tile, slate, and similar roofs can cost $500+ a square
A. Heating

Our preference is to use a masonry heater as the primary heat source with a radiant in-floor system as a secondary heat source. Other options, including forced-air, are examined below.

1. Masonry Heater

The masonry heater will have the following characteristics:

- wood-fired
- centrally located between the open kitchen, family room, dining room area
- firebox access towards family room
- bake-oven option with access towards kitchen area
- outside combustion air intake if required by code
- warming benches
- integral wood storage area
- supporting foundation in basement (poured cement or cement block on appropriate footings)
- factory built heater core (cheaper than full custom masonry)
- custom masonry facing of brick or stone or tile?
- chimney must be of appropriate height to prevent backdrafting
- should fall under standard building codes for masonry fireplaces (see [ASTM] for a national standard if building inspector needs more information)
- Heat-Kit brand core is recommended since it can be obtained locally and installed by experienced personnel (Gimme Shelter). Other suppliers are listed in section D. Masonry Heaters on page 56.
- estimated cost: $10,000 - 15,000 ($6500 for core unit with bench, $1000 foundation, $1000 chimney, $? facing)

See the following for more information:

- attachment 2. Gimme Shelter Masonry Stoves
- attachment 3. “Short Course on Masonry Heating Systems” by Norbert Senf, Masonry Stove Builders
- attachment 4. Dulley Update Bulletin No. 847 - Masonry Fireplaces
- [Lyle]

2. Radiant Floor Heating

General requirements:

- zoned (1-4 zones should be sufficient)

See the following for more information:

- [Hydronics], [Radiant] and [RPA]

a. System Types

- radiant air floors (air is the heat carrying medium)
- electric radiant floors
- hot water (hydronic) radiant floors - most popular and cost effective (preferred)
XV. HVAC

- baseboard - less expensive but less efficient due to lower thermal mass. Use with carpeting.

b. Installation Types

- wet: large thermal mass of a concrete slab floor or lightweight (thin slab) concrete over a wooden subfloor
- dry: radiant floor tubing sandwiched between two layers of plywood or attached tubing under the finished floor or subfloor
- a wet floor has much better thermal mass, a dry floor is faster and less expensive to build

c. Floor Coverings

- ceramic tile or concrete is the most common floor covering
- almost any floor covering can be used but some perform better than others
- anything that can insulate the floor also reduces or slows the heat entering the space in turn increasing fuel consumption
- while solid wood flooring can be used, the installer is strongly advised to be very familiar with radiant floor systems before attempting to install natural wood flooring over a radiant floor system

d. Advantages

- even heating throughout the whole floor
- room heats from the bottom up, warming the feet and body first
- eliminates the draft and dust problems associated with forced-air systems
- even heat distribution equates with lower heating bills
- radiates heat for a longer period of time than a forced air system
- does not increase the infiltration of outside air into the house
- allows lower boiler temperatures allowing them to last longer (a 45 year life is not unusual)
- fuel saving of 15% to 20% over a forced air system is common
- no heat registers or radiators - system is “invisible”
- no fan noise

e. Disadvantages

- additional floor support may be necessary because of the added weight
- cost of installing a hydronic radiant floor is approximately $4-6 per square foot
- cannot be used for cooling in humid climates (due to condensation)
- thermal delay with a concrete slab can be significant (takes a long time to warm up if allowed to cool)
- floor covering restrictions
3. Gas Boiler

4. Spot Room Heating
   - electric
   - Eco-Therm gas room heaters

5. Forced Air Gas Furnace
   General requirements:
   - high efficiency
   - zoned
   - variable speed blower
   - all duct joints sealed with mastic (NOT duct tape)
   - cost is typically 2/3 that of a hydronic radiant system

B. Ventilation

Due to a tight building envelope and the potential for excessive house depressurization by high exhaust flow appliances, an active ventilation system is required. General ventilation system requirements:

- **active** - cannot rely on natural building envelope leakage
- **balanced** - incoming air flow should match outgoing air flow. A make-up air system may be required to compensate for powerful exhaust ventilators (range hood, dryer).
- **safe** - must maintain sufficient air flow to avoid excessive house depressurization which can cause gas/wood burning appliances (masonry heater, furnace, range, water heater, etc.) to backdraft
- **energy efficient** - should allow heat recovery and system (units and ductwork) should be sized appropriately for optimal operation

The ventilation system should take into account the typical air flows of all intermittent exhaust devices such as bathroom fans, kitchen range hood, clothes dryer, central vacuum, etc. as well as the average air flows of chimney vented combustion systems such as gas furnace, gas water heater, masonry heater, etc. ([Gulland], page 87).

In order to determine ventilation and make-up air requirements, a blower-door house depressurization test will likely be required. For more information on ventilation requirements with respect to gas/wood burning appliances, see [Gulland].

Other design requirements:

- all ductwork should run through internal walls (no exterior wall or attic ductwork)
- all ductwork, furnaces and air handlers should be sealed against air leakage (with mastic). This includes supply plenum, attachments to air handler or furnace, return plenum, etc. Seams near air handler or furnace should be sealed with both fiberglass mesh and mastic due to local vibration and flexure.
- use round, rigid ducts and 45° take-offs wherever possible
- duct sizing requirements should be observed for all appliances
- minimum/maximum duct length requirements should be observed for all appliances
XV. HVAC

- no returns in basement
- return systems should be hard ducted and sealed with mastic - no building cavities should be used as returns (i.e. stud bays or panned joists)
- no HVAC return or exhaust ducts should be located near the kitchen range hood
- range hoods and clothes dryers should not be exhausted through an air-to-air heat exchanger because of potential grease and lint problems
- filtration of inside/outside air should be addressed
- exterior air intake and exhaust vents should be separated by at least 12 feet to eliminate cross-contamination
- initial duct runs for outside air should be insulated
- variable speed blowers should be used where possible
- entrance/exit points for ventilation ducts should be located on side walls (avoid venting through the ceiling plane)

See E.HVAC on page 56 for a list of suppliers.

1. **Heat Recovery Ventilator**

A heat recovery ventilator with dedicated ductwork can be used to provide active and balanced ventilation.

- usually 3 exhausts total located in bathrooms or kitchen
- use 6” ducts, not 4” ducts
- use solid ductwork, not flexible (seal joints with mastic)
- incoming air is usually run to single point - typically the basement since the air is cool
- can use override switches to increase exhaust from specific areas (bathrooms)
- 2-speed or low-speed continuous is best
- parallel exhaust only systems may still be required in bathrooms and kitchen
- ~$1500

2. **Central Exhaust Ventilator**

A central exhaust ventilator is probably not suitable for the house since it doesn’t provide make-up air (i.e. not a balanced system).

3. **Make-up Air System**

Make-up air systems are described in detail in [Gulland] pages 81 - 90. General design requirements:

- amount of make-up air required should be determined by a blower door test
- make-up air flows above 200 CFM may require a supplementary duct heater to temper cold incoming air

4. **Intermittent Exhaust Devices**

All the following devices should be directly vented to the exterior.
a. **Kitchen Range Hood**
   - should be directly vented to the exterior

b. **Bathroom Fans**
   - can be directly vented to the exterior or can be part of a balanced ventilation system. In general it’s best to have separate point-source exhausts in bathrooms even if exhausts for a balanced ventilation system are used.

c. **Clothes Dryer**
   - should be directly vented to the exterior

d. **Central Vacuum**

5. **Chimney Vented Combustion Systems**
   Only sealed combustion, direct vented, power vented or induced draft appliances should be used.

   a. **Gas Furnace**

   b. **Gas Water Heater**

   c. **Masonry Heater**

C. **Air Conditioning**

1. **Whole House Fan**
   - usually operate at night if outside air is cooler

2. **Ductless Split-System**
   - can be wired at build time and installed later if needed
   - usually only installed in 1 or 2 strategically located rooms (bedroom, office)

3. **High Velocity**

4. **Forced Air**
   A forced air conditioning system usually consists of two parts: an outside compressor and an inside air handler. The blower of a forced air furnace often doubles as the air handler.
D. Water Heater

1. **Solar**

   “Domestic solar water heating systems are a proven technology which can make a significant contribution to the hot water requirements of the average family. A wide variety of solar domestic hot water systems are available. Modern solar water heaters will now work when the outside temperature is well below freezing and are protected from overheating on hot, sunny days. Many models also have their own built-in, back-up heater which can meet all of a consumer's hot water needs - even when there is no sunshine.” ([REED])

2. **Gas (LP)**
   - could be combined with gas boiler for hydronic heating
   - should be sealed direct vent (not draft hood type)

3. **Electric**
XVI. Utilities

A. Electricity
   • above ground poles vs. underground? (underground: $5/ft. x 500 ft. = $2500)
   • coordinate with driveway installation?

B. Gas
   • LP tank - size? cost? location?

C. Septic
   • mound required
   • septic tank below level of house (gravity flow - no backflow)!
   • consider 2nd septic tank ($700) if near woods
   • drainfield life is 20 yrs. minimum
   • new baffle system in mound is recommended
   • ~$10,000
   • graywater system?
   • see [Kahn] for more information

D. Water
   • well
   • use appropriately sized well tank
   • ~$5000 (250 ft. x $20/ft.)

E. Telephone
   • coordinate with driveway installation
   • $?

F. Satellite
   • may need for TV and/or Internet access
XVII. Flooring

A. Wood

B. Cork

- $5 - $8/ft.$^2
- need to seal twice a year (easy, mop it on)
- 5 yr. warranty
- see Natural Cork on page 57 for more information

C. Linoleum

- 10 yr. warranty
- porous - reseal annually
- see Natural Cork on page 57 and Forbo-Nairn Floorcoverings on page 57 for more information

D. Industrial Rubber

E. Industrial Carpet

F. Low-pile Carpet

- wool
- sisal

G. Ceramic Tile

H. Stone (Slate, Limestone, etc.)

I. Concrete

- pigmented
XVIII. References

A. Architecture/Design


[Alexander3] Online guide to using the patterns from *A Pattern Language*. http://www.jacana.demon.co.uk/pattern/


B. Construction


XVIII. References


C. HVAC


D. Energy Efficiency


E. Kitchen & Bath


XVIII. References


F. Electrical/Plumbing


G. Landscaping


H. Wine/Root Cellar


I. Miscellaneous Web Sites

Table 1: General Building

<table>
<thead>
<tr>
<th>Website</th>
<th>URL</th>
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<tbody>
<tr>
<td>Alternative Building - ArchitectureWeek Online Library</td>
<td><a href="http://www.architectureweek.com/topics/handmade.html">http://www.architectureweek.com/topics/handmade.html</a></td>
</tr>
<tr>
<td>Beautiful house plans, home building products, home builders, and a builder magazine at builderonline.com</td>
<td><a href="http://www.builderonline.com/frmHomePage/0,1002,%E2%80%991%E2%80%99,00.html">http://www.builderonline.com/frmHomePage/0,1002,’1’,00.html</a></td>
</tr>
<tr>
<td>Buildscape.com - In Depth Stories</td>
<td><a href="http://diy.buildscape.com/resources/indepth/">http://diy.buildscape.com/resources/indepth/</a></td>
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### Table 1: General Building

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<th>Source</th>
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<tbody>
<tr>
<td>Construction Concepts</td>
<td><a href="http://www.constructionconcepts.net/">http://www.constructionconcepts.net/</a></td>
</tr>
<tr>
<td>Documenting Internet Sources in MLA Style</td>
<td><a href="http://www.english.eku.edu/HARNACK/ENG301/MLA.htm">http://www.english.eku.edu/HARNACK/ENG301/MLA.htm</a></td>
</tr>
<tr>
<td>Frank Lloyd Wright Home and Studio Foundation</td>
<td><a href="http://www.wrightplus.org/index.html">http://www.wrightplus.org/index.html</a></td>
</tr>
<tr>
<td>Green Built Home</td>
<td><a href="http://www.wi-ei.org/GBH/index.htm">http://www.wi-ei.org/GBH/index.htm</a></td>
</tr>
<tr>
<td>Guide for Writing Research Papers</td>
<td><a href="http://webster.commnet.edu/mla.htm">http://webster.commnet.edu/mla.htm</a></td>
</tr>
<tr>
<td>Home and Garden</td>
<td><a href="http://www.growinglifestyle.com/">http://www.growinglifestyle.com/</a></td>
</tr>
<tr>
<td>James Dulley columns to save money, utility bills, environment, energy, home improvement</td>
<td><a href="http://www.dulley.com/">http://www.dulley.com/</a></td>
</tr>
<tr>
<td>Solar Solutions RECD Inc: Distributor of Solar Modules and Systems</td>
<td><a href="http://www.solarsolutions.ca/">http://www.solarsolutions.ca/</a></td>
</tr>
<tr>
<td>The American Institute of Architects</td>
<td><a href="http://www.aia.org/">http://www.aia.org/</a></td>
</tr>
<tr>
<td>The Homestead.org Online Homesteading Resource</td>
<td><a href="http://www.homestead.org/">http://www.homestead.org/</a></td>
</tr>
<tr>
<td>United States Green Building Council</td>
<td><a href="http://www.usgbc.org/">http://www.usgbc.org/</a></td>
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### Table 2: HVAC/Energy Efficiency

<table>
<thead>
<tr>
<th>Source</th>
<th>URL</th>
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</thead>
<tbody>
<tr>
<td>North Carolina Solar Center</td>
<td><a href="http://www.ncsc.ncsu.edu/">http://www.ncsc.ncsu.edu/</a></td>
</tr>
<tr>
<td>Welcome to American Solar Energy Society</td>
<td><a href="http://www.ases.org/">http://www.ases.org/</a></td>
</tr>
<tr>
<td>Midwest Renewable Energy Association</td>
<td><a href="http://www.the-mrea.org/">http://www.the-mrea.org/</a></td>
</tr>
<tr>
<td>About WisconSUN</td>
<td><a href="http://www.wisconsun.org/">http://www.wisconsun.org/</a></td>
</tr>
<tr>
<td>Consumer Energy Information Home Page</td>
<td><a href="http://www.eren.doe.gov/consumerinfo/">http://www.eren.doe.gov/consumerinfo/</a></td>
</tr>
<tr>
<td>GAMA (Gas Appliance Manufacturers Association)</td>
<td><a href="http://www.gamanet.org/">http://www.gamanet.org/</a></td>
</tr>
<tr>
<td>Home Page-Rocky Mountain Institute</td>
<td><a href="http://www.rmi.org/">http://www.rmi.org/</a></td>
</tr>
<tr>
<td>House Design: Walkers</td>
<td><a href="http://www.owlcroft.com/newhouse/">http://www.owlcroft.com/newhouse/</a></td>
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</tbody>
</table>
### Table 2: HVAC/Energy Efficiency

<table>
<thead>
<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>Radiant Panel Association Home Page</td>
<td><a href="http://www.radiantpanelassociation.org/">http://www.radiantpanelassociation.org/</a></td>
</tr>
<tr>
<td>Welcome to Home Energy</td>
<td><a href="http://www.homeenergy.org/">http://www.homeenergy.org/</a></td>
</tr>
<tr>
<td>Welcome to Lifebreath</td>
<td><a href="http://www.lifebreath.com/">http://www.lifebreath.com/</a></td>
</tr>
<tr>
<td>Welcome to Wisconsin Focus on Energy</td>
<td><a href="http://www.wifocusonenergy.com/">http://www.wifocusonenergy.com/</a></td>
</tr>
</tbody>
</table>

### Table 3: Kitchen/Bath

<table>
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<tr>
<th>Reference</th>
<th>URL</th>
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<tbody>
<tr>
<td>HomeCrest Design Online</td>
<td><a href="http://homecrest.kitchen-design.com/">http://homecrest.kitchen-design.com/</a></td>
</tr>
<tr>
<td>Kitchen Cabinets by Mill’s Pride</td>
<td><a href="http://www.millspride.com/mills/home.htm">http://www.millspride.com/mills/home.htm</a></td>
</tr>
<tr>
<td>Professional Food Service Equipment</td>
<td><a href="http://www.kessenichs.com/">http://www.kessenichs.com/</a></td>
</tr>
<tr>
<td>TOTOUSA - World’s Largest Toilet Manufacturer</td>
<td><a href="http://www.totousa.com/index1.html">http://www.totousa.com/index1.html</a></td>
</tr>
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</table>

### Table 4: Masonry Heater/Fireplace

<table>
<thead>
<tr>
<th>Reference</th>
<th>URL</th>
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<tbody>
<tr>
<td>CSIA.ORG - How to Select Firewood For Heating Your Home</td>
<td><a href="http://www.csia.org/home/firewood.html">http://www.csia.org/home/firewood.html</a></td>
</tr>
<tr>
<td>Improving Fireplace Efficiency</td>
<td><a href="http://www.leeric.lsu.edu/energy/fireplace/">http://www.leeric.lsu.edu/energy/fireplace/</a></td>
</tr>
<tr>
<td>Radiant Fireplaces, Bake Ovens &amp; Cook-stoves@Thermal Mass, Inc.</td>
<td><a href="http://www.thermalmass.com/">http://www.thermalmass.com/</a></td>
</tr>
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### Table 4: Masonry Heater/Fireplace

<table>
<thead>
<tr>
<th>Masonry Heater/Fireplace</th>
<th>URL</th>
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<tbody>
<tr>
<td>Rumford Fireplaces</td>
<td><a href="http://www.rumford.com/">http://www.rumford.com/</a></td>
</tr>
<tr>
<td>The Masonry Heater Association Home Page</td>
<td><a href="http://www.mha-net.org/">http://www.mha-net.org/</a></td>
</tr>
<tr>
<td>- Information on masonry heaters, manufacturers, and masonry heater builders</td>
<td></td>
</tr>
<tr>
<td>The Russian Stove</td>
<td><a href="http://larsenfamily.com/russian_stove/">http://larsenfamily.com/russian_stove/</a></td>
</tr>
<tr>
<td>woodheat home</td>
<td><a href="http://www.woodheat.org/">http://www.woodheat.org/</a></td>
</tr>
</tbody>
</table>
XIX. Suppliers

A. Appliances

Abbaka
high-end range hoods (start at $2700)
http://www.abbaka.com

Sub-Zero
refrigerators and freezers
http://www.subzero.com

Viking
gourmet level ranges, ovens, vent hoods, etc.
http://www.viking.com

B. Surveying, Soils & Excavating

Badger Surveying & Mapping Service, LLC
2121 N. Sherman Ave.
Madison, WI 53704
608.244.2010, 608.244.6272 fax
Al Kaukl, Survey Supervisor

Soils & Engineering Services, Inc.
1102 Stewart St.
Madison, WI 53713-4648
608.274.7600, 800.236.2947
608.274.7511 fax
SES@frontiernet.net
http://www.frontiernet.net/~ses
Octavio Tejeda, P.E. President

S&E Enterprises
655 S Nine Mound Rd.
Verona, WI
608.845.8909
- has excavator with large jackhammer
- recommended by Mike Duerst

C. Construction Materials

Fireslate
Stone-like material for counters, sinks, flooring, hearths, etc.
http://www.fireslate.com/

ACCEL Roofing Products
Metal roofing
http://www.atas.com/index.html

James Hardie
Hardiplank fiber-cement siding
http://www.jhmh.com/products.htm

Shelter Supply
17725 Juniper Path
Lakeville, Mn 55044
800.762.8399, 612.898.4500
612.898.4555 fax
info@sheltersupply.com
http://www.sheltersupply.com
XIX Suppliers

D. Masonry Heaters

Biofire
http://biofireinc.com/

Envirotech Radiant
Dietmeyer, Ward & Stroud Products

Firespaces, Inc.
Walter Moberg Design
http://www.firespaces.com/

Gimme Shelter Construction Inc.
sells and installs Heat-Kit cores
http://www.gimmeshelteronline.com/

Heat-Kit
http://www.heatkit.com

Maine Wood Heat Co., Inc.
*Finnish Fireplaces: Heart of the Home.*
beautiful door options for heaters
http://www.mainewoodheat.com/

Temp-Cast
http://www.tempcast.com

Tulikivi
sold locally by Bachman Pools & Spas
http://www.tulikivi.com

E. HVAC

American Aldes Ventilation Corporation
heat recovery ventilators
central exhaust systems
make-up air systems (work with radiant systems or forced-air)
http://www.americanaldes.com/

Solar Works
Sol-Aire solar powered ventilation system - 90 CFM, could possibly be integrated with range hood switch
http://home.solarvt.com/SolarVT/solaire.html

Trane
http://www.trane.com

Galvalume Sheet Producers of North America
Galvalume (coated steel) metal roofing
http://www.SteelRoofing.com/

Metal Roofing Specialists, Inc.
Standing seam metal roofs
http://www.metalroofingspecialist.com/

Delcoa Industries, Inc.
Metal roofing
http://www.delcoa.com/

Morin Corporation
Standing seam metal roof panels
http://www.morincorp.com/seamroof.htm

Metal Roofing Specialists, Inc.
Standing seam metal roofs
http://www.metalroofingspecialist.com/

Morin Corporation
Standing seam metal roof panels
http://www.morincorp.com/seamroof.htm

Galvalume Sheet Producers of North America
Galvalume (coated steel) metal roofing
http://www.SteelRoofing.com/
F. Flooring

Forbo-Nairn Floorcoverings
linoleum (Marmoleum)
http://www.forbo-nairn.co.uk/

Natural Cork
cork tiles & floating floors,
Deco Cork linoleum/cork floating floors
1710 North Leg Court
Augusta, GA 30909
800-404-2675
706-733-6120
706-733-8120 fax
http://www.naturalcork.com/

G. Lighting

H. Plumbing
Figure 1: Topographic Map of the Lot
Figure 2: Metal work from [Legler] page 153
Figure 3: House colors from [Susanka2] pages 97, 98, 104, 105

**Above** Colors and textures were carefully selected to give the house a subtle distinctiveness. Because the lines of the window are so fine, their bright red coloring is not overbearing but the well-applied masonry draws the eye back to a second level. In texture, the powdered pebbles of the upper story contrast with the narrow log siding of the area below. But because they are both stained the same color, the effect is one of restraint.

**Above** Although the form of this house is simple, the dark green trim, corner boards, and columns highlight its shape and bring out its personality. The diamond motif above the dormer window adds a playful touch that distinguishes it from a standard builder home at very little expense.
Figure 4: 1997 Life Dream House by John Rattenbury of Taliesin ([Rattenbury])

Figure 5: Council Ring from [Legler] page 156
Figure 6: Masonry Heater Door and Bakeoven Door Examples
Figure 7: Entry Bench ([Susanka2] p. 250) & Half Wall w/ Columns ([Susanka2] p. 45)
Laundry requirements vary dramatically from family to family. For a couple without kids, a small closet may be sufficient, as long as there’s enough space for folding. In this house, the laundry is within easy reach of the master bedroom, where most of the wash is generated, and when not in use, it disappears. In all, the laundry occupies just 16 sq. ft.

If a compact laundry center will work for you, consider a stackable washer/dryer unit and locate it off a space that can readily do double duty on laundry day. A full-size stackable unit is an excellent space saver, making room for adjacent cabinets. If you use a standard side-by-side top-loading washer and dryer, the top surfaces are inconvenient to use as counter space. And the popular European front-loading machines, though elegant, prevent you from adding any items once the washing cycle has begun—an issue for some.

Figure 8: Hideaway Laundry ([Susanka2] p. 211) & Mudroom Door ([Susanka2] p. 156)
Figure 9: Built-in Kitchen Benches ([Susanka2] p. 108)
Figure 10: Large Block Quarry Tile Floor ([Susanka2] p. 209)
Figure 11: Built-in Cutting Board ([Susanka2] p. 70)
Figure 12: Fireslate ([Susanka2] p. 101, 248)
Figure 13: Cookbook ([FHB_KB2000] p. 104) & Corner Pot Storage ([BKB1] p. 17)
Figure 14: Fireplace Separating Dining/Living Areas ([Legler] p. 183)
Figure 15: Mottled Beige Wall Color (called “rose chamois”, [Legler] p. 120)
Figure 16: Built-in Bookshelves & CD storage ([Susanka2] p. 184, 159, 73)
Figure 17: Two Masonry Heaters and Two Rumford Fireplaces
Figure 18: Masonry Heater Examples 1
Figure 19: Masonry Heater Examples 2
Figure 20: Masonry Heater Examples 3
Figure 21: Bed Alcove ([Susanka2] p. 247) and Desk Alcove ([Susanka2] p. 241)

ABOVE The master bedroom has a cabinlike feel, with lots of wood paneling and a spectacular view of the valley. The bed sits in an alcove created by a lowered ceiling that’s 7 ft. 6 in. from the floor. The alcove makes a cozy pocket of space in a room with an otherwise tall ceiling.
There are alternatives to tile for bathroom floors and walls. Here, a narrow band of trim divides the room into upper and lower sections, and a simple change of color adds lots of personality without the expense of tile. The floor is made of cork, a natural and sustainable material.

Figure 22: Multiple Bathroom Colors ([Susanka2] p. 243)
Figure 23: Shelves on Stairway and/or Landing ([Susanka2] p. 7, 111, 158)
Figure 24: Colors We Like 1 ([Susanka2] p. 181)
Figure 25: Colors We Like 2 ([Susanka2] p. 238)
XXI. Attachments

1. Gimme Shelter Construction Specifications
2. Gimme Shelter Masonry Stoves
3. “Short Course on Masonry Heating Systems” by Norbert Senf, Masonry Stove Builders
4. Dulley Update Bulletin No. 847 - Masonry Fireplaces
5. Dulley Update Bulletin No. 643 - Mini-Split Ductless Air Conditioning Systems
6. Dulley Update Bulletin No. 581 - Radiant Floor Heating
Construction specifications:

**Foundation:** Exterior 4" drain tile in gravel bed at footing level. Interior radon barrier consisting of 4" flexible pipe in gravel bed below slab run to a sealed sump pit venting to outside. 2" minimum rigid insulation under slab, vapor barrier run continuously to connect with wall vapor barrier, caulked and taped at seams and sump penetrations. Interior basement walls are 2x4 walls set 2" to 3.5" inches away from exterior walls. Entire cavity is then blown with fiberglass/adhesive system (BIBS) at R-30. Vapor barrier is continuously tied to under slab VB and joist VB. All mechanical penetrations through exterior are caulked, airtight electrical boxes on all exterior walls are taped and caulked to VB.

**Framing:** Floor joists are set back 5.5" on 2x10 treated plates, 2' flange of VB is laid on plates before joists are set, assuring a continuous VB connection to basement and sidewall VB. Deck is then sheathed with 1x10 pine, VB is temporarily stapled to deck and 2x6 exterior sidewalls are dropped onto treated plates. This "band cavity" can then be blown full of BIBS fiberglass and sealed as part of the wall insulation and VB package, assuring a higher R value and a tighter perimeter than in conventional framing. All penetrations through the band joist are caulked and taped.

**Exterior walls:** 2x6 walls with horizontal strapping create a 7" wall cavity blown with BIBS system for R-29. Vapor barrier is tied to band flange and ceiling VB by tape or caulk assuring a continuous seal. Airtight electrical boxes are caulked and taped to VB. 1x10 pine sheathing is used as exterior sheathing and as base for conventional exterior treatments. Alternative exterior is to place the strapping on the outside of the wall and use vertical pine or cedar in a single layer as both sheathing and siding (either in a board and batten or vertical T&G application). Double masonry walls, straw bale construction and clay/straw (cob) construction are other structural choices.

**Interior surfaces:** Walls-thincoat plaster finish surface(one or two step) for higher durability and greater thermal mass, wood paneling, masonry. Floors-tile, concrete, soil cement for mass and durability, native hardwoods for wood flooring.

**Roof system:** Truss or rafter framing incorporates a 12" energy heel which allows for the full amount of insulation at perimeter. Blown cellulose at a minimum of 16" for R-60 ceiling ins. Continuous VB tied to wall VB, all penetrations sealed with caulk and tape. IC airtight ceiling cans sealed to VB when set, prior to insulation (observe code clearances). Galvanized standing seam metal roof recommended for long term performance.

**Recommended systems:**
Air-to-air heat exchanger, exhaust only fans with makeup air (controlled ventilation) or breathable wall systems; whole house fan (cooling); fresh air intake for combustible appliances and heaters; in-floor radiant heating, masonry heaters; efficient lighting and appliances; renewable electrical systems, central vacuum.

**Resources:** Shelter Supply-17725 Juniper Path-Lakeville, Mn. 55044 800-762-8399
Fine Homebuilding (periodical) in-floor heating, design, mechanical systems.

(715) 677-4289 (715) 366-2957
- Renewable resource
- Clean-burning  
  (EPA emissions — 1.3 g/hr.)
- Comfortable — consistent  
  radiant heat
- Convenient — one fire every  
  12 to 24 hours
- Safe — no creosote build-up,  
  fires last only 2-3 hours,  
  stove surface temperature  
  seldom exceeds 130°
- Veneer — may be brick, stone,  
  tile or stucco
- Bake ovens
- Cooking ranges
- Heated benches
- Domestic hot water and  
  hydronic options

Gimme Shelter Construction, Inc.  
PO Box 176  
Amherst, Wisconsin 54406  
(715) 366-2957  
(715) 677-4289

Member of Masonry Heater  
Association of North America
Masonry Stoves are a unique blend of fire, stone, and earth. They combine high efficiency combustion technology with the art and craft of stone masonry. Because of their ability to store a day's worth of heat from a short intense burn, they provide stable, efficient, radiant heat from a fireplace style hearth. They often include bake ovens, heated benches and hydronic options.

We Offer These Modular Stoves —

HEAT-KIT —

- Standard firebrick and pre-cast components
- Cast iron doors
- Standard core module dimensions 52” w x 34” d x 7’ h with 4” veneer
- Heated bench, cookstoves, see through firebox, bake ovens available
Short Course on Masonry Heating Systems

by:
Norbert Senf
Masonry Stove Builders / Lopez Labs
RR 5, Shawville, Que. J0X 2Y0
V 819.647.5092  F 819.647.6082
e-mail: mheat@travel-net.com

Presented at
All Fuels Expo 96
Burlington, Vermont
February 2, 1996
**Short Course on Masonry Heating Systems**

**Introduction:**

What is a masonry heater?
A masonry heater allows wood to be burned for home heating in a unique way. It’s main distinction is the ability to store a large amount of heat. This means that you can rapidly burn a large charge of wood without overheating the house. The heat is stored in the masonry thermal mass, and then slowly radiates into your house for the next 18 to 24 hours.

This results in a number of benefits. If you burn wood fairly rapidly, it is a clean fuel. It has a low ash content and almost no sulfur content. If you try to burn it too slowly, however, the fire will change from flaming to smoldering combustion. The burning process is incomplete and produces tars. Atmospheric pollution increases dramatically. The ratio of emissions between complete and incomplete combustion with wood can be as high as 100 to 1.

These characteristics of wood combustion become very important if we are planning a wood fired heating system for an energy-efficient house. The average energy demand of this newer type of house is often quite low. For most of the time, it may require only 1 to 2 KW of heat. For most conventional woodstoves, this is below their “critical burn rate”, or the point where they start to smolder. In other words, woodburning and energy efficient houses don’t really suit each other very well, unless you have some way to store heat so that your stove can operate in the “clean” range all of the time.

Masonry heaters fill the bill very well. If you need even a very small amount of heat, such as between seasons when you simply want to take off the chill, you simply burn a smaller fuel charge—yet you still burn it quickly. The large surface is never too hot to touch. You have a premium radiant heating system with a comfort level that is second to none.

**Brief history**

The first controlled use of fire by man predates our own species, and is now believed to have occurred 1.4 million years ago by Homo erectus. Agriculture, in contrast, is only about 10,000 years old. Although chimneys were known in Han China 2,000 years ago, they only came into general use among our British forebears around the sixteenth century. Interestingly, of the northern European cultures only the British and French have an open fireplace tradition. Since our North American heritage is mainly British and French, we share this tradition. Not surprisingly people in both countries, peasant and nobleman alike, used to basically freeze in the winter. In our harsh North American climate, the open fireplace was replaced for primary heating by the closed combustion iron stove in the 18th century. The open fireplace is commonly found to this day as a main heat source in the milder climate of the British Isles.

We still carry this ancient relationship with fire in our consciousness, even though few people are still aware that the words “hearth” and “heart” share a common origin.

Other northern and middle European cultures had a somewhat different development that led to a masonry heating tradition. Several different heater types evolved in separate regions. Four types are commonly recognized in North America, and will be described later.

**Wood Combustion Fundamentals**

**Combustion chemistry**

From high school chemistry, we recall that all chemical compounds are formed by a combination of about a hundred chemical elements. The elements can neither be converted into each other nor split into simpler substances by chemical means. The elements are represented by symbols. The symbols of interest to us for the combustion chemistry of wood are carbon (C), hydrogen (H), and oxygen (O).

Wood combustion is a complicated process consisting of several main chemical reactions and a very large number of intermediate reactions. Depending on the conditions in the firebox, many alternate paths are available to the reacting compounds. As you know, when wood is burned the range of possible products that can leave the stack is very wide.
Elementary analysis
Wood has a complicated chemistry, but it can be broken down into an elementary analysis as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Formula</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon (C)</td>
<td></td>
<td>41.0%</td>
</tr>
<tr>
<td>Hydrogen (H$_2$)</td>
<td></td>
<td>4.5%</td>
</tr>
<tr>
<td>Oxygen (O$_2$)</td>
<td></td>
<td>37.0%</td>
</tr>
<tr>
<td>Water (H$_2$O)</td>
<td></td>
<td>16.0% (Air dried)</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>1.5%</td>
</tr>
</tbody>
</table>

The brackets give the molecular formula. For example, C refers to 1 atom of carbon, which for carbon also happens to be one molecule. H$_2$ refers to one molecule of hydrogen, which consists of two atoms. There is also about 1% Nitrogen, which we will ignore.

The atomic weights of the different elements are as follows, and refer to the atomic weight of Hydrogen, the lightest element, which is 1.

H  1  
C  12  
O  16  

Thus we get the molecular weight of carbon dioxide, CO$_2$, as 44 and carbon monoxide, CO, as 28.

44 grams of CO$_2$ and 28 grams of CO both have the same number of molecules, and therefore the same volume. A liter of CO$_2$ therefore weighs $\frac{44}{28}=1.57$ times as much as a liter of CO at the same temperature.

Combustion reactions
During complete combustion, the following chemical reactions take place:

\[
\begin{align*}
C & + O_2 = CO_2 \\
2H_2 & + O_2 = 2H_2O
\end{align*}
\]

During incomplete combustion, we get the following:

\[
\begin{align*}
2C & + O_2 = 2CO \\
2CO & + O_2 = 2CO_2
\end{align*}
\]

The CO can itself be combusted as follows:

\[
2CO + O_2 = 2CO_2
\]

As wood is heated, it releases hydrocarbons in the form of volatiles or gases, and they are given the general molecular formula C$_m$H$_n$. The products from complete combustion of hydrocarbons are CO$_2$ and H$_2$O (water vapor or steam). During the charcoal phase, we’re combusting C without any H$_2$, so we get CO$_2$ or CO, but no H$_2$O. 

All of these reactions are exothermic, i.e., they result in a conversion of chemical energy into heat, namely:

\[
\begin{align*}
1kg \text{ C} & + 2.67kg \text{ O}_2 = 3.67kg \text{ CO}_2 & + 32,000 \text{ BTU or 9.6 kWh} \\
1kg \text{ C} & + 1.33kg \text{ O}_2 = 2.33kg \text{ CO} & + 9,500 \text{ BTU or 2.9 kWh} \\
1kg \text{ CO} & + 0.57kg \text{ O}_2 = 1.57kg \text{ CO}_2 & + 9,500 \text{ BTU or 2.9 kWh} \\
1kg \text{ H}_2 & + 8.0kg \text{ O}_2 = 9.0kg \text{ O}_2 & + 135,000 \text{ BTU or 40.5 kWh}
\end{align*}
\]

Once the chemical composition of a fuel is known, the above formulas can be used to calculate the heat content.

If we oven dry the wood, then it becomes 98.5% combustibles. We’ve taken out the water, and everything except the ash (and nitrogen) is combustible. The elementary analysis now becomes:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>50.0%</td>
</tr>
<tr>
<td>H$_2$</td>
<td>6.0%</td>
</tr>
<tr>
<td>O$_2$</td>
<td>42.0%</td>
</tr>
<tr>
<td>Ash</td>
<td>2.0%</td>
</tr>
</tbody>
</table>
**Combustion air**
The theoretical combustion air requirement can be calculated from the chemical composition of the fuel.

With complete combustion and dry air:

\[ \text{Air}_{th} = 8.8 \text{C} + 26.5 \text{H}_2 - 3.3 \text{O}_2 \text{ m}^3/\text{kg}. \]

This is also known as stochiometric air.

**Example**
Let's run through an example:
Calculate the theoretical air requirement for wood combustion as well as the actual combustion air if the exhaust gas contains 10% CO₂.

For wood with the following analysis:
- C = 41%
- H₂ = 4.5%
- O₂ = 36%
- N₂ = 1%
- H₂O = 16%
- Ash = 1.5%

Using our formula, stochiometric, or theoretical air, becomes:

\[ \text{Air}_{th} = 8.8 \times 0.41 + 26.5 \times 0.045 + 3.3 \times 0.36 = 3.60 \text{ m}^3/\text{kg} \]

**Excess air**
In reality, more than the theoretical amount of air is required, since some air passes through the firebox without taking part in the combustion. This is called excess air.

\[ \text{Excess air} = \text{CO}_2_{max.}/\text{CO}_2_{measured} \]

The maximum CO₂ possible in wood fuel flue gas is 20.9%.

Returning to our example, the excess air is therefore \( n = 20.9/10 = 2.09 \), i.e., 209% excess air.

**Efficiency**
Combustion efficiency measures how much of the wood's chemical energy is released during the burn. This is typically around 96 - 99% for most good masonry heaters. The chemical loss consists of unburned carbon monoxide and hydrocarbons that exit the chimney.

Heat transfer efficiency measures how good the appliance is at delivering the released energy to your house instead of out the chimney (stack). One way to define it is in terms of stack loss, something that can be measured with combustion testing equipment.

For wood, we will ignore the fact that the wood changes continuously in chemical composition as it goes from cordwood to charcoal, and assume an average composition. We've already dealt with the chemical loss due to incomplete combustion. There are three other types of stack loss.
Latent heat loss
This results from the fact that you are boiling off the water content of the wood into water vapor. It takes about 2,000 BTU to turn a kg of liquid water at 212°F to a kg of gaseous water at 212°F. Note that this loss does not involve a change of temperature, but rather a change of state from liquid to gas. It is termed latent heat, as opposed to sensible heat which is something you can sense as a temperature change. This is an unavoidable loss, unless you use a condensing chimney to reclaim the latent heat, as in a high efficiency gas furnace.

For wood that is at 20% moisture content, this ends up being about a 13% loss. One source of confusion with efficiency numbers and claims by manufacturers is that in Europe the latent heat loss is not counted. This means that if you see European literature on a stove claiming 80% efficiency, you have to subtract 13% to get a North American number.

Stack temperature
The gas leaving the chimney is above ambient temperature, which represents an efficiency loss. With 20% moisture wood and 200% excess air, you have to keep the gas temperature in the chimney above about 180°F to prevent condensation, which is undesirable unless your chimney is built specifically to handle it. You also need to maintain draft.

Excess air
If you are moving excess air through the system, it ends up at the stack temperature. Therefore, the more excess air, the higher the loss. With a masonry heater, we can pretty much pick whatever stack temperature we want in the design process. The main challenge is controlling excess air. Wood needs 200% to 300% excess air, or complete combustion will be hard to achieve and we will see elevated CO levels in the stack.

It is interesting to note that the theoretical maximum efficiency possible with a non condensing woodburning system burning wood at 20% moisture is about 80% overall efficiency.

Overall efficiency = Combustion efficiency × Heat transfer efficiency.

A very good real world number for a masonry heater is about 75% overall.

Emissions and flue deposits
If we cut back enough on combustion air, we will see a rise in emissions. The emissions question revolves around the subject of incomplete combustion. Incomplete hydrocarbon combustion gives rise to carbon monoxide (CO), soot (C), free hydrogen (H₂) and numerous tars and other organic compounds.

As chimney service professionals, you are all intimately familiar with certain of these compounds. At one end of the scale we have soot, which is pure carbon. It is a non volatile fluffy solid. At the other end of the scale we have complex organic chemicals. Some of these are volatile, which means we don’t see them as they leave the chimney. Others are semi-volatile. They either condense after they leave the chimney into extremely small tar droplets, or smoke, or they condense before they leave the chimney and form a flue deposit. You all know that the most dangerous kind of flue deposit is shiny creosote, which is the most flammable because it is closest to the volatile end of the scale. It’s pretty hard to light soot - it’s more like trying to light a charcoal barbecue. This shouldn’t surprise us, since charcoal and soot are different forms of the same chemical, carbon.

The woodsmoke that enters the atmosphere is considered to be a serious health hazard. I have seen one medical reference claiming that it is 40 times as harmful as cigarette smoke. If you turn down the air on an airtight woodstove enough, your woodfire goes from a flaming fire to a smoldering fire. Your emissions can increase by a factor of a hundred, i.e., 10,000%. Smoldering combustion should be avoided at all costs, because, aside from the pollution it inflicts on the environment, it gives woodburning a bad name.

Emissions are of great interest to the masonry heater builder. A masonry heater is by far the cleanest way to burn cordwood on a domestic scale, i.e. in batch mode from a cold start. Because we have heat storage at our disposal, we can use whatever burn rate we want.

Carbon monoxide (CO)
Carbon monoxide deserves a special mention. We have already seen how it arises from incomplete combustion and can contribute to stack loss and to emissions. CO is also a fuel, since we saw earlier that it contains 9,500 BTU of chemical energy per kilogram. At the tail end of a wood fire, during the charcoal stage, we are seeing CO combustion. We’ve already seen that charcoal is pure carbon, or C. It can burn either completely to CO₂, or partially to CO. The CO can then either burn to CO₂ or exit the chimney as a pollutant.
It is a potential safety hazard with all combustion appliances, including masonry heaters. Most masonry heaters have flue dampers, and if you close it before the fire is out, you can die from CO poisoning. CO is colorless, odorless, and potentially lethal. It is particularly dangerous because the ratio between low concentrations when you first start feeling physical effects such as headache and between fatal concentrations when you black out is only about 1:100. Fortunately, reliable CO detectors have recently become available at low cost. Everybody who has any combustion equipment in the house should have a CO monitor. As a masonry heater builder you need to tell your clients, in writing, to install a CO detector in the portion of the house that has the heater.

Combustion testing

Demonstration of a TESTO 342 combustion analyzer

This is a combustion gas analyzer that is manufactured in Germany and used there by many sweeps, stove builders and furnace technicians. I believe that before you are allowed to build a masonry heater in Germany you have to get an OK from the Bezirgsschornsteinfegermeister, or district master chimney sweep, who will check out the venting setup and make sure that clearances are followed.

This particular instrument consists of the following:
- a flue gas probe
- a connecting hose
- a sample conditioning system
- a handheld battery powered analyzer
- an optional small remote controlled printer

It measures stack oxygen, stack CO, stack temperature and stack pressure (draft). The CO measurement is accurate to 20 PPM and you can use it to measure ambient CO in a house. It is programmed for 16 different fuels, including wood at 20% moisture, and can calculate stack loss directly. You can get an optional infrared remote printer that gives you a printed report.

I'll describe briefly what you would do to use it:

It is not designed for homeowner use and you have to read the manual carefully before using it, because it is a sensitive, not to mention expensive, piece of gear that will break if you don't follow the instructions.

Once you push the on button, it goes through a calibration phase. A pump turns on and pumps ambient air through the two electrochemical measuring cells. After about a minute, you follow the prompts on the LCD screen and adjust the oxygen number to read 21.0, which is ambient. It then jumps to a fuel selection sub-menu. Assuming you are just measuring one fuel, you don't have to change this.

You then insert the flue gas probe into the flue. Next, you turn on the pump and can read various screens full of information. You can program it to give up to 5 different screens. You then stop the pump and pull the flue gas probe out into fresh air. After you are done either printing out or writing down the reading, you need to turn the pump back on in order to flush out the measuring cells.
Table 1. Test summary from a typical Lopez Labs test

<table>
<thead>
<tr>
<th>RUN No.</th>
<th>HK-D12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Moisture..........</td>
<td>16.4</td>
</tr>
<tr>
<td>Total Weight...........</td>
<td>47.9</td>
</tr>
<tr>
<td>Kindling Weight.........</td>
<td>2</td>
</tr>
<tr>
<td>Number of Pieces........</td>
<td>8</td>
</tr>
<tr>
<td>Fuel Surface/Vol.........</td>
<td>3.96</td>
</tr>
<tr>
<td>Run Length................</td>
<td>1.5</td>
</tr>
<tr>
<td>Av. Stack Temp...........</td>
<td>401</td>
</tr>
<tr>
<td>Av. O2%..........................</td>
<td>12.76</td>
</tr>
<tr>
<td>Av. CO%..........................</td>
<td>0.12</td>
</tr>
<tr>
<td>Stack Temp. Factor........</td>
<td>0.78</td>
</tr>
<tr>
<td>Stack Dilution Factor.....</td>
<td>2.57</td>
</tr>
<tr>
<td>Burn Rate  dry kg/hr......</td>
<td>11.39</td>
</tr>
<tr>
<td>Boiling of Water Loss....</td>
<td>12.25</td>
</tr>
<tr>
<td>CO Loss %....................</td>
<td>2.03</td>
</tr>
<tr>
<td>HC Loss %....................</td>
<td>0.20</td>
</tr>
<tr>
<td>Dry Gas Loss %.............</td>
<td>14.83</td>
</tr>
<tr>
<td>Filter Catch gm. ..........</td>
<td>0.0319</td>
</tr>
<tr>
<td>g/kg  Condar ..........</td>
<td>0.53</td>
</tr>
<tr>
<td>g/kg  CO .................</td>
<td>17.93</td>
</tr>
<tr>
<td>Combustion Effic ..........</td>
<td>97.76</td>
</tr>
<tr>
<td>Heat Trans. Effic ........</td>
<td>72.92</td>
</tr>
<tr>
<td>Overall Efficiency........</td>
<td>71.29</td>
</tr>
</tbody>
</table>

Figure 1. Flue gas analysis curves for a 1½ hr test run

Particulate Emissions for 29 Masonry Heater Tests

Figure 2. Lopez Labs 2 yr test results on one masonry heater
Masonry Heater Operating Principles

**Burn cycle**
Most North American heaters, as mentioned, are at the large end of the traditional scale. Most heaters are fired once per day. Burn cycle varies with owner lifestyle. With a typical couple where both people are away at work all day, the heater usually gets fired in the evening. Most heaters double as fireplaces, so heater owners get to see a real wood fire every night. The house is warm in the evening, overnight, and in the morning. As the house sits unoccupied, it slowly cools. A backup system can give the house a small boost just before its occupants arrive after work, and the cycle is repeated.

**Options**
Bakeovens can be incorporated into many heater types, and are getting very popular. Other common options are domestic hot water and heated sitting benches. With properly engineered heat exchangers, hot water heating systems such as radiant floors can also be driven.

**Safety**
CO danger has already been mentioned. It is worth repeating that reliable, inexpensive CO detectors have recently become available and should be mandatory equipment for owners of any combustion appliances. In the province of Ontario, they will soon become mandated in the provincial building code.

**Maintenance and servicing**
A properly designed, built and operated masonry heating system requires little service beyond a yearly checkup by a qualified chimney service person. A small amount of fly ash may need to be vacuumed from the channels. Our neighbour has a contraflow heater that we built for him in 1981, and he has never serviced it. There is no flue deposit at all, there is probably some fly ash, and all of the hardware is in mint condition after 15 years of normal use.

I have once seen creosote deposits in a masonry heater. The owners ran out of firewood the first winter and were cutting green trees and burning them right off the stump.
Some Masonry Heater Design and Construction Principles

Principal heater types
Among North American heater masons, there are generally regarded to be 4 principal heater types:
- Grundofen (German and Austrian)
- Contraflow (Finnish)
- Kakelugn (Swedish)
- Russian

The most commonly built type of heater is the contraflow, illustrated below:

Figure 3. Cutaway illustration of a contraflow heater.
There are a number of ways of constructing a masonry heater:

- Factory prefabricated heater (Tulikivi, Biofire). The complete heater including facing is assembled on site from prefabricated components.
- Factory prefabricated heater core (Tempcast, Envirotech). Heater core is assembled onsite from factory components. Heater facing is installed onsite.
- Hybrid cores (Heat-Kit, AlbieCore). Factory components are combined on site with standard refractory modules (firebricks). Heater facing is installed onsite.
- Handbuilt. Can be built from purchased plans (Maine Wood Heat Co.) or custom designed.

It should be noted that the first three options are relatively new. Until quite recently, all masonry heaters were handbuilt onsite and often custom-designed.

Heat output calculation

We will look at two ways of calculating masonry heater output:

Using the German system, we can first calculate what our heating output requirement is in BTU/hr or in KW. Next, we pick one of the four heater types. Table 2, below, gives us a design surface temperature, which is assumed as a constant. If we know the surface temperature, then it is a simple matter to look up the corresponding heat output, in BTU/ sq. ft. or kW/m². The required output is then kW/m² × m², i.e., we simply calculate the required masonry heater surface area.

A second method of calculating heat output is simpler and somewhat more practical for North America. We tend to build whole house heaters almost exclusively, whereas most of the traditional European heaters were room heaters. In other words, most of the categories of smaller heaters simply don’t exist here.

For contraflow heaters, we can base our heat output calculation on several assumptions:

- Essentially, we try to build the highest output heater that we can. Oversizing is not an issue the way it is with airtight stoves, since heat output on a masonry heater is easily downsized simply by burning a smaller fuel charge. The charge itself is still burned at a high rate:
- the heater shape is somewhat fixed and less flexible than a heater without a glass fireplace door.
- we use the largest practical wood charge, about 60 lb. This gives us the largest practical firebox, 22½”.
- we use the heaviest practical construction (“extra heavy” in the German system). This gives us the minimum practical sidewall thickness for a double skin contraflow heater, or about 6”. Another way to look at it is that we are essentially trying for the highest surface temperature on a heavy heater.

Using the above rules of thumb, we end up with a heater that burns a 60 lb. wood charge and has about an 18 hr. cycle (time constant). If we assume a 75% overall efficiency, then 60 lb. of 20% moisture wood translates into about 300,000 BTU, or about 90 kWh of heat output.

Next, we can custom tailor our heat output by varying the firing cycle of the heater. We can burn 60 lb. once, twice, or three times per day. Three times per day is unusual, so we have a practical maximum output of 300,000 BTU × 2 or 600,000 BTU/day. Averaging this, we get 600,000/24 or 25,000 BTU/hr. (7.6kW) maximum design output.

In modern energy efficient housing, it is usually unnecessary to build a larger heater. There should always be a backup heating system. If it kicks on for, say, 5% of the heating season then it avoids the extra expense of an extra large heater.

Where it is necessary to have more output, there are several choices:

- Use a shorter firing cycle (8 hrs)
- Use a backup system
- Custom design a larger heater
- Use a standard heater with add-on storage. This is known as a heat battery. Make sure that it won’t invalidate the core manufacturer’s warranty. Heat batteries are usually custom designed to fit the situation.
Channel sizing and calculation
We will look at the German system for Grundofen calculation.

Terminology
Masonry heater terminology can sometimes be confusing. Many North American terms are borrowed from other languages due to the fact that there is no masonry heater tradition among English speaking peoples. There is some confusion in particular with German terms. The common term in Germany for a masonry heater is Kachelofen or “structural clay tile faced stove”. The term Grundofen (plural Grundöfen) is better, and literally means “ground stove”. This is to distinguish it from the Einsatzofen, or “insert stove”. The Einsatzoven consists of a metal stove insert and a Kachel or structural clay tile facing. North American stovemasons don’t consider this to be a true masonry heater, because it is mainly a convection system as opposed to a heat storing, radiant system. From our point of view, the more accurate German term for masonry heater is Grundofen. Very few stoves in North America use Kachel facings, so the term Kachelofen is not really accurate.

Design and Construction Sequence

Figure 4. Construction sequence for Grundofen system
### Table 2. Grundofen construction types and their characteristics

<table>
<thead>
<tr>
<th>Type</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevailing climate usual for this type of construction</td>
<td>Heating intervals particularly long, very low temperatures</td>
<td>Heating intervals of medium length, low temperatures</td>
<td>short heating periods, mild temperatures</td>
</tr>
<tr>
<td>Heat storage capacity</td>
<td>Highest mass</td>
<td>Medium construction</td>
<td>Light construction</td>
</tr>
<tr>
<td></td>
<td>Highest storage capacity</td>
<td>Good storage capacity</td>
<td>Adequate storage</td>
</tr>
<tr>
<td>Usual mode of operation</td>
<td>One large burn daily</td>
<td>One burn daily with one reloading</td>
<td>One burn daily with several reloadings</td>
</tr>
<tr>
<td>Type of heating cycle</td>
<td>A relatively long warmup time is followed by very long, steady heat output</td>
<td>A normal warmup time is followed by a long heat output</td>
<td>Room is warm after short warmup, but cools quicker unless stove is reloaded</td>
</tr>
<tr>
<td>Mass per KW output, kg</td>
<td>350</td>
<td>230</td>
<td>175</td>
</tr>
<tr>
<td>Average surface temperature, °F</td>
<td>147</td>
<td>176</td>
<td>194</td>
</tr>
<tr>
<td>Rated output, kW/m²</td>
<td>0.7</td>
<td>0.93</td>
<td>1.16</td>
</tr>
</tbody>
</table>

### Table 3. Cross sectional area of Grundofen heat exchange channel, cm²/kW - cordwood fired

<table>
<thead>
<tr>
<th>Construction Type</th>
<th>First Channel</th>
<th>Last Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>130 to 150</td>
<td>90</td>
</tr>
<tr>
<td>Medium</td>
<td>110 to 130</td>
<td>90</td>
</tr>
<tr>
<td>Light</td>
<td>100 to 130</td>
<td>80</td>
</tr>
</tbody>
</table>
Refractory materials
Refractory means having the ability to withstand heat. Knowledge of refractory materials is not normally required for installers of factory made heaters. Installers are usually factory trained to install specific models of heaters, and are not necessarily stovemasons. For core-only systems, masonry skills are required to install custom facings. Sometimes the core is installed by a factory trained installer and the facing is done separately by a local mason.

A stovemason is capable of designing and handbuilding custom heaters to the customer’s requirements. We’ve taken a brief look at how masonry heaters are designed and sized, and how some of the internal components are laid out.

Refractory materials is a large subject area. As chimney professionals, you are familiar with some of these.

Fired clay masonry units
An example of a fired clay masonry unit is an ordinary clay brick. It is composed of clay and has been fired in a kiln. It is different from a concrete brick, which is composed of portland cement and inert aggregate and is hardened by chemical action instead of by heat.

A firebrick is usually lighter in color than a common clay brick, which is usually red. The red color comes from iron, which is a common impurity in clay. Iron and other impurities such as lime lower the melting point of the clay. Fireclay is similar to ordinary clay except that it has fewer impurities. This gives it a higher melting point and allows it to withstand higher temperatures after it has been fired.

When you are looking for a good firebrick for use in building masonry heaters, you don’t really care what temperature the brick is rated at. Even the lowest rated firebrick is capable of withstanding much higher temperatures than it will ever see in a masonry heater firebox. A super heavy duty industrial firebrick is not necessarily what you are looking for. These bricks are designed to be heated to high temperatures and kept there. This is a key point. In a masonry heater, although the firebrick doesn’t have to withstand an extremely high temperature, it gets heated and cooled rapidly and often. This is termed thermal cycling, and is your main enemy as a stove mason. It is related the thermal shocking, which means changing the temperature of a material rapidly.

This can be illustrated by an example that you are all familiar with, the red clay flue liner. As chimney professionals you see a lot of cracked red clay flue liners. These liners are often made from fireclay, so they actually have no problem at all when it comes to handling high temperatures. You can heat them cherry red with no adverse effects, but you have to do it slowly. If you heat or cool them rapidly, they crack. They can take heat but they can’t take thermal shock.

Clay flue liners crack because of their geometry. Clay has a coefficient of thermal expansion, which means that it expands by 1% for every 100 degrees Centigrade temperature rise. Fired clay is not very flexible, so if you heat a flue liner unevenly parts of it will expand faster than other parts, causing it to crack. Because the liner is relatively thin, it is easy to get hot spots.

A second property of clay that affects its thermal cycling properties is its chemical composition. The two main constituents of clay are silica and alumina. Pure alumina is white and has a very high melting point. Porcelain is an example of a high alumina clay. Silica can cause problems in refractories. It undergoes a reversible change in crystal structure known as a quartz inversion at 573°C accompanied by a change in volume.

Castable refractories
Castable refractories are used to make what amounts to high temperature concrete. An example from the chimney lining trade would be the various pumped liner systems. Castable refractory, like ordinary concrete, consists of an aggregate and a binder. In concrete, the binder is portland cement and the aggregate is sand and gravel. In castable refractory, the most common binder is calcium aluminate cement, also known as fondue cement or lumnite. You can buy it in a 90 lb bag just like portland cement, and it has some similar properties and uses. In fact, non-soluble refractory mortar, which has become mandated in NFPA 211 and some state building codes for joining flue liners, is basically a mixture of calcium aluminate cement and sand. The aggregate in castable refractory usually is crushed firebrick or some other refractory mineral substance.

Refractory mortars
Refractory mortars are typically used for setting refractory standard modular unit masonry (firebricks). Non-soluble mortars have already been mentioned, and are used for joining flue liners and joining large precast refractory modules.

Firebricks, if they are not going to be exposed to water as in a chimney flue, are normally set in clay mortar, either heat setting or air setting. Heat setting mortar consists solely of clay, and sets only after the clay has been taken up past its fusing temperature. This will never happen in a domestic scale masonry heater, except perhaps in portions of the firebox and only if low melting point clays (plastic earthenware clays) were used. Air setting refractory mortars such as Sairset from A.P.Green
consist of fireclay with sodium silicate added. Sodium silicate is also known as water glass. It is used by potters as a deflocullant, which means that it keeps clay particles in suspension, giving the clay a slimy feel. It is also the material that you buy as stove gasket glue in small bottles. It’s about $10 per gallon at A.P. Green. It sets by drying, and remains somewhat water soluble after it has set. This is a problem in chimney flue liners, but not in masonry heaters since they never get wet.

Setting firebricks
As mentioned, firebricks are normally set in refractory clay mortar, either heat set or air set. Airsets are commonly used on masonry heaters but non-airsets also to some degree. Firebricks can be trowelled or dipped. Sairset comes in the bucket at trowelling consistency. All commercial refractory work is done by dipping. It is extremely fast, since firebricks are very dimensionally consistent and can therefore be set with very thin joints. In order to dip firebricks, you need to thin the refractory mortar by adding water. It has the right consistency when a dry firebrick laid flat on the surface sinks about halfway.

Insulating Refractories
There are a number of types of insulating refractories. They include:

- insulating castable refractories
- ceramic blanket and ceramic paper
- refractory insulating board or millboard

Other Refractories
Soapstone is a unique refractory and masonry material. Compared to a pound of concrete, a pound of soapstone can store approximately 20% more heat. Its main distinctive thermal property is that it has about 4 times the conductivity of concrete or about 6 times the conductivity of soft clay brick. Another way of saying this is that its R value is 1/4 that of concrete. It is somewhat similar to a metal in this respect. This means that a soapstone heater of equivalent mass will heat up faster on the outside surface and reach a higher surface temperature, due to the high conductivity. On the other hand, the higher rate of heat transfer to the room also means that it cools down faster than other masonry materials. Understanding the thermal properties of soapstone gives the heater mason an additional way to handle unusual design requirements when they arise. For example, we use soapstone heat transfer plates in castable refractory bakeoven floors to even out cool spots. A nice feature of soapstone is that it can be carved quite easily.

Expansion joints
The quickest way to go out of business in the masonry heater business is to build heaters that crack their facings. When fired, the interior of a heater, particularly the firebox, heats up first and expands. If the proper expansion joints are not left at appropriate locations between the heater core and the facing, the facing will crack. This is guaranteed, and has put a lot of new heater builders out of business over the years. You can wrap the core with mineral wool, but this will compromise performance unless it is very thin. Don’t use an airspace filled with sand, either. Expansion joints are fairly simple once you learn exactly where you need to put them.

Hardware
Metal hardware for masonry heaters should be designed for long service. Firebox doors and frames should be cast iron. Only ceramic glass should be used.

Finishes
Finished can be almost anything within the entire huge range of masonry. Most popular in North America are brick, stucco, stone and tile. Some examples are given in the slideshow.
Codes and Standards
If you are building a masonry heater, your client typically will have to deal with a local building inspector and also his/her insurance company. The insurance company will usually want to know that you are installing a “listed appliance”, and/or that you have a building permit.

A listed appliances carries a label from a recognized testing laboratory stating that it has been safety tested for clearances to combustibles in accordance with the applicable UL (Underwriters Laboratories) standards. The clearances will be spelled out on the tag. Listing is possible with factory-made heaters, but not practical for site-built units. These fall under the building code, which carries provisions for clearances to combustibles for masonry fireplaces and chimneys.

Very few code jurisdictions currently recognize masonry heaters specifically. One exception is the state of Washington. The nearest applicable provisions are usually the masonry fireplace and chimney sections of the locally recognized code, which often references NFPA 211 (the National Fire Protection Association standard).

Masonry fireplaces codes typically specify the following:

Clearances to combustibles from:
- the firebox opening
- cleanouts
- the masonry itself

Materials and minimum thicknesses for
- the firebox
- a non-combustible hearth extension
- other surfaces

If a prefabricated non-masonry chimney will be used, it may be necessary to find a connector listed for attachment to masonry.

To address the lack of specific standards for masonry heater construction in North American building codes, an ASTM task group was formed about 10 years ago. ASTM is the world’s largest consensus standards organization. It differs from UL in that standards development is an open process and anybody has the right to have their particular concerns addressed before a standard can be voted on.

ASTM Standard Guide E 1602 - 94 was passed in 1994 and is titled “Construction of Solid Fuel Burning Masonry Heaters”.


Scope
- Provides dimensions for sitebuilt masonry heater components.
- Provides clearances that have been derived by experience.
- Does not apply to components that have been safety tested and listed.

Definitions
- Gives definitions for masonry heater specific terminology.

Significance and Use
- “4.1 This guide can be used by code officials, architects, and other interested parties to evaluate the design and construction of masonry heaters. It is not restricted to a specific method of construction, nor does it provide all specific details of construction of a masonry heater. This guide does provide the principles to be followed for the safe construction of masonry heaters.”
- Not intended to be a complete set of construction instructions.
- “4.3 ... construction shall be done by or under the supervision of a skilled and experienced masonry heater builder.”

Requirements
- Clearances to combustibles
- Minimum dimensions and materials for various heater elements
- Other construction details

Typical Masonry Heater Types
- Lists 5 masonry heater types with example illustrations
Figure 5. ASTM clearances to combustibles for masonry heaters

Slide Show
Examples of heater design and construction
Manufactured vs. handbuilt systems
Marketing examples

Practical Demonstration
Layout and construction of the bottom end of a contraflow heater
Firebrick techniques

Question Period and Discussion
Thank you for your interest in writing to me about using true masonry fireplaces. True masonry fireplaces are unique in the way that they are designed to burn firewood. They are also very attractive and unique looking.

The basic design concept is a short duration, very high-temperature burn. With the heavy masonry mass, that sudden rush of heat is absorbed by the huge masonry materials as the flue gases snake through many passages inside the fireplace. By the time the flue gases (almost smokeless) finally reach the chimney, they have transmitted nearly all their heat to the masonry materials. Very little heat is lost up the chimney. Another advantage of the quick hot fire is low pollution and almost 100% complete combustion of the firewood. This results in little creosote build up.

True masonry fireplaces are safe to use. Since there usually is only one or two short burns per day, you never have a fire burning at night while you sleep. The exterior of the fireplace does not get as hot as a standard fireplace, so there is less risk of burning when brushing against it. In fact, some of them have built-in benches. Since you will use fairly small pieces of firewood to attain the rapid high-intensity burn, you probably will not strain yourself hauling firewood.

It is obvious from the physical size and the complexity of the smoke passages, building a true masonry fireplace is not inexpensive. Some large ones with decorative tiles, soapstone and baking ovens will cost many thousands of dollars. Keep in mind, you are getting more than just a fireplace for heating. As the diagrams on these pages show, they can be very decorative.

The actual design you select will depend on your budget, the layout and heating needs of your specific house. Even though some of these manufacturers and designers listed offer “kits”, you will probably not be able to build it entirely yourself without the help of an experienced mason for finishing it properly.

Not included is the cost of labor or the time required to finish. The components come with a three dimensional model and complete installation instructions. Optional baking and warming ovens can be added. The unit has a 25 year warranty. The stainless steel secondary air burn of fire gases before they go out the chimney, gives the fireplace the cleanest burn possible.

Manufacturers and Builders of Masonry and Soapstone Heaters

AMERICAN ENERGY SYSTEMS INC., 50 Academy Lane, Hutchinson, MN 55350 - (800) 495-3196 - (320) 587-6565

www.magnumfireplace.com

description - This is a factory built fireplace that uses a chimney constructed on site of masonry and fire clay materials. There are seven different models to choose from — arched series in either one-sided or see-through models, a two-sided see-through model for adjoining rooms and peninsulas or a tri-view model with a large glass door and 18” x 58” viewing area. The damper and combustion controls are on one rod to give you precise control over the fire. The preheated air wash glass system keeps the glass clean for clear fire viewing. The doors have high-temperature ceramic glass for safety. There are 1/2” solid heavy door latches that are lockable. The actual design you select will depend on your budget, the layout and heating needs of your specific house. Even though some of these manufacturers and designers listed offer “kits”, you will probably not be able to build it entirely yourself without the help of an experienced mason for finishing it properly.

BIOFIRE INC., 3220 Melbourne, Salt Lake City, UT 84106 - (801) 486-0266 - www.biofireinc.com

description - These masonry stoves (Kachelofen) are custom designed, sized and engineered. The designs vary and heat 350 sq. ft. to 2,000 sq. ft. The modular bricks are made of ceramic material and have 25% more surface area extracting more heat from the exhaust gases. They fit together with tongue and groove construction. The components come with a three dimensional model and complete installation instructions. Optional baking and warming ovens can be added. The masonry stoves are available with a stucco or a tile finish — many colors, shapes, dimensions to choose from. They are hand-painted tiles with flowers, animals and folk designs. There are several door options to choose from— black, arch, glass or gold trim. A fuel load door can be located stucco or a tile finish — many colors, shapes, dimensions to choose from. There are hand-painted tiles with flowers, animals and folk designs. There are several door options to choose from— black, arch, glass or gold trim. A fuel load door can be located.

BOHEMIA INTNL, 345 Estes Park Estates Dr., Lyons, CO 80540 - (303) 823 8232

description - These are ceramic tiled woodstoves and heated benches called Kachelofen. They are manufactured using handmade and decorated tiles. Custom design is available. The average stove has approximately 60 pieces of tile. The average tile weighs 6 pounds.
D & W MASONRY INC., — ENVIROTECH, PO Box 323, Vashon Island, WA 98070 - (206) 463-3722

FIRESPACES, INC., 223 NW Ninth Ave., Portland, OR 97209 - (503) 227-0547 www.firespaces.com

LOPEZ QUARRIES MASONRY HEATERS/FIRECREST FIREPLACES, 111 Barbara Lane, Everett, WA 98203 - (425) 353-8963 www.rockymountainfireplaces.com

MAINE WOOD HEAT CO., INC. — ENVIROTECH, PO Box 160, Norridgewock, ME 04957 - (207) 696-5442 www.mainewoodheat.com

MASSONREY HEATER ASSOC. — MASONRY HEATER ASSOC. 1252 Stock Farm Rd., Randolph, VT 05060 - (802) 728-5896 www.mha-net.org

MASONRY STOVE BUILDERS, RR 5, Shawville, Quebec, Canada JOX 2Y0 - (613) 257-6077

MAYLAND HEARTH & SOAPSTONE LLC, 127 North St., Goshen, CT 06756 - (860) 491-3091

NEW ENGLAND HEARTH & SOAPSTONE LLC, PO Box 4024, New York, NY 10023 - (800) 843-3473 www.tulikivi.com

TEMP-CAST ENVIRONMENTAL HEATING & COOKING, PO Box 94059, Toronto, Ontario, Canada M4N 3R1 - (800) 561-8594 www.tempcast.com

WILKENING FIREPLACE CO., HCR 73 Box 625, Walker, MN 56484 - (800) 367-7976 http://hearth.com/wilkening/
### Hardwood Fuel Values

<table>
<thead>
<tr>
<th>Species</th>
<th>Energy Content (millions Btu/cord)</th>
<th>Moisture Content</th>
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<tr>
<td></td>
<td>Heartwood</td>
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<td>Sugar Maple</td>
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<tr>
<td>American Beech</td>
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<tr>
<td>Red Oak</td>
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<tr>
<td>Yellow Birch</td>
<td>26.6</td>
<td>43</td>
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<tr>
<td>White Ash</td>
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<tr>
<td>American Elm</td>
<td>23.8</td>
<td>49</td>
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<tr>
<td>Red Maple</td>
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<td>38</td>
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<tr>
<td>White Birch</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Eastern Hemlock</td>
<td>17.1</td>
<td>49</td>
</tr>
</tbody>
</table>

### Seasoned Wood — All firewood contains water. Freshly cut wood can be up to 45% water, while well seasoned firewood generally has a 20-25% moisture content. Well seasoned firewood is easier to start, produces more heat, and burns cleaner. It is important that the water is gone before the wood will burn. If your wood is cut 6 months to a year, and it can be stored properly.

### Storing Wood

- **The MRC — Masonry Refractory Core System** by Firespaces
  - A typical Russian Heater Design
    - A heater with a simple design that should be located in a central part of the home, often built as a room divider. It can be faced with brick, stone, stucco, soapstone, tile granite or marble.
    - 1) Capping slab
    - 2) Chimney
    - 3) Clean-out
    - 4) Combustion air
    - 5) Downdraft channel
    - 6) Exhaust gas
    - 7) Exterior wall
    - 8) Firebox
    - 9) Firebox door
    - 10) Heat exchange area
    - 11) Shut-off damper
    - 12) Updraft channel
    - 13) Expansion joint

- **Masonry Heater from American Energy Systems**
  - A) High temperature class “A” chimney systems
  - B) Stainless steel chimney flue adapter
  - C) 5” concrete slab heat exchanger top
  - D) Lightweight hadite block for heat chamber
  - E) Fiberglass insulation
  - F) Upper grill option — heated room air enter here
  - G) 6” outside air pipe for combustion air
  - H) 1.25” fireback lining
  - I) Directional air baffles
  - J) Ceramic glass
  - K) Lower grill — cooler room air enters here

- **Typical Finnish Contraflow Heater**
  - 1) Insulating base with slab with outside air damper
  - 2) Combustion air inlet
  - 3) Ash drop
  - 4) Firebox lintel with heat shield
  - 5) Bake oven floor heat bypass
  - 6) Exhaust gas (to chimney)
  - 7) Chimney damper
  - 8) Hi-temperature insulating board
  - 9) Refractory capping slab
  - 10) Insulating concrete

- **Firewood Tips from The Chimney Safety Institute of America**
  - Seasoned Wood — All firewood contains water. Freshly cut wood can be up to 45% water, while well seasoned firewood generally has a 20-25% moisture content. Well seasoned firewood is easier to start, produces more heat, and burns cleaner. It is important that the water is gone before the wood will burn.
  - Storing Wood — Wood should be stored off the ground if possible. A wood shed, where there is a roof but open or loose sides for plenty of air circulation to promote drying, is an ideal site. Next best is to keep the wood pile in a sunny location and cover it on rainy or snowy days, being sure to allow air movement and to avoid trapping ground moisture under the covering.
  - Don’t forget that your woodpile also looks like heaven to termites, so it’s best to only keep a week or so worth of wood near the house. With proper storage you can turn even the greenest wood into firewood in 6 months or a year, and it can be expected to last 3 or 4 years if necessary.
  - Buying Wood — Firewood is generally sold by volume, the most common measure being the cord. A standard cord of firewood is 128 cubic feet of wood, generally measured as a pile 8 feet long by 4 feet tall by 4 feet deep. A face cord is also 8 feet long by 4 feet tall, but it is only as deep as the wood is cut, so a face cord of 16” wood actually is only ½ of a cord, 24” wood yields ½ of a cord, and so on.
  - It is best to have your wood storage area set up in standard 4 or 8 foot increments, pay the wood seller the extra dollars often charged to stack the wood, pay only when the wood actually measures up to an agreed upon amount.
  - Although firewood is usually sold by volume, heat production is dependent on weight. Pound for pound, all wood has approximately the same BTU content, but a cord of seasoned hardwood weighs about twice as much as the same volume of softwood, and consequently contains almost twice as much potential heat. If the wood you are buying is not all hardwood, consider offering a little less in payment.
The flame path in the fireplace firebox will also heat oven to low to medium temperature for slow cooking.

The bake oven fireplace can be fired in either the upper or lower firebox, but it cannot be fired in both at once.

To ignite the fire, open the ashbox door, loading door, and the shut-off damper. Thereafter, during the gas combustion process, close the ashbox door and regulate primary air with the ashbox door draft slide. The ashbox door can also be latched slightly ajar during the first half of the burning cycle. Secondary combustion air is regulated through the main door draft slides. The fire should be concentrated and vigorous. Do not poke or disturb the fire at this stage.

When gas combustion is largely completed and only a bed of live coals remains, the secondary draft slide in the main loading doors should be closed. When the coals have burned down considerably, they should be poked to mix the whole layer and get it to burn completely and evenly. Once this fire is out, wait at least three or four hours before a second loading to achieve more heat output and to keep thermal stresses within the system tolerable.

The dampers are cracked slightly open or designed with built-in gas slots to allow carbon monoxide to escape up the chimney. When all the embers are dark, combustion is complete and no more carbon monoxide is being produced. Only at this stage can the dampers be completely closed.

You should never neglect a masonry heater while the fire is burning or while the damper is open.

---

**Types of Masonry Heaters and Several Decorative Tiles from Biofire**

- Individually designed to meet your heating requirements and your personal and individual taste and style.
- Large selection of tile styles and colors, as well as special tiles for Stucco Biofires.
- Once approximately every 12 hours, you put a small amount of wood in your unit and light it to keep the area warm.
- Wood takes about an hour to burn completely. It burns very hot, fast and clean. This clean, complete burn makes the fireplace environmentally friendly.
- The refractory materials in the firebox and flue passageways very quickly absorb this heat and release it evenly over the next 12 hours.
- Fired once every 12 hours gives you 12 hours of even radiant heat.
- Gives off primarily radiant heat. Radiant heat ensures dust free air and proper humidity, creating a feeling of warmth.

- The inside core consists of a refractory firebox and a number of passageways.
- Each unit is individually designed to meet the draft in the chimney. The type of chimney, the chimney height, the chimney diameter, and the elevation are taken into account.
- Using this information, with the help of a computer, the draft in the chimney is calculated and the firebox and passageways are engineered.
- A to-scale wood model is built, showing exactly where every piece goes. This ensures that the same high efficiency results that were achieved in testing are duplicated in your home.

**Tile Biofire**
**Stucco Biofire**
**Fireplace Biofire**
**Decorative Tiles**

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For a free Topics List of 200 Update Bulletins (including a description of each), send a self-addressed stamped business-size envelope to: Jim Dulley, List, P.O. Box 54987, Cincinnati, Ohio 45254 or read on the Internet - [http://www.dulley.com](http://www.dulley.com)
Thank you for your interest in writing to me about mini-split ductless air-conditioning system to be used instead of or with central systems or window units. Mini-split ductless systems are one of the few methods to cool an entire house that does not have a central ducting system. They can also be used in addition to existing central ducted air-conditioning to cool problem rooms or to zone cool the house for energy savings.

A mini-split ductless system is basically a small scale central air-conditioner with an outdoor compressor/condenser unit and an indoor cooling/blower unit. Instead of the indoor cooling coils being in a central duct/blower system in a basement, utility room, or attic, a smaller cooler unit is located on a wall or ceiling in a room. Placing two or three of them throughout a house can cool the entire house. Some models are also available with heat pumps and/or electric resistance heat for winter use too.

On the following pages, I have listed the highest quality mini-split ductless systems available. All of them have good efficiency ratings and operate in a similar manner. If you are planning to install several indoor cooler units, each one has its own system.

### Selected Manufacturers of Ductless Mini-Split Air-Conditioning/Heat Pump Systems

**CARRIER CORP.,** PO Box 4808, Syracuse, NY 13221 - (800) 227-7437 www.carrier.com

**Cool only units**

<table>
<thead>
<tr>
<th>Model</th>
<th>Series</th>
<th>Wall Mount</th>
<th>Cooling</th>
<th>SEER</th>
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<td>CAH</td>
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**Heat pump units**

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**Multi-zone systems**

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**Features**

- The wireless remote has an automatic shift of fan speed, sleep mode — slowly raises temperature at night, 24-hour timer, time of day, sensor dry and automatic operation, high sensitive IC-thermostat and 3-minute delay circuit to prevent a fuse from blowing. The air handlers are quiet and equipped with four-way deflectors to direct air in any angle. There is an automatic restart after power failure. There is electric backup heat on several models and auto change over on the heat pump units. The indoor and outdoor units can be placed up to 49 feet apart.

**ENVIROMASTER INT’L CORP.,** 5780 Success Dr., Rome, NY 13440 - (315) 336-3716 www.enviromaster.com

**Cool only units**

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</table>

**Features**

- Hydronic heat, hot water and steam is available on several of the “FLC/FLH” models. There are power induced fresh air options. The “WSP/WH” series has unit mounted digital controls. Options include a digital remote control, condensate pump for heat pump units and electric heat options to 5 kW. The units have a nice profile featuring a perforated intake grille and manually adjustable discharge vanes. The “CAH” series has motorized air distribution vanes for sweep or set directions, fresh air and condensate pump, branch knockouts for secondary outlets and electric heat. The “CSP/CHP” also has fresh air knockout sections and optional electric heat to 10kW. It is a ceiling mounted evaporator for applications where fully exposed or partially recessed cabinetry can be used. For partially recessed mounting, these units easily adapt to standard T-bar, drop ceiling openings. It is designed for applications where the unit may be concealed in soffits or other structural spaces with only the intake and discharge grilles exposed. The aluminum supply air louvers are dual adjustable for air flow direction, to provide air flow throws to suit any installation. The “TBH” unit has an attractive intake/discharge grille that replaces any two by four foot ceiling panel and only electric wiring and refrigerant tubing is needed between the ceiling unit and the outside condensing unit. Sea coast coated coil options are a good choice for corrosive environments. Models are designed for 100 foot maximum tubing runs.

---

* This is the capacity in Btu. Btuh means Btu’s of cooling or heating output per hour.

** SEER is the cooling efficiency rating for an air conditioner or heat pump. HSPF is the heating efficiency rating for a heat pump in the heating mode.
### FRIEDRICH AIR CONDITIONING CO., PO Box 1540, San Antonio, TX 78295 - (210) 357-4400  www.friedrich.com

<table>
<thead>
<tr>
<th><strong>Cool only units</strong> model</th>
<th><strong>cooling</strong> cooling</th>
<th><strong>SEER</strong></th>
<th><strong>Heat pump units</strong> model</th>
<th><strong>cooling/heating</strong> cooling/heating</th>
<th><strong>SEER/HSPF</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- “M” series — wall mount</td>
<td>9,000 to 29,500</td>
<td>10.0 to 11.0</td>
<td>- “M” series — wall mount</td>
<td>9,500 to 23,500 / 6,300 to 22,500</td>
<td>10.0 to 10.5 / 6.8 to 7.3</td>
</tr>
<tr>
<td>- “C” series — in-ceiling</td>
<td>24,000 to 41,000</td>
<td>10.0 to 10.5</td>
<td>- “C” series — in-ceiling</td>
<td>24,000 to 41,000 / 25,900 to 38,900</td>
<td>10.0 to 10.5 / 7.6</td>
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</tbody>
</table>

### Heat pump units multi-zone systems - There are dual-zone systems available.

<table>
<thead>
<tr>
<th><strong>Cool only units</strong> model</th>
<th><strong>cooling</strong> cooling</th>
<th><strong>SEER</strong></th>
<th><strong>Heat pump units</strong> model</th>
<th><strong>cooling/heating</strong> cooling/heating</th>
<th><strong>SEER/HSPF</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- “M” series — wall mount</td>
<td>9,000 to 18,000</td>
<td>10.0 to 11.0</td>
<td>- “M” series — wall mount</td>
<td>9,400 to 23,500 / 10,800 to 23,500</td>
<td>10.5 / 7.2</td>
</tr>
<tr>
<td>- “C” series — in-ceiling</td>
<td>31,500 to 36,500</td>
<td>10.0</td>
<td>- “C” series — in-ceiling</td>
<td>20,500 to 21,000</td>
<td>10.0</td>
</tr>
</tbody>
</table>

### GE APPLIANCES, Appliance Park, Louisville, KY 40225 - (800) 626-2000  www.geappliances.com

<table>
<thead>
<tr>
<th><strong>Cool only units</strong> model</th>
<th><strong>cooling</strong> cooling</th>
<th><strong>SEER</strong></th>
<th><strong>Heat pump units</strong> model</th>
<th><strong>cooling/heating</strong> cooling/heating</th>
<th><strong>SEER/HSPF</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- “HDC” series — wall mount</td>
<td>6,800 to 22,000</td>
<td>10.0</td>
<td>- “HDP” series — wall mount</td>
<td>9,000 to 18,000 / 9,000 to 19,000</td>
<td>10.0 / 6.8</td>
</tr>
</tbody>
</table>

### GOODMAN MFG. CORP. 1501 Seamist, Houston, TX 77008 - (713) 861-2500  www.goodmanmfg.com

<table>
<thead>
<tr>
<th><strong>Cool only units</strong> model</th>
<th><strong>cooling</strong> cooling</th>
<th><strong>SEER</strong></th>
<th><strong>Heat pump units</strong> model</th>
<th><strong>cooling/heating</strong> cooling/heating</th>
<th><strong>SEER/HSPF</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- “HDC” series — wall mount</td>
<td>8,600 to 22,000</td>
<td>10.0</td>
<td>- “HDP” series — wall mount</td>
<td>6,800 to 19,000 / 11,400 to 19,000</td>
<td>10.0 / 6.8</td>
</tr>
</tbody>
</table>
**GOODMAN MFG. CORP. — continued**

**features** - The units are available with a wireless remote control that allows you to take total control of the system and provides you with programmable time and temperature control. The microprocessor control provides a 12-hour timer with an energy savings sleep mode. The unit is equipped with a 3-speed motor and the single blower design assures quiet operation. There is maximum air flow through the multi-flap 4-way discharge louvers. The permanent filters are easy to remove for washing and cleaning — helps to remove airborne dust and keeps the system operating at maximum capacity and efficiency. The sleek, contemporary styling of the indoor unit allows for a stylish appearance and easy cleaning. The compact design of the outdoor system has horizontal discharge air flow. The narrow footprint makes it ideal for ground level, rooftop or wall mounting. The isolated compressor compartment keeps noise levels to a minimum.


- **Cool only units**
  - **model** - “LS-C” series — wall mount  
  - **cooling** — 9,000 to 12,000  
  - **SEER** — 10.0
  - **model** - “LS-D” series — wall mount  
  - **cooling** — 18,000 to 23,000  
  - **SEER** — 10.0

- **Heat pump units**
  - **model** - “LS-C” series — wall mount  
  - **cooling/heating** — 9,000 to 12,000 / 9,000 to 12,000  
  - **SEER/HSPF** — 9.3 to 10.0 / 6.8
  - **model** - “LS-D” series — wall mount  
  - **cooling/heating** — 17,800 to 23,000 / 18,700 to 23,000  
  - **SEER/HSPF** — 9.3 to 10.0 / 6.8

**features** - The units have a slim, low profile design that blends with any decor. The whole system is engineered to be extremely quiet, and the 3-speed cross-flow fan is optimized to deliver a balanced airflow without vibration or noise. A built in microprocessor continuously adjusts the fan speed to ensure maximum comfort. The sleep mode button on the remote automatically programs fan speed and temperature for a comfortable night’s sleep. The LCD wireless remote allows you to set the room temperature, adjust the fan speed and the air flow direction easily. The 2-way electric air swing louver efficiently directs airflow where you need it the most. The washable air filter keeps dust away from the unit for maximum performance and longer life of the compressor. The unit is also equipped with a 24-hour on/off timer so you can operate it only when needed, helping to save energy. There is a 5-year limited warranty on the compressor and a 1-year limited warranty on parts.

**MITSUBISHI ELECTRONICS, 4505 Newpoint Place Parkway, Lawrenceville, GA 30043 - (800) 433-4822 www.mrslim.com**

- **Cool only units**
  - **model** - “Mr. Slim MS” — wall mount  
  - **cooling** — 8,500 to 16,100  
  - **SEER** — 10.2 to 11.3
  - **model** - “Mr. Slim MF” — floor mount  
  - **cooling** — 12,000 to 14,500  
  - **SEER** — 10.0 to 10.3
  - **model** - “Mr. Slim PK” — wall mount  
  - **cooling** — 12,500 to 34,200  
  - **SEER** — 10.2 to 11.3
  - **model** - “Mr. Slim PC” — ceiling mount  
  - **cooling** — 24,000 to 43,000  
  - **SEER** — 10.0 to 10.4
  - **model** - “Mr. Slim PL” — in-ceiling  
  - **cooling** — 12,300 to 42,500  
  - **SEER** — 10.0 to 10.4

- **Heat pump units**
  - **model** - “Mr. Slim MSH” — wall mount  
  - **cooling/heating** — 8,800 to 16,200 / 10,500 to 17,200  
  - **SEER/HSPF** — 10.0 to 10.7 / 6.8
  - **model** - “Mr. Slim PKH” — wall mount  
  - **cooling/heating** — 18,000 to 34,200 / 18,600 to 45,500  
  - **SEER/HSPF** — 10.2 to 11.1 / 6.8 to 7.2
  - **model** - “Mr. Slim PCH” — ceiling mount  
  - **cooling/heating** — 24,000 to 42,000 / 18,400 to 43,000  
  - **SEER/HSPF** — 10.0 to 10.4 / 7.1 to 7.4
  - **model** - “Mr. Slim PLH” — in-ceiling  
  - **cooling/heating** — 17,300 to 42,000 / 18,000 to 44,300  
  - **SEER/HSPF** — 10.0 to 10.4 / 7.0 to 7.4

- **multi-zone systems** - Dual- and triple-zone systems are available.

**features** - The “Mr. Slim” outdoor compressor unit can be mounted almost anywhere within 50’ on the smaller units and up to 160’ away from the larger indoor units. The wireless remote controller has operation mode settings. I feel too cool or too warm allows you to adjust the temperature instantly to reach your desired comfort level. Computerized dehumidification in the dry mode places the system on priority dehumidification rather than temperature control. There is also a night setback mode, energy-saving cooling feature, 3-speed or automatic fan control, 24-hour on/off timer (operation can be set to start or stop after a specified time in one-hour units from 1 to 24), self-diagnostic display and vane control. The angle of the air outlet vanes can be adjusted. Choose from auto (automatically adjusts the angle), swing vane mode or adjust manually for precision directional flow. There are five different vertical airflow angles that can be selected to match the room layout and the location of people. The heat pump units start with a low fan speed to prevent the unit from blowing cold air into the room. When the blower first comes on you will get warm air. The microprocessor controlled booster heater speeds the warming process. Some heat pump models have backup electric resistance heat for extremely cold weather. The “MS/MSH” series has an indoor unit that is only 32 inches wide by 11 inches tall by 7 inches deep and weighs less than 18 pounds.

**SANYO AIR CONDITIONING PROD., 21605 Plummer St., Chatsworth, CA 91310 - (818) 998-7322 www.sanyohvac.com**

- **Cool only units**
  - **model** - “K” series — wall mount  
  - **cooling** — 9,000 to 34,000  
  - **SEER** — 10.0 to 11.0
  - **model** - “T” series — ceiling mount  
  - **cooling** — 23,400 to 45,000  
  - **SEER** — 10.0 to 10.9
  - **model** - “R or X” series — in-ceiling  
  - **cooling** — 11,500 to 35,000  
  - **SEER** — 10.0 to 10.4

- **Heat pump units**
  - **model** - “K” series — wall mount  
  - **cooling/heating** — 9,000 to 33,000 / 10,800 to 40,000  
  - **SEER/HSPF** — 10.0 to 10.5 / 6.8 to 7.6
  - **model** - “F” series — floor mount  
  - **cooling/heating** — 11,500 to 16,500 / 12,200 to 18,000  
  - **SEER/HSPF** — 10.0 to 10.3 / 6.8
  - **model** - “T” series — ceiling mount  
  - **cooling/heating** — 21,400 to 43,000 / 22,800 to 47,000  
  - **SEER/HSPF** — 10.0 to 10.2 / 6.8 to 7.2

- **multi-zone systems** - There are dual- and triple-zone systems available. See page 4 for more details.

**features** - The units have an LCD wireless remote control for all the functions — time of day, current room temperature, set temperature, fan speed and night setback for a comfortable night’s sleep, auto-louver (oscillates the air discharge vane up and down for even air distribution) or timer functions if selected. There is a 24-hour on/off program timer which includes automatic 1-time daily on/off setting, off timer, on timer and combination timer to help you save energy by operating the unit only when needed. There is a power failure automatic restart. The automatic fan mode adjusts the fan speed to high, medium or low accordingly to the room temperature to maintain your comfort settings. The microcomputer controlled system is constantly monitoring time and temperature against preset conditions for energy cost savings and to maintain the room temperature. The washable filters can be removed without tools. The heat pumps have a hot start heating system — prevents any cold blasts at the beginning while the heat pump is warming up.
Auto Louver Function — Enhances the air distribution by enabling you to automatically set a gentle, air sweep motion in various patterns from the remote control. A vertical louvered motion for systems 9C1, 12C1, 9R1 and 12R1; and a dual louvered function for systems 18C1, 24C1, 30C, 18R1 and 24R1 provide improved air flow.

Power Diffuser — Triggered by the maximum auto louver function; this additional louver opens based on Artificial Intelligence (AI) technology monitoring sensor to meet comfort needs.

Super Vane Design — A double flap configuration boosts airflow, sending air to every corner of the room.

Sleep Function — Automatically adjusts the temperature while you sleep to make you more comfortable. Smaller models also incorporate an extra quiet fan speed.

Dry Mode — Is used to help control humidity levels when cooling may not be needed.

Energy Saver Mode — Allows the unit to keep your room cool enough for comfort by using a relaxed thermostat setting automatically, reducing power consumption.

Moderate Low Ambient Operation — This additional feature allows the system to operate indoors even when outdoor ambient temperatures are 32°F; without any additional accessory.

Auto Restart — In the event of a temporary power failure the air conditioner will automatically restart in the same operating mode as before, once power has been restored.

Filter Check Timer — The front cover is easy to remove, making air filter cleaning simple. In addition, the built-in filter check lamp indicates when it is time to clean the filter.

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**General Electric Remote Control Features**

1) Displays the operation conditions.
2) Operation starts when this button is pressed and stops when the button is pressed again.
3) Selects the operation mode.
4) Sets the time of starting and stopping operation.
5) Adjusts the time.
6) Sets the timer when the desired time is obtained and to cancel the timer operation.
7) Stops or starts louver movement and sets the desired up/down airflow direction.
8) Sets sleep mode auto operation.
9) Circulates the room air without cooling or heating (turns indoor fan on/off).
10) Checks the room temperature.
11) Switches temperature reading from Centigrade to Fahrenheit.
12) The reset button is used prior to resetting time or after replacing batteries.

**Mitsubishi Remote Control Features**

• The 24-hour on/off timer allows you to program the exact times you want the unit to operate so energy is not wasted.

• Three-speed or automatic fan control.

• In dry mode, system places priority on dehumidification rather than temp control.

• Easy-to-read digital display indicates the set temperature in increments of 2°F.

The “I Feel” temperature control allows you to adjust the temperature instantly with one tap of a button. Simply select “Too Warm” or “Too Cool” to achieve the desired comfort level.

• Auto/swing vane mode quickly heats or cools down a room by distributing air high or low to ensure best air distribution, or operate manually by choosing from five different angles for precise directional flow.

---

**Tri-Zone Air Conditioners by Sanyo**

• Tri-Zone design — means the 3 indoor evaporators are each connected to the same outside high-performance condenser through a 3½” wall opening.

• Single outside condenser — utilized 3 separate rotary compressors and refrigerant circuits for maximum efficiency.

• Wireless remote control — with large LCD screen controls all 3 indoor units and permits user to select all functions and the desired room temperature setting from anywhere in the room. The liquid crystal display shows the time of day, current room temperature, set temperature, fan speed and the night setback, auto-louver or timer functions if selected.

• Microcomputer-controlled system — constantly monitors time and temperature against preset conditions for maximum energy cost savings as well as to ensure correct indoor temperature at all times.

• 24-hour on/off program timer — allows you to set various time-based functions including automatic one-time/daily on/off setting, off timer, on timer and combination timer.

• Full width centrifugal blower — distributes a quiet, even flow of conditioned air to the room from the indoor evaporator.

• Ductless mini-split system — means speedier, less costly installation (than adding ducts for central air-conditioning) and very quiet operation.

• The ultra-quiet wall-mounted evaporator is connected through a 3½” wall opening to an innovative, powerful yet quiet outdoor condenser, eliminating the need for expensive and time-consuming ductwork.

• Preservation of security and view — since window space and large wall openings are not required for these split system installations, building safety is enhanced and the view preserved.

• Washable filters — easy to remove for cleaning without tools. Helps with maximum efficiency.

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**How Much You Save by Installing a New Ductless Mini-Split Air Conditioner**

<table>
<thead>
<tr>
<th>SEE</th>
<th>Approximate Annual Operating Cost — ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>200 300 400 500 600 700 800 900</td>
</tr>
<tr>
<td>7.0</td>
<td>175 260 345 430 515 600 690 780</td>
</tr>
<tr>
<td>8.0</td>
<td>150 225 300 375 450 525 605 685</td>
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<td>9.0</td>
<td>135 200 270 335 400 465 540 610</td>
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<td>120 180 240 300 360 420 485 550</td>
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<tr>
<td>11.0</td>
<td>110 165 220 275 330 385 440 500</td>
</tr>
<tr>
<td>12.0</td>
<td>100 150 200 250 300 350 405 455</td>
</tr>
</tbody>
</table>

To use this chart — Estimate the approximate SEER efficiency of your current air conditioner. Check with your contractor. Then locate your current annual operating costs. Look down in the same column across from the new efficiency for new operating cost.

**Example** — If your current air conditioner has a SEER of 6.0 and its annual operating (electricity) cost is $500, the cost to operate a new 11.0 SEER air conditioner will be about $275, an annual savings of $225.

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For a free Topics List of 200 Update Bulletins (including a description of each), send a self-addressed stamped business-size envelope to: Jim Dulley, List, P.O. Box 54987, Cincinnati, Ohio 45254 or read on the Internet - http://www.dulley.com
Thank you for your interest in writing to me about comfortable warm water (“warm feet”) radiant floor heating for homes. It is one of the most efficient methods to heat a home because you can keep your thermostat setting relatively low and still be comfortable. For each degree that you can lower your thermostat setting, you will save about 2% on your heating bills.

Radiant heat from the floor warms objects and people in the room, not just the air. This is similar to the way that you feel warm in the sun on a cold winter day. Also, by not directly heating the air in the room, hot air does not tend to stagnate near the ceiling. Radiant floor heating is also quiet and does not stir up dust and allergens like a forced air system. It would still be wise to use some small room air cleaners with it.

I have listed the highest-quality manufacturers of complete radiant floor systems and components. Most homes use a gas or oil boiler, but for mild climates or for just a room or two, a water heater may work fine. You can also use solar-heated water or a water-to-water ground source heat pump for the high efficiency. Although some of the complete systems are not difficult to install, have the manufacturer or dealer determine the proper size system for your needs. Also check your local codes to see if a licensed professional must do the installation.

If you are doing an entire house, consider installing a zoning system to allow you to vary the temperatures in various rooms of the house. This is simple to do and many of the manufacturers listed offer zoning controls. The three companies listed below make special cement products that are ideal for use with warm water radiant floor heating.

---

**Selected Manufacturers of Lightweight Cement Underlayments**

ELASTIZELL CORP., PO Box 1462, Ann Arbor, MI 48106 - (734) 761-6900 www.elastizell.com

HACKER INDUSTRIES, 610 Newport Center Dr., Suite 100, Newport Beach, CA 92660 - (800) 642-3455 www.firmfill.com

MAXXON CORP. — THERMA FLOOR, 920 Hamel Rd., Hamel, MN 55340 - (800) 356-7887 www.maxxon.com

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**Selected Manufacturers of Warm Water Radiant Floor Heating Systems**

BURNHAM RADIANT HEATING CO., PO Box 3079, Lancaster, PA 17604 - (717) 397-4701 www.burnham.com

- **type of tubing** - cross-linked polyethylene with and without oxygen barrier
- **diameter sizes** - 1/2” • 3/4” • 1”
- **zoning available** - yes — up to ten
- **features** - The tubing is covered with a 25-year limited warranty. There are brass or copper manifolds available. The brass manifolds will accept 1/2” tubing only and has 2, 3 or 4 circuit configurations that can be connected to allow different manifold sizes. The copper manifolds are available as buildable units or long sections that need to be cut to the correct size. Plastic bend supports, pipe fasteners and anchor clips are available that will not damage the pipe during installation. Boilers are also available that carry a lifetime limited warranty.

EMBASSY INDUSTRIES, INC., 300 Smith St., Farmingdale, NY 11735 - (631) 694-1800 www.embassyind.com

- **type of tubing** - cross-linked polyethylene with and without oxygen barrier
- **diameter sizes** - 3/8” • 1/2” • 5/8” • 3/4”
- **zoning available** - yes — up to four zones with three zone extensions
- **features** - The manifold is modular, you can add a section to the manifold if needed. The manifold has a flow-rate indicator so it is easy to adjust the flow-rate to each zone. Accessories available — aluminum snap plate (tubing snaps into groove) that fasten between joists below the floor, in the ceiling or on plywood floors • double groove aluminum snap plates for floor, wall or ceiling • a plastic tube support channel that holds tubing in place in 8’ lengths • bend support that allows 90° angle bends • baseboards, contemporary panel radiators and towel warmers, finned tube, kick space heaters and unit heaters.

HEATLINK USA, INC., 89 54th St. SW, Grand Rapids, MI 49548 - (800) 968-8905 (616) 532-4266 www.heatlink.com

- **type of tubing** - synthetic rubber with an aluminum oxygen barrier and braided fiber reinforcing • cross-linked polyethylene with and without oxygen barrier
- **diameter sizes** - 3/8” • 1/2” • 5/8” • 3/4”
- **zoning available** - yes — up to sixteen zones
- **features** - The tubing has a limited lifetime warranty for residential applications (as long as you live in your home) and a 20-year warranty for snow melting applications. The “HydroControl” panels (pumps, controls, valves and gauges) are custom built for your application and comes with a one-year parts and labor warranty. The standard manifold is all brass, swedged manifold (2-, 3- and 4-branch that can be connected to one another) is 1” copper and the “CustomCut” manifold is 4’ long with fittings spaced 3” apart.

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**Update Bulletin No. 581**

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**MODULAR RADIANT TECH., INC.,** PO Box 2067, Vashon, WA 98070 - (206) 463-1267  www.pfgindustries.com

type of tubing - cross-linked polyethylene with and without oxygen barrier
diameter sizes - 3/8” • 1/2” • 5/8”  zoning available - yes — up to nine zones
features - The tubes are embedded directly in a concrete slab or covered with 1 1/4” of “Therma-Floor” underlayment, see page 4. This is a pourable floor underlayment. It is crack-resistant, noncombustible and transfers heat from the tubes to the room. It eliminates hot and cold spots, squeaky floors and helps stop noise between living areas. The floor temperature can be thermostatically controlled through a heat sensor inside the “Therma-Floor” or through an air-sensing thermostat. There is a 25-year warranty on the tubing and a 1-year warranty on mechanicals.

**SLANT/FIN CORP.,** 100 Forest Dr., Greenvale, NY 11548 - (516) 484-2600  www.slantfin.com

type of tubing - cross-linked polyethylene with an oxygen diffusion barrier
diameter sizes - 3/8” • 1/2” • 9/8”  zoning available - yes — up to seventeen zones
features - The “Therma-Floor” radiant heating system is baseboard compatible and has adapters for connecting the tubing to baseboard heating. The manifold is modular and allows for easy expansion of zones. It has a built-in balancing valve and is made of fiberglass reinforced nylon, injection-molded parts. There are pipe tracking systems — grooved channels for wet installation or toroidal fiber tracks for dry installations. The tubing is easy to install with high heat output. “Therma-Floor” is crack-resistant and resilient. There is a 25-year warranty on the tubing and a 1-year warranty on the manifold. There is also a 25-year warranty on the equipment and a 25-year warranty on the system. No special tools or skills are required and a simple installation manual is included with each system.

**SLANT-EASE, 20714 State Highway 305, Suite 3C, Poulsbo, WA 98370 - (360) 478-9600  www.slantease.com

type of tubing - cross-linked polyethylene with and without oxygen barrier
diameter sizes - 3/8” • 1/2” • 9/8”  zoning available - yes — up to six zones
features - The tubing carries a 25-year warranty. Computerized design assistance is available for a system installed in an existing home or for new construction. There are two manifolds available — an adjustable brass manifold or a copper line “Easy Mod” manifold. “ThermalBoard” is a radiant heating system using thermally coated composite wood product, factory grooved to accommodate 3/8” tubing. The tubing is tightly secured in the groove resulting in thermal transfer. It is primarily intended for attachment to new or existing plywood sub floors or walls in residential new construction or retrofit radiant floor applications. It may also be used over existing concrete slabs.
Partly Cross-Linked Polyethylene (Poly PXC) — All polyethylene tubes have very long service lives and exceptional resistance to chemical attack. Poly PXC tubing has the best overall heat exchange properties and put out twice as much heat as most other products. It is much lower in cost because of its relatively thin walls and somewhat larger diameter. The temperature and pressure rating is 150°F at 50 psi maximum which is lower than other products, but more than adequate for most applications. The ending radius is 12 inches (i.e. it takes 2 feet to make a 180 degree turn). It is somewhat more prone to kinking because of the thinner walls. In concrete applications, the lower temperature and pressure ratings do not matter because you end up with a reinforced concrete pipe with a plastic liner which will be many times stronger than necessary. It is plenty rugged enough to withstand the abuse of a concrete pour. The larger bending radius will not pose difficulty in a slab of any reasonable size, particularly if the reverse return spiral is used.

Poly PXC tubing is more difficult to run than other tubings when it is run between floor joists, but you will have to run less of it because of the high heat output. Poly PXC is rated potable.

Fully Cross-Linked Polyethylene (PEX) — This tubing has higher temperature and pressure ratings as well as a thicker wall. It puts out less heat per foot and thus, has a higher overall cost. It is easier to maneuver in tight places because of its smaller bending diameter and thicker walls. This is important in between joist spaces but less important in a concrete slab of any size. It is available with an oxygen diffusion barrier at added cost. It has high code acceptance. Some would say that the product is over engineered but it is available for the person who wants added assurance and is willing to pay for it.

Metal Tubing (Copper) — Copper tubings and other metals have gone the way of the horse and buggy for the most part. They are more expensive than the plastics and do not last as long. They are incompatible with concrete because of chemical reactions and problems with expansion and contraction. Their superior conductivity cannot be put to advantage because of the need to spread out the heat. They do have good code acceptance and high temperature and pressure ratings. Workmen are familiar with it and it is readily available. Copper is often used in small jobs such as bathrooms where the high cost is not as important and there is no minimum ordering requirement.

Rubber Hoses — The most important benefit of these products are their flexibility and ease of installation. The diameters are usually small and bending radius can be as small as an inch or two. This advantage, however, does not make up for some significant disadvantages. The service life is uncertain. Some products are nearly identical to automotive heater hose and are not likely to last much longer than 10 years. They have high cost and cannot be used in potable systems. In our opinion, their usefulness is limited to very difficult retrofit situations where nothing else can be installed.
Single Concrete Pour Over Slab Insulation Using Copper Coated Wire Ties —
1) Lay out the recommended type high density insulation over the base material.
2) Lay out the wire mesh or rebar.
3) Connect one end of the loop to the supply manifold.
4) Secure the tubing to the wire mesh or rebar.
5) Tie the tubing to the wire mesh or rebar using copper coated wire ties and wire twister. Secure the tubing to the wire mesh or rebar every four feet along straight runs.
6) Once the complete loop has been laid out, connect the end of the loop to the return manifold. Complete the tubing installation.
7) Securely fasten, as necessary, the wire mesh or rebar to the insulation.
8) Pressure test the system in accordance with local building codes.
9) Apply a suitable concrete mixture over the tubing.

Poured Floor Underlayment on a Suspended Wood Floor —
1) Connect one end of the loop to the supply manifold.
2) Make sure the wood stapler head is securely fastened to the stapler and the stapler is loaded with 1 1/4” staples. Staple the tubing to the wood subfloor.
3) Staple the tubing as necessary along the straight runs to ensure it will stay in place.
4) Once the complete loop has been laid out, connect the end of the tubing to the return manifold.
5) Attach the walking stick to the stapler and fasten the tubing to the subfloor every two feet or as necessary to prevent it from dislodging and/or floating up into the pour. Complete the tubing installation.
6) Pressure test the system in accordance with local building codes.

On a Suspended Wood Floor Using Aluminum Heat Emission Plates —
1) Mark the approximate location of the tubing on the subfloor.
2) Starting at the area farthest from the manifold, glue and nail a 1x6 furring strip to the subfloor along the exterior wall.
3) Using a heat emission plate as a guide, nail and glue another furring strip parallel to the first. Leave a 1” space between furring strips for the groove of the heat emission plate.
4) Staple heat emission plates to furring strips on one side of tubing. This allows the plates to expand as subfloor or finish flooring is nailed down. Leave a small gap between plates.
5) Connect one end of the loop to the supply manifold.
6) Following the tubing layout pattern, snap the tubing into the heat emission plate.
7) Connect the other end to the return manifold. Complete the tubing installation.
8) Pressure test the system in accordance with local building codes.

Poured Floor Underlayment on a Suspended Wood Floor Using a Rail System —
1) Lay out rails parallel with floor joists (perpendicular to tubing layout direction).
2) Fasten rails to subfloor using 1” wood screws.
3) Connect one end of the loop to the supply manifold.
4) Snap the tubing into each rail at the recommended spacing. The tubing will be installed in a single wall serpentine layout pattern.
5) Once the complete loop has been laid out, connect the end of the tubing to the return manifold.
6) Pressure test the system in accordance with local building codes.
7) Apply a concrete mixture over the tubing.

Under a Suspended Wood Floor Using Aluminum Heat Emission Plates —
1) Connect the loop to the supply manifold.
2) Snap the tubing into the heat emission plates, and following the tubing layout plan, staple the heat emission plates to the underside of the subfloor. Leave a small gap between each plate. Place two staples on each end between tubing, and two in the center between tubing.
3) Connect the end of the loop to the return manifold. Complete the installation.
4) Pressure test the system in accordance with local building codes.
5) Install suitable insulation below the slab to limit downward loss.

The patented panel design consists of two pieces of floor underlayment bonded to an aluminum heat transfer sheet to form one panel unit. This unit can be screwed down from above or below the subfloor.

The extremely shallow design of the panel system results in a maximum of only 1/2” buildup. The low profile means no door molding or floor baseboard alterations.

The 7” width allows two panels to be installed under the subfloor between joists. This system can react to temperature changes within minutes (rather than hours, which is characteristic of concrete systems) a feature extremely important to woodframe buildings.

By using this system the tubing remains exposed while nailing wood flooring. There is no time delay before applying the finish floor. The low weight panels eliminate special structural reinforcements normally needed for wet concrete floor heating systems.

The panels are 7” or 10” wide by 48” long. The panels are designed to allow tubing to snap into place and stay there.

Therma-Floor from Maxxon

Therma-Floor is a gypsum underlayment designed to pour over hot water tubes or electric heating cables. It acts as the thermal mass for any radiant floor system. It encases tubes/cables in crack resistant, noncombustible gypsum. Its special formula resists breakdown to 150ºF. And because it’s poured only 1/16” thick, the heating system is more responsive, more comfortable.
Thank you for your interest in writing to me about efficient methods to bring indoor fresh air into your home without opening windows and wasting much energy. This is very important for good indoor air quality, especially in new airtight homes with many synthetic products that may out-gas pollutants. In humid climates, it is also a great plus for indoor humidity control.

A heat recovery ventilator is the most effective and efficient method to bring in fresh outdoor air. The two basic types are a standard heat exchanger (no transfer of moisture between the incoming and outgoing air flows) and an enthalpic heat exchanger (transfers moisture). Enthalpic models are more often used for year-round fresh air ventilation and in warmer climates. The standard non-enthalpic units (typically cost a little less) are very effective in winter for fresh air and humidity control. Non-enthalpic units can also be used in the summer too, but in very humid climates, they can bring in excessive humidity.

Broan, Honeywell and Venmar all make excellent quality units that are similar in design and operation. Carrier’s model is a very clean, durable design. Stirling makes an easy-to-install window model that has an unusually high heat transfer efficiency using a rotary heat exchanger design. All of the Stirling models are non-enthalpic. Therma-Stor’s unit is unique in that it just brings in fresh air when needed with no outdoor exhaust. The fresh air first flows through a filter and a dehumidifier.

Selected Manufacturers of Residential Heat Recovery Ventilation Systems

**AIR FOR LIFE**, 2901 4th St. SE, Minneapolis, MN 55414 - (612) 331-8286 www.airforlife.com

- **model** - “BossAire”
- **heat exchanger type** - crossflow
- **flow rate** - 70 to 350 cfm  
- **power usage** - 80 to 157 watts  
- **efficiency** - 85%
- **warranty** - 2 years: parts; lifetime: cell
- **features** - The cell and motors are housed in a heavy gauge galvanized steel enclosure with a baked enamel finish. There is a unique draw-through double-pass design that pulls both the supply and exhaust air through the ducts.

**AMERICAN ALDES**, 4537 Northgate Ct., Sarasota, FL 34234 - (941) 351-3441 www.americanaldes.com

- **model** - “Aldes HRV”
- **heat exchanger type** - crossflow
- **flow rate** - 50 to 230 cfm  
- **power usage** - 84 to 164 watts  
- **efficiency** - 74% to 95%
- **warranty** - 2 years: parts; 15-years: core
- **features** - An internal dehumidistat automatically increases the ventilation rate when humidity rises. There are washable filters on each air stream to protect the core. They are easy to access and clean. There is an efficient five-speed motor. Optional operating controls available — sixty minute timer, digital electronic timer kit, wall-mount remote dehumidistat, programmable ventilation control that includes a programmable timer, dehumidistat and air quality monitor. Both standard and enthalpic cores are available.

**BROAN**, 926 W. State St., Hartford, WI 53027 - (800) 548-0790 www.broan.com

- **model** - “Guardian ERV”
- **heat exchanger type** - crossflow
- **flow rate** - 130 to 201 cfm  
- **power usage** - 150 to 225 watts  
- **efficiency** - 76% to 81%
- **warranty** - not available
- **features** - The “Guardian ERV” units have an enthalpic core that transfers energy and moisture vapor between incoming and outgoing air streams. The HRV model does not transfer moisture between the air streams. The dehumidistat automatically shifts the unit to high speed whenever humidity exceeds the preset desired level. An optional air quality sensor control can be added that senses and detects increases of pollutants in the air and adjusts the speed setting automatically. It has a light that tells you when it’s time to clean the filter. There are remote controls available for kitchen or bathrooms — pushbutton 20-minute timer, 60-minute timer control for high speed operation or remote dehumidistat. No tools are required to remove the core for cleaning or replacement. The foam filters are easy to get to and completely washable.

**CARRIER**, PO Box 4808, Syracuse, NY 13221 - (800) 227-7437 www.carrier.com

- **model** - “V series”
- **heat exchanger type** - crossflow
- **flow rate** - 65 to 265 cfm  
- **power usage** - 144 to 552 watts  
- **efficiency** - 69% to 84%
- **warranty** - 5 years: parts; lifetime: core
- **features** - The door swings open after unlatching two briefcase-style latches so no tools are needed when the filters and core need cleaning. There is an automatic defrost — damper defrost periodically recirculates indoor air when temperatures drop below 23°F to prevent frost from forming. There is an incoming air filter to remove some contaminants like pollen and dust and an exhaust air filter that eliminates large airborne particles. A wall-mounted control unit is equipped with three different modes. The recirculation mode provides air movement throughout your home without bringing in outside air. The continuous mode works 24 hours a day to provide a continuous flow of fresh outdoor air into your home. The intermittent mode operates when the indoor humidity exceeds your desired level, providing maximum fuel economy. See illustration (inside look of a typical heat recovery ventilator) on page 4.
**DES CHAMPS LABORATORIES, PO Box 220, Natural Bridge Station, VA 24579 - (540) 291-1111 www.deschamps.com**
- **model**: "E-Z-Vent II"
- **heat exchanger type**: counterflow
- **flow rate**: 0 to 240 cfm
- **power usage**: n/a
- **efficiency**: -
- **warranty**: 3 years
- **features**: An optional electrostatic air filter is available that replaces the standard disposable filters that allows supply air to be filtered removing small airborne particulates from the airstream. There are briefcase-style latches giving easy access for cleaning or service. There are dual, variable-speed motors to adjust the airflow and eliminate the need for balancing dampers. An optional radiant defrost system that is thermostatically controlled is available for operation during the winter months.

**GATEWAY INTERNATIONAL, 16247 Forest Meadows, St. Louis, MO 63005 - (314) 532-0517**
- **model**: "Ventex VT80"
- **heat exchanger type**: rotary
- **flow rate**: 50 to 80 cfm
- **power usage**: 25 to 40 watts
- **efficiency**: 75% to 80%
- **warranty**: 1 year
- **features**: This is an enthalpic through-the-wall or window unit. The honeycomb-designed heat exchanger is made of seventy feet of corrugated sheets that are coated with high heat-absorbent material. Two fans drive air streams in and out through the heat exchange rotor. An optional window installation kit and activated carbon filters are available. It has high and low speeds to meet your specific needs. It weighs 30 pounds and the dimensions are 25-5/8" wide, 14-1/8" high and 10" deep. See illustration on page 4.

**HONEYWELL, 1985 Douglas Dr. North, Minneapolis, MN 55422 - (800) 328-5111 (612) 951-1000 www.honeywell.com**
- **model**: "Perfect Window HRV"
- **heat exchanger type**: crossflow
- **flow rate**: 150 to 204 cfm
- **power usage**: 84 to 157 watts
- **efficiency**: 80%
- **warranty**: 2 years
- **features**: The HRV heat transfer core is aluminum and it is easy to clean. There is a 4-speed fan control for specific demands and automatic built-in defrost control. The pre-filter is permanent and washable. The digital electronic fan timer has preset times of 20, 40 and 60 minutes. It has a child lock-out procedure. An optional dehumidistat is available that automatically switches to a preset speed when the humidity reaches a specified level. The unit includes vibration isolation hardware and duct collars for quiet operation. The "Perfect Window ERV" unit contains an enthalpic core that reduces humidity in the summer and retains humidity in dry weather.

**KANALFLAKT, PO Box 2000, Bouctouche, NB, Canada E0A 1G0 - (506) 743-9500 www.kanalflakt.com**
- **model**: "Enviro SE Series"
- **heat exchanger type**: crossflow
- **flow rate**: 150 to 268 cfm
- **power usage**: 172 to 310 watts
- **efficiency**: 63% to 64%
- **warranty**: 7 years: parts • lifetime: core
- **features**: The "Enviro SE Series" has a polypropylene core with an optional aluminum core available. There are up to three operating modes and three operating speeds. The fans are easy to reach and an optional electronic filter can be added. The steel cabinet is lined with an insulating layer to keep noise levels down. There is an automatic defrost cycle, dehumidistat controls and variable-speed options with optional electronic wall mounted controls. The "Enviro KHP 1400" has a permanently sealed heat pipe core that is partially filled with an oxygen friendly refrigerant. It is comprised of a series of copper tubes, banded by aluminum fins to expand the heat transfer area. Each pipe is mounted at a slight angle inside the unit to ensure one end of each tube is positioned in the warm air flow and the other in the cold air flow. There are many other models to choose from.

**LENNOX INDUSTRIES, PO Box 799900, Dallas, TX 75379 - (800) 953-6669 (972) 497-5000 www.lennox.com**
- **model**: "Lennox HRV"
- **heat exchanger type**: crossflow
- **flow rate**: 125 to 150 cfm
- **power usage**: not available
- **efficiency**: 85% to 90%
- **warranty**: 5 years: parts • lifetime: core
- **features**: The fans that move the air are very quiet and are driven by an energy-efficient 5-speed motor. The aluminum heat exchange core allows efficient heat exchange between outgoing and incoming airflows. A built-in dehumidistat control helps reduce any conditions of high humidity. There is high filtration efficiency without any restriction of air flow. The damper-style defrost protects the unit in high-frost conditions. A digital control system monitors the air stream with remote devices and sensors, providing efficient ventilation. An insulated and sealed cabinet reduces condensation, noise and air loss. Efficient motors and fan housings dramatically reduce noise and vibration transfer. The filters are easy to access and clean. Optional remote dehumidistat and timers automatically switches the unit to a higher speed when humidity exceeds the setting. The remote timer will boost air flow on demand. Electronic controls make it easy to customize performance by adding a number of accessories.

**MITSUBISHI ELECTRONICS, 3100 Avalon Ridge Pl., #200, Norcross, GA 30071 - (800) 433-4822 www.mitsubishi-hvac.com**
- **model**: "Lossnay"
- **heat exchanger type**: crossflow
- **flow rate**: 50 to 210 cfm
- **power usage**: 90 to 120 watts
- **efficiency**: 73% to 82%
- **warranty**: 1 year: parts • 15 years: core
- **features**: All units are enthalpic. The "Lossnay" energy exchange core has the air flowing through multiple air passages separated by a webwork of specially cut, engineered composite resin. The unique moisture transfer feature eliminates condensate and frosting in most applications. The front panel hinges open and provides easy access to the filters, blowers and core. The unit has 1" of foil-faced fiberglass on the top, bottom, back and sides with an additional 1/4" layer of rubber on the front cover for thermal and sound insulation. Optional controls are — dehumidistat control for excess moisture during the wintertime, 24-hour timer control or point-of-use controls for kitchen and bathrooms so you can turn on the ventilating system when needed.

**NUTECH ENERGY SYS, 511 McCormick Blvd., London, Ontario, Canada, N5W 4C8 - (519) 457-1904 www.lifebreath.com**
- **model**: "Lifebreath"
- **heat exchanger type**: crossflow
- **flow rate**: 40 to 1200 cfm
- **power usage**: 35 to 333 watts
- **efficiency**: 69% to 90%
- **warranty**: 5 years: parts • core
- **features**: The unit has a five-speed motor to deal with temporary increases in humidity and contaminants. Both standard and enthalpic cores are available. Filters protect the heat exchange core and can be cleaned by rinsing and replacing them. The heat exchange core is made of aluminum to transfer maximum amounts of heat to the incoming air. There is a built-in dehumidistat that automatically increases the air exchange rate when the humidity rises. A wall-mounted, digital timer has preset timed periods — 20, 40 or 60 minutes. A high tech defrost electronic control opens or closes the damper to keep the unit free of ice buildup. There is an optional remote air sensor that monitors air quality and increases the rate of ventilation to remove odors or contaminants.
### RAYDOT INC., 145 Jackson Ave., Cokato, MN 55321 - (800) 328-3813 (320) 286-2103 www.raydot.com

<table>
<thead>
<tr>
<th>model</th>
<th>flow rate</th>
<th>efficiency</th>
<th>warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;SafeAire&quot;</td>
<td>64 to 250 cfm</td>
<td>74% to 90%</td>
<td>5 years</td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- crossflow</td>
<td>- 84 to 333 watts</td>
<td>warranty</td>
<td></td>
</tr>
<tr>
<td>model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;RD Series&quot;</td>
<td>100 to 210 cfm</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- crossflow</td>
<td>- 80 to 114 watts</td>
<td>warranty</td>
<td></td>
</tr>
</tbody>
</table>

**features**: The “Purepak” filtration system is designed to be used with the HRV to remove all air particles as small as .3 microns in diameter. It has a HEPA filter with an activated charcoal prefilter. There is a built-in dehumidistat and there is a position variable speed control. Optional remote controls are available. A digital electronic timer with 20, 40 or 60 minutes is ideal for bathrooms or kitchens. It has a prooflockout feature. A programmable (7-day, 24-hour) ventilation controller includes a programmable dehumidistat and an air quality sensor that increase ventilation to remove excessive odors and/or contaminants. A remote dehumidistat, toggle switch or crank timer are available. “RD-225-H” is for vertical installation space that is limited in crawl spaces, attics or basements.

### RESEARCH PRODUCTS, PO Box 1467, Madison, WI 53701 - (608) 257-8801 www.resprod.com

<table>
<thead>
<tr>
<th>model</th>
<th>flow rate</th>
<th>efficiency</th>
<th>warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;PerfectAire&quot;</td>
<td>120 to 150 cfm</td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- crossflow</td>
<td>- 168 watts</td>
<td>warranty</td>
<td></td>
</tr>
<tr>
<td>model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;The ERV&quot;</td>
<td>64 to 300 cfm</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- crossflow</td>
<td>- 160 to 333 watts</td>
<td>warranty</td>
<td></td>
</tr>
</tbody>
</table>

**features**: The front panel opens to provide for easy access to the filters, core and the blowers. It is insulated with 1” foil-covered fiberglass ductboard with an R-factor of R-4.25. The crossflow treated media and aluminum core uses special technology (enthalpic-type air exchanger) which allows the transfer of moisture as well as heat. The exhaust air stream is partially humidified so that the exhaust air seldom reaches the dew point — no condensate drain or defrost cycle needed.

### SNAPPY AIR DISTRIBUTION (STANDEX), 1011 11th Ave. SE, Detroit Lakes, MN 56502 - (800) 328-2044

<table>
<thead>
<tr>
<th>model</th>
<th>flow rate</th>
<th>efficiency</th>
<th>warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;The ERV&quot;</td>
<td>64 to 300 cfm</td>
<td>96% to 99%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rotary</td>
<td>- 256 watts</td>
<td>warranty</td>
<td></td>
</tr>
<tr>
<td>model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;RecoupAerator SD-190&quot;</td>
<td>197 cfm</td>
<td>96% to 99%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rotary</td>
<td>- 256 watts</td>
<td>warranty</td>
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</tbody>
</table>

**features**: All units are enthalpic. All components are made from heavy steel with corrosion protection or from high-quality, impact resistant plastics with fire-retardant additives. The housing construction is 22 gauge phosphated steel with scratch-resistant polyurethane paint. The aluminum prefilter can be cleaned easily. The “SW-120” is a single-zone model that can be installed in a window or through-the-wall. It weighs 52 lbs. It can be plugged into your standard electrical supply, just like a window fan. It installs easily in almost any double hung window. Special orders are available for other types of windows. It can be fitted into an external wall, either in new construction or retrofit applications. The unit comes with complete installation instructions. Comes with a 30-day money-back guarantee, plus a full two-year limited warranty. There is a flashing light on the controller of the “SD-95+” that informs you when the filters and heat exchanger need cleaning.

### STIRLING TECHNOLOGY, PO Box 2633, Athens, OH 45701 - (800) 535-3448 (740) 594-2277 www.stirling-tech.com

<table>
<thead>
<tr>
<th>model</th>
<th>flow rate</th>
<th>efficiency</th>
<th>warranty</th>
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</thead>
<tbody>
<tr>
<td>&quot;RecoupAerator SD-95+&quot;</td>
<td>50 to 200 cfm</td>
<td>96% to 99%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rotary</td>
<td>- 225 watts</td>
<td>warranty</td>
<td></td>
</tr>
<tr>
<td>model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;RecoupAerator SW-120&quot;</td>
<td>85 to 110 cfm</td>
<td>96% to 99%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rotary</td>
<td>- 115 to 184 watts</td>
<td>warranty</td>
<td></td>
</tr>
</tbody>
</table>

**features**: All units are enthalpic. All components are made from heavy steel with corrosion protection or from high-quality, impact resistant plastics with fire-retardant additives. The housing construction is 22 gauge phosphated steel with scratch-resistant polyurethane paint. The aluminum prefilter can be cleaned easily. The “SW-120” is a single-zone model that can be installed in a window or through-the-wall. It weighs 52 lbs. It can be plugged into your standard electrical supply, just like a window fan. It installs easily in almost any double hung window. Special orders are available for other types of windows. It can be fitted into an external wall, either in new construction or retrofit applications. The unit comes with complete installation instructions. Comes with a 30-day money-back guarantee, plus a full two-year limited warranty. There is a flashing light on the controller of the “SD-95+” that informs you when the filters and heat exchanger need cleaning.

### THERMA-STOR PRODUCTS, PO Box 8050, Madison, WI 53708 - (800) 533-7533 (608) 222-5301 www.thermastor.com

<table>
<thead>
<tr>
<th>model</th>
<th>flow rate</th>
<th>efficiency</th>
<th>warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Ultra-Aire&quot;</td>
<td>220 cfm</td>
<td>95%</td>
<td></td>
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<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- not applicable</td>
<td>- 782 watts</td>
<td>warranty</td>
<td></td>
</tr>
<tr>
<td>model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;RecoupAerator SD-190&quot;</td>
<td>197 cfm</td>
<td>96% to 99%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rotary</td>
<td>- 256 watts</td>
<td>warranty</td>
<td></td>
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</tbody>
</table>

**features**: This indoor air quality device combines fresh air ventilation, air filtration and high-capacity humidification control. There is no heat exchanger to capture outgoing heat. The control panel contains a fan/filter switch that allows continuous air circulation and filtration independent of humidification. There is a dehumidistat with settings from 20% to 60%. An optional control contains a timer that activates a motorized damper to provide programmed fresh air ventilation periods.

### VENMAR VENTILATION, 550 Lemire Blvd., Drummondville, QC, Canada, J2C 7W9 - (800) 567-3855 www.venmar-ventilation.com

<table>
<thead>
<tr>
<th>model</th>
<th>flow rate</th>
<th>efficiency</th>
<th>warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Duo&quot;</td>
<td>64 to 180 cfm</td>
<td>79% to 88%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rotary</td>
<td>- 160 to 250 watts</td>
<td>warranty</td>
<td></td>
</tr>
<tr>
<td>model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Solo&quot;</td>
<td>64 to 189 cfm</td>
<td>70% to 81%</td>
<td></td>
</tr>
<tr>
<td>heat exchanger type</td>
<td>power usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- crossflow</td>
<td>- 150 to 240 watts</td>
<td>warranty</td>
<td></td>
</tr>
</tbody>
</table>

**features**: The “Duo” models (enthalpic) are for year-round ventilation and the “Solo” models are used primarily for homes using a forced air heating system. The units are equipped with the “HomeShield” defrost system to prevent ice buildup on the recovery model without a drop in indoor air pressure. The recovery module and filters are washable. The “SilentSure” system reduces noise and vibration due to the positioning of the motor. There is a complete line of wall controls. The “Detector” picks up carbon monoxide and other pollutants triggering the high speed mode. There are three automatic operation modes — intermittent exchange is low speed every 20 minutes, continuous low speed and continuous high speed.

**Note**: All models listed are whole-house designs unless otherwise listed as window or through-the-wall designs.
1) Exhausts from kitchen and/or bathrooms or other central locations to outdoors.
2) Supplies outdoor air directly to each bedroom, to each floor without a bedroom and to the principal living areas.

### Types of Heat Recovery Ventilator Cores

#### Heat Pipe
![Heat Pipe Diagram]

#### Counterflow
![Counterflow Diagram]

#### Rotary
![Rotary Diagram]

#### Crossflow
![Crossflow Diagram]

### Common Airborne Contaminants in the Home

<table>
<thead>
<tr>
<th>Problem</th>
<th>Source</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Vapors</td>
<td>Emitted from many common household items and new construction materials — carpet, furniture, paint, common cleaners, and adhesives.</td>
<td>Dizziness, Headaches, Allergic Reaction, Respiratory Troubles.</td>
</tr>
<tr>
<td>Combustion Gases</td>
<td>Malfunctioning or backdrafting furnaces or water heaters can emit carbon dioxide and carbon monoxide to the interior of the home. Untended appliances (gas ranges, dryers, space heaters) can expel gases.</td>
<td>Dizziness, Headaches: Carbon Monoxide Poisoning can lead to severe illness and even death.</td>
</tr>
<tr>
<td>Mold, Fungus</td>
<td>Mold and fungus growth occurs in areas of the home where there is excessive moisture: around window frames, inside ductwork, and inside walls.</td>
<td>Mold and Fungus, especially Aspergillus, can cause severe respiratory illness and allergic reactions.</td>
</tr>
<tr>
<td>Bacteria, Viruses</td>
<td>Passed from person to person in poorly ventilated rooms.</td>
<td>Passes on airborne viruses, i.e. the common cold, flu.</td>
</tr>
<tr>
<td>Radon</td>
<td>A naturally occurring radioactive gas that seeps into a home from the ground that surrounds it. In a supertight home, radon can quickly build up to dangerous levels.</td>
<td>Radon poisoning can cause severe illness and premature death.</td>
</tr>
<tr>
<td>Household and Pet Odors</td>
<td>Cooking, cigarette smoke, pest, laundry.</td>
<td>Household odors are not necessarily dangerous, they can be offensive. Second-hand smoke from cigarettes is a dangerous health hazard.</td>
</tr>
</tbody>
</table>

For a free Topics List of 200 Update Bulletins (including a description of each), send a self-addressed stamped business-size envelope to: Jim Dulley, List, P.O. Box 54987, Cincinnati, Ohio 45254 or read on the Internet - [http://www.dulley.com](http://www.dulley.com)