



## **Comfort Condition Your Home**

Thermal and Acoustical Insulation by Knauf



## Knauf Thermal and Acoustical Insulation... **The Key to Building a Comfort Conditioned Home**

Successful home builders understand the necessity of creating “an edge” to distinguish themselves from the competition. Being a builder of comfort conditioned homes is a profitable “edge” that will impress quality-conscious home buyers. Upgraded thermal and acoustical insulation is an investment that will pay for itself many times over and give them years of energy-saving, comfortable living. Warm in winter. Cool in summer. And quiet year round.

Knauf fiber glass insulation delivers comfort by providing maximum energy efficiency as well as peace and quiet, resulting in a home with a greater resale value. Insulating a home with Knauf thermal and acoustical insulation is a home builder’s mark of distinction, a sign that he cares about energy efficiency and comfort.

### **An Energy Efficient Option That Really Pays Off**

Home buyers value energy-efficient options that provide them with payback opportunities. According to a Professional Builder consumer survey<sup>1</sup>, one of the most important upgrades consumers select when buying a home is energy efficient features (88%). Energy efficient features are considered extremely important to 92% of consumers and 69% of the builders polled.



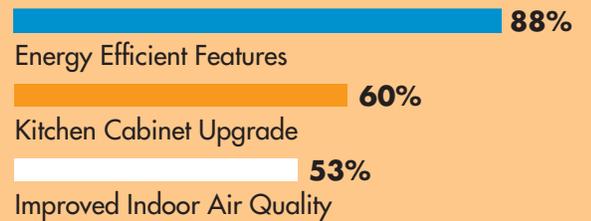
Some of these features that consumers would like to see as standard include efficient furnaces, boilers, water heaters (87%), insulation above code requirements (80%) and passive solar heating design (57%).

There's a growing demand for homes that save on utility bills as they protect our energy resources. At the same time, families are spending more leisure time at home and working out of their homes, too. That makes indoor comfort a highly desired new home feature. And better insulated homes also qualify for energy-efficient mortgages and some utility rebates that increase your customers' home buying power.



## Is added energy efficiency a value to the homeowner?

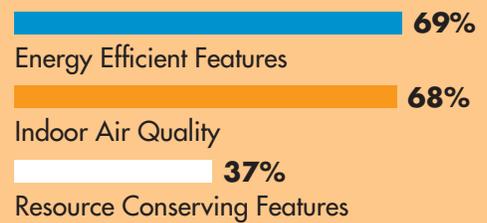
### Three most important upgrades when buying a new home:



### Extremely/Very important features in new home (Consumers)



### Extremely/Very important features in new home (Builders)



<sup>1</sup>2003 Professional Builder Consumer Survey



## Knauf High Density and Acoustical Insulation... **Design Flexibility and Greater Value for Quality Conscious Buyers**

As energy costs climb and energy codes become more stringent, comfort conditioned homes will become an even greater value for quality-conscious buyers. Of all the energy-efficient steps you can take, adding Knauf high-density fiber glass insulation probably makes the most financial sense. After all, it involves a low initial cost and no operating expenses. Fiber glass insulation pays for itself in just a few years and then continues to save the homeowner money.



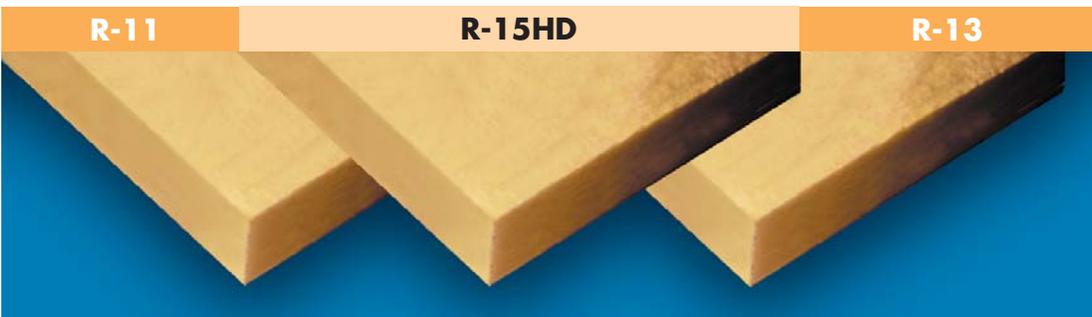
## Maximize Your Insulating Power

Knauf's line of high density (HD) batts give you the design flexibility to build cathedral ceilings and increase window area using conventional framing, while maintaining energy efficiency. It's a significantly lower-cost approach than using 2 x 6 framing, or adding thicker insulated sheathing and extended door and window frames.

For example, Knauf HD batts let you achieve an R-19 sidewall with 2 x 4 framing and half-inch insulated sheathing. It can even decrease your costs by letting you downsize heating and cooling systems. Our HD insulation has more fibers per inch of fiber glass, so it provides greater R-value per inch of insulation than standard batts. As an example, our R-15HD insulation is the same thickness as standard R-11 and R-13, but offers 36% and 15% more insulating power, respectively. It's an excellent way to maximize insulation in a 2 x 4 framed wall.

## Offering Sound Advice

Comfort doesn't end with temperature. Sound control is every bit as important to today's home buyer, which is why Knauf QuietTherm® Insulation is an excellent option. It not only provides an acoustical barrier, but is also labeled with an R-value to indicate its additional thermal insulating benefits. You can show buyers how thoroughly installing Knauf QuietTherm batts in walls and under floors, as well as insulating around drain pipes and shower stall and bathtub cavities, will ensure the peace and quiet they desire, in and around such rooms as home theatres, home offices and bathrooms.



### Maximizing Insulating Power:

Knauf R-15 HD is the same thickness as standard R-11 and R-13, but offers 36% and 15% more insulating power.



## Knauf Jet Stream® 73.3 Insulation... **Blanketing your Comfort Conditioned Home With Protection**

A properly insulated attic is one of the keys to building a comfort conditioned home. It's where homes lose the most energy through leaks and cracks if the insulation is not installed with care. Most attics are insulated with blown or loose-fill insulation by a professional who can operate the blowing equipment and assess the right coverage necessary to achieve the correct R-value for the home. A thick layer of higher performing Knauf Jet Stream® 73.3 Blowing Insulation will blanket the home with warmth in the winter and keep it cool during the hot summer months.

### **Higher Performing Jet Stream 73.3 Takes Thermal Efficiencies to New Heights**

Engineered with state-of-the-art technology, this high performance insulation is the best choice to insulate or re-insulated attics and hard-to-reach areas. Jet Stream 73.3's higher thermal performance also delivers more R-value at the eaves or in low-pitch attics. With Jet Stream 73.3, crews can achieve R-30 (a minimum of 10<sup>3/8</sup>" ) with 14 bags per thousand square feet of attic space.



### **Prepare for Installation Efficiency to Take Off**

Higher crew productivity means higher profits. Crews that blow Jet Stream 73.3 can blow through their jobs at jet speed. Advanced fiber technology allows Knauf Jet Stream 73.3 to break up easily in the hopper so it processes fast and blows consistent and smooth. With the right machine settings, Jet Stream 73.3 can process more than a bag per minute, getting your crew in and out of each job quickly.

### **Jet Stream 73.3 Quality Assures Superior Insulation for Your Comfort Conditioned Home.**

Knauf Jet Stream 73.3 is made of 100% virgin wool, an excellent energy-efficient barrier. It performs consistently, no matter what the season or climate and the results are always a uniform, professional looking appearance. And Knauf Jet Stream 73.3 Blowing Insulation is Greenguard Certified for Children and Schools™ to meet the toughest air quality standards in the industry.



### **Higher Performing Knauf Jet Stream 73.3 Blowing Insulation:**

High performance insulation to give attics and other hard-to-reach areas more R-value in your home.



**The Professional Touch:** Blown insulation should always be professionally installed to get the right coverage of the attic and R-value for your home.



**Fill hard-to-reach areas** around doors and windows, as well as around pipes and fixtures, with ease.



**A professionally finished job**—dust-free, with no excess material left on walls or floor.



## Knauf Perimeter Plus® Fiber Glass Blowing Insulation... **Fills Wall Cavities Completely, Creating a Thermal Barrier for Your Comfort Conditioned Home**



Knauf Insulation introduces Perimeter Plus® Blow-in-Blanket System to insulate your comfort conditioned home in warmth and quiet. This fiber glass blowing insulation is designed and manufactured for use in the patented BIBS system.\* With its unique green color, Perimeter Plus provides easy identification, assuring customers they are getting the superior performance they require.

Perimeter Plus Blowing Wool installs fast, clean and safe into wall cavities from crawl spaces to cathedral ceilings. It blows consistently and fills evenly to easily take on tight corners and hard to reach areas around pipes and electrical wires and fixtures.

\*Perimeter Plus Fiber Glass Blowing Wool is BIBS approved and can only be installed by BIBS certified installers to ensure the highest quality installed performance. BIBS Blow-in-Blanket System is a patented process consisting of a wall cavity, loose fill blown behind a special netting material.



### Filling in the Gaps and Blanketing Your Home in Comfort

Knauf Perimeter Plus Blow-in-Blanket System offers the highest effective R-value possible, filling gaps and voids in your wall cavity to create a thermal barrier from the outside air. The Knauf BIBS system delivers up to an R-15 in 2 x 4 construction and an R-23 in 2 x 6 construction.

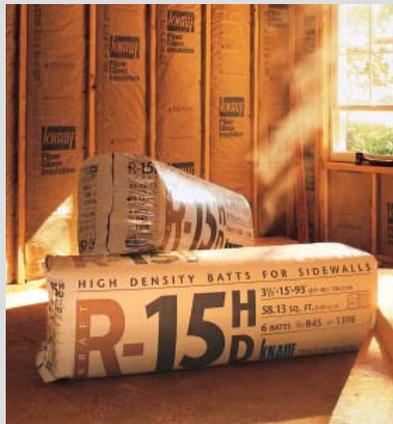
### Total Performance for the Life of Your Home

Engineered specifically for the blow-in blanket application, Perimeter Plus doesn't settle like other products, giving you the thermal and acoustical performance you need in both interior and exterior wall cavities for the life of your home. And Knauf Perimeter Plus Blowing Insulation is Greenguard Certified for Children and Schools™ to meet the toughest air quality standards in the industry.

### Knauf Perimeter Plus, Performance that never ends:

- The most economical alternative wall system.
  - Higher R-value than cellulose.\*
  - Lower installed cost than foam.
- Keeps start up costs minimal without the need for capital-intensive specialty equipment by utilizing commonly used blowing machines.
- Up to R-15 in 2x4 construction and R-23 in 2x6.
- Does not settle, maintaining R-value over the life of the home.
- Improves acoustics by reducing transmission of unwanted noise throughout the home
- Dry installation ensures no moisture of mildew introduced to wall cavity. It won't corrode pipes or wires and no drying time is needed between trades.
- Fills all gaps and voids, even hard-to-reach areas around pipes, electrical wires and fixtures.
- Dust free and no adhesives required
- Non-combustible (ASTM E 136)
- Perimeter Plus is GreenGuard Children and Schools certified.
- BIBCA and Knauf Insulation provide valuable support to help strengthen your business.

\*As compared to published cellulose manufacturer R-values for 2x4 and 2x6 wall cavities.





## Your Energy Savings Checklist

# When Insulating a Comfort Conditioned Home . . . The Pros Know, Every Detail Counts.

Make a professional insulation contractor your partner in building comfort conditioned homes to help you make the most of every home, minimize callbacks and increase buyer satisfaction. The professional contractor knows the capabilities of all materials and can suggest cost-effective alternatives to expensive measures like insulated sheathing and framing modifications. The pro understands local building and energy codes, and can anticipate and solve potential problems to assure fire safety and moisture control while controlling air infiltration. Working with a pro may also expose you to preferential mortgage options available for energy-efficient homes.

Most of all, the contractor's professionally trained crew will take a whole-home approach to ensure the integrity of the thermal envelope. Many contractors are required to provide a certificate of insulation, indicating the R-values of installed insulation throughout the home. Just one more way the pro works to give you peace of mind.

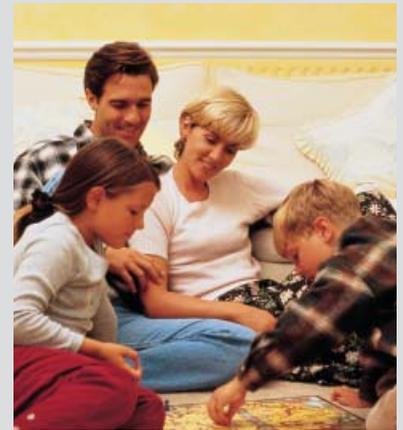
You can spot insulation pros by the material they use, and Knauf premium quality fiber glass insulation is the professional's choice. Its superior handling characteristics and consistent quality help the contractor do a better job for you.

### Checking the Details Add Up to Big Energy Savings

Your professional insulation contractor pays attention to the smallest details, insulating places most people would never think about. But all those small details add up to big energy savings and extra comfort for your customers.

Installed correctly, insulation will make the most of your investment by creating satisfied homeowners. The pro who uses Knauf insulation is a quality-minded expert who will help bring more home buyers to your door.

- Insulate locations like band joists, headers between floors and scuttle covers.
- Insulate interior soffits and drops over cabinets and bathrooms.
- Correctly install batts or blankets around bridging or cross-bracing behind plumbing and electrical runs, light fixtures and electrical outlets.
- Acoustically insulate bathrooms, home offices, utility rooms, home theaters, work areas and bedrooms.
- Seal attics before blown insulation is installed.
- Install the correct quantity of bags at the right thickness for the desired R-value.
- Use insulation to shield plumbing from sub-freezing temperatures.
- Maintain ventilation beneath the roof decks of cathedral ceilings with high density insulation.
- Ensure safe operation with proper installation next to recessed lights and other heat-generating fixtures.
- Correctly apply vapor retarders to protect homes from moisture damage.
- Add crawlspace and attic ventilation when needed to avoid structural damage from moisture, and maintain maximum thermal protection.
- Combat air infiltration in ways that both enhance the home's comfort and make it more affordable.



## Knauf Insulation . . . **Building Our Reputation for Quality into Every Comfort Conditioned Home.**

We built our reputation for quality with fiber glass insulation for tough industrial and commercial applications. We extended that commitment to the residential market, offering builders a full line of top-quality insulation for every need.



In home construction, quality issues such as indoor air standards are especially important. Consumers are more savvy about the importance of low-emitting products and the demand for IAQ (Indoor Air Quality) friendly homes continues to increase. Knauf Insulation has addressed these concerns by working with the Greenguard™ Environmental Institute to provide third-party IAQ performance certification for building insulation. By receiving Greenguard and Greenguard Children and Schools certification, Knauf standard, high density and Quiet Therm batts and blowing insulation meet the toughest indoor air standards in the industry.



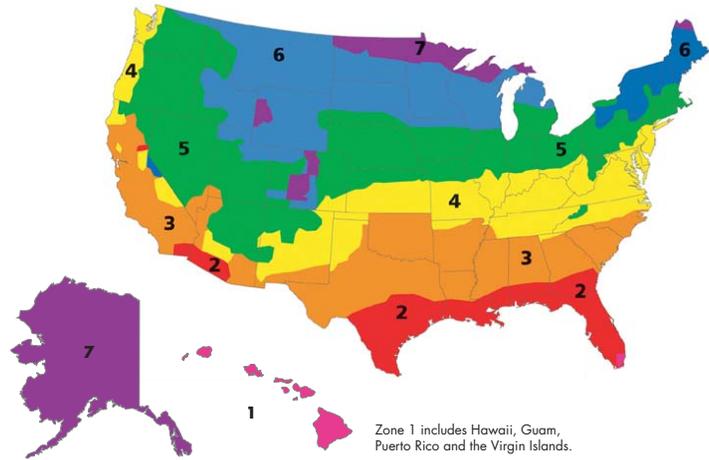
## 2008 DEPARTMENT OF ENERGY R-VALUE RECOMMENDATIONS

### Clean and Consistent

Knauf fiber glass insulation is clean and consistent, guaranteed to deliver the labeled R-values when properly installed. Unlike some other types of insulation, Knauf products are noncombustible, so they provide peace of mind. And Knauf insulation won't promote mold growth, support vermin, or settle or sag when properly installed.

### Commitment to Quality

Simply put, you won't find an insulation manufacturer with a stronger commitment to quality than Knauf or one that does a better job of giving you and your customers your money's worth. From the attic to the basement, for thermal or acoustical control or both, Knauf insulation and your professional Knauf contractor are your best choices to provide comfort conditioned homes and give you the competitive distinction you need to increase your selling power.



All of Alaska is in Zone 7 except for the following boroughs in Zone 8: Bethel, Dellingham, Fairbanks N Star, Nome, North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, Yukon-Koyukuk.

### New Wood-Framed Houses

Zone	Heating System	Attic	Cathedral Ceiling	Wall		Floor
				Cavity	Insulation Sheathing	
1	All	R-30 to R-49	R-22 to R-15	R-13 to R-15	None	R-13
2	Gas, oil, heat pump Electric furnace	R-30 to R-60	R-22 to R-38	R-13 to R-15	None	R-13, R-19, R-25
3	Gas, oil, heat pump Electric furnace	R-30 to R-60	R-22 to R-38	R-13 to R-15	None	R-5
4	Gas, oil, heat pump Electric furnace	R-38 to R-60	R-30 to R-38	R-13 to R-15	R-2.5 to R-6 R-5 to R-6	R-25 to R-30
5	Gas, oil, heat pump Electric furnace	R-38 to R-60	R-30 to R-38 R-30 to R-60	R-13 to R-15 R-13 to R-21	R-2.5 to R-6 R-5 to R-6	R-25 to R-30
6	All	R-49 to R-60	R-30 to R-60	R-13 to R-21	R-5 to R-6	R-25 to R-30
7	All	R-49 to R-60	R-30 to R-60	R-13 to R-21	R-5 to R-6	R-25 to R-30
8	All	R-49 to R-60	R-30 to R-60	R-13 to R-21	R-5 to R-6	R-25 to R-30

### Existing Wood-Framed Houses

Zone	Add Insulation to Attic		Floor
	Uninsulated Attic	Existing 3-4 Inches of Insulation	
1	R-30 to R-49	R-25 to R-30	R-13
2	R-30 to R-60	R-25 to R-38	R-13 to R-19
3	R-30 to R-60	R-25 to R-38	R-19 to R-25
4	R-30 to R-60	R-38	R-25 to R-30
5-8	R-49 to R-60	R-38 to R-49	R-25 to R-30

**Wall Insulation:** Whenever exterior siding is removed on an

**Uninsulated wood-frame wall:**

- Drill holes in the sheathing and blow insulation into the empty wall cavity before installing the new siding, and
- Zones 3-4: Add R5 insulative wall sheathing beneath the new siding.
- Zones 5-8: Add R5 to R6 insulative wall sheathing beneath the new siding.

**Insulated wood frame wall:**

- For Zones 4-8: Add R5 insulative sheathing before installing the new siding

**Reference:** DOE/CE-0180 2008. Insulation Fact Sheet

# Comfort Conditioning . . . **By Design**



## Ceilings/Attics

### 1 Cathedral Ceilings

To maximize R-value and maintain ventilation in confined spaces, use high density R-38HD (10¼") or R-30HD (8¼") Cathedral Ceiling Batts as a cost-effective alternative to larger ceiling joists.

### 2 Sloped Ceilings

With available space of 10" or more, use standard Knauf R-38 (12") or R-30 (10") ceiling batts to insulate between and over framing members. Batts won't slide down slope, as loose-fill insulation might.

### 3 Batted Attics

Install Knauf standard R-38 (12") or R-30 (10") Ceiling Batts with integral vapor retarder facing conditioned space.

### 4 Batted Attics with Blown Cap

Install faced R-30 (10"), R-26 (9") or R-19 (6¼") batts. Then blow Knauf Jet Stream Blowing Insulation over top to achieve desired R-value (R-30 to R-60 or above). Install baffles or vent chutes to maintain proper ventilation.

### 5 Blown Attic

Install Knauf Jet Stream 73.3 Blowing Insulation to achieve desired R-value (R-30 to R-60 and above). Install baffles or vent chutes to maintain proper ventilation.

### 6 Cantilevers

For bay windows, overhangs, cantilevers or floor assemblies with less than 10" of available space, install R-38HD (10¼"), R-30 (10"), R-26 (9") or R-30HD (8¼")batts.

## Sidewalls

### 7 Exterior Walls

Because exterior walls cannot be economically retrofitted, it pays to maximize exterior sidewall insulation during construction. Use faced insulation, or unfaced insulation. When installing Knauf's unfaced batts, place between framing members. The selection and positioning of an appropriate vapor retarder, if required, should be in accordance with local codes and practices. Use R-15HD (3½"), R-13 (3½") for 2x4 framed walls. Use R-21HD (5½"), R-19\* (6¼") for 2x6 framed walls.

\* When compressed to 5½", effective R-value = 17.8.

### 8 Perimeter Plus™ Blow-in-Blanket® System

Install Perimeter Plus to achieve an R-15 in 2 x 4 and an R-23 in 2 x 6 construction for a consistent thermal and acoustical barrier throughout the home. Fills gaps, tight corners and hard-to-reach areas around pipes and fixtures.

### 9 Framed Basement Walls

Insulate framed basement walls with unfaced insulation. Use R-13 (3½") or R-11 (3½") on 2 x 4 framed walls. When installing Knauf's unfaced batts, place between framing members. The selection and positioning of an appropriate vapor retarder, if required, should be in accordance with local codes and practices.

## Basements/Crawlspaces

### 10 Unfinished Basement Walls

Insulate poured concrete or block basement walls with white reinforced vinyl faced R-10 blanket or durable reinforced foil-faced R-11 blanket.

### 11 Crawlspaces

Drape exterior walls of crawlspace areas with R-11 reinforced foil faced blanket or unfaced R-11 batts, and separate 4 or 6 mil poly vapor retarder. Always use 6 mil poly moisture barrier on crawlspace floor.

## Floors/Overhangs

### 12 Protected Areas (over slab, or protected crawlspaces)

Insulate floors over unheated, but protected spaces, using Knauf R-19 (6¼") faced insulation. Install kraft vapor retarder toward conditioned space, below plumbing and HVAC lines.

### 13 Unprotected Areas (floors over garages, overhangs, cantilevers, or bays)

Use the maximum thickness the cavity space will allow, using R-30HD (8¼"), R-26 (9"), R-30 (10"), R-38HD (10¼") or R-38 (12"). Kraft vapor barrier should face conditioned space. Plumbing and HVAC lines should not be installed in these areas; if essential, install them above the insulation line.

## Sound Conditioning

### 14 Interior Walls

Install R-13 (3½"), R-11 (3½") or R-8 (2½") insulation in interior walls around baths, bedrooms and media rooms to limit room-to-room noise transmission. Unfaced insulation can be friction-fit in place, or kraft faced insulation\* can be stapled in place as needed.

\*Kraft faced products must not be left exposed. Cover with approved finish surface, such as gypsum board

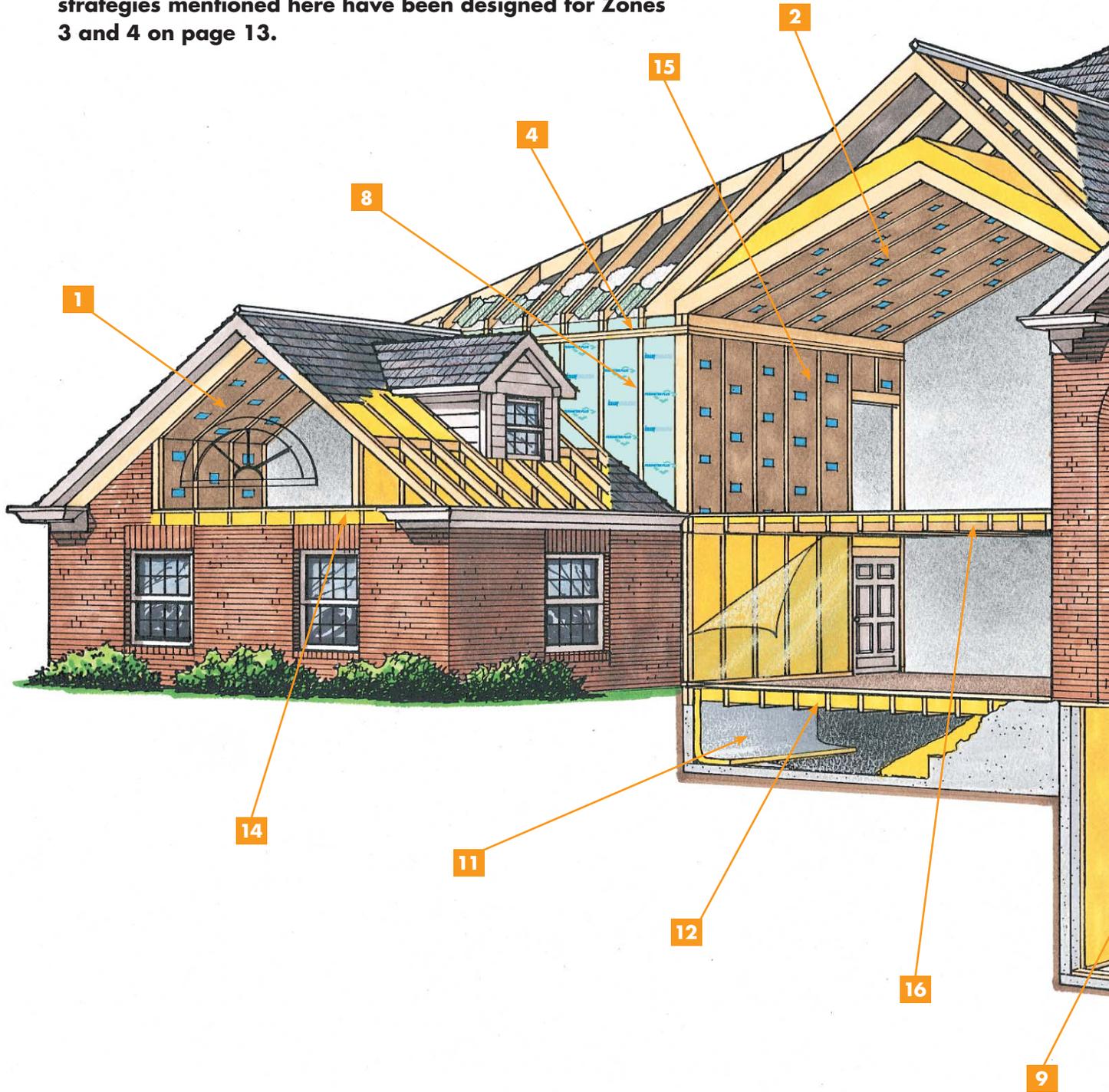
### 15 Mechanical Rooms

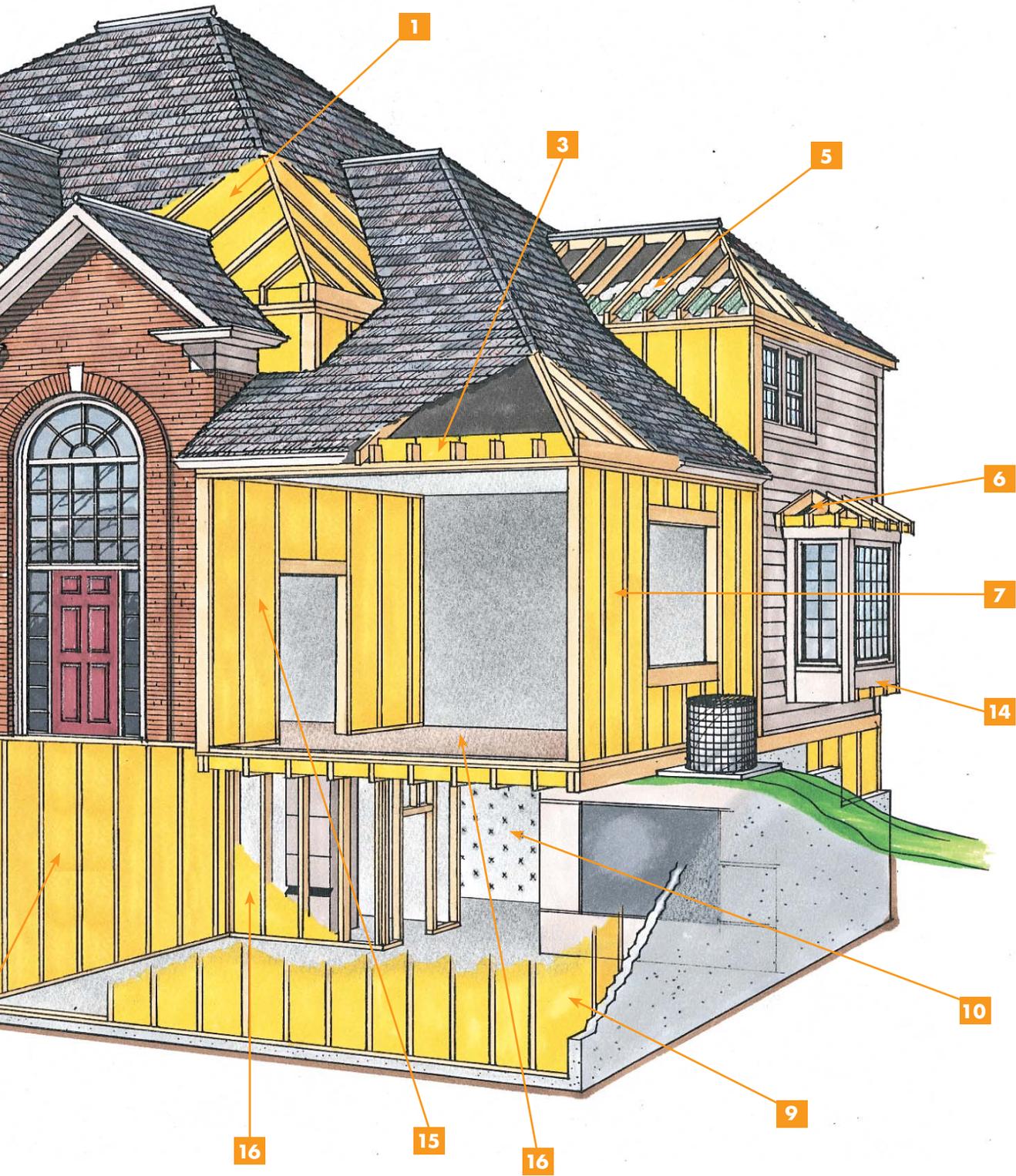
Install unfaced R-13 (3½"), R-11 (3½") or R-8 (2½") insulation in walls surrounding mechanical rooms and in cavities containing plumbing lines, to absorb unwanted noise.

### 16 Interior Floors

Reduce floor-to-floor noise transmission by installing R-19 (6¼"), R-13 (3½"), R-11 (3½") or R-8 (2¼") insulation.

**This example illustrates some of the ways to transform a typical house into a comfort conditioned home. The strategies mentioned here have been designed for Zones 3 and 4 on page 13.**





Ceiling/Attics												
Product R-Value	Material Thickness	Installed R-Value	Minimum <sup>1</sup> Cavity Depth	Framing Material	Framing Centers				Available Facings <sup>2</sup>			
					12 oc	16 oc	19 oc	24 oc	Unfaced	Kraft	Foil	FSK Foil <sup>3</sup>
R-38HD	10¼"	R-38	11¼"	2 x 12		•		•	•	•		
R-30HD	8¼"	R-30	9¼"	2 x 10		•		•	•	•		
R-38	12"	R-38	13"	Truss		•		•	•	•		•
R-30	10"	R-30	11"	Truss	•	•	•	•	•	•	•	•
R-26	9"	R-26	10"	2 x 12 /Truss		•		•	•	•		
R-22	6½"	R-22	7¼"	2 x 8		•	•	•	•	•		

Sidewalls												
R-21HD	5½"	R-21	5½"	2 x 6		•		•	•	•		
R-15HD	3½"	R-15	3½"	2 x 4		•		•	•	•		
R-22	6½"	R-22	7¼"	2 x 8		•	•	•	•	•		
R-22	6½"	R-19.2	5½"	2 x 6		•	•	•	•	•		
R-19	6¼"	R-17.8	5½"	2 x 6	•	•	•	•	•	•	•	•
R-13	3½"	R-13	3½"	2 x 4	•	•	•	•	•	•	•	•
R-11	3½"	R-11	3½"	2 x 4	•	•	•	•	•	•	•	•

Basements/Crawlspaces												
R-19	6¼"	R-19	Draped	24 oc	•	•	•		•	•		
R-13	3½"	R-13	Draped	24 oc	•	•	•		•	•		
R-11	3½"	R-11	Draped	24 oc	•	•	•	•	•	•		
R-10	3"	R-10	Draped	24 oc	•	•	•	•	•	•	•	

Floors/Overhangs												
R-38	12"	R-38	12"	I-Beam		•		•	•	•		•
R-38	12"	R-36.5	11¼"	2 x 12		•		•	•	•		•
R-30	10"	R-30	10"	2 x 12	•	•	•	•	•	•	•	•
R-26	9"	R-26	9"	2 x 10		•		•	•	•		
R-22	6½"	R-22	7¼"	2 x 8		•	•	•	•	•		
R-19	6¼"	R-19	7¼"	2 x 8	•	•	•	•	•	•	•	•
R-19	6¼"	R-17.8	5½"	2 x 6	•	•	•	•	•	•	•	•
R-11	3½"	R-11	5½"	2 x 6	•	•	•	•	•	•	•	•

Framed Basement Walls												
Product R-Value	Material Thickness	Installed R-Value	Minimum <sup>1</sup> Cavity Depth	Framing Material	Framing Centers							
					Unfaced	12 oc	16 oc	19 oc	24 oc			
R-21	5½"	R-21	5½"	2 x 6	•		•			•		
R-19	6¼"	R-17.8	5½"	2 x 6	•	•	•	•		•		
R-15HD	3½"	R-15	3½"	2 x 4	•		•			•		
R-13	3½"	R-13	3½"	2 x 4	•	•	•	•		•		
R-11	3½"	R-11	3½"	2 x 4	•	•	•	•		•		
R-11	3½"	R-9.5	2¾"	2 x 3	•	•	•	•		•		
R-8	2½"	R-8	2¾"	2 x 3	•		•			•		
R-5	1½"	R-5	1½"	2 x 2	•		•			•		
R-3	¾"	R-3	¾"	2 x 1	•		•			•		

Sound												
Product R-Value	Material Thickness	Installed R-Value	Minimum <sup>1</sup> Cavity Depth	Framing Material	Framing Centers				Available Facings <sup>2</sup>			
					12 oc	16 oc	19 oc	24 oc	Unfaced	Kraft	Foil	FSK Foil <sup>3</sup>
R-19	6¼"	R-17.8	5½"	2 x 6	•	•	•	•	•	•		
R-13	3½"	R-13	3½"	2 x 4	•	•	•	•	•	•		
R-11	3½"	R-11	3½"	2 x 4		•	•	•	•	•		
R-8	2½"	R-8	2¼"	2 x 3		•		•	•	•		

<sup>1</sup> Minimum cavity depth required in ceilings allows for 1" of continuous air space behind installed insulation.

<sup>2</sup> Vapor retarders

<sup>3</sup> FSK Foil-reinforced, approved for exposed application. Meets ASTM C 665, Type III, Class A.

# KNAUF INSULATION



Knauf batts and blowing wool are certified for indoor air quality as low emitting products by The GREENGUARD Environmental Institute™, to both the GREENGUARD Certification Program™ and the more stringent GREENGUARD For Children and Schools™ standard. [www.greenguard.org](http://www.greenguard.org)



At Knauf Insulation, we manufacture a wide variety of products that serve a common goal, helping to make the most of our planet's energy resources. A family-owned global company, we understand and are committed to high standards in quality, performance and environmental responsibility. Every step we take today toward energy conservation helps ensure better lives for generations to come.



## LEED Eligible Product

Use of this product may help building projects meet green building standards as set by the Leadership in Energy and Environmental Design (LEED) Green Building Rating System.

Credit 4.1 - 4.2 Recycled Content  
Credit 5.1 - 5.2 Regional Materials

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