Lesson A3–12

Insulating Agricultural Structures

Unit A. Mechanical Systems and Technology

Problem Area 3. Construction Systems

Lesson 12. Insulating Agricultural Structures

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: **VIII:** Plan, implement, manage, and/or provide support services to facility design and construction; equipment design, manufacture, repair, and service; and agricultural technology.

Benchmark: **VIII-B:** Follow architectural and mechanical plans to construct building and facilities.

Performance Standard: **1.** Identify and select appropriate building materials. **6.** Insulate facility.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe how to stop air leaks.
2. Explain how to compare insulating materials.
3. Explain the installation and cost of insulation.

List of Resources.

The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Burkybile, Carl. *How Can I Save Money and Energy By Insulating My Home?* University of Illinois: Information Technology & Communication Systems.

Landers, Jack M. *Home Repair and Maintenance.* Tinley Park, Illinois: Goodheart-Willcox Company, 1996. (Textbook, Unit 32)

Web site: www.doityourself.com/energy/audit.htm

Other Resources. The following resources will be useful to students and teachers:

Weiss, William. *Home Maintenance*. Peoria, Illinois: MacMillian/McGraw-Hill, 1983. (Textbook, Chapter 16)

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Samples of different insulations
Weatherstripping and caulking samples

Terms.

The following terms are presented in this lesson (shown in bold italics):

Blankets
Cellulose
Dead air space
Door threshold
Extruded polystyrene
Fiberglass
Foam plastics
Glazing putty
Live air space
Loose fill insulation
Molded polystyrene
Polyisocyanurate
Polyurethane
R value
Rigid board insulation
Rock wool
Rope caulk

Storm door
Storm window
Thermopane windows
Triple-glazed windows
Tube caulking
Weatherizing
Weatherstripping
Weatherstripping tape

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Show students a copy of a high energy bill. Ask them if they have ideas on how to reduce energy costs in homes and agricultural buildings. Hopefully they will talk about adding insulation and stopping air leaks. Not only will these actions save money and energy, but they will also increase comfort and reduce condensation. Do an internet search on energy conservation. Consider having students do an inventory of the condition of their buildings at home and come in with a list of suggested energy saving steps.

Summary of Content and Teaching Strategies

Objective 1: Describe how to stop air leaks.

Anticipated Problem: How can I stop air leaks?

I. The first step in making a building more energy efficient is stopping air leaks. Air leaks waste money and cold drafts make people uncomfortable even in rooms where the thermometer shows a comfortable temperature. ***Weatherizing*** a building is the process of stopping air leaks. It begins with an inventory of the condition of doors, windows, and other possible air leak locations.

   A. A ***storm window*** or ***storm door*** is a frame with glass that provides an additional layer of protection against the cold with an air space between the original and the storm. If air in the cavity comes and goes it is a "***live air space***". ***Thermopane windows*** have two layers of glass with a sealed air space between the two. The sealed air space, called ***dead air space***, is much better at stopping cold from entering the building. ***Triple-glazed windows are*** windows that have three glass panes and two dead air spaces. While these windows are very expensive, they are even more effective in stopping cold air. When money is not available to buy storm windows a sheet of plastic can be attached to the inside or outside of the window. While this approach is not very attractive, it will pay for itself several times over in comfort and energy savings.

   B. Cracks around windows and doors should be sealed with caulking. Large cracks should first be filled with a material packed into place with a putty knife or other blunt tool, and

then sealed with caulking. ***Tube caulking*** is flexible sealant that is normally applied by cutting the end off of the tube, inserting the tube into a caulking gun, and then squeezing the gun handle. It comes in a variety of colors and qualities. Select caulking that has a long warranty and will be remain flexible rather than become brittle. ***Glazing putty*** is the material that seals between the frame and the glass of a wooden window. If the glazing putty has cracked and come loose, the air leak can be stopped by re-glazing the window. Air leaks on the inside between the window and its frame can be sealed with weatherstripping tape or rope caulk. ***Weatherstripping tape*** is a clear tape like scotch tape that sticks to window frame surfaces. ***Rope caulk*** comes as a roll of caulking in a rope form.

C. Loose-fitting windows and doors can be thought of as being just a little bit open all the time. The material used to plug these leaks is called ***weatherstripping***. The felt and rubber types are considered temporary, while metal/rubber combination types are more permanent. Foam tape with a sticky side can be easily installed and has become very popular. A ***door threshold*** is fastened to the floor under the bottom edge of a door to prevent air leaks. It may be wood or a combination of metal and rubber.

Utilize readings in the suggested resource texts. They will present students with introductory information on the contents of this objective. Do a search on the internet using words such as: energy conservation, weatherstripping, caulking, energy audits. A sample web site would www.doityourself.com/energy. Visit the lumber yard or hardware store to see types of caulking and weatherstripping available locally. Use TM: A3–12A and TM: A3–12B to show caulking and weatherstripping. Pick a building to evaluate using LS: A3–12A checklist and then weatherize the building.

Objective 2: Explain how to compare insulating materials.

Anticipated Problem: Which insulation should I use?

II. ***R value*** is a measure of a material's resistance to heat flow. The higher the R value the better the quality of the insulation. Before buying insulation, compare the costs per unit of R. Divide the cost per square foot by the R value to determine the best buy. For example, if you buy 3½ inch thick fiberglass batts rated at R-11, and the cost is $.15 per square foot, divide $.15 by 11R to get $.0136 per unit of R.

A. In addition to R value and cost, the form of the insulation is a factor in selecting which to use. Insulation is available as rigid boards, loose fill, blankets, and foam plastics. ***Rigid board insulation*** comes in 4' × 8' sheets and is used as wall sheeting. Insulation boards vary from an R value of 2.5 to 8.0 per inch. ***Molded polystyrene***, commonly known as Styrofoam or "bead board", has an R value of 3.6 per inch. ***Extruded polystyrene***, commonly called "blue board", has an R value of 5.3 per inch. ***Polyisocyanurate,*** commonly sold as thermax or high-R sheeting, is a foam-plastic, glass-fiber reinforced core with aluminum foil face layers. It is sometimes called "silver board" and has a R value of 8 per inch.

B. ***Blankets*** come as rolls or batts 4 foot long either 3½ or 6 inches thick. They are made to fit between building framing members placed on 16 or 24 inch centers. Blankets come as rolls or batts which generally have a vapor barrier of kraft paper or aluminum foil. ***Fiberglass***, composed of glass fibers, is the most common roll or batt type insulating material. It has an R value of 3.0 to 3.2 per inch.

C. ***Loose fill insulation*** is either poured in or blown in. Rock wool and cellulose are the insulating materials commonly used in this form. ***Rock wool*** (R3 per inch) is composed of mineral fibers and is naturally fire resistant. ***Cellulose*** (R3.5 per inch) is made from paper or wood fibers that are chemically treated to become fire and insect resistance.

D. ***Foam plastics*** are insulating materials that are sprayed into place. ***Polyurethane*** (R6.2 per inch) is the most commonly used foam and may be sprayed in wall cavities, onto roofs, or against crawl space walls.

Assign readings in the recommended texts. Each of them has more complete information on the content of this objective. Use insulation samples to illustrate the four forms of insulation (rigid board, blankets, loose fill, and foam plastics). Compare R values and the various insulating materials using TM: A3–12C and TM: A3–12D.

Objective 3: Explain the installation and cost of insulation.

Anticipated Problem: How much insulation is needed and how is it installed?

III. The amount of insulation to use depends on the area where you live and local utility prices. For example, people living where the climate is mild all year will not require as much insulation as those who live in an extremely cold area. Recommendations by government agencies, public utility companies, and insulation companies should guide you in deciding how much insulation is needed.

A. Once the decision of how much R value to add is made, calculate the number of square feet to be insulated. The amount of insulating material can then be figured.

B. Many insulating jobs can be done by the average homeowner. When installing insulation, wear a long-sleeved shirt, gloves, and goggles. Use a nose mask when blowing in cellulose.

C. When installing batts or rolls of fiberglass the vapor barrier should always face the lived-in side. Press down on the insulation with a square and use a utility knife to cut from the vapor barrier side. In an attic lay the fiberglass between the ceiling joist with the barrier facing down. If you add an additional fiberglass layer at a later date, use unfaced batts. ***Unfaced batts*** are fiber with no vapor barrier. To insulate new construction walls, use a stapler to staple the vapor barrier to the sides of the studs.

D. To pour in or blown in cellulose or rock wool into a new attic area, start by positioning a plastic vapor barrier. For pour in, just open the bag and pour it in place. For blown in insulation one person is needed to open the bags and put the insulation into a blowing machine hopper. The second person operates the hose in the attic to add the required number of inches of insulation. Many companies will furnish a blowing machine with the

purchase of blown in insulation. The R value of a building ceiling with fiberglass already in place is often increased by blowing cellulose in top of the fiberglass. Cellulose mixed with glue is now being blown in to new wall cavities. A special machine is used to cut the excess insulation off and a plastic vapor barrier is stapled over the studs. Uninsulated wall cavities can be drilled with one or two inch diameter holes between each set of studs and cellulose blown in.

E. Foam insulation can be pumped into wall cavities. A special machine is used to pump the foam onto crawl space walls, into wall cavities, and onto roof areas. This type of installation is normally left to a professional who owns the equipment needed.

Students need to read the suggested chapters in the recommended texts. They provide more complete information on the topic. Use TM: A3–12E to indicate R values for your area. TM: A3–12F will illustrate some of the steps in insulating attics. TM: A3–12G summarizes the steps in insulating walls.

Review/Summary. Review ways of stopping air leaks (storm windows, caulking, and weatherstripping). Use the insulation samples to compare forms of insulation (rigid boards, blankets, loose fill, and foam plastics) and insulating materials (fiberglass, rock wool, cellulose, molded polystyrene, extruded polystyrene, polyurethane, and polyisocyanurate). Review the recommended R values for the area where you live. Review LS: A3–12B to make sure that students understand how to calculate the amount of insulation needed to raise the R value to the recommended levels.

Application. Complete an energy use evaluation/energy audit for a building. After collecting data on energy use, then weatherize the building and add insulation as needed. Consider participating in the EnergyNet Program where students input the data into a computer program and receive output data with recommendations on ways to reduce energy usage. The accompanying lab sheets will also help students to apply the concepts.

Evaluation. Take the written test and complete the lab sheets. Evaluation student weatherizing and insulation installation work.

Answers to Sample Test:

Part One: Matching

1 = b, 2 = c, 3 = e, 4 = i, 5 = h, 6 = a, 7 = g, 8 = d, 9 = f, 10 = j

Part Two: Completion

1. R value
2. windows, doors
3. Warm, ceiling or attic
4. blankets, rigid boards, loose fill, and foam plastics
5. lived in

6. Weatherizing
7. Tube, rope
8. Thermopane
9. Glazing putty
10. cost/sq. ft. divided by the R value

Part Three: Short Answer

1. Installation
   a. Staple the paper or foil vapor barrier to the side of the studs with the vapor barrier facing toward the lived in side.
   b. Place a plastic vapor barrier next to the ceiling joists. Open bags of cellulose and dump them into the hopper of the blowing machine. Have a helper in the attic to direct the blower hose and the insulation around the entire ceiling area to the desired depth.
   c. Use two inch roofing nails or plastic cap nails to nail on the blue board. Lines on the board match the location of the studs for nailing.
2. Go to a map of the United States as such TM: A3–12E to find recommended R values for the area where you live. It is also helpful to consult with your utility company and businesses that sell insulation.

Sample Test Name _____

Test

Lesson A3–12: Insulating Agricultural Structures

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. blankets
b. cellulose
c. extruded polystyrene
d. fiberglass
e. foam plastics
f. loose-fill
g. molded polystyrene
h. polyisocyanurate
i. polyurethane
j. rock wool
k. unfaced batts

_____ 1. Insulation made from paper and wood fibers used for loose fill installation.
_____ 2. Insulation board commonly called "blue board" with an R value of 5.3/inch.
_____ 3. General term used to describe insulation that is pumped into wall cavities.
_____ 4. Insulation that may be pumped onto crawl space walls or roof surfaces.
_____ 5. Insulation board commonly called "silver board" with an R value of 8/inch.
_____ 6. Insulation that comes in rolls or batts with an R value of 3/inch.
_____ 7. Insulation board commonly called "bead board" with an R value of 3.6/inch.
_____ 8. Insulation board made from glass fibers that is fitted between studs or joists.
_____ 9. General term used to describe insulation that is either blown in or poured in.
_____ 10. Blanket type insulation with no vapor barrier.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. _____ is a measure of a material's resistance to heat flow.
2. Before adding insulation, first caulk and weatherstrip around _____ and _____.
3. _____ air raises so insulating the _____ is extremely important.
4. The four forms of insulation are _____, _____, _____, and _____.
5. The vapor barrier should always face the side of the wall that is _____.
6. _____ is the process of stopping air leaks.

7. _____ caulking is used outside while _____ caulking is used inside and can easily be removed.
8. _____ windows have two panes of glass with a dead air space between them.
9. _____ is the material that seals between the frame and the glass of a wooden window.
10. To see which insulation is the best buy compare divide the _____ by _____.

Part Three: Short Answer

Instructions. Provide information to answer the following questions.

1. Describe how to install:
   a. Fiberglass batts in a wall.

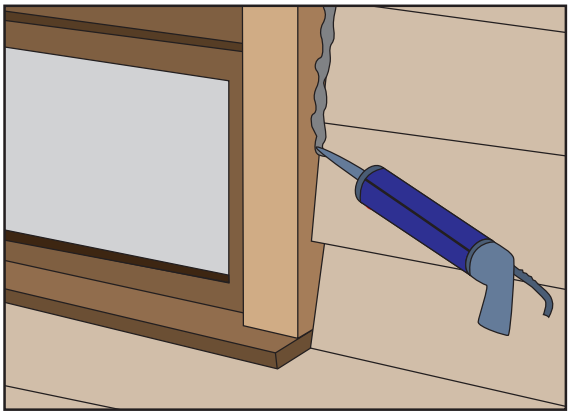
   b. Blown in cellulose in a ceiling.

   c. Blueboard as wall sheeting.

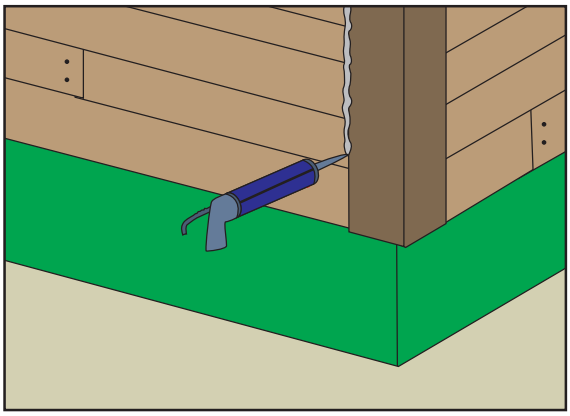
2. How can I determine how much insulation is enough?

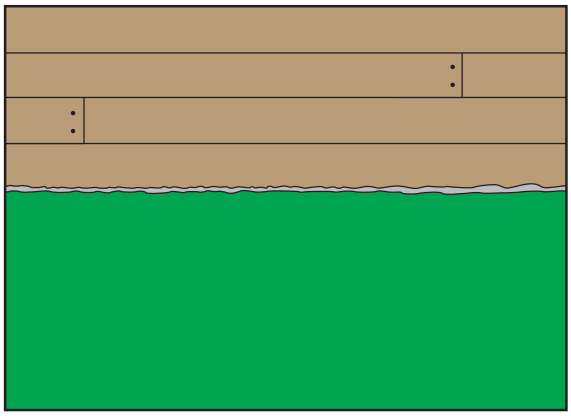
TM: A3–12A

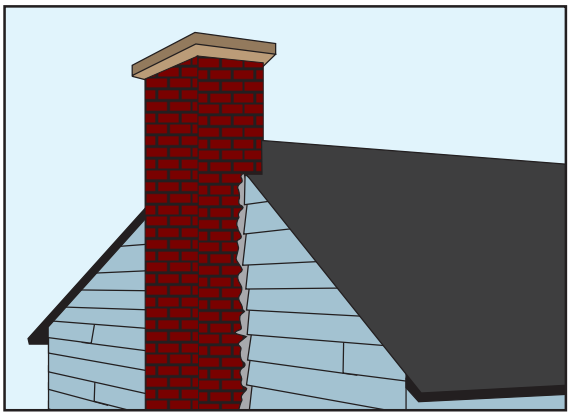
APPLYING CAULKING

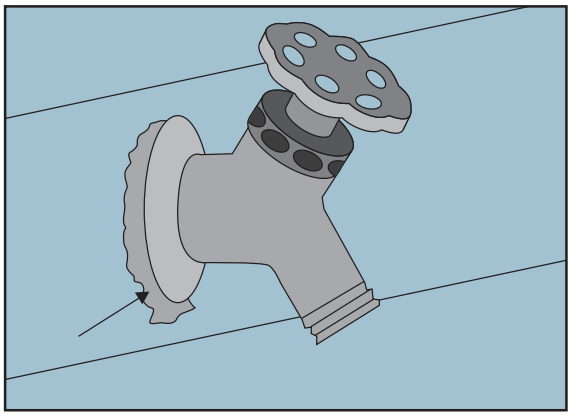


Caulking should be applied outside around windows and door frames…









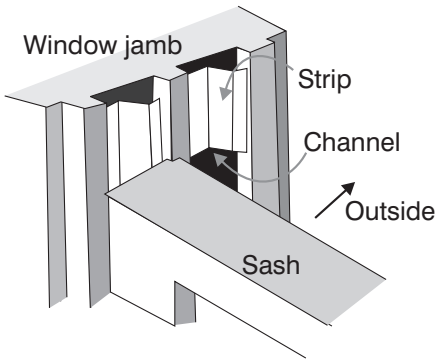
…and wherever else two different materials or parts of the house meet.

(Courtesy, Interstate Publishers, Inc.)

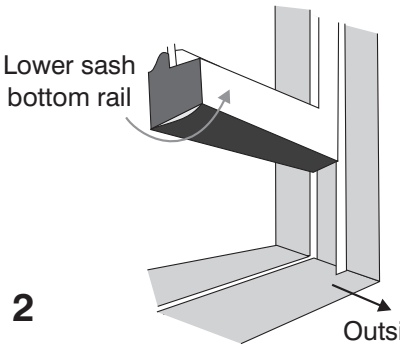
TM: A3–12B

USING WEATHERSTRIPPING

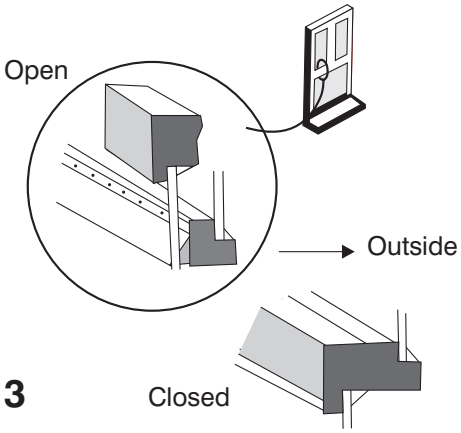
Thin Spring Metal



Install by moving sash to the open position and sliding strip in between the sash and the channel. Tack in place into the casing. Do not cover the pulleys in the upper channels.

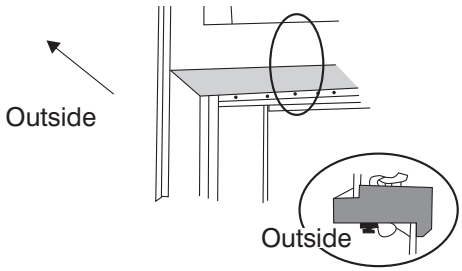


Install strips the full width of the sash on the bottom of the lower sash bottom rail and the top of the upper sash top rail.

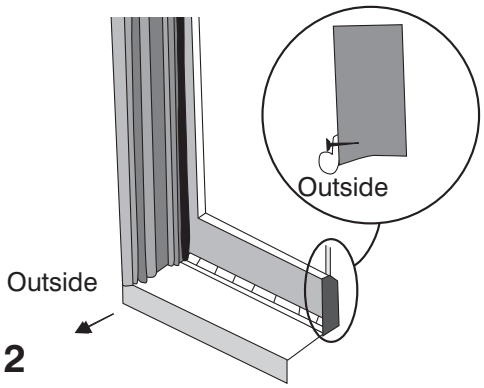


Then attach a strip the full width of the window to the upper sash bottom rail. Countersink the nails slightly so they will not catch on the lower sash top rail.

Rolled Vinyl

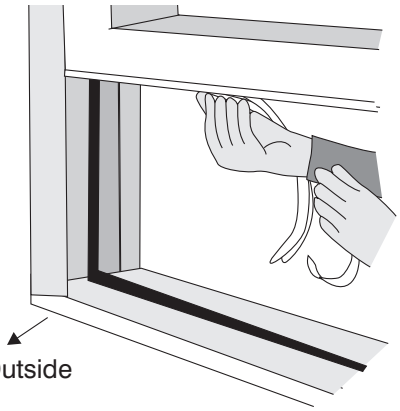


Nail vinyl strips on double-hung windows as shown. A sliding window is much the same and can be treated as a double-hung window turned on its side.



Casement and tilting windows should be water stripped with the vinyl nailed to the window casing so that as the window shuts, it compresses the roll.

Adhesive-Backed Foam Strip

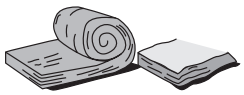
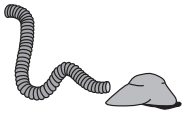
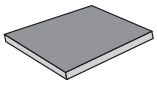
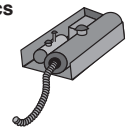


Install adhesive-backed foam, on all types of windows, only where there is no friction. On double-hung windows, this is only on the bottom (as shown) and top rails. Other types of windows can use foam strips in many more place.

(Courtesy, Interstate Publishers, Inc.)

TM: A3–12C

FORMS AND TYPES OF INSULATION

Form	Method of Installation	Where Applicable	Advantages	Materials
Blankets (Batts or Rolls) 	Fitted between wood-frame studs, joists, and beams	– All unfinished walls, floors, and ceilings	– Do-it-yourself – Best suited for standard stud and joist spacing, which is relatively free from obstructions – Blankets: Little waste because it is handcut – Batts: More waste, but easier to handle than large rolls	Rock wool Fiberglass
Loose Fill (poured in) 	Poured between attic joists	– Unfinished attic floors and hard-to-reach places – Irregularly shaped areas and around obstructions	– Do-it-yourself – Easy to use for irregularly shaped areas and around obstructions	Rock wool Fiber glass Cellulose fiber Vermiculite Perlite
Blown Fill 	Blown into place by special equipment	– Anywhere that frame is covered on both sides, such as side walls – Unfinished attic floors and hard-to-reach places	– Insulation that can be used in finished areas – Easy to use for irregularly shaped areas and around obstructions	Rock wool Fiberglass Cellulose fiber
Rigid Insulation 	Must be covered with ½-inch gypsum board or other finishing material for fire safety	– Basement masonry walls – Exterior walls under construction – Foundation perimeter	– High insulating value for relatively little thickness	Polystyrene board Polyurethane board Polyisocyanurate board
Foam Plastics 	Preformed boards or “Foamed in” with special equipment	– Walls of existing buildings	– High “R” value Flows in filling cracks and crevices without leaving voids	Polystyrene Polyurethane Urea formaldehyde

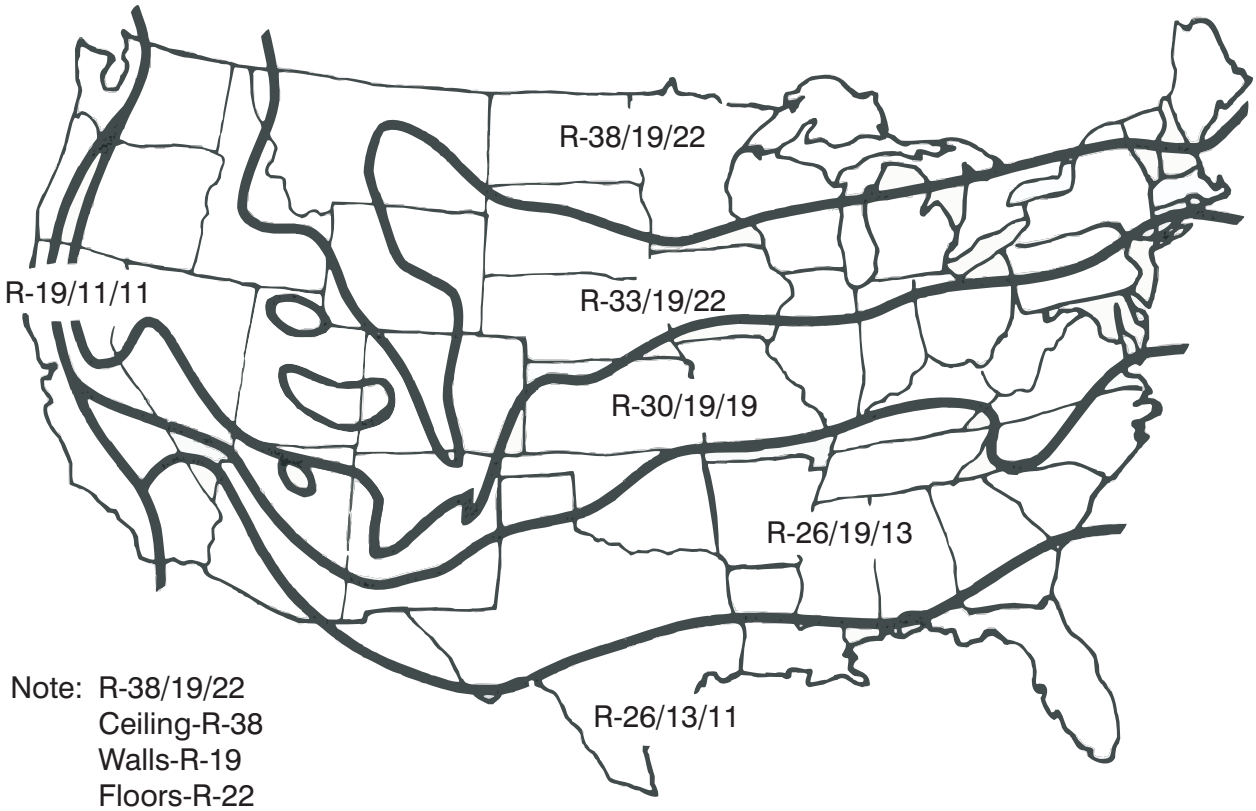
TM: A3–12D

INSULATING MATERIALS: R VALUE COMPARISONS

Typical R Values						
Insulating Material	Inches Needed for					
	Approx. R/Inch	RII	RI9	R22	R34	R38
Loose Fill						
Fiberglass	3.0–3.2	3.5	6	7	10.5	12
Mineral Wool (rock wool)	3.0–3.2	3.5	6	7	10.5	12
Cellulose	3.1–3.7	3	5.5	6	10	11
Vermiculite	2.2	5	9	10	15.5	17
Batts or Blankets						
Fiberglass	3.2	3.5	6	7	10.5	12
Mineral Wool	3.2	3.5	6	7	10.5	12
Rigid Board						
Molded Polystyrene (beadboard or white board)	3.6	3	5.5	6	9.5	10.5
	5.3	2	3.5	4	6.5	7
Extruded polystyrene (Styrofoam TG or Blue board)	8.0	1.5	2.5	3	4.5	5
Polyisocyanurate (thermax or high-R sheeting) white vinyl or aluminum foil vapor barrier						
Foam						
Urea formaldehyde	4.8	2.5	4	4.5	7	8
Polyurethane	6.2	2	3	3.5	5.5	6

TM: A3–12E

MINIMUM RECOMMENDED R VALUES



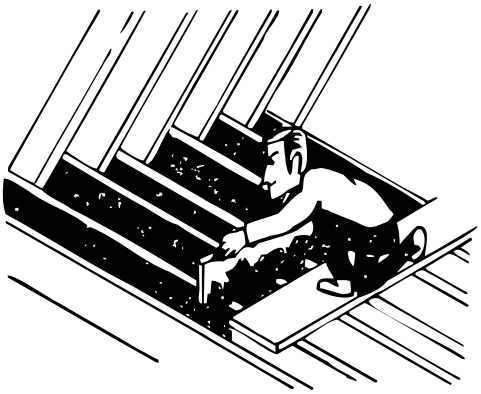
Note: R-38/19/22
Ceiling-R-38
Walls-R-19
Floors-R-22

TM: A3–12F

INSULATING ATTICS

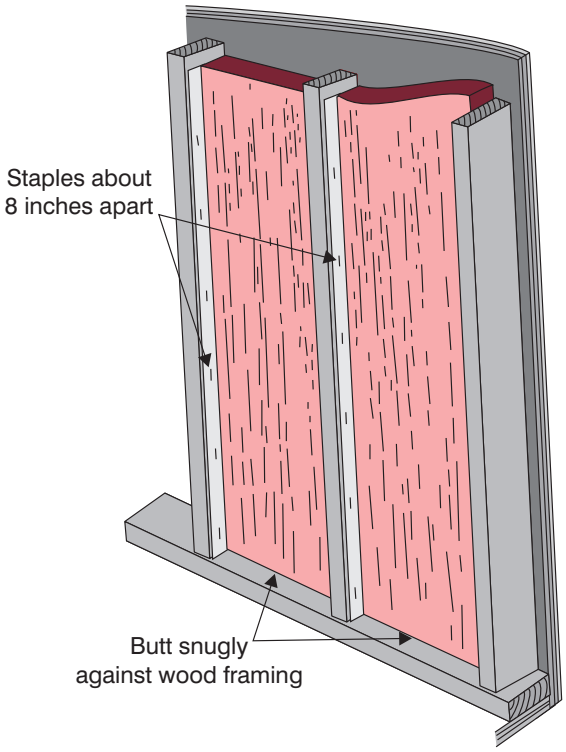
Laying batts in the attic with vapor barrier down.

Installing pour-in insulation.

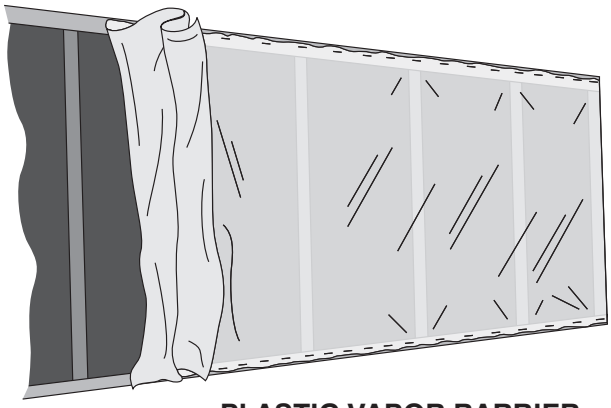


Leveling pour-in insulation.

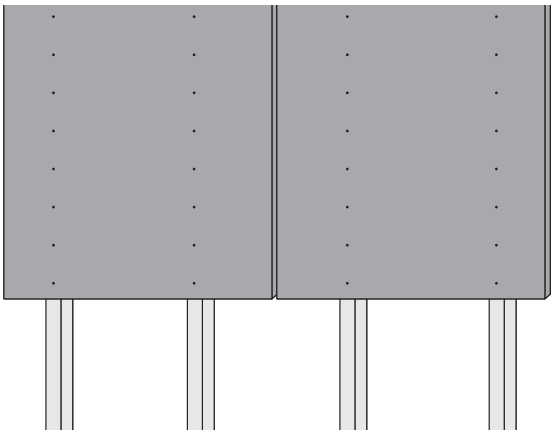
INSULATING WALLS



HOW TO INSULATE WALLS



PLASTIC VAPOR BARRIER



COVER WITH WALLBOARD

(Courtesy, Interstate Publishers, Inc.)

LS: A3–12A Name _____

Lab Sheet

Inventory of Potential Air Leaks

DOORS

_____ 1. Are there any noticeable cracks at areas where the door meets the frame that need to be weatherstripped?

_____ 2. Is there any space between the frame and the interior and exterior walls of the house that needs caulked?

_____ 3. Is there a gap between the bottom of the door and the threshold?

_____ 4. Is there space between the base of the threshold and the floor underneath?

_____ 5. If your door has glass panes, are the panes properly glazed?

_____ 6. Are any of the panes cracked or broken?

_____ 7. Does weatherstripping that exists need to be replaced?

_____ 8. Does your home have adequate storm doors that are properly hung and caulked?

WINDOWS

_____ 1. Are there any moving parts that allow air to leak?

_____ 2. Are there gaps or flaws in construction around the frame?

_____ 3. Is the glazing compound around the glass old and cracked or missing entirely?

_____ 4. Are the seams around the window trim caulked?

_____ 5. Does weatherstripping at the base of the window need to be replaced or installed?

_____ 6. Do the windows have panes that are cracked or broken?

_____ 7. Do the windows have drapes, shades, or blinds to reduce the entrance of cold air?

_____ 8. Are storm windows that fit properly and are caulked installed?

OTHER POTENTIAL AIR LEAK AREAS

_____ 1. Are there foundation cracks or cracks in basement walls?

_____ 2. Are there separations between any two materials of the house construction, like an exterior chimney and the house?

_____ 3. Are there any cracks in siding or missing mortar between bricks?

_____ 4. Are there leaks around:

_____ a. utility pipes

_____ b. phone lines

_____ c. electric lines

_____ d. the mail slot

_____ e. clothes drier vent

_____ f. outside light connections

_____ g. TV antenna entry

_____ h. window air conditioner units

_____ i. electrical outlets

_____ j. the fireplace damper

LS: A3–12B Name_____

Lab Sheet

Given information:

Insulation	"R" Value/inch
Mineral wool (rock wool)	3.0
Cellulose	3.5
Extruded polystyrene (blue board)	5.3
Polyisocyanurate (thermax)	8.0

1. If you have no insulation how many inches of cellulose would need to be blown in the attic to give an "R" value of 30?
2. If you have 3½ inches fiberglass batts in your attic how many inches of mineral wool (rock wool) would need to be blown in to reach an "R" value of 30?
3. How much cellulose would need to be added to the 3½ inches of fiberglass in problem No. 2 to bring the total "R" value to 30?
4. If a basement wall gets two inches of blue board glued to it, what would be the added "R" value?
5. If a new house has 2 × 4 stud walls with 3½ inch fiberglass batts and 1 inch of thermax sheathing, what would be the total "R" value of the two insulations?
6. If a new house has 2 × 6 stud walls with 6 inch fiberglass batts and 1 inch of blue board sheathing what would be the combined "R" value?
7. Given information on a 30 lb. bag of cellulose:

Total "R" Value	Inches of Thickness	Sq. Ft./bag
R-40	10.8	15.2
R-32	8.5	19.2
R-24	6.5	25.0
R-22	6.0	27.5
R-19	5.2	31.3
R-13	3.5	45.5
R-11	3.0	55.6

If your house were a 30 foot × 30 foot 2-story house and you wanted to blow in cellulose in the attic how many bags would you need to buy for the following situations:

a. adding 6 inches

b. adding 8.5 inches

c. adding 10.8 inches