

Lesson A3–10

Roofing Agricultural Structures

Unit A. Mechanical Systems and Technology

Problem Area 3. Construction Systems

Lesson 10. Roofing 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. 3. Construct with wood and metal.

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

1. Explain the application of asphalt and fiberglass roofing materials.
2. Explain the application of metal roofing materials.

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:

Espenschild, R. F. *Applying Asphalt Roofing and Siding Products*. University of Illinois: Information Technology & Communication Systems (U3035).

Espenschild, R. F. *Metal Roofing and Siding For Farm Buildings*. University of Illinois: Information Technology & Communication Systems (U3045).

Hometime Video. *Roofing*. Sponsored by Chevrolet Trucks.

Phipps, Lloyd J., et al. *Introduction to Agricultural Mechanics*, Second Edition. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2004. (Textbook, Chapter 11)

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

Construction Skills Transparency Set. Danville, Illinois: Interstate Publishers, Inc.

Asphalt Roofing Transparency Set. University of Illinois: Information Technology & Communication Systems.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheet
Roofing nails
Roofing materials samples

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

Drill screws
Flashing
H-clips
Metal drip edge
Pipe flashing collar
Plastic cap nails
Purlins
Ridge
Ridge cap
Ridge vent
Ring or screw-shank roofing mails
Rolled roofing
Roof vents

Roofing felt
Selvage-edge roll roofing
Shingle
Smooth-surfaced roll roofing
Straight blade utility knife
Wood shingles

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.

Have students watch the video listed in the recommended resource section. Ask students what roofing materials are used on agricultural buildings. See if they can tell how preferred roofing materials have changed over time (wood shingles to asphalt shingles to metal roofing). See how many students have helped applying roofing materials and have them talk about the procedures they used.

Summary of Content and Teaching Strategies

Objective 1: Explain the application of asphalt and fiberglass roofing materials.

Anticipated Problem: How are shingles installed?

- I. A **shingle** is the individual roofing unit made of slate, wood, asphalt, or fiberglass. The shingles used today are almost all three tab seal-down asphalt or asphalt-fiberglass combination shingles. In the early years of this country, most roofs were covered with wood or slate shingles. Asphalt roofing products began in the late 1800's and by 1937 had taken over 75 percent of the roofing market. Asphalt roofing products offered fire resistance, beauty, versatility, and economy. In recent years adding fiberglass to the asphalt has increased the fire resistance and decreased the weight of a shingle.
 - A. Regardless of the type of shingle used, roofing starts with the covering of the rafters or trusses with roof sheeting. Today most buildings are sheeted with wafer board. **H-clips** are metal brackets shaped like an H installed between each set of rafters where two pieces of sheeting meet. The clip helps strengthen the joint and prevents one sheet from warping up and the other from warping down resulting in a wavy roof. Staggering the end joints of the sheet also results in a stronger roof. The sheeting is generally nailed with 6d nails, 4 inches apart at the edge and 6 inches apart on the other rafters. A power nailer saves time. **Metal drip edge**, commonly called T-tin because of its shape, is nailed in place at the outer edges of the roof. Next, cover the sheeting with roofing felt. **Roofing felt** is an asphalt saturated felt that comes in a roll. Most common thicknesses used are 15 and 30 pound. A **straight blade utility knife** is a retractable triangular pointed knife that works well to cut the felt. Plastic cap nails are used to nail on the felt. **Plastic cap nails** have a one inch diameter cap on a ring shank nail. When the wind

blows, the felt is less likely to blow off than if regular roofing nails are used. Nail spacing is partly dependent on the amount of time the felt will be exposed prior to installing shingles. The longer the exposure, the closer the nails need to be. Generally, three rows of nails (top at 18 inches apart, middle at 12 inches apart, and bottom at 6 inches apart) are used.

- B. **Wood shingles** are cedar or other rot resistant wood cut in a beveled 16 inch long piece with an approximate $\frac{1}{2}$ inch base thickness. They are sold by the thousand or in bundles of 250 each. A square (enough to cover 100 square feet) consists of four bundles or 1,000 shingles. In contrast a square of asphalt shingles is three bundles. Wood shingles give a natural rustic look to a building but are very expensive and rarely used on agricultural buildings. To install wood shingles start nailing shingles at the base of the roof using staggered joints with each layer and a 4 inch, 4 $\frac{1}{2}$ inch, or 5 inch exposure. Each row of nails will be covered by the next layer of shingles.
- C. The first asphalt roofing material developed was rolled roofing. **Rolled roofing** is a three foot wide and 36 foot long roll. Rolled roofing is not as attractive as shingles and has a shorter life expectancy, but is cheaper. **Smooth-surfaced roll roofing** is used in a single coverage type installation where it is overlapped only a few inches. **Selvage-edge roll roofing** has mineral granules over the bottom half of the roll and is installed in a half-lapped technique which results in double coverage that looks more like shingles. By nailing two rows of roofing nails in the top half and then applying roofing tar, the rolled roofing can be applied without any nails being exposed. Be sure to tar under the bottom half of the first roll. Rolled roofing is easily cut with a utility knife.
- D. Today, shingles for the most part are used instead of rolled roofing. Most shingles used today are three tab seal-down asphalt or asphalt-fiberglass combination shingles. At the base of the roof start with a roll of nine inch starter strip or cut off the tabs of the shingle so that the tar strip on the remaining part of the shingle will be near the bottom edge of the roof. Use one inch roofing nails at the end and every 12 inches. To start the shingles either begin at a straight end of the roof or go near the middle to establish a straight line from the bottom of the roof to the peak of the roof. Square the line with the bottom edge of the roof by using a square and a chalk line to mark it. If another chalk line is marked six inches to the left or right, applying the shingles with staggered joints is easier. Line up the first row on the first chalk line and start the second row of the line six inches over. Continue back and forth as additional rows are started. This technique allows an experienced roofer to start the shingles and a less experienced crew to work at both the left and right in order to roof the building in a short period of time. The shingles that hang over the edge of the roof can then be cut at the end of the job with a hook blade utility knife. A straight blade utility knife cuts shingles best from the back side while the curved blade knife works well cutting from the top. If the shingles are lapped with the standard five inch exposure, mark a chalk line 27 feet from the bottom of the roof. If the top of the 4th row of shingles does not come to line, adjust the coverage until they are on the line. Snap chalk lines every 20 inches above the 27 inches (example: 47, 67, 87, etc.) to use with every 4th row of shingles. The results will be straight shingle rows even with an inexperienced crew of roofers. Each shingle should be nailed just above the tar strips at

the ends and above the tab notch. Roofing guns powdered by compressed air work great to save time.

- E. **Flashing** is sheet metal that comes in 50 foot rolls in a variety of widths to use in areas where roof leaks are most likely to occur. Near chimneys, dormers, and in roof valleys, flashing provides another layer of protection. See the references or a roofing supplier for installation recommendations. A **pipe flashing collar** is a rubber or metal sleeve with a plastic or sheet metal flange that is used to seal around exhaust and vent pipes that come through the roof. **Roof vents** are metal or plastic caps that cover roof ventilation holes near the top of the roof. As a general rule place the shingles under the bottom half of the flashing collar or roof vent and on top of the upper half of the collar or vent. Some roofs use a ridge vent rather than several roof vents. A **ridge vent** is located at the ridge of the roof to provide a way to exhaust warm moist air. It generally runs from one end to the other. Whether a ridge vent is used or not, the **ridge cap** is made of single tab shingles spaced so that a five inch exposure is left after nailing.

Assign students to read the suggested chapters in the recommended resource texts. These resources contain excellent information on the topic. Show students examples of wood shingles, rolled roofing, and shingles on nearby roofs or use the transparency TM: A3–10A. Seek a field trip opportunity to see a roofer in action and help with the job. Show students roofing material samples as well as tools used to do the job. Use TM: A3–10B to illustrate installation of rolled roofing and TM: A3–10C to illustrate installation of shingles. Use LS: A3–10A to build a mock roof including rafters, sheeting, roofing edge, roofing felt, and shingles.

Objective 2: Explain the application of metal roofing materials.

Anticipated Problem: How are metal roofing materials installed?

- II. Metal has gradually replaced asphalt and asphalt-fiberglass shingles in many agricultural buildings especially when the pole-type or rigid-arch type buildings are built. While metal roofing is noisy in a rain storm and not as attractive as shingles, it is fire resistant, cheaper, and much easier and faster to install. Metal roofing will be either steel or aluminum sheets. Manufacturers specify the type of nails or screws and their placement/spacing as well as the amount of sheet overlap to use. Start placing sheets at the lower corner away from the prevailing winds. The result will be that the wind will blow over the top of the lap instead of into the lap. Most sheets are sold in 24 inches and wider widths and lengths of 8 foot, 12 foot, 16 foot, etc.
- A. With metal roofing after the rafters or trusses are in place, horizontal nailing boards called **purlins** are installed to attach the roofing sheets. The purlin spacing depends on the type and thickness of the roofing sheets. Follow manufacturer's recommendations.
- B. While steel sheets are stronger than aluminum they are subject to rust. To prevent rust, steel can be purchased with a baked on enamel paint or a galvanized coating. Galvanized steel roofing comes as corrugated sheets with a zinc coating. Better grades are coated with two ounces of zinc per square foot. The thickness of the steel used is either 26 or 28

gauge. Roofing sheets that need only short term storage may be left in bundles, stored flat, and covered with plastic. Roofing sheets that need to be stored for a long period of time before use should be stood on end inside a building with the bottom ends slightly apart. This procedure prevents “wet storage stain” that can occur from moisture condensation.

- C. Aluminum roof sheeting will not rust but is expensive, thin, and easily damaged. Buildings covered with aluminum must have nailing boards with closer spacing than for galvanized steel.
- D. When installing metal roofing, use care climbing ladders and scaffolds. Use grounded GFI protected power tools. Be careful when handling sheets near overhead power lines. Metal roofing that is cut with shears or portable electric saws may have very sharp edges so leather gloves are a good idea. Be sure to wear safety glasses when cutting the sheets. Always cut from the bottom or underneath side of the sheet so that if the saw leaves marks they will not be visible. Wear rubber-soled shoes and use caution when moving around on the roof area.
- E. Corrugated roofing is made from flat sheets that have been formed into a series of alternate ridges and grooves, or hills and valleys, that run in the same direction. The corrugations give the sheets a greater stiffness, increased load-carrying ability, and prevent water siphoning between the sheets into the building. The corrugation patterns vary (triple drain, 2½ inch corrugations, 1¼ inches corrugations, and 3V-crimp, etc.) so follow the manufacturer’s recommendation for sheet overlapping procedures.
- F. The corrugated patterns of roofing are usually applied one course at a time from gable end to gable end, always starting at the eave rather than the ridge. The *eave* is where the roof meets the wall. The *ridge* is the peak or high point of a roof with at least two angles. Start placing sheets at the lower corner away from the prevailing winds. This procedure will help get the wind, rain, and snow to blow over and not under the laps in the roofing. Extend the sheet with its edge down at least one corrugation over the gable end and allow three inches of overhang at the eaves so that guttering can be attached later. Use extra care when laying the first sheet. Be sure it is square with the roof and properly located. If the roof slope is 30 foot long or less, only one horizontal row of sheets is needed.
- G. Metal roofing may be fastened with ring or screw-shank nails. **Ring** or **screw-shank roofing nails** have a lead, neoprene, or rubber washer to prevent leakage and rings or screws to prevent the nail from popping out over time. Set nails just off-center through the peak, or top of the roofing, for corrugated sheets. Leave the valleys open for drainage. Nails driven at a slight angle will have increased holding power and tighten the side lap. Drive the nail just far enough to set the sheet tight against the purlin. If you drive the nail too far you will damage the head or nail washer, flatten the corrugation, and misalign the sheet. If you do not drive the nail down securely, the roofing will be loose. Nail the side ribs first, then the center of the sheet. Do not nail the drain edge of a sheet until it is side-lapped by the adjacent sheet. You may need to use a scratch awl or drill to start the hole for locations where multiple sheets come together. If a nail misses the purlin, remove it and close the hole with a sealer and a sheet metal screw.

- H. Another fastening technique is the use of drill screws. **Drill screws**, sometimes called drive screws, are hexagonal headed self-tapping screws with a sealing washer. A special magnetized bit used with a power drill makes easy work of installing the screws. Drill screws with sealing washers are widely used to fasten metal roofing. They are self-drilling and self-seating with power drivers. They are available in carbon steel for galvanized roofing and stainless steel or aluminum for aluminum roofing. Both nails and screws should be spaced according to manufacturer's recommendations.
- I. At the ridge of the roof use the ridge cap metal designed to match with the roofing metal you have used. Add guttering and downspouts to finish the job.

Use the TM: A3–10D to show procedures for nailing metal roofing and TM: A3–10E to show installation procedures. Take a field trip to see metal roofed buildings. Seek an opportunity for students to observe the actual installation of the roofing.

Review/Summary. Compare preparing the rafter/truss surface for shingles vs. metal roofing. Discuss roof sheeting, applying roofing felt, and installing purlins for metal roofing. Discuss the advantages and disadvantages of each type of roof for use on an agricultural building: wood shingles, rolled roofing, asphalt shingles, asphalt-fiberglass shingles, galvanized steel sheets, painted baked-on enamel steel sheets, and aluminum sheets. Compare and contrast the cutting procedures, fasteners used, and ease of installation of the various roofing materials. Use *Hometime Roofing* video to review this lesson.

Application. Seek opportunities in the school or community to install shingles and metal roofing materials.

Use LS: A3–10A to build a mock roof section. Install sheeting, roof edge, roofing felt, and shingles to the mock roof section.

Evaluation. Take the written test and evaluate the skills demonstrated in the construction and shingling of the mock roof section.

Answers to Sample Test:

Part One: Matching

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

Part Two: Completion

1. curved, straight
2. H
3. Flashing
4. eave, ridge
5. bottom

6. rings, screw, drill
7. under, over

Part Three: Short Answer

1. Fire resistance, lighter weight.
2. Increase stiffness, load carrying ability, and prevent water siphoning.
3. Thickness of the sheet and thickness of the zinc coating.

Test

Lesson A3–10: Roofing Agricultural Structures

Part One: Matching

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

- | | |
|--------------------------------|-----------------------------------|
| a. aluminum roofing | f. roof sheeting (wafer board) |
| b. asphalt shingles | g. roofing felt |
| c. asphalt-fiberglass shingles | h. selvage-edge rolled roofing |
| d. galvanized steel roofing | i. smooth-surfaced rolled roofing |
| e. purlins | j. wood shingles |

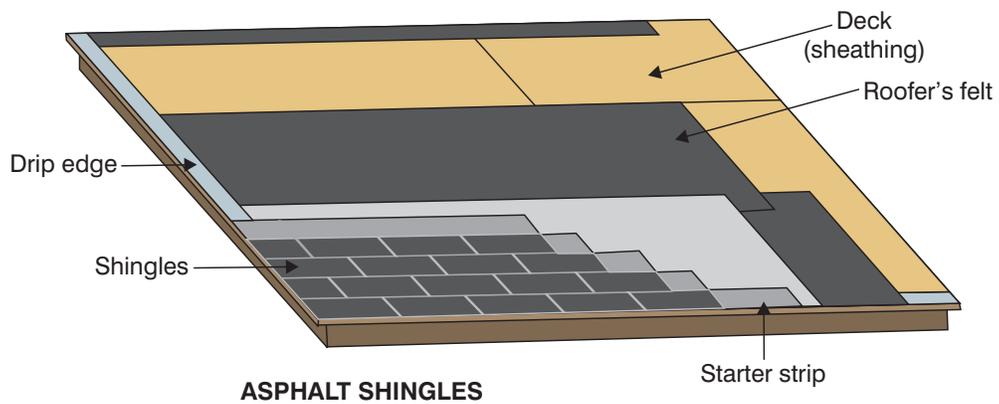
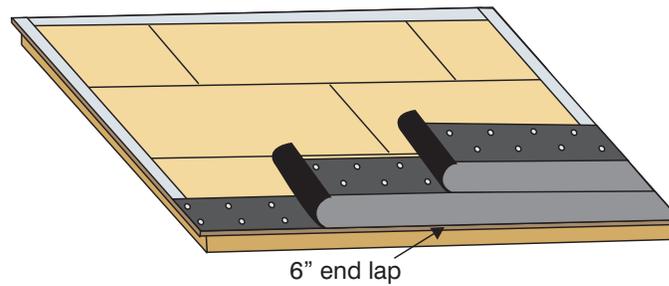
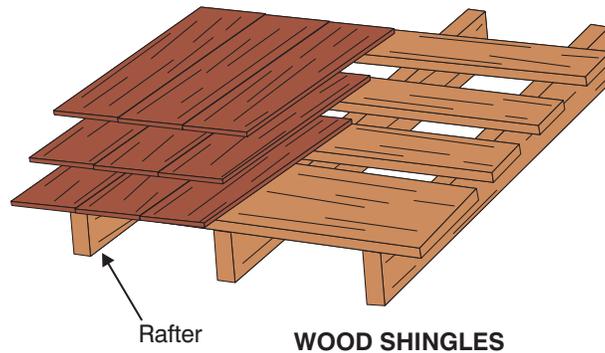
- _____ 1. What metal roofing is fastened to.
- _____ 2. What roofing felt is fastened to.
- _____ 3. Shingle that gives a building an old rustic look.
- _____ 4. Three tab seal-down shingle with a base that is not fire resistant.
- _____ 5. Three tab seal-down shingle with a light weight fire resistant material added.
- _____ 6. Corrugated roofing with a zinc coating.
- _____ 7. Corrugated roofing that is thin, expensive, and usually has a baked enamel paint surface.
- _____ 8. Rolled roofing used in a single coverage installation with only a few inches of overlap.
- _____ 9. Rolled roofing used in half lap double covered installations.
- _____ 10. Installed on roof sheeting prior to shingling a roof.

Part Two: Completion

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

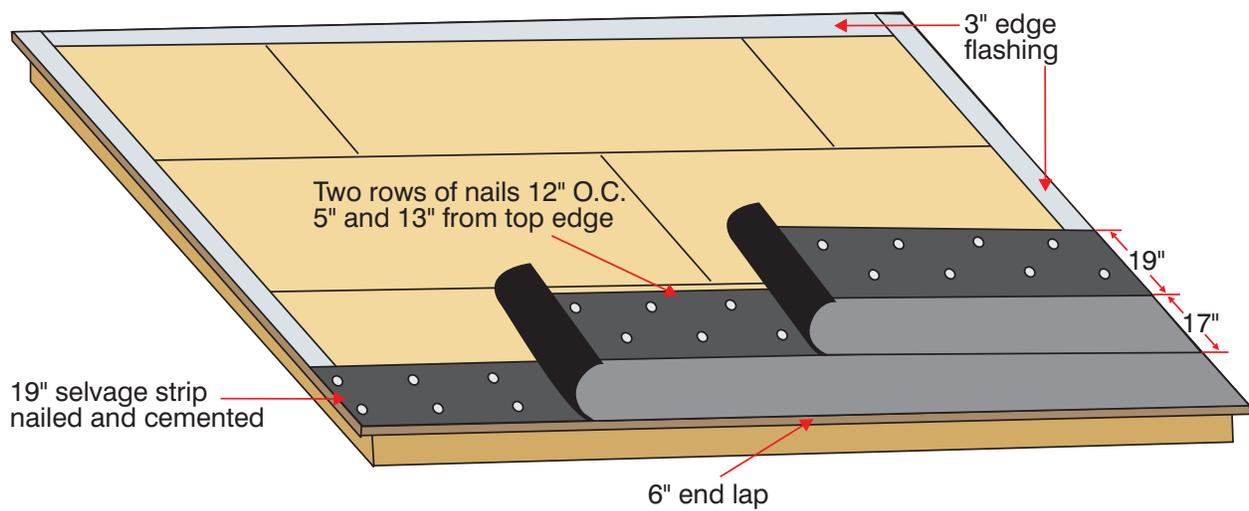
1. When cutting shingles from the top side use a _____ blade type utility knife but when cutting from the back side use a _____ blade type utility knife.
2. To strengthen the roof sheeting between rafters install an _____ clip between sheet edges.
3. _____ is sheet metal that is used where roof leaks are most likely to occur.

WOOD AND ASPHALT ROOFING MATERIALS



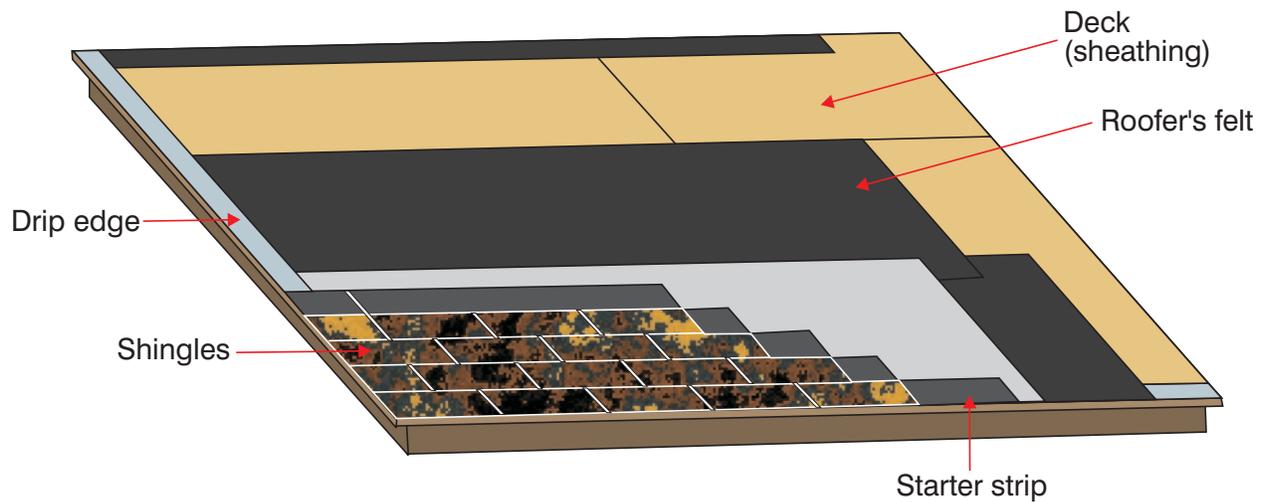
(Courtesy, Interstate Publishers, Inc.)

INSTALLING SELVAGE-EDGE ROLLED ROOFING



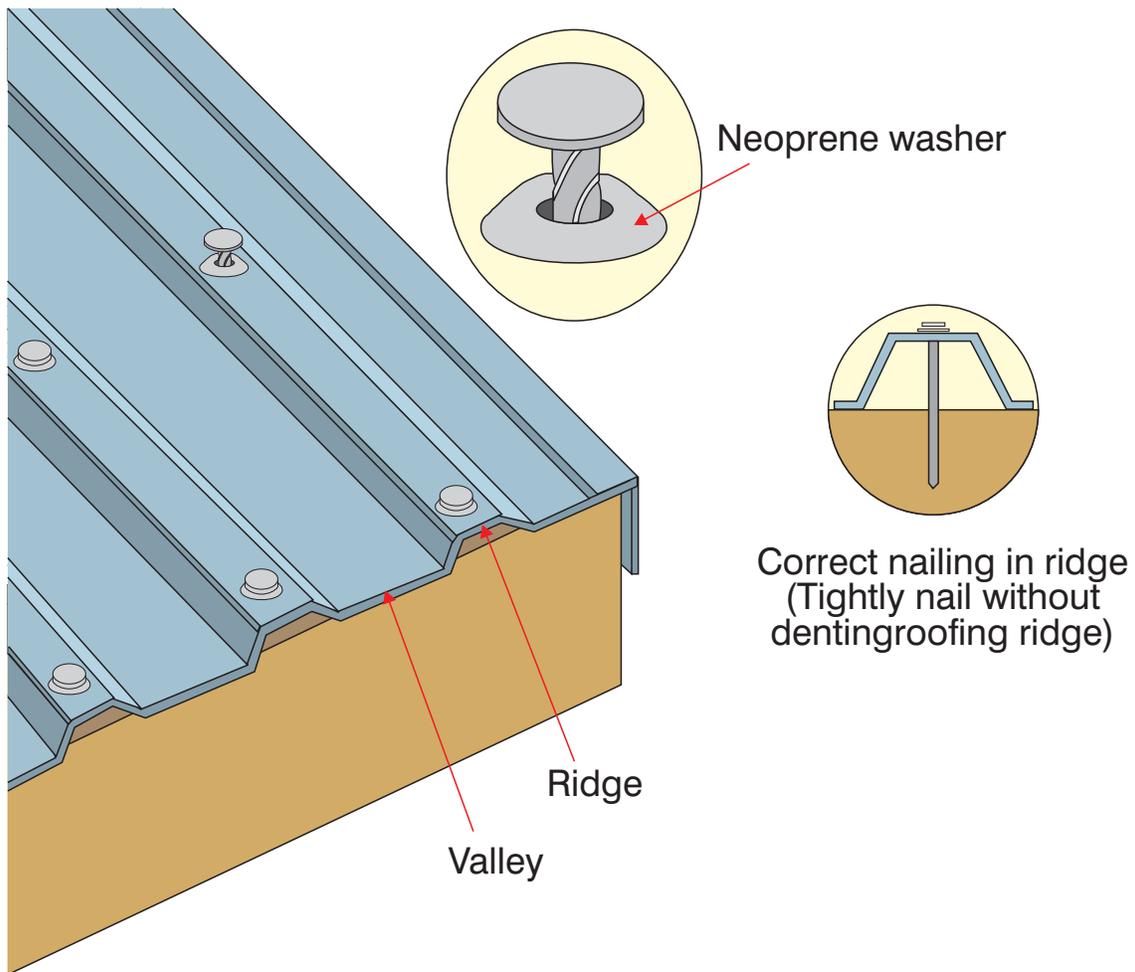
(Courtesy, Interstate Publishers, Inc.)

COMPONENTS OF A SHINGLED ROOF



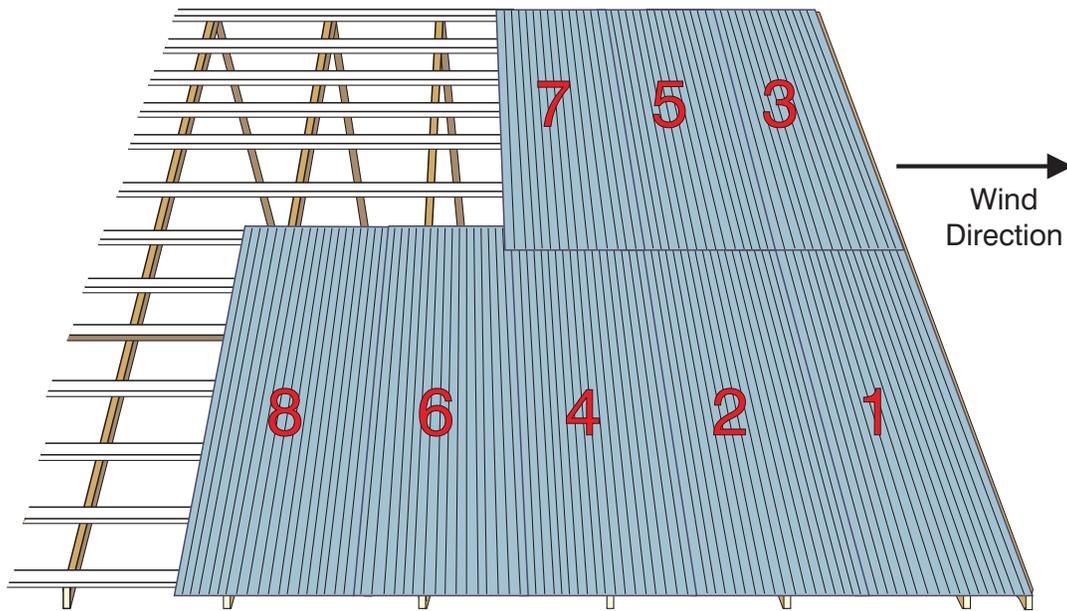
(Courtesy, Interstate Publishers, Inc.)

ATTACHING METAL ROOFING

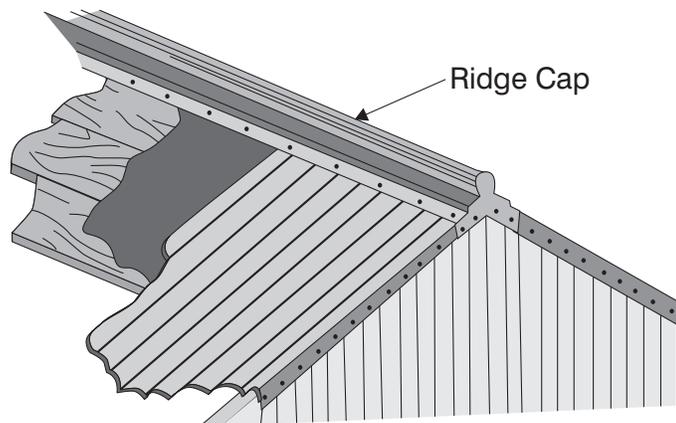


(Courtesy, Interstate Publishers, Inc.)

METAL ROOFING INSTALLATION PROCEDURES



Order of Installation



(Courtesy, Interstate Publishers, Inc.)

Lab Sheet

Building and Shingling a Mock Roof

Materials:

Five 8-foot long 2×4 's
16d common nails
1 $\frac{7}{16}$ inches 4×8 wafer board
7d box nails
Three 10 foot pieces of metal roof edge
roofing felt
plastic cap nails
roofing nails
One bundle of shingles

Tools:

Tape measure
Hammer
Straight blade utility knife
Framing square
Tin snips
Portable power circular saw

Procedures:

1. Build a 4×8 frame with 2×4 's. Space "rafters" on 2 foot centers using 16d nails to fasten them in place.
2. Cover the frame with the wafer board (roof sheeting) nailed with the 7d nails.
3. Use tin snips to cut the metal roof edge to fit the length and height of the roof. Use the roofing nails to fasten the roof edge onto the mock roof.
4. Use plastic cap nails to nail roofing felt onto the sheeting (wafer board). Use a 4 to 6 inch lap. Cut the felt to length with a straight blade utility knife.
5. Use a framing square and the utility knife to accurately cut the tabs off of 3 shingles below the tab notch. When cutting the tabs off turn the shingle upside down and use a straight blade utility knife to cut from the back side. Starting at the left end, nail the remaining part of the shingles on at the bottom of the roof with the tar strip near the lower edge of the roof. Nail near both ends of the shingle and 12 inches in from each end.

6. Cut 6 inches off of the first shingle so that the half tab of the remaining $2\frac{1}{2}$ tabs is at the beginning edge (left edge). Using this $2\frac{1}{2}$ tab shingle start the 1st row by lining up the edge of the shingle with the left edge and bottom edge of the roof. Nail on the 1st row.
7. Start the 2nd row with a full three tab shingle. The bottom of the 2nd row should be even with the top of the tab notches in the 1st row of shingles.
8. As additional rows of shingles are applied alternate starting with $2\frac{1}{2}$ tabs and 3 tabs. The completed mock roof should have the tab notches for every other row in a straight line up the roof.