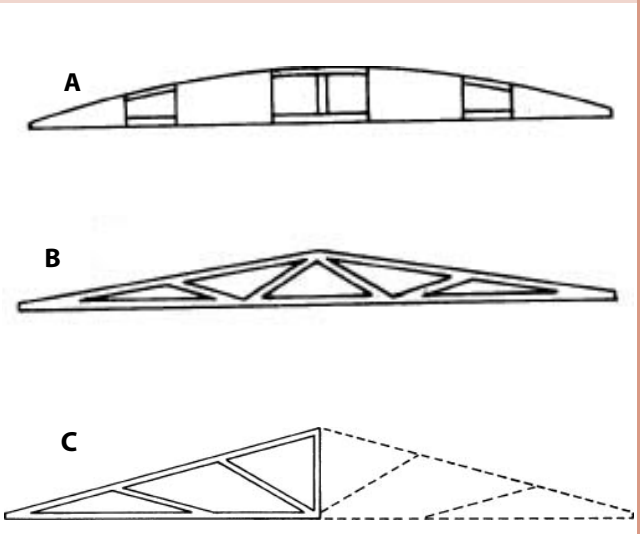
Chapter 10 Roofs and Ceilings

The roof of a mobile or manufactured home is often the most cost-effective place to reduce winter and summer heat flows. This chapter explains how to insulate and repair your home's ceiling and roof.

Roofs are the main source of heat loss in the winter and heat gain in the summer. As a result, roofs are the main contributor to high energy bills in manufactured homes.

A leaking roof is a serious and urgent problem that can also ruin the building quicker than almost anything else.

Figure 10-1 Three Common Types of Mobile Home Roofs

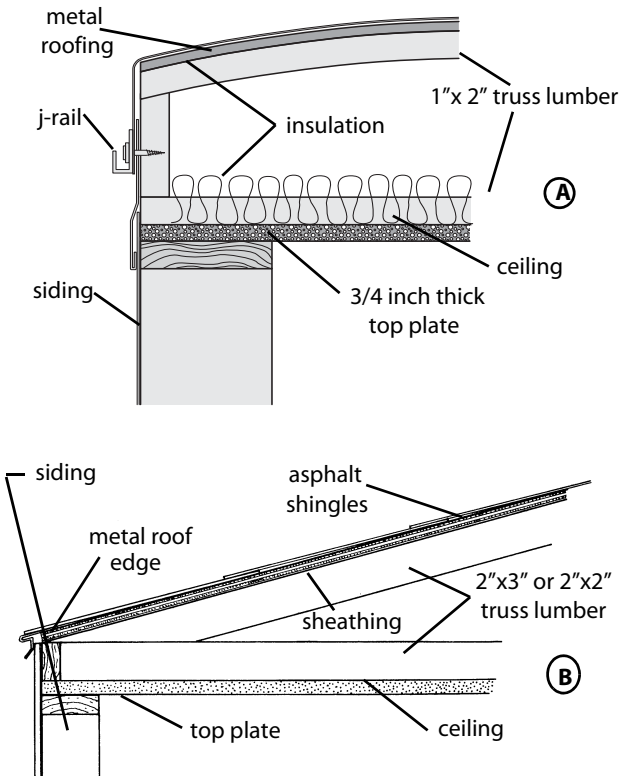


A. Bowstring trusses are common with metal roofs; B. Sloping standard trusses are common with shingle roofs; and C. On double-wides each unit has a half truss roof which combines with the other half to form a gable roof.

Roof Design

Most mobile home roofs are built with either bowstring trusses, standard sloped trusses, or half trusses. The centers of trusses are generally spaced 16 inches apart. Occasionally, you may find trusses spaced 24 inches apart.

Figure 10-2 Corner Details of Mobile Home Roofs



A. Construction detail of a metal roof; and B. Construction detail of a standard sloped roof with asphalt shingles.

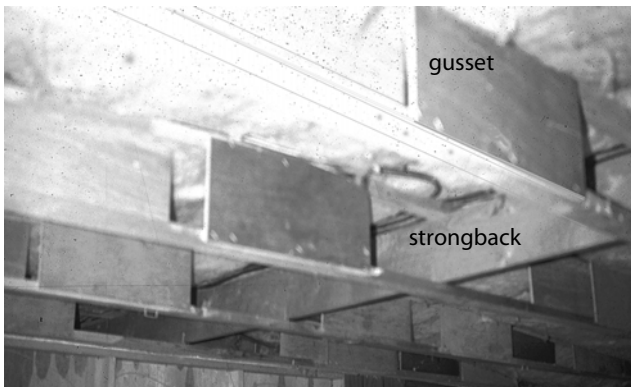
Bowstring trusses have the shallowest cavities. These cavities are usually not vented. Standard-sloped roofs on single-wide homes usually have a little more room. Half trusses on double-wide homes have as much as two feet of space between the ceiling and roof. Cavities under shingled roofs are usually vented, and HUD now requires homes with non-metal roofs to be vented. (*See "Ventilating Attics and Crawl Spaces" on page 66.*)

Roofing Materials

Manufactured homes have either metal roofing or asphalt or fiberglass shingles. Metal roofs are 30-gauge galvanized steel, rolled and crimped together in pieces 3.5-to-4.5 feet wide. The seams run crosswise across the roof. Metal roofing isn't attached to the trusses, but instead is attached to the top edge of the wall.

Shingles usually accompany sloped roofs on newer single- and double-wide homes. Shingles are nailed to plywood or some type of wood composite sheathing attached to these trusses.

Figure 10-3 Bowstring Trusses



Trusses are held together by gussets and reinforced by a strongback.

Existing Roof Insulation

Older single-wide mobile-home roofs are constructed with shallow roof cavities that have 1-to-4 inches of insulation installed on top of the ceiling between the trusses. Metal roofs often have some insulation underneath the metal roofing to reduce condensation. Some homes have insulation both on top of the ceiling and underneath the roofing—fiberglass, 1-or-2 inches thick in each place.

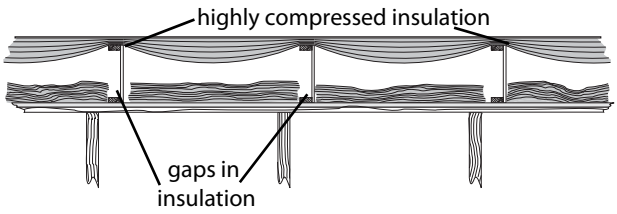
Many mobile and manufactured homes have inadequate roof insulation. Gaps in the insulation between trusses, insulation voids created by careless installation, and shifted insulation caused by the home's transportation all reduce roof cavities' R-values. Fortunately, mobile home roof cavities can be re-insulated.

Trusses and other objects in the roof cavity are obstacles to installing more insulation. The arrangement of roof framework will dictate what methods are used to add insulation to the roof cavity, or how insulation will be fastened to the roof surface. Roof-cavity installation methods must install insulation completely around any obstacles for the insulation to be effective. Obstacles on the roof like chimneys, vents and strongbacks require care and planning when installing rooftop insulation.

On metal roofs, you can determine the location of trusses and other structural framing by walking on the roof and feeling where the roof is most solid. To inspect the roof cavity from inside the home, look for some convenient access where you can see the construction details and thickness of insulation. The furnace closet or water-heater closet may have a hole or gap around the chimney that allows for inspection.

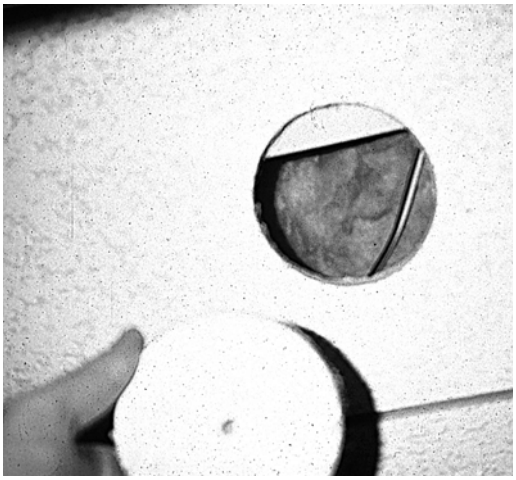
Or, drill a 4-inch hole with a hole saw in the ceiling of a closet near the center of the home's width anywhere along its length. A 4-inch hole allows room to reach up into the cavity, measure the thickness of existing insulation at the ceiling or roof, and note construction details that affect insulation installation. (Patch the hole with a 4-inch plastic plug or the original round piece of ceiling tile sealed with caulking or construction adhesive).

Figure 10-4 Insulation Installation



Gaps in insulation and highly compressed insulation are two reasons why roof R-values are often low in manufactured homes.

Figure 10-5 Ceiling Inspection Hole



A 3- or 4-inch inspection hole allows the inspector to look and actually reach up into the narrow cavity to measure the depth of the insulation.

Removing the siding at the gable end gives an excellent view of the roof's construction and its insulation level. Corrugated-metal gable siding and even lap siding are fairly easy to remove. Installing insulation through the gable can be an effective way of filling part of the roof after the inspection.

Use great care when inspecting roof cavities from up on the roof, because of the potential for causing a leak. On shingle roofs, remove a gable vent (gables are the triangular wall sections at the roof's ends) and inspect the cavity with a flashlight. Or, remove vents or patches on the roof to inspect the roof cavity. The vents or patches should be carefully resealed when inspection and insulation are complete.

Roof Moisture Problems

Condensation and roof leaks cause moisture problems in roof cavities. Repair leaks and solve condensation problems before insulating. Otherwise, moisture problems could damage the insulation and reduce its effectiveness.

Vapor barriers are used to prevent attic condensation problems. The 1976 HUD Code required a vapor barrier in mobile home attic. The HUD Code's 1994 revisions required attic ventilation. Carefully air sealing the ceiling is even more important than the vapor barrier because air leaks can transport moisture faster than vapor diffusion.

How do you discriminate between a roof leak and a condensation problem in the roof cavity? Roof leaks will show themselves after rain or during snow melt. Roof leaks are usually marked by stains having concentric rings—darker at the center and lighter toward the edges.

Roof-cavity condensation usually occurs during cold weather, especially during a sudden thaw or on a sunny day when the sun melts ice frozen in the roof cavity. Condensation stains tend to be found in clusters near the home's edge. Condensation stains might look like roof leaks if they're near a large air leak between the home and roof cavity.

Figure 10-6 Incomplete Roof Insulation

In winter, the uninsulated metal roof at the edge of this mobile home sweats, staining the ceiling. Installing blown ceiling insulation solves this problem.

Roof Condensation

Condensation in roof cavities is often mistaken for roof leakage. Condensation occurs when warm moist air touches a cold surface or mixes with cool air. If warm, humid, house air escapes into the roof cavity during winter months, water condenses when this air touches the roof's cold underside. Water droplets form on the roof's underside soaking wood sheathing, rusting metal roofing, and/or dripping down and staining the ceiling below.

Condensation can saturate wood roof sheathing, softening the sheeting by dissolving its glue. Localized areas of softening are usually caused by large air leaks or roof leaks. Wider areas of softening may be caused by high indoor relative humidity coupled with no vapor barrier. Or, the attic may be cooler than humid outdoor ventilating air, leading to condensation on the sheathing. If the plywood or particle board under the shingles feels soft throughout the roof, the problem is probably caused by widespread condensation, wetting the sheathing from underneath.

In summer months, cool, dry, air-conditioned air from the home and hot, humid air from the roof cavity meet at ceiling penetrations (such as holes around pipes and wires) or at seams (such as the marriage wall of a double-wide home). This summertime condensation is often marked by dark-colored mold colonies in the ceiling panels and surrounding lumber.

Homes with ducts in the ceiling may see condensation during summer air-conditioning, when water condenses on the cool ducts or at leaks in the ducts, and then drips onto the ceiling.

To reduce roof-cavity moisture, provide better site drainage. Install a ground-moisture barrier. Reduce indoor humidity. Seal air leaks in the ceiling and walls. Check existing vents—they may not be circulating air or the roof may be un-ventilated.

Roof Leakage

Roof penetrations and seams are the most likely places for metal-roof leaks. Water puddles are also a common problem on the metal roofs of single-wide homes because these roofs don't have much of a slope, and water can collect in small indentations. Rumble washers, used to reduce roof rumble, are also a common roof-leak area. The edges of shingle roofs sometimes deteriorate from ice-damming in cold climates. Shingles often blow off in windy areas, causing leaks.

Inspect the following areas carefully for leaks.

- Flashing around vents, pipes, and chimneys,
- Seams in metal roofs,
- Joint between roof and wall on metal roofs,
- Rumble washers on metal roofs,
- Damaged shingles, especially at the roof edge, and
- Flashing around evaporative coolers.

Localized areas of soft sheathing around penetrations or at the roof edge are probably due to roof leaks or to large air leaks in the ceiling that deposit condensation in the roof cavity.

If you encounter a wet roof cavity, seal roof leaks and all areas that might leak.

Roof-Cavity Ventilation

Stopping the moisture's entry is essential to preventing attic moisture problems. Attic ventilation is a last resort for removing condensed moisture or leaked rain water. Relatively dry outdoor air can be used to ventilate and remove accumulated moisture from attics. Attic ventilation usually has a drying effect on attics but sometimes has a wetting effect.

Ventilating with outdoor air can remove moisture from the attic, but only if air circulates through the wet parts of the attic and only if the air is relatively dry—two requirements not always fulfilled. Even with this ventilation, moisture still invades the attic.

If the cavity is still wet after sealing roof leaks and reducing moisture sources, consider power-ventilating the roof cavity. Buy a fan-powered vent and install it on the rooftop or in the gable. Run the power-ventilator when the weather is the warmest and driest for your region. Humidistatic controllers can automatically ventilate the roof cavity when the humidity is favorable. Power ventilators should pressurize the roof cavity in cold climates and depressurize the cavity in warm climates. Pressurizing the cavity in cold weather keeps moist indoor air out. Depressurizing the roof cavity in hot weather prevents hot humid attic air from being forced into the air-conditioned home.

The 1994 revisions to the HUD Code require attic ventilation with at least 50% of the vent area located high on the roof of new manufactured homes. At least 40% must be low on the roof—soffit vents, eave vents, or low gable vents. Metal-roofed mobile homes having no roof sheathing are an exception to the new rule and need not be ventilated. (*See "Ventilating Attics and Crawl Spaces" on page 66.*)

Roof Maintenance and Repair

Roof maintenance and repair are the most important tasks to insure the longevity and structural integrity of the home. Whether or not you plan to add insulation to the roof cavity, roof maintenance and repair work should be your first priority.

Sealing Cracks and Holes Ceilings

The roof cavity's underside inside the home is commonly called the ceiling.

To patch a large hole in the ceiling, cut out a rectangular piece including the damaged section between two truss centers. Use the trusses as fastening backers for the patch. To reinforce the patch's other two joints, use two 1-by-4 or 2-by-4 wood pieces installed at right angles to the trusses. Attach these cross pieces with screws and construction adhesive. Predrill holes for the screws. Make the patch from matching material such as white fiberboard or sheetrock.

Figure 10-7 White Latex Roof Coating

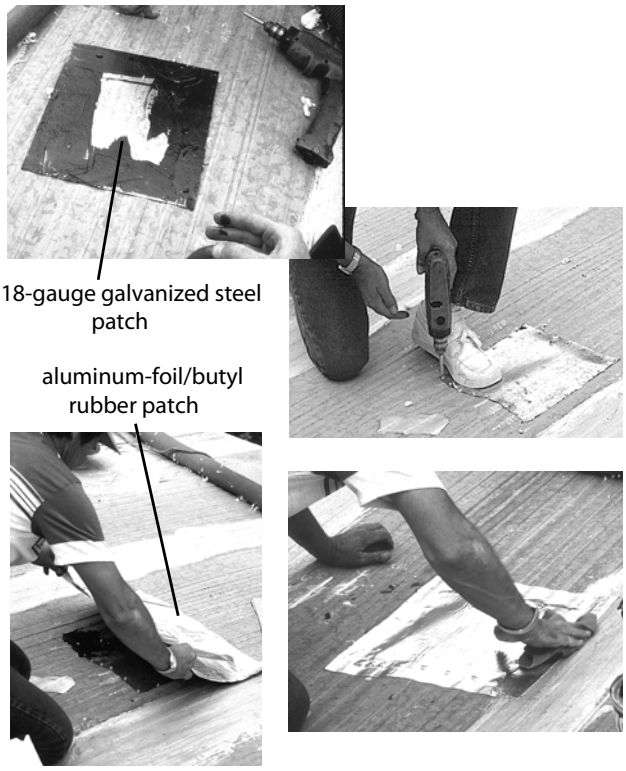
Technician applies a patch, using two layers of the coating with reinforcing fabric in between.

Smaller holes can be patched without cutting all the way back to the trusses. Use short pieces of 1-by-4 for backers on two sides of the patch. First screw through the ceiling into the 1-by-4 pieces while holding these pieces firmly against the attic side of the ceiling. Next screw the patch to these same 1-by-4s. Then seal the seams with caulking or sheetrock joint compound and fabric tape.

Medium-sized gaps around penetrations can be stuffed and then caulked. For stuffing, use foam rubber or fiberglass (be sure to use fiberglass around chimneys, since it is fire-resistant). Use pure silicone caulk near chimneys that may get hot. Manufactured homes usually have double- or triple-wall chimneys, so special caulking around them isn't usually necessary, because they don't get much warmer than 140°F. Even triple-wall chimneys need to be 2 inches away from combustible materials. Double-wall chimneys often have additional protective metal collars around them at the ceiling. If your chimney collar is missing you can make a new one out of a doughnut-shaped piece of lightweight aluminum sheeting with a slit to allow its installation around the chimney.

Seal smaller cracks and gaps (around flues and plumbing vents that penetrate the ceiling) with acrylic latex caulk.

Figure 10-8 Patching a Large Hole



A technician screws a metal patch to the metal roofing after applying mastic to the patch's underside. A second patch of foil-faced sticky butyl rubber is applied over the first. This second patch is rubbed (in cold weather, it's heated too) to help it adhere.

Repairing Roof Leaks

Roof leaks are among the most destructive of building problems. Roofs should be inspected and maintained regularly.

Metal-Roof Repair — The most important consideration for patching a metal roof is to try to build up the area to be patched so that it doesn't lie in a depression. You may need to make the hole bigger in order to insert plywood or insulation to push the flexible roof up slightly at the patch. A patch located at a low point in the roof will likely fail.

The most common and inexpensive all-purpose patching system for metal is asphalt-based black mastic, reinforced with fabric webbing. Apply this

patch by spreading the mastic in a thin even base coat with a trowel. Then, lay fabric webbing into the base coat, and cover the webbing with a top coat. After drying, brush the patches with an asphalt-aluminum coating. This bright-silver coating, which contains reflective aluminum particles, will help protect the patch from damaging sunlight and heat.

Sheets or strips of butyl rubber with aluminum-foil skin make quick patches on metal roofs. These instant patches stick tenaciously to warm roofs. If installed during cooler weather, they may need to be heated to make them stick adequately. This butyl-aluminum sheeting, packaged in rolls 4-to-36 inches wide, is clean and convenient to install.

White latex rubber roof coating is a long-lasting and highly reflective roofing material. Latex rubber is spread from 5-gallon buckets with a brush, roller, or spraying machine. The most durable applications are reinforced with fabric webbing with coating applied in several coats. Surface preparation is crucial to adhesion of latex roof coating, which is very sensitive to both water and oily residues. Follow the manufacturer's instructions precisely to ensure success. Some latex coating systems employ a primer coat with one or more top coats. Latex roof coatings can be used on both metal and asphalt roofs.

Covering the entire metal roof with white latex rubber coating or with asphalt-aluminum coating prolongs roof life, saves money on air conditioning costs, and improves summertime comfort. The bright-white latex coatings are preferable in hot climates because they are such good solar-heat reflectors.

Shingle-Roof Repair — Leaks in shingle roofs are difficult to find. These roofs have many seams that could be leaking, but how do you know which ones are? The sun, rain, hail, wind, and the thawing and refreezing of snow eventually wear shingles out. This wearing process takes 15-to-30 years, depending on climate.

When a shingle roof leaks, it's usually time to replace it. You'll have to tear the existing shingles off before installing new ones because a manufactured home's roof is not designed to support the weight of multiple layers of shingles. Carefully renail the roof sheathing before installing new shingles.

It's possible to replace a shingle or a section of shingles, damaged by wind or ice-damming. Pry the damaged shingles' nails out and then loosen the nails in the shingles above the damaged ones. Remove the damaged shingles and nail in their replacements, reinforcing the bonds between them with roof cement if you live in a windy area.

Sheets of aluminum or galvanized steel are also used to patch shingles. These 5-inch-wide patches are shoved under shingles, to protect worn surfaces under the tabs. Use roof cement to glue them in.

If appearance isn't important, worn shingle roofs can be renewed by applying a generous coat of asphalt-aluminum roof coating every 5-to-10 years.

Roof Structural Repair

If you live in a windy region, consider installing straps or metal plates to fasten the trusses more tightly to the wall. Strapping that bonds the truss to a wall stud every 2-to-4 trusses is particularly effective. During repairs, inspect the perimeter of the roof carefully to make sure that the edge of shingles or metal roofing lay flat, especially if you live in a windy region. There should be no roofing, trim, or fasteners protruding, open, or loose. The wind can pry under protruding areas and eventually tear them off.

If water stands in puddles on a metal roof, eventually the roof will leak there. Large indentations or creases in metal roofing may indicate a leveling problem. If this is the case, the sagging should also be noticeable at the floor level—refer to information about leveling mobile homes pre-

sented in *Chapter 2* ***Foundations***. If your foundation is level, the indentations are likely due to a sagging roof structure.

Truss repair can be done from the rooftop or from underneath; the rooftop option is generally easier. But, if the roof has leaked and you have to replace the ceiling, you can repair the trusses and sagging roof at the same time you replace the ceiling. If you replace the ceiling tile, note that it extends over top of the interior wall. Therefore, you'll have to cut the ceiling at the wall's edge to remove a piece of ceiling tile damaged near its edge. Be sure to reinstall the vapor barrier if you replace sections of ceiling unless you live in a warm climate.

To fix indented sections of metal roof caused by sagging metal or damaged trusses, cut out three sides of a rectangle, leaving the fourth as a hinge in the area of the metal roof where the water puddles. Fold back this flap of roofing and repair damaged trusses. The metal roofing isn't usually attached to the trusses.

Usually a truss can be repaired in place, without removing it. Since the lumber is of smaller dimensions—typically 1-by-2s, 2-by-2s, or 2-by-3s—than lumber used on site-built houses, repairing the truss is more like furniture-making than ordinary house carpentry. Use construction adhesive and screws driven into pre-drilled holes to fasten repair lumber and plywood. Gussets (sheeting fastened to the sides of trusses to strengthen them and help them hold their shape) can be made from scrap wood paneling or $^{1}/_{4}$-inch plywood.

It's not usually necessary to remove broken truss lumber. Unless splinters are obstructing the repair, just bridge the break by a couple feet on each side with similar-dimension lumber as the broken piece. If the lumber is badly splintered or rotten, cut the damaged lumber out. Avoid attaching patches to the truss's flat side—this will allow you room to reinforce the truss's weak area with a plywood gusset glued and screwed to that flat side. Fasten the lumber patches and gussets with both screws and glue for maximum strength.

Reinforcing a sagging metal roof involves slipping plywood or $^{3}/_{4}$-inch-thick lumber underneath the metal roofing and over top of the trusses. The plywood or lumber will raise the low area, establishing better water drainage. But, be careful that during the repair you don't create another low spot by building the sagging area up too high. After fastening the plywood to the trusses with glue and screws, fold the roofing flap back to its closed position and fasten it to the new plywood with short sheet-metal screws. Cover the whole cutout area with a metal patch overlapping 4 inches in all directions. Screw the metal patch to the existing metal roof and to the plywood reinforcing panel with sheet-metal screws. The edge of the patch should be bedded in roof cement and the seam sealed with one of the coating methods described in *"Repairing Roof Leaks" on page 126*.

Eliminating Roof Rumble

Roof rumble is a common complaint from occupants of manufactured homes with metal roofs. Since metal roofs are typically attached only at the perimeter of the roof (along the top of the wall), the metal roof skin lays loosely on top of the trusses. As a result, some metal roofs move and rumble in the wind or with changing temperatures.

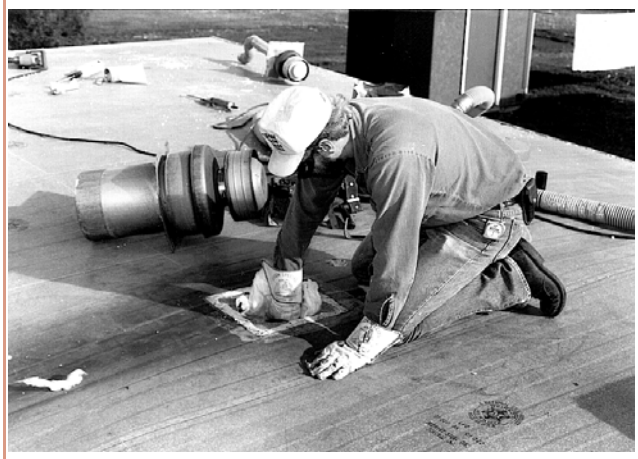
On a windy day, you can look up to the roof and see what areas are making noise. Then, after the wind quits blowing, get up on the roof and secure the roof's rumbling areas to its trusses. A rumble washer is large washer with a rubber gasket and a small hole for a sheet metal screw in the center. Install screws and rumble washers one or two at a time. Don't use any more than necessary, because they are can cause leaks. Use roofing sealant over the rumble washers to prevent them from leaking. Remove the rumble washers before moving the home to prevent them from wearing holes in the roof, which moves during transport.

Roof-Overs

A roof-over or Ramada Roof is a new site-built roof, installed atop a mobile-home roof. Roof-overs should be self-supporting like pole barns. In fact, many roof-overs are just small pole barns. Insulating the roof cavity with fiberglass and installing an insulated rubber or urethane roof is less expensive and usually a better way of obtaining a new insulated roof.

Roof-overs weigh thousands of pounds that the home was never designed to support. If you have an existing roof-over that is not self-supporting, you should install perimeter footings and piers every 8 feet underneath the home's edge to prevent the home's rim joist from sagging. If you plan to build a roof-over, consult a book on pole buildings.

Figure 10-9 Protecting the Chimney



This technician is stuffing unfaced fiberglass batts around the chimney, forming a dam to prevent blown-in polystyrene beads from touching the double-wall chimney.

Roof Insulation

Adding insulation to a mobile and manufactured home roof cavity presents special challenges, because it is usually not possible to physically venture into the roof cavity, as usually can be done with a site-built home.

Before following the procedures below, review *Chapter 6* ***Insulation*** for a thorough discussion of general materials and techniques.

Moisture and Roof-Cavity Insulation

Filling a mobile home's metal roof cavity with insulation is controversial. Eliminating the cavity's 2-to-6-inch air space will inhibit drying should the insulation get wet. Therefore it's very important to ensure that the insulation doesn't get wet by patching and coating all potential leak sites and by thoroughly air-sealing the ceiling from the interior.

Filling the roof cavity can actually prevent condensation by eliminating the air spaces where the warm, moist air and the cool, dry air mingle. Insulation also can restrict the flow of moist air from home or outdoors. The insulation closer to the ceiling is likely to remain drier than before, because it is kept warm by new insulation above it.

Moisture problems are caused by filling metal roof cavities with blown fiberglass. Most metal roof cavities are not vented. The new insulation doesn't restrict outdoor ventilation air in these cases, because there wasn't any to begin with.

However, vented roof cavities—primarily shingle roofs with sheathing—should not be completely filled. Doing so would reduce outdoor air circulation that can carry moisture away through vents. A space at the top of the cavity—including areas underneath roof vents—should remain open.

In case condensation or roof leakage do occur in the future, select lighter and less absorbent insulation materials for insulating roof cavities. Cellu-

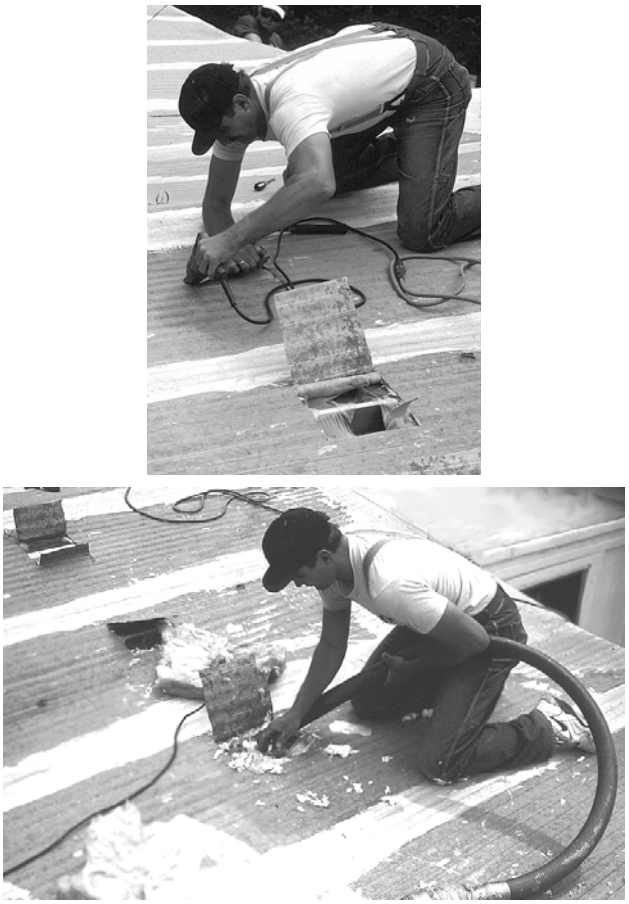
lose is too absorbent to be used in un-vented metal roof cavities. Fiberglass absorbs far less water than cellulose. Polystyrene beads absorb even less than fiberglass.

Roof-Cavity Insulation

Blowing insulation into the roof cavity is the most effective and economical method for adding insulation to the manufactured home's roof assembly.

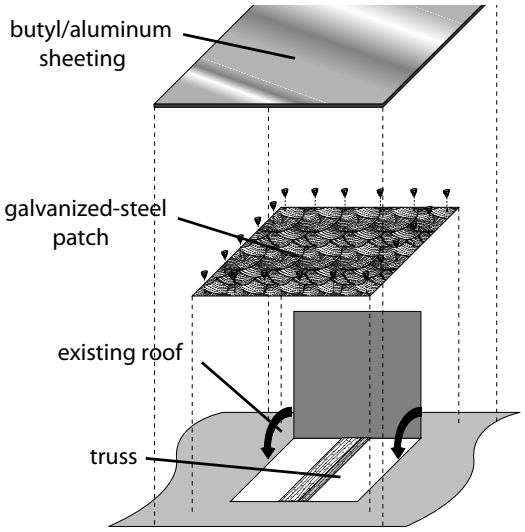
Blown insulation is cheaper than the foam insulation installed on rooftops. And, it's more effective than merely installing rooftop insulation, because blown insulation provides a continuous, seamless blanket where it does the most good—directly above the ceiling. Leaving an air space between indoors and the new insulation—as happens with most applications of rooftop insulation—doesn't work as well as a thick insulation blanket right above the ceiling.

Figure 10-10 Blowing a Metal Roof Cavity



A technician cuts 10" by 10" holes, inserts a flexible fill-tube all the way to the edge of the home, then blows insulation, pulling the tube out as the cavity fills.

Figure 10-11 Square Holes for Insulating



Square holes can be easily patched with galvanized steel glued with roof cement and screwed with self drilling screws. The second patch is stick butyl rubber with an aluminum-foil skin.

Preparing for Roof-Cavity Insulation —

Remember, insulation will lose its thermal resistance if it gets wet. Look for signs of past water damage inside and outside. Find out why the damage occurred.

Before proceeding with roof-cavity insulation on metal roofs or on shingle roofs, carefully follow these preparatory steps:

Step 1: Inspect the ceiling, including closets and cabinets. Completely seal all penetrations and seams in the ceiling.

Step 2: Inspect all seams on the roof, especially those around roof penetrations. Seal open seams and repair damaged areas before or during insulation.

Step 3: Take steps to maintain safe clearances between insulation and hot objects like flues and recessed light fixtures—especially when using polystyrene-bead insulation.

Roof-Cavity Insulation – Metal Roofs —

After you have adequately prepared, you are ready to gain access to roof cavities under metal roofs. Be sure to have your patching materials selected and on-site. Read the relevant parts of *"Repairing Roof Leaks" on page 126* before cutting holes and installing patches. Listed below are five options for getting access and blowing insulation:

Option 1: Cut 10-inch-square holes in the center of the metal roof on top of every other truss. This will allow access to roof cavities on both sides of the trusses. Centering the 10-inch-square hole on top of the truss produces two 4-by-10-inch rectangular holes that provide access into two adjacent truss spaces. These holes provide enough room for roof-cavity inspection and for moving the insulation fill-tube around, providing good coverage. Blow fiberglass insulation through a 2-or-$2^1/_2$ inch diameter flexible fill-tube into the cavity all the way out to the edges. To patch the holes use 14-by-14-inch square piece of 18-gauge galvanized steel, screwed to the galvanized roof and glued with roof cement. Cover that patch with an 18-by-18-inch square of foil-faced butyl rubber.

Figure 10-12 Blowing Insulation through the Roof's Edge

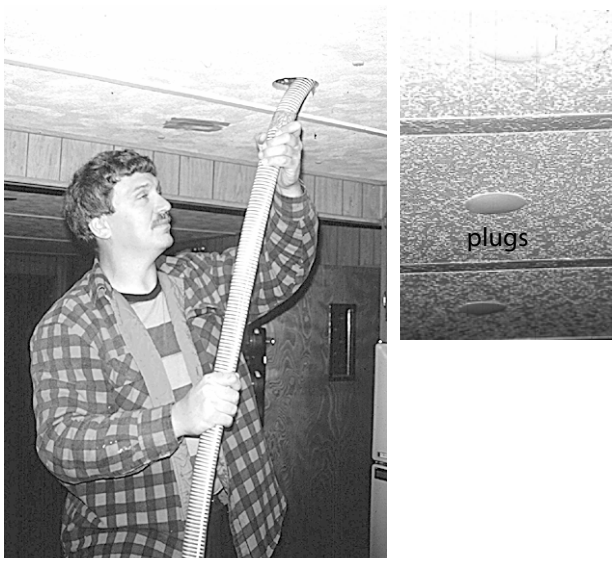
Technicians stand on scaffold to blow fiberglass insulation through the edge of the roof and into a metal roof's cavity.

Option 2: Remove the screws from the metal j-rail along the length of the roof edge on the leeward side of the home, if possible. Then remove the staples or nails that hold down the roof edge. Pull up the metal roof far enough to insert a 10-to-14-foot rigid fill-tube. Blow fiberglass insulation through the fill-tube into each truss space. Reseal the edge thoroughly using putty tape or exterior-grade caulking under the roof edge and j-rail. This method won't work if the roof has a strongback that prevents the tube from going all the way across the home. (*See page 122* for a photo.)

Option 3: Remove the siding on each end of the roof cavity. Insert a long, rigid fill tube into the cavity as close to one edge as possible. Fill the cavity from the edges toward the center. The longer the fill tube the more difficult to ensure an adequate fill. This method is best combined with one of the other options, especially Option 1. Filling from each end with a 16-foot fill tube would save cutting and patching about a dozen 10-by-10-inch holes.

Option 4: Drill one or more rows of $2^1/_2$-inch holes in the metal roof. Use these holes to blow insulation into the roof cavity through a $1^1/_2$-inch flexible fill tube. After insulating, patch the holes with $2^1/_2$-inch plastic plugs, cemented in place with pure silicon caulk. Then, cover plugs with a 6-inch square butyl-aluminum-foil patches.

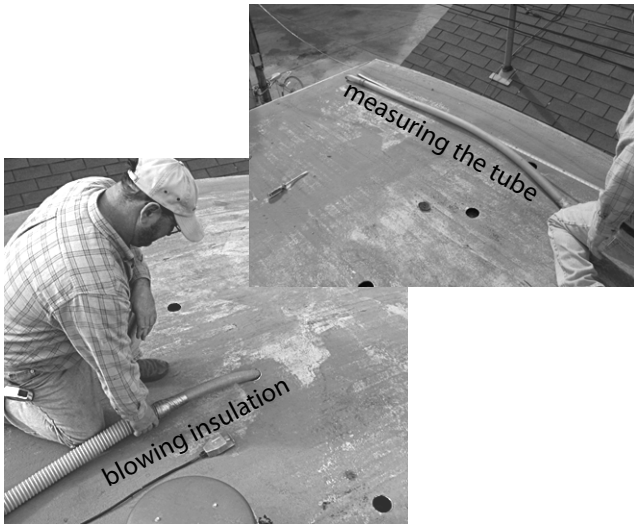
Figure 10-13 Blowing through the Ceiling Indoors



The technician is careful not to damage the ceiling board when inserting the tube and pulling it out.

Option 5: Drill one or more rows of $2^1/_2$-inch holes in the interior ceiling along the length of the home. Use a line or spacer block to drill the holes in straight rows. Next, blow in fiberglass or polystyrene beads through a flexible fill tube. Then, cement $2^1/_2$-inch white plastic plugs into the holes with construction adhesive or adhesive waterproof caulk. The plugs appears fairly natural against a white ceiling.

Figure 10-14 Blowing the Roof Cavity through Holes in the Metal Roof



Before blowing insulation, the technician first measures and marks the tube so he'll know when the tube is inserted all the way to the edge.

Figure 10-15 Insulating a Single-Wide from the End Wall

It's fairly easy to insulate the first 15-to-25 feet of roof cavity from the ends. Starting from the edges and working toward the center usually works well.

Roof-Cavity Insulation Shingle Roofs —

Shingle roofs usually have a steeper slope and more space inside the roof cavity than metal roofs. Shingle roofs are usually vented—these vents should not be obstructed. Leave at least 12-to-18 inches of vent space above the insulation at the peak of the roof. New roof vents may even be added to improve ventilation and provide better access for blowing insulation.

Figure 10-16 Insulating Shingled Double-wide Roof Cavities

Technicians can look into a double-wide home's roof cavity to monitor their progress. With a deeper cavity, it's easier to move the hose around and to insulate a large area from one hole exposed by removing a vent.

Use the two options below—separately or together—to insulate shingle roofs:

Option 1: On double- and single-wide homes, you can insulate large areas of the roof by blowing insulation through existing roof vents. The roof-vent holes are usually about 10-inch square and provide enough room to move the hose around, blowing in all directions through each hole. Areas of the cavity that may be unreachable from existing vents can be insulated through newly-installed vents.

Option 2: Remove vents in the gable end—the roof's triangular end wall; or, cut new vents in the gable end; or remove the siding from the gable end. Removing the siding from the entire gable end gives superior access to the roof cavity for insulation installation and inspection. Insert a long rigid fill-tube. Blow insulation very carefully, starting from the middle of the

roof cavity and filling toward the gable ends. Stop frequently to inspect the cavity using a flashlight. Notice where insulation has covered and where it hasn't.

Rooftop Insulation

Adding insulation to the top of a metal roof is a more common practice than blowing the cavity under the metal roof. However, rooftop insulation is more expensive than cavity insulation, and it isn't as effective as cavity-filling for homes in cold climates. Rooftop insulation is most economical for homes with high air conditioning costs and high heating costs that also need major roof repairs. Before adding rooftop insulation, fill the roof cavity with blown fiberglass to maximize energy savings. Rooftop insulation over a poorly insulated roof cavity will provide considerably less energy savings than roof-cavity insulation.

There are three common ways to add insulation to the top of a roof:

1. Installing 2 inches or more of rigid insulation, followed by a synthetic rubber cap over the insulation.
2. Installing 2 inches or more of rigid insulation, followed by a metal roof over the insulation.
3. Spraying 2 inches or more of polyurethane over the existing metal roof and coating it with a waterproof coating.

Figure 10-17 Rooftop Insulation

A crew installs beadboard insulation over a metal roof, fastening the insulation down with screws and large washers.

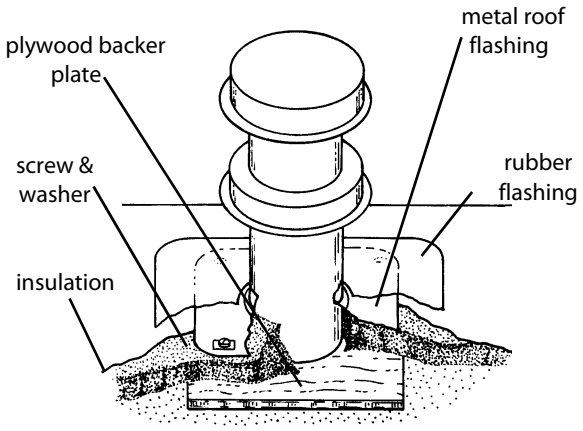
Insulated Rubber Roof Cap — An insulated synthetic rubber roof cap significantly reduces winter heat loss and summer heat gain through a roof. This roof cap covers the home with a membrane that will last at least 30 years, if installed correctly.

Follow the manufacturer's instructions carefully. If installed with excellent workmanship, the membrane could last 50 years. With poor workmanship, the membrane could leak in 10 years or less.

Figure 10-18 Covering the Insulation with Rubber Roofing

A technician drags the continuous sheet of rubber roofing across the roof.

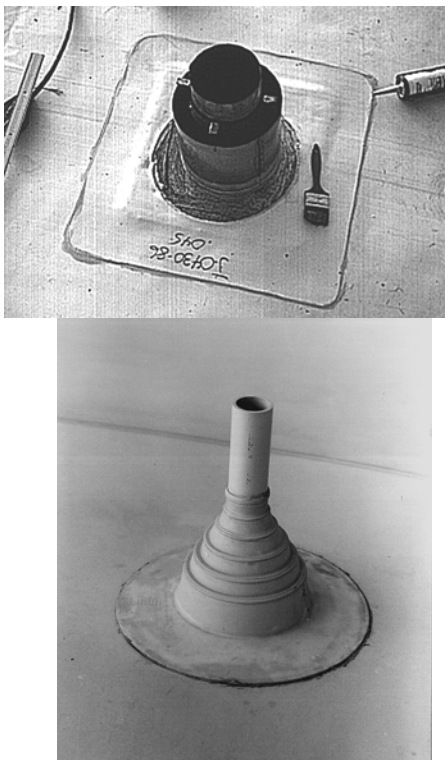
Figure 10-19 Flashing Detail for an Insulated Rubber Roof



The plywood plate, fastened to the old roof under the insulation and new roofing, gives solid backing for the screws that hold the metal flashing down.

Although black is the most common and least expensive type of rubber roofing, a bright white rubber is preferred. Black roofs get hot and the heat could shrink the insulation. Especially in warm climates, white rubber roofing is worth the extra cost.

Figure 10-20 Flashing Around Chimneys and Plumbing Vents



The lifespan of the roof depends on the careful installation of flashing around chimneys, pipes, and vents. The flashing on the top is manufactured; the one on the bottom is site-fabricated.

With insulated rubber roofing systems, insulation board—polyurethane foam or polystyrene foam—is installed directly over the existing roof and then covered by rubber roofing material. These are general instructions to let you know what's involved. Follow the specifications and instructions of the roofing manufacturer carefully when you actually install the roof. Following are general installation instructions.

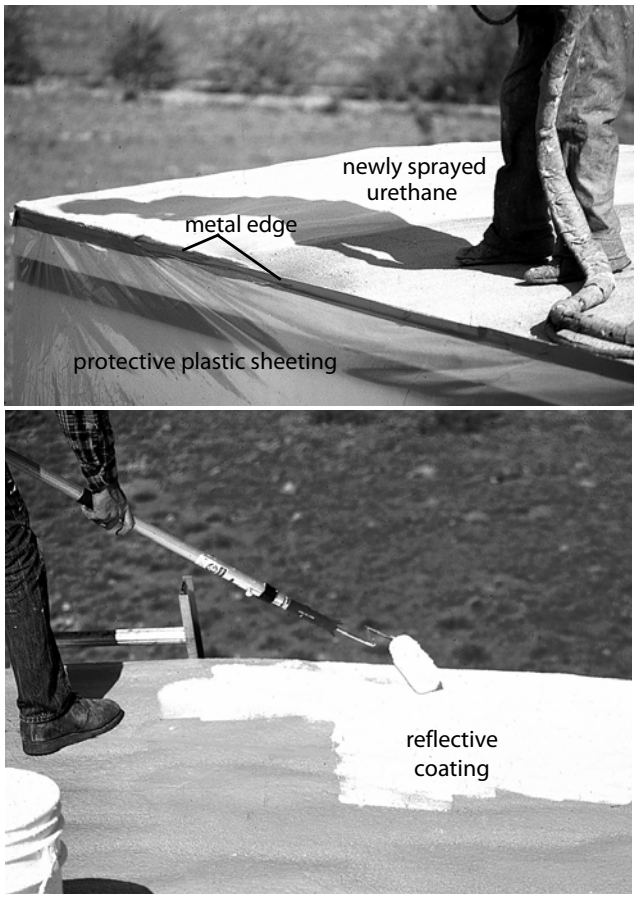
Step 1: Remove existing plumbing and heating vents protruding from the roof; also remove the vent flashings around these protrusions. Remove roof-mounted evaporative coolers and raise their mounting blocks above the level of the new roof. The new roof level equals the old roof level plus the thickness of the insulation and the rubber roofing. If there isn't any solid surface around the chimney underneath the existing metal roofing, fasten plywood squares to the existing roof surface around the chimney to provide a wood backer for fastening the chimney flashing through the new roofing and insulation.

Step 2: Fasten the insulation board to the roof trusses using screws long enough to penetrate into the truss $^{1}/_{2}$-to-1 inch. Use large washers, called fender washers or roof deck plates, to prevent the screws from pulling through the insulation. Cut the insulation to fit around all the vent holes. Leave at least 3 inches clearance around hot vents like wood stove flues. Stuff fiberglass around pipes and vents to insulate spaces left by mis-cuts or spaces intentionally left for fire safety clearance (heat shouldn't be a problem here—fiberglass is noncombustible and all legal chimneys are double- or triple-wall).

Step 3: Lift the leading edge of the membrane over the edge of the roof and drag it up onto the roof. This is a job for two-to-four people. Spread the membrane out so that at least 6-inch overhangs on all sides. Then locate all the vent holes and cut openings in the membrane for each vent.

Step 4: Extend plumbing, heating and exhaust vents at least 10 inches above the new roof level. Fabricate or buy new rubber flashing for around the vent pipes. New flashings can be purchased from a roofing-materials dealer or fabricated from rubber membrane on-site. Apply the membrane's special contact adhesive to the back of the flashing. It is important to apply this adhesive evenly and continuously. It is also important to keep the rubber membrane around penetrations clean during the flashing installation. After the contact-type adhesive dries, adhere the flashing, seal all seams and edges of the membrane and flashing on the roof with a special seam sealant. Remember that most roof leaks occur at seams and flashings: Careful adhesive application and seam sealing will determine how long the roof will keep water out.

Figure 10-21 Polyurethane Roof Cap



Sprayed polyurethane roofing needs a metal edge to maintain a constant thickness to the roof's edge. Plastic sheeting protects the home from overspray.

Step 5: Install the new termination bar just above or below the existing j-rail at the junction between the roof and wall. Begin at the center on both long sides of the roof and work towards the ends of the roof, driving sheet metal screws into the termination bar's pre-drilled holes. Straighten the membrane and work out any

wrinkles as you proceed. Do not fasten the termination rail the last 1-to-2 feet at the corners until you have folded the corners of the rubber roofing (see Step 6). Follow the same procedure for the ends of the roof. Begin in the center and work towards the corners. Again, do not fasten the termination rail the last 1-to-2 feet at the corners until you have folded the corners (see Step 6).

Step 6: Fold the membrane at each corner so that the crease faces downward. Fasten the last 1-to-2 feet of the termination rail. Then, trim off the excess membrane hanging below the new termination rail.

Sprayed Polyurethane Roof Cap — A polyurethane foam roof cap can be installed for about the same cost as an insulated rubber roof, or maybe a little less. The polyurethane foam roof cap is not quite as durable as a well-installed rubber roof cap but could last 40 or 50 years if recoated every 4-to-10 years.

As with insulated rubber roof cap, chimneys and vents should be extended. The polyurethane must be protected from contact with chimneys. You can wrap the chimney with fiberglass during spraying so the urethane doesn't spray and adhere to the chimney.

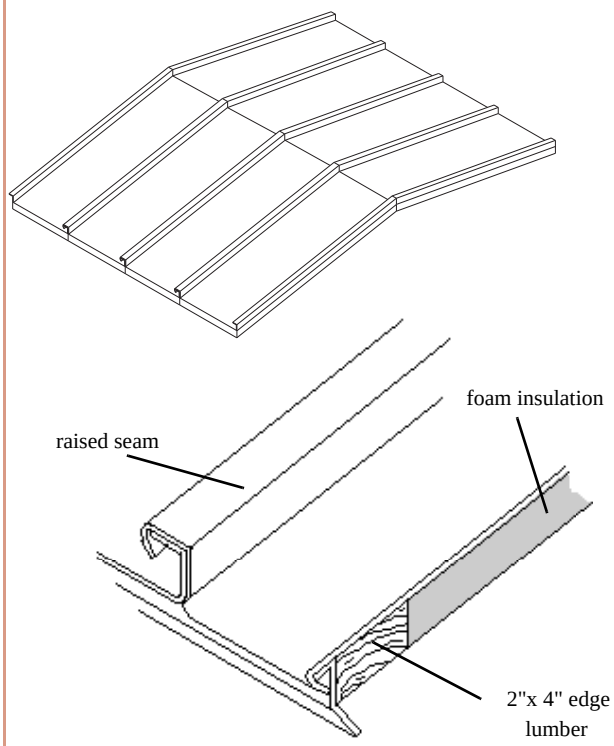
The contractor should install a metal edge around the perimeter of the roof to maintain the thickness of the insulation—usually 2-to-3 inches—all the way out to the edge of the roof.

Polyurethane insulation should not be installed on windy days or when the temperature is below 50°F. The contractor should use plastic or paper masking to prevent over-spray that could damage walls and other objects around the home.

The newly sprayed polyurethane insulation should have a smooth grainy surface like an orange peel and not look like the rougher surface of a popcorn ball.

The polyurethane should be coated with a reflective coating specially designed to protect polyurethane from sunlight and water. The coatings used with polyurethane are similar to latex roof coatings described in *"Repairing Roof Leaks" on page 126*.

Figure 10-22 Insulated Metal Roofs



Insulated metal replacement roofs are durable and offer the option of a small overhang, but they are expensive.

Metal Roof Caps — Combining rigid foam board insulation with a metal roofing system is attractive and very durable. These insulated metal roofs for mobile homes are generally the most expensive type of rooftop insulation.

Metal roof caps are available from roofing contractors and mobile home contractors. Installation requires specialized metalworking equipment.

One advantage to some metal roof systems is that the technicians can allow the new roof to overhang the exterior walls an inch or two on roofs currently lacking overhangs. Supported by metal roofing's strength, the foam insulation extends

out and is boxed in by metal. The overhang provides a little shading and drops rain water away from the wall.

Roof Insulation Safety

There are important safety considerations when insulating and repairing mobile home roofs.

For occupants, roof insulation and repair can be accompanied by two major fire dangers: 1. Recessed light fixtures; and 2. Flue pipes from furnaces, water heaters, and wood stoves. And, workers must be particularly aware of two major safety considerations: 1. Walk-boards and scaffolding; and 2. Respirators.

Fire Prevention

Mobile home flue pipes are usually double- or triple-wall pipe assemblies. The surface of the outer pipe is not likely to ever exceed 140°F—within the safe range for most building materials, fasteners, and sealants. However, to be completely safe, don't install combustible material within 2 inches of these flues. Use noncombustible materials, like fiberglass insulation, an additional metal pipe sleeve, and a metal collar at the ceiling to protect combustible materials from flue's warm surfaces.

You should never see a single-wall flue pipe going through the ceiling of a manufactured home. If someone has mistakenly installed one, corrective action should be taken immediately.

Keep all insulation at least 3 inches away for recessed light fixtures except for those fixtures specifically rated for contact with insulation (IC-rated). Since crawling around in the roof cavity is usually impossible, the best way to protect a recessed light fixtures and bathroom fans is to blow insulation around them from the roof, and then remove the fixture from inside and push the insulation back 3 inches.

Installing fiberglass insulation in a roof cavity rather than rooftop insulation generally makes the roof cavity safer from a fire safety perspective, because the noncombustible insulation surrounds combustibles like wood and inhibits a fire from spreading.

Working Safely on Roofs

Metal roofs may feel a little flimsy, but they're usually safe to walk on. If you doubt the structural soundness of a roof:

1. Walk near the edge where the roof is strongest; and
2. Use plywood or wooden planks near the center.

Extend ladders at least 3 feet above the roof for ease and safety getting on and off them. Or, secure them with rope so they don't slip when you're climbing.

Use scaffolding when insulating the roof cavity from the edge or end. The long fill-tube used for this operation is too clumsy to use safely from a ladder.

Remember: Blowing any type of insulation creates dust that irritates the lungs. Always wear a respirator when you are blowing insulation.