

# MICROWAVE ANTENNAS

## KS-21972 CONICAL ANTENNA

### REPAIR OF BULLET HOLES

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#### 1. GENERAL

**1.01** This section contains instructions for repairing bullet holes in the KS-21972 conical antenna parabolic reflector, side wall, or weather cover. A conical (fiberglass) antenna that has been damaged by piercing bullets may be repaired in place while the antenna remains operational. Materials for making repairs are furnished with the KS-21972, List 10 Repair Kit. The kit includes only those items that need to be replenished as part of the repairs and *not* the required tools and equipment, which should be provided locally. Special tools, such as the patch-retainer tool, must be fabricated locally.

**1.02** Whenever this section is reissued, the reason for reissue will be stated in this paragraph.

**1.03** The aluminum patches and retainers provided with the kit for repairing the antenna proper are limited to making repairs of holes whose finished elliptical size does not exceed 1-5/8 inches by 2-1/4 inches. Additional patches and retainers for these and larger sizes can be fabricated locally (Fig. 1). Metal patches should be limited to repairing holes whose finished elliptical size does not exceed 2-5/8 inches by 3-3/4 inches. When larger holes are encountered, contact the antenna manufacturer.

**1.04** The patches furnished for repairing the weather cover are limited to repairing ellipti-

cal holes whose finished size is 1 inch by 1-1/2 inches. Patches for larger holes can be fabricated from discarded weather covers (Fig. 1).

**1.05** Elliptical holes prepared in the side wall of an antenna should be made so that the long axis lies with the vertical axis of the antenna. Elliptical holes prepared in the parabolic reflecting surface should be made so that the long axis lies with the transmission path.

**1.06** The polyester and epoxy repair materials in the kit are heat-sensitive. They handle and cure best at temperatures of 60°F to 80°F. Use an artificial heat source to achieve this temperature range in cold weather.

**Note:** The shelf life of the silver conductive epoxy, resin, and gel coats can be extended beyond the normal 6 months by refrigerating at temperatures of 35°F to 40°F. Do not freeze. Storing at temperatures above 70°F will shorten shelf life.

**1.07** Dirt and dust on the surface of an area to be repaired will prevent a good bond. Remove any surface contaminants by brushing and then wiping with a solvent.

#### 2. SAFETY PRECAUTIONS

**2.01** Telephone company personnel should observe the following safety precautions when working on antennas and towers.

**Danger 1:** *Whenever work is being performed aloft, all persons on or near the tower should wear approved protective hats. Maintenance personnel working aloft should take every precaution to avoid dropping tools or materials, since these items could inflict serious injury on ground personnel.*

#### NOTICE

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**Danger 2:** When inspecting the antenna, do not stand in front of the weather cover if the system is operating because of the danger of hazardous radiation.

**Danger 3:** Do not allow MEK peroxide to come in contact with the eyes and skin. For protection, wear safety goggles and surgical-type rubber gloves when working with MEK peroxide.

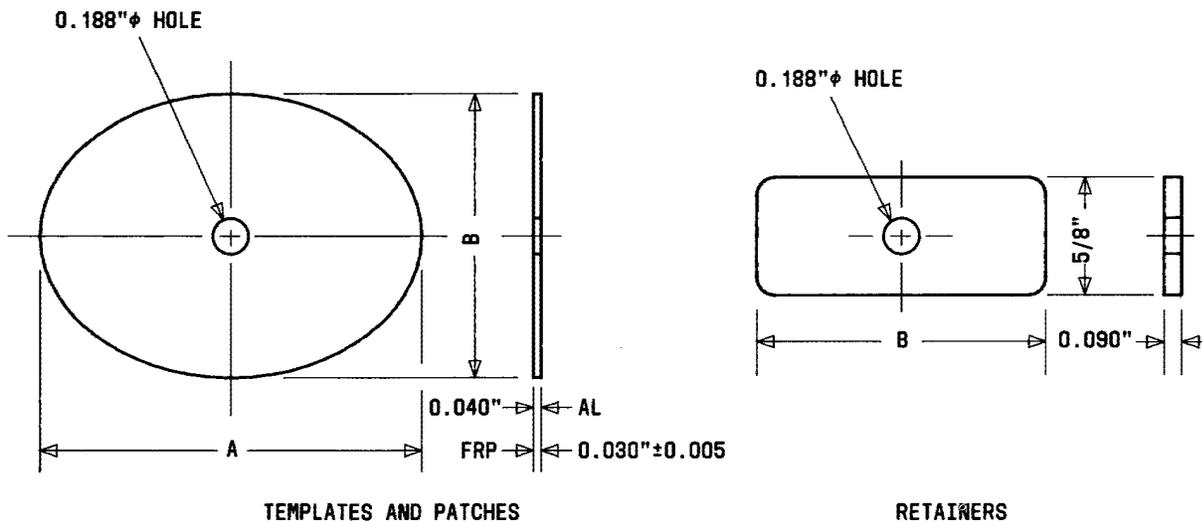
**Danger 4:** While making repairs, wear safety goggles, gloves, and a dust respirator for protection when cutting, grinding, sanding, or filing fiberglass.

**Danger 5:** Do not attempt any repairs during inclement weather or if towers are wet or ice-coated.

**Danger 6:** Acetone and xylene, the solvents used for surface preparation, are flammable. Read the instructions on the container, and follow recommended practices in the handling and use of these solvents.

**3. ANTENNA REPAIR PROCEDURES**

**3.01** Chart 1 describes the procedures for repairing bullet holes in the KS-21972 conical antenna.



**DIMENSIONS**

SIZE	TEMPLATE		PATCH		RETAINER
	A	B	A	B	B
0 (NOTE 1)	-	-	1-1/2	1	-
1	1-1/2	1	2	1-1/2	1-1/2
2	1-3/4	1-1/4	2-1/2	1-3/4	1-3/4
3	2-1/4	1-5/8	3	2-1/4	2-1/4
4	2-3/4	2	3-1/2	2-3/4	2-3/4
5	3-1/4	2-1/4	4-1/4	3-1/4	3-1/4
6	3-3/4	2-5/8	4-7/8	3-5/8	3-5/8

**LEGEND**

AL = ALUMINUM, 6061-T6  
FRP = FIBERGLASS - REINFORCED PLASTIC;  
SEE NOTE 2

**NOTES:**

- PATCH NO. 0 IS A FILL PATCH FOR USE IN REPAIRING THE WEATHER COVER
- PATCHES FOR REPAIRING THE WEATHER COVER CAN BE MADE FROM DAMAGED WEATHER COVERS

**Fig. 1—Dimensions of Patches and Retainers for Repairing Holes in Antenna**

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**CHART 1**  
**REPAIR INSTRUCTIONS FOR HOLES IN PARABOLIC  
REFLECTOR, ANTENNA SIDE WALL, OR  
WEATHER COVER**

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The following tools and equipment should be provided locally.

**APPARATUS:**

- 1 — Thermometer (to read ambient temperatures in °F)
- 1 — File, Round, 10-inch bastard, with No. 6 handle
- 1 — File, Round, 8-inch bastard, with No. 4 handle
- 1 — Saw, Mini Hack, Stanley No. 15-210 or equivalent
- \* — Blades, Hacksaw, 10-inch with 18 teeth per inch
- 1 — Goggles, Safety
- 1 — Artificial Heat Source, eg, heat lamp or heat gun
- 1 — Cord, Extension, 3-conductor with ground (length as required)
- \* — Rags, clean, absorbent
- 1 — Pliers, Long-Nose
- 1 — Pliers, Gas
- 1 — Wrench, Open-End, 11/32-inch
- 1 — Tool, Patch-Retainer (Fig. 2)
- \* — Solvent (Acetone or Xylene; see Danger 6)
- 1 — Knife, Pocket

\* Quantity as required.

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CHART 1 (Contd)

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**APPARATUS (Contd)**

1 —Board, Mixing (6-inch square Formica-backed)†

1 —Scissors

1 —Block, Sanding

\* —Sandpaper, 80-grit and 180-grit‡

\* —Marker, Black

\* Quantity as required.

† May be cut from a sink cutout.

‡ A portable or rechargeable electric drill with a disc pad and sanding discs, if available, will greatly facilitate sanding operations.

The following materials are contained in the KS-21972, List 10 Repair Kit.

**APPARATUS:**

4 —Patches, Elliptical, 1-1/2 inches by 2 inches (size 1; for size reference, see Fig. 1)

4 —Patches, Elliptical, 1-3/4 inches by 2-1/2 inches (size 2)

4 —Patches, Elliptical, 2-1/4 inches by 3 inches (size 3)

4 —Retainers, Patch, 5/8-inch by 1-1/2 inches (size 1)

4 —Retainers, Patch, 5/8-inch by 1-3/4 inches (size 2)

4 —Retainers, Patch, 5/8-inch by 2-1/4 inches (size 3)

12 —Screws, RHM, No. 8-32 by 7/8-inch, 300 series CRES

12 —Nuts, Hex, No. 8-32, 300 series CRES

1 set—Templates, Hole Pattern, Cardboard

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**CHART 1 (Contd)**

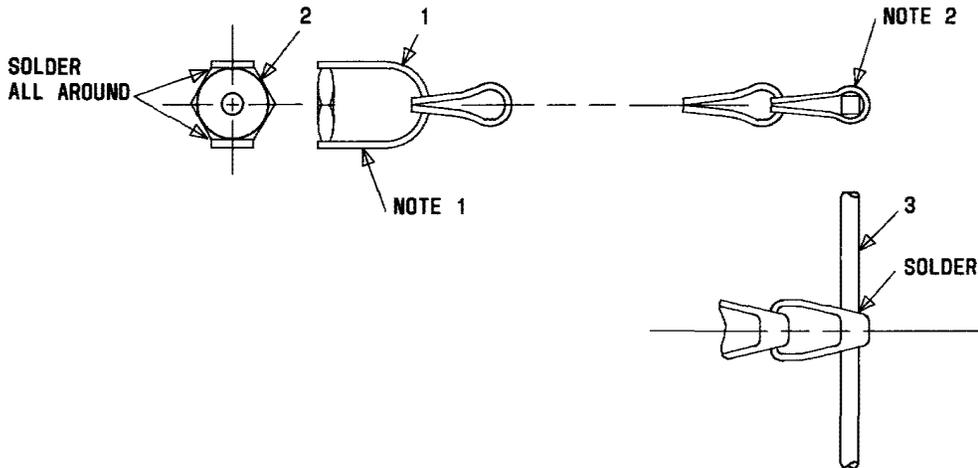
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**APPARATUS (Contd)**

- 2 tubes—Epoxy, Conductive, Silver
  - 6 —Swabs, Cotton-Tipped
  - 1/2 pint—Putty, Polyester
  - 1 piece—Cloth, Glass Fabric, 4-foot square, style 1800 or 7500 with a 550 finish
  - 1 pint—Resin, Polyester, promoted, UV stable and thickened with a thixotropic agent
  - 30 cc—Catalyst, Methyl Ethyl Ketone (MEK) Peroxide (see Danger 3)
  - 1 —Eyedropper, 1.00-cc capacity graduated in levels of 0.25 cc
  - 4 —Cups, Paper, 8-ounce, unwaxed
  - 1 —Respirator, Dust
  - 4 —Brushes, Paint, 1-inch, nylon
  - 4 —Sticks, Stir
  - 1 —Squeegee, Plastic, 3-inch
  - 1 pair—Gloves, Surgical
  - 1 pint—Gel Coat, Aviation White
  - 1 pint—Gel Coat, International Orange
  - 1 can—Foam, Aerosol, 400-gram
  - 4 —Window Patch Kits
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CHART 1 (Contd)

STEP	PROCEDURE
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ITEM	DESCRIPTION
1	SASH CHAIN, BRASS, NO. 40 BY 12 LINKS (APPROXIMATELY 6 7/8" LONG)
2	NUT, BRASS, NO. 8-32
3	ROD, BRASS, 1/8" X 1/8" X 0-5" LONG

- NOTES:
1. SPREAD FIRST LINK OF CHAIN SUFFICIENTLY TO SPAN FLATS OF NO. 8-32 NUT. KEEP SIDES OF LINK PARALLEL SO THAT THEY WILL LIE FLAT AGAINST THE NUT
  2. CENTER ROD IN LAST LINK OF CHAIN AND THEN CRIMP LINK PRIOR TO SOLDERING

Fig. 2—Patch-Retainer Tool

**A. General (for holes in other than weather cover)**

- 1 Using 80-grit sandpaper, sand a 4-inch area around the enlarged hole. The area should be thoroughly roughened to provide a good bonding surface for the subsequent patching and gel coat operations.
- 2 Inversely assemble and thoroughly secure the two round files in their respective handles. When assembled, the tang end should be the free end and *not* the end in the handle.

## CHART 1 (Contd)

STEP	PROCEDURE
<b>B. Hole in Parabolic Reflector</b>	
3	Insert the smaller of the two files, tang first, into the hole in the outer surface. Gently ease the file in so that it traces the path left by the bullet. The file tang should exit on the inner surface of the antenna which lies at a depth of about 4 inches. Using the tilt angle of the file in combination with the 4-inch thickness, reference-mark the outer surface with the approximate location of the hole in the underlying surface. (See Fig. 3.) Mark off an elliptical or diamond-shaped area of approximately 3 inches by 4-1/2 inches centered around this reference mark.
4	Using the file as a starter, enlarge the exit hole in the outer surface enough to insert the hacksaw blade. File towards the reference mark.
5	Using the hacksaw, cut away the outer skin in the marked-off area. The cutaway area should be large enough to insert one's hand, about 3 inches by 4-1/2 inches.
6	Cut away the inner foam core using the hacksaw blade, a pocketknife, or other suitable tool.
7	Complete the procedures in Steps 10 through 28 and then continue with Step 8.
8	Using the aerosol foam, fill the dug-out cavity to above the outer skin. When the foam hardens, cut it flush with the outer surface.
9	Complete the procedures in Steps 29 through 36.
<b>C. Hole in Antenna Side Wall</b>	
10	Examine the hole to determine the extent of damage and the size of the patch required. Keep in mind that the damage must be cut back to sound material. Although not visible, the inner surface of entry holes will generally show greater evidence of damage. The reverse is true for exit holes. This is because the impacting bullet shreds the glass fibers and causes a crazing of the surrounding resin as it passes through the wall. This damage, however, is usually limited to an area not exceeding 1 inch in diameter.
11	Center one of the elliptical templates over the hole, and mark off the area which is to be cut out. Place the template so that the long axis lies either in the vertical plane for holes in the antenna side wall, or front-to-back for holes in the reflector. Trace the outline of the template with a black marker. Also, mark the antenna to denote the long axis of the template. These latter marks are required for subsequent patch orientation.

## CHART 1 (Contd)

STEP

PROCEDURE

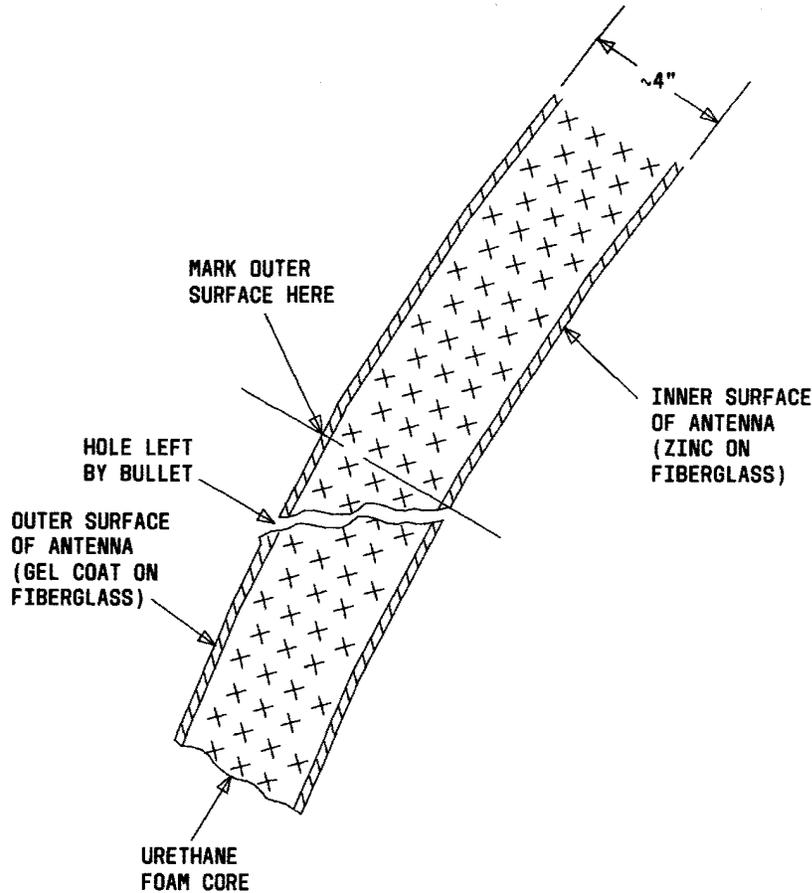


Fig. 3—Hole in Parabolic Reflector Surface

- 12 Insert one of the files, tang first, and file away the area within the confines designated by the template. File only on the draw stroke. The filing debris should be pulled away from the antenna. Keep the antenna pressurization equipment turned on while filing. Temporarily plug any unrepaired holes so that the pressurized air will be forced out the hole under repair, thereby helping to keep filing debris from falling into the antenna.

## CHART 1 (Contd)

STEP	PROCEDURE
13	If there is still an exit or entry hole to be repaired, the antenna pressurization equipment may remain on; however, remove any temporary plugs before continuing further. If there are no further holes, turn off the pressurization equipment.
14	Install a screw through a patch and retainer. The number on the patch and retainer should correspond with the number on the template used to outline the size of the cut hole. See also the cross-referenced dimensions given by the table in Fig. 1. The length of the retainer should correspond to the width of the patch. The mark on the patch designating its long axis should face the retainer. Install the nut about 1/4 inch onto the screw. Attach this assembly to the patch-retainer tool. Lock the tool in place by jamming the nut of the tool fingertight against the nut of the assembly. (See Fig. 4.)
15	Using a rubber-gloved finger, carefully probe the interior zinc surface surrounding the hole. If there is evidence of a defect, make a mark on the outer surface corresponding to the location of the underlying defect.
16	If microwave absorber backs either the entry or exit hole, pry away the absorber from the edge of the hole so that the metal patch can be seated against the interior zinc surface rather than against the absorber.
17	Remove the seal on a tube of silver conductive epoxy, and thoroughly knead the two components together. Massaging the tube against the antenna with the removed seal facilitates mixing.
<b>Note:</b> When performing Steps 18 through 21, wear surgical-type rubber gloves to apply the conductive epoxy.	
18	Cut one corner off the tube to give a hole about the size of a pencil lead.

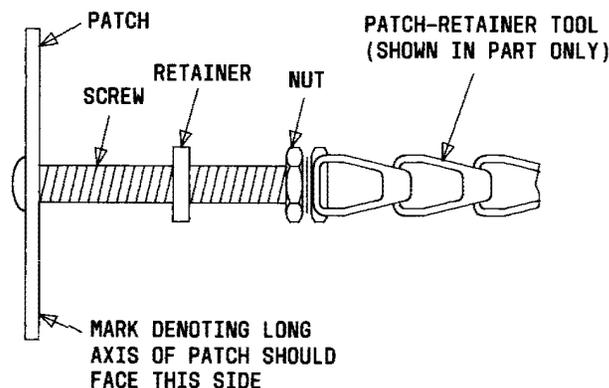


Fig. 4—Illustration of Patch-Retainer Tool Use

## CHART 1 (Contd)

STEP	PROCEDURE
19	Squeeze a small amount of epoxy onto a rubber-gloved finger. Apply epoxy to each of the damaged areas inside the antenna as correspondingly noted by the reference marks on the outside surface.
20	Apply epoxy to the inside perimeter of the hole which appears to be damaged.
21	Apply epoxy under the head of the screw and around the edge of the patch that will subsequently bear against the inner wall of the antenna (Fig. 5).
22	Remember that if there are no further holes to be repaired, the antenna pressurization equipment must <b>not</b> be operating at this time.
23	Insert the patch and retainer into the hole. Keeping a firm grip on the patch-retainer chain, orient the patch so that the mark denoting its long axis aligns with the marks denoting the major axis of the hole. Using long-nose pliers, extract the retainer and rotate it 90 degrees so that it bridges the short axis of the hole. With the 11/32-inch open-end wrench, rotate the keeper nut until it seats fingertight against the retainer. (See Fig. 6.)
24	Remove the patch-retainer chain. The patch assembly should now stay in place by itself.

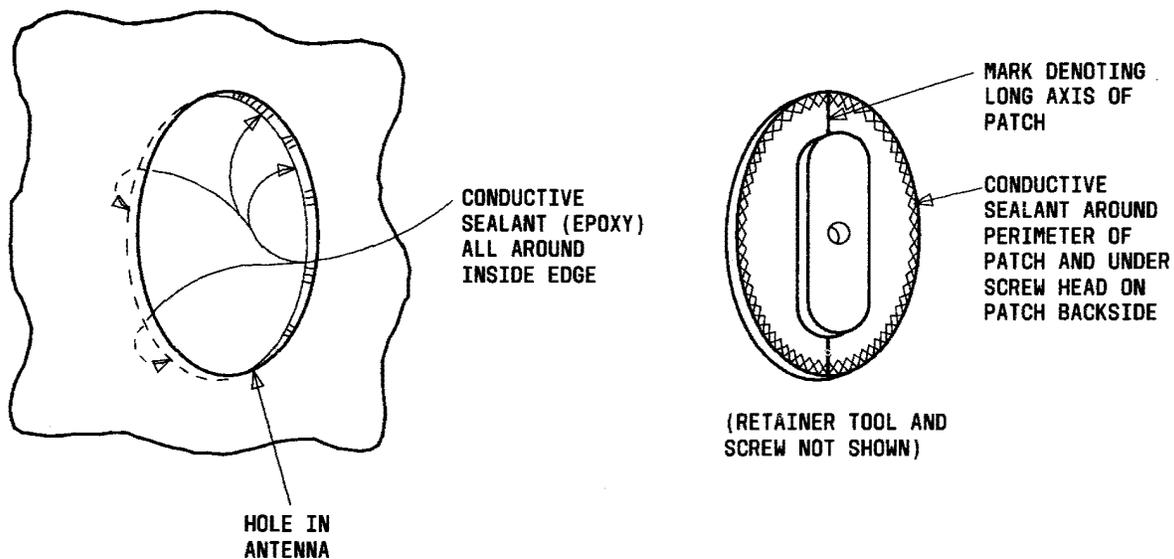


Fig. 5—Epoxy Application

CHART 1 (Contd)

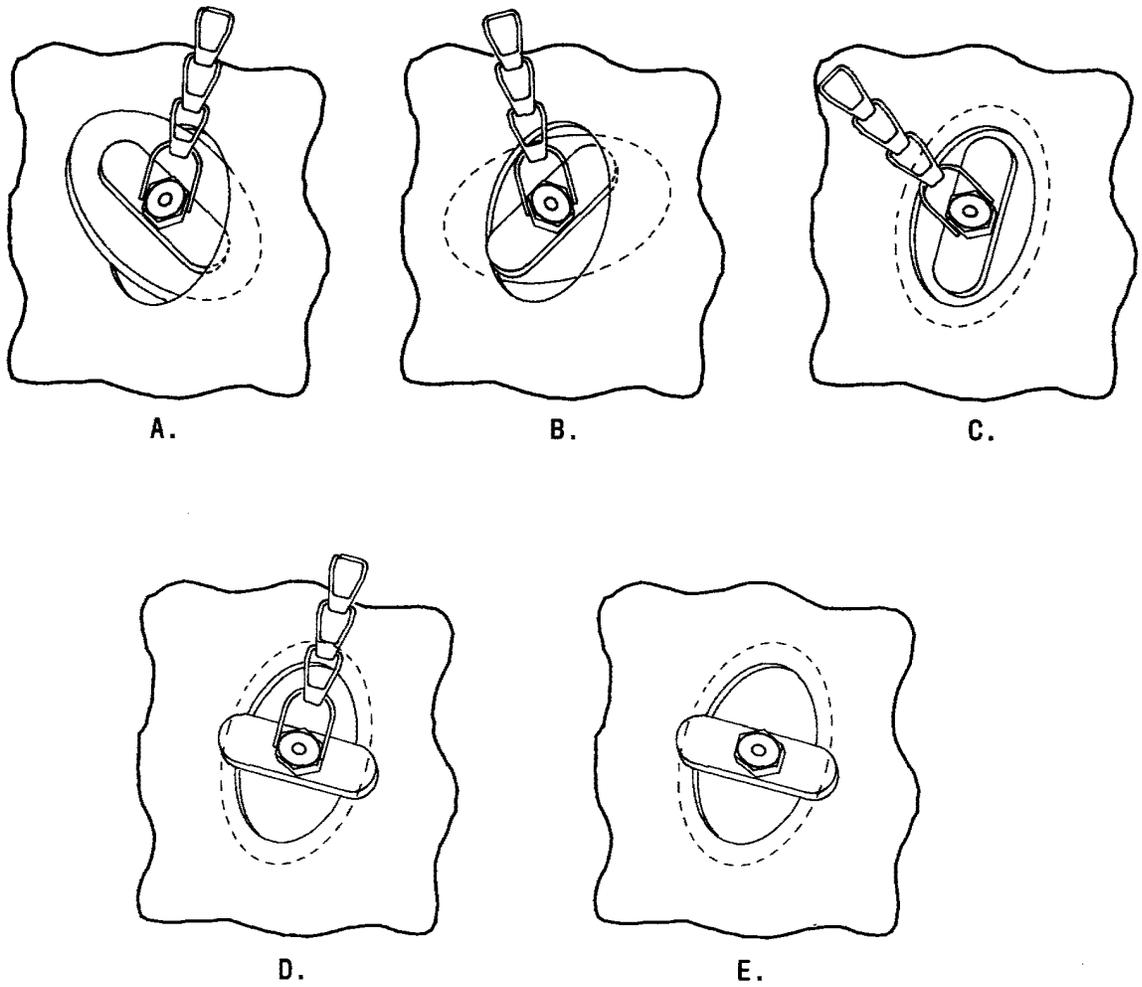


Fig. 6—Sequential Views of Patch Installation

## CHART 1 (Contd)

STEP	PROCEDURE
25	Inspect the patch to make sure it is properly oriented and centered. The retainer should bridge the hole evenly.
26	Tighten the keeper nut from one to one-and-one-half additional turns. <b><i>Do not overtighten!</i></b> Overtightening will distort the patch which could result in an inferior RF and/or mechanical seal. Using a hacksaw blade, cut off the protruding portion of the screw as close as possible to the nut. Do not use pliers or cutters. Keep the patch and retainer from shifting during the cutting operation by holding the keeper nut with pliers.
27	Apply the remainder of the silver conductive epoxy to a cotton-tipped swab. Using the swab, force the epoxy into the confines and recesses where the patch makes contact with the bottom edge of the hole. Epoxy can also be applied around the hole where the base of the screw exits through the patch.  <b><i>Danger: When performing Step 28, do not allow MEK peroxide to come in contact with the eyes and skin. For protection, wear safety goggles and rubber gloves when working with MEK peroxide.</i></b>
28	Place a golf-ball size amount (about 1 liquid ounce) of polyester putty onto the Formica-backed mixing board. Add MEK peroxide as a catalyst using the calibrated eyedropper to dispense the amount required. (See Fig. 7 and Table A.) Thoroughly mix the catalyst and putty. Using the stir stick, apply this mixture and work it into the cavity under the retainer and around the keeper nut and protruding screw shank. Completely cover the screw and retainer, and use the plastic squeegee to make a smooth finish. If this repair will be covered with fiberglass, shrink the filler by applying artificial heat and then scuff-sand the filler to provide a good bonding surface for the next operation. If not, return to Step 8.
29	Cut four sections of glass-fabric cloth, making each approximately 3 inches larger all around than the repair.
30	Pour about 4 ounces of polyester resin into an unwaxed paper cup. Catalyze the resin by adding a small amount of MEK peroxide, using the calibrated eyedropper. The amount of catalyst required will be influenced by the ambient temperature. (See the graph in Fig. 7 and Table A.) Use a stir stick to thoroughly mix this solution.
31	Brush some of the resin solution over the patched hole and surrounding sanded area. Apply a layer of glass cloth, using the brush to smooth the cloth down and remove air bubbles. Apply more resin, if necessary, and another layer of glass cloth. Do not be overgenerous with the resin. It is important, however, that the glass cloth be completely saturated. Dabbing (bristles perpendicular to surface) with the brush will ensure saturation. Continue with this process until four

CHART 1 (Contd)

STEP

PROCEDURE

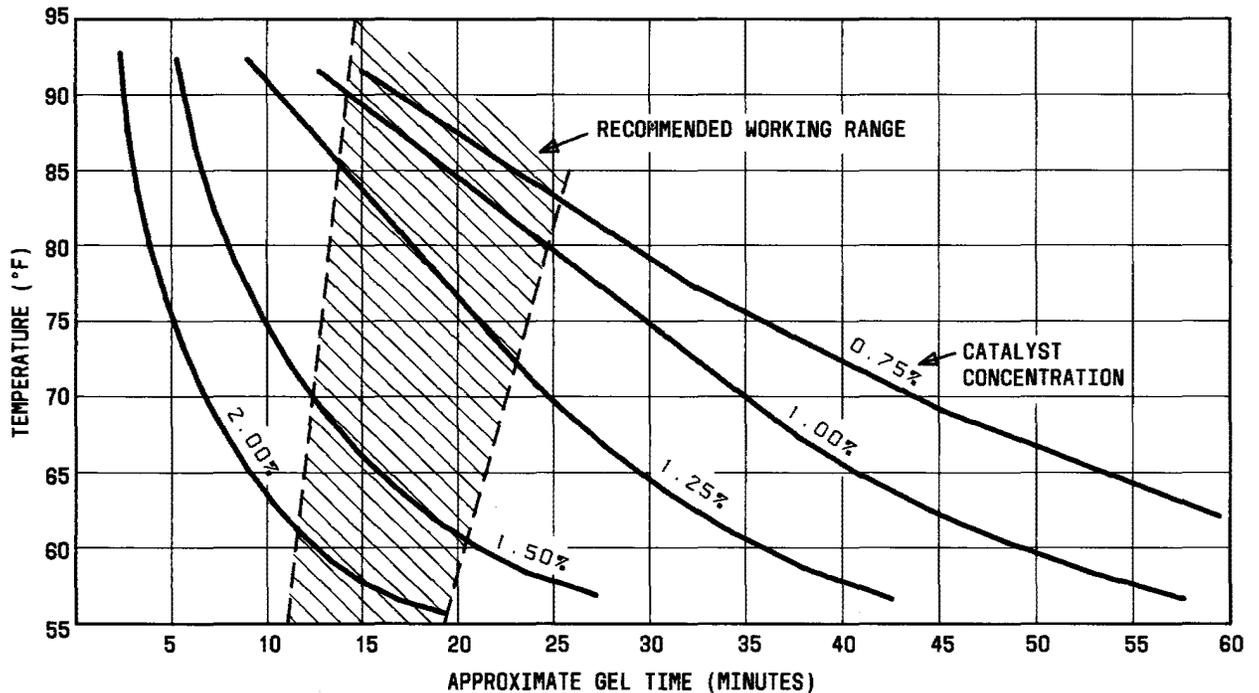


Fig. 7—Gel Time vs Temperature for Various Catalyst Concentrations

layers of glass cloth have been applied. Each layer of glass cloth should be rotated approximately 20 to 25 degrees from the underlying layer to avoid a thick buildup at the edges. Use the resin sparingly. The greater the glass-to-resin ratio, the stronger will be the repair. Remove entrapped air by brushing and dabbing each layer as it is applied.

- 32 The amount of time required for the resin to harden enough for repressurization of the antenna depends on the ambient temperature. The graph given in Fig. 7 relates resin gel time to ambient temperature for various catalyst concentrations. If the temperature is below 60°F, apply artificial heat to the repair to accelerate gelation of the resin.
- 33 If the temperature is warm enough, the exterior surface of the patched area should be hard enough for sanding after 30 minutes. Sand the entire area to roughen it and provide a good bonding surface.
- 34 Pour about 4 ounces of the proper color gel coat into a paper cup, and depending on the ambient temperature, catalyze with the proper amount of MEK peroxide (Table A). Stir this solution to a homogeneous mixture.

CHART 1 (Contd)

STEP	PROCEDURE
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TABLE A

RESIN VOLUME IN OUNCES	PERCENT CATALYST				
	0.75	1.00	1.25	1.50	2.00
	CC OF MEK PEROXIDE				
4	0.90	1.20	1.50	1.80	2.40
2	0.45	0.60	0.75	0.90	1.20

- 35 Using a paint brush, apply the catalyzed gel coat to the patched area.
- 36 Since ambient temperature affects cure rate, the time to full cure and antenna repressurization will vary. If the preceding repair procedures have been followed and the ambient temperature is adequate, or if an artificial heat source is used, the antenna can be repressurized after 4 hours.
- D. Hole in Weather Cover**
- 37 Use the loose filler patch from the window patch kit as a template to mark off an ellipse around the bullet hole in the weather cover.
- 38 Using the 8-inch round bastard file, file out the marked-off area. File only on the draw stroke. Keeping the antenna pressurization equipment turned on while filing will help prevent debris from falling back into the antenna. Temporarily plug any unrepaired entry or exit holes so that the pressurized air will be forced out the hole being repaired.
- 39 Attach the patch-retainer tool to the patch assembly. Insert the patch assembly into the hole, and draw the assembly up against the weather cover to check the prepared hole for size. The filler patch should seat properly within the hole. Remove the patch assembly and make any necessary adjustments in the hole size.
- 40 Scrape off the Tedlar covering in a 1/2-inch area surrounding the hole. Dust and clean both the inside and outside area with a solvent-dampened rag.

## CHART 1 (Contd)

STEP	PROCEDURE
41	If there is still an exit or entry hole to be repaired, the antenna pressurization equipment may remain on; however, remove any temporary plugs before continuing further. If there are no further holes, turn off the pressurization equipment.
42	Mix the epoxy resin from one Double/Bubble* package.
43	Apply epoxy resin over the entire protruding screw side of the patch assembly.
44	Insert the patch assembly into the hole and properly seat it. Remove the patch-retainer tool. The cohesion of the epoxy should keep the patch assembly in place.
45	Apply epoxy to one side of the cover patch and, if required, to both sides of the loose filler patch which was initially used for the hole template. The loose filler patch should be required only if the hole is within 6 inches of the weather cover edge.
46	Install the loose filler patch, if required, followed by the cover patch and nylon nut. If the nut turns tightly, hold the screw with pliers to prevent the patch from shifting.
47	Reattach the patch-retainer tool. Hold the patch assembly snugly against the weather cover, and using the 11/32-inch open-end wrench, tighten the nylon nut of the patch assembly. Keep the cover patch properly aligned.
48	Remove the patch-retainer tool and cut off the excess portion of the nylon screw. Use a hacksaw blade rather than pliers or wire cutters.
49	When the epoxy has gelled, coat the repaired area with white gel coat following the procedure discussed in Steps 34 and 35.
50	Since ambient temperature affects cure rate, the time to full cure and antenna repressurization will vary. If the preceding repair procedures have been followed and the ambient temperature is adequate, or if an artificial heat source is used, the antenna can be repressurized after 4 hours.

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