

**NATIONAL RADIO ASTRONOMY OBSERVATORY**  
**Socorro, New Mexico**

VLBA Antenna Memo Series 17

**VLBA Panel Repair**

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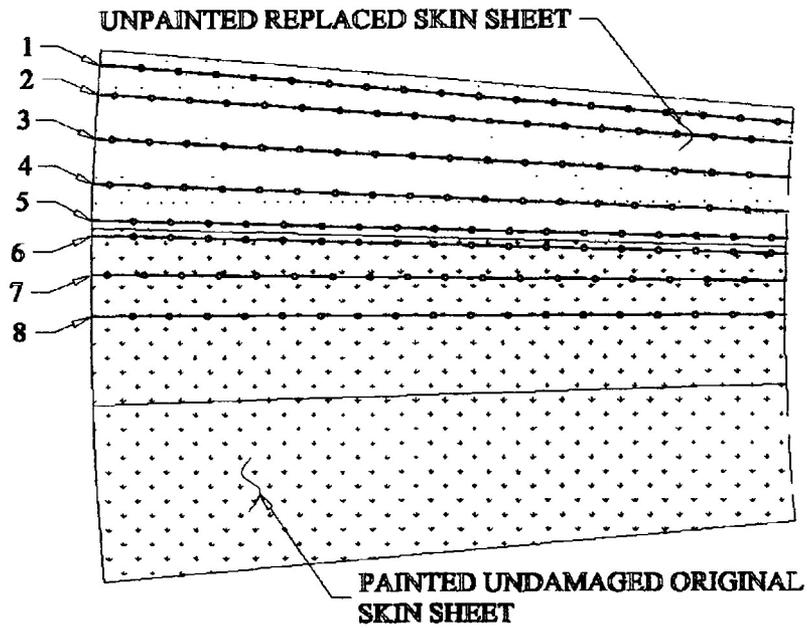
**ATTACHMENTS:** PANEL REPAIR PROCEDURE

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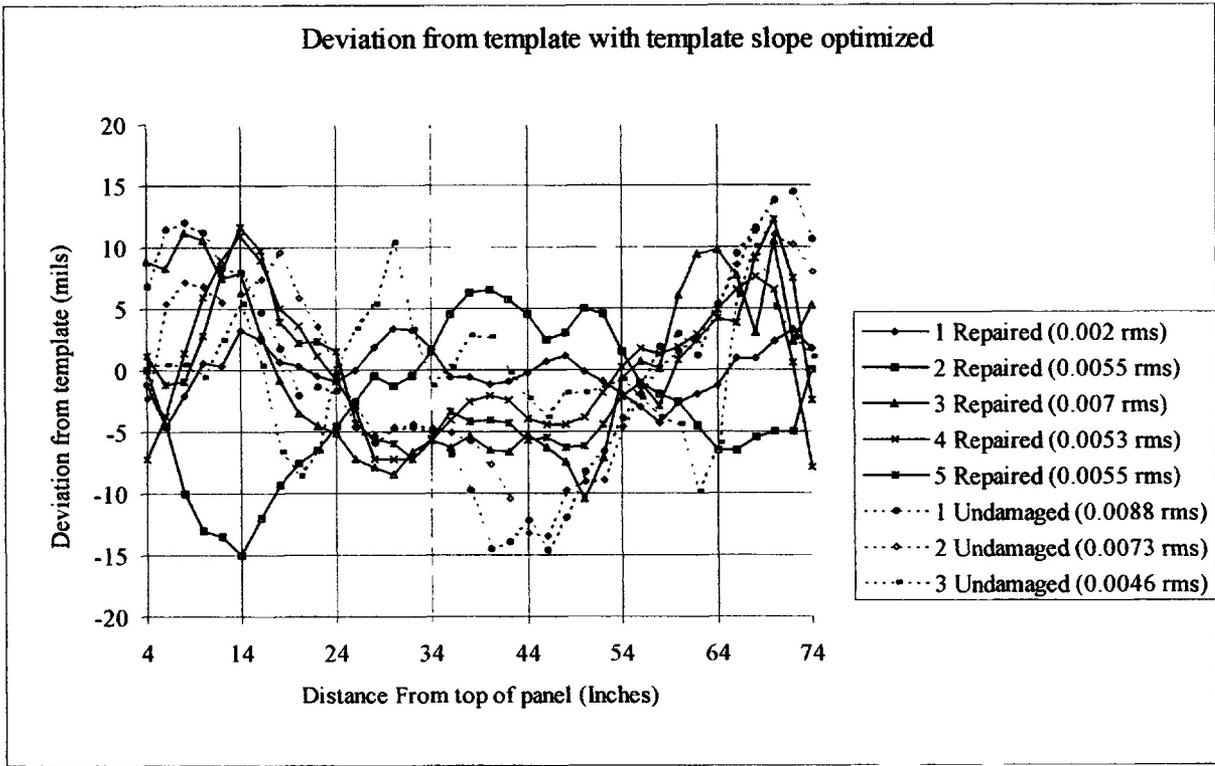
Several primary reflector panels were recently damaged during an ice storm at the Mauna Kea VLBA antenna. This is the second time we have seen damage from falling ice at this antenna. The first time the ice storm was much worse and several panels had to be replaced with panels ordered as spares during VLBA construction. The cost of replacing the panels is between \$2500 and \$4000 each (depending on tier). An attempt to restore the panels by pounding out the dents at Hicks Body Shop in Socorro reportedly proved to be cost prohibitive due to our stringent surface tolerance requirements.

Recently we decided to remove the damaged surface skin and rivet a new aluminum sheet in place using aircraft industry tools and repair techniques. As a test, a few surplus aircraft skin tools were procured and a surface skin was replaced using the attached procedure. A contour template was made so that the repaired surface could be checked. Using this template the skin could be measured only along a radial chord. An actual 3-Space RMS surface measurement was not performed (photogrammetry would work well for this measurement. See VLA Test Memo #220). The replaced skin sheet was measured along the chords numbered 1-5 in Figure 1. The chords numbered 6-8 measured the surface of the painted undamaged portion of the panel as a comparison. The chords 1, 3, 6 and 8 were located over panel stiffeners. Chord 5 was located over a 1/16" sheet that was riveted to the panel stiffener under chord 6. The average RMS deviation from the specified chord was 0.005" (125 $\mu$ m) for the unpainted replaced surface skin. The average RMS deviation for the painted undamaged portion of the panel was 0.007" (175 $\mu$ m). The results from each individual measurement are shown in Figure 2. The cost of repair, excluding a one time tooling cost was approximately \$100 for material and two man-days of labor (excluding painting).

This technique has proven to be an adequate method for the repair of surface skins. With proper tools and practice, it should be possible to become quite proficient at these repairs. However, we have still not addressed the problem of preventing ice damage in the first place. Grating panels were installed on the quad legs to prevent the ice from falling off until it had melted sufficiently to prevent damage. This has proved effective for the smaller ice storms, but during major storms that occur about every three years we are still experiencing damage. We are currently trying to decide if it would be cost effective to install a de-icing system. One possible de-icing system uses thin metal bladders mounted along the quad legs. Low-pressure compressed air is then intermittently flowed into these bladders during an ice storm. The bladders then expand breaking the ice off in small sheets.



**Figure 1. Location of panel surface measurements. The surface was measured at 2" intervals along each chord (36 measurements/chord).**



**Figure 2, Results of individual chord measurements.** The data clearly shows that the unpainted repaired surface is more accurate than the painted original surface. With consistent paint thickness this panel will be as good as original.

## Panel Repair procedure.

1. Inspect panel and evaluate need for repair. Panels with surface imperfections less than 30 in<sup>2</sup> should probably not be repaired. Spare parts should be salvaged from badly damaged panels.
2. If Z-section is bent, straiten or replace with salvaged section from cannibalized panel. Replace the Z-section before removing the surface skin, so that proper alignment can be maintained.
3. Repair panels with damaged surface skins by replacing the aluminum face sheet. This is accomplished by drilling the rivets, removing the surface skin and replacing with new aluminum sheet per steps below.
  - a) Drill rivets heads with #24 drill (be careful not to drill into Z-Brace). Punch out rivets with 1/8" punch. Remove damaged aluminum sheet.
  - b) Cut new panel sheet to approximate dimensions. Clamp in position on Z-sections. Back drill through old rivet holes with #21 drill. Insert Cleco clamps in holes to ensure that rivet holes will line up after bending.
  - c) Remove Clecos, de-bur and countersink holes in aluminum sheet. Use microstop tool for both deburing and countersinking.
  - d) Clamp aluminum sheet in place on panel with Clecos installed in every other hole..
  - e) Install flat head rivets in non "Cleco-ed" holes.. This requires a rivet gun and a bucking bar. Use rivets that are 1½ rivet diameters longer than the required grip length. If the 5/32" hole in the Z is severely wallowed use a 3/16" diameter rivet.
  - f) Remove Clecos and rivet remaining holes
  - g) Cut Aluminum sheet to required profile using trim router set up so that the follower bearing follows the Z-sections.
  - h) Inspect rivet heads and shave if necessary.
  - i) Paint.

The following material is required to repair a skin panel:

4'X8' X 0.063" Thick 6061-T6 aluminum sheet (will repair 2 skin sheets). Cost \$93.

100 MS20426AD5-6 aluminum rivets. Cost \$3/100

100 MS20426AD5-7 aluminum rivets. Cost \$3/100

**Total cost material = \$99/panel**

**Time required = 16 man hours.** This may improve significantly with practice and tools listed below.

The following table lists the tools that we will need to procure to repair panels efficiently:

Tools Needed	Quantity needed	Cost
#21 push button Clecos	80	\$28
Cleco pliers	2	\$8
3 Microstop tools	3	\$60
Microstop bits: Rivet Shaver	2	\$20
#21 Countersink	4	\$16
#10 Countersink	2	\$8
3/8" chuck, 3500 rpm drill, Taylor	1	\$55
12" drill bit set, 40,30,10,21	3	\$15
ACAT size 3x rivet gun	1	\$149
Toolbag special, rivet sets, bucking bars, etc.	1	\$99
<b>Total</b>		<b>\$458</b>