NATIONAL RADIO ASTRONOMY OBSERVATORY
Socorro, New Mexico

VLBA Antenna Memo 99

Azimuth Rail Repair at Pie Town, NM

August 14 – August 17, 2017

Michael Romero
August 31, 2017

1.0 EXECUTIVE SUMMARY

The Pie Town VLBA azimuth rail was developing a growing crack in the location of a prior rail repair job. The rail was welded to repair a broken section. A larger steel leveling plate was installed to provide support and prolong the repair. The welded repair area started to develop a crack several years ago, but had recently started growing at an increased rate. It was determined to replace rail now that manpower and good weather was available. The single damaged rail section was removed and replaced with a new rail section. The new rail section was successfully leveled and bedded in epoxy grout.

2.0 INTRODUCTION

In 2010 a section of the rail in Pie Town boke in half. The solution at the time was to weld the rail back together. See report for details. Over time the welded area began to fail and the crack appeared. Figures below detail the cracked rail section.

A maintenance team traveled to Pie Town to replace the failed rail section. This report documents the results as well as the tools and procedures used to conduct this repair.

2.0 PROCEDURE

The following section records the procedure that was used to replace the rail.

3.1 Measure existing rail

A target was placed on the idler wheel and a Wild N2 optical level was used to measure the rail height over all 120 rail bolts. The antenna was then parked and locked out so that it was completely off of the rail that was being replaced. Figure 3.1.1 details the rail flatness with general tilt removed using least squares curve fit. The broken rail segment was between bolts 17-37.

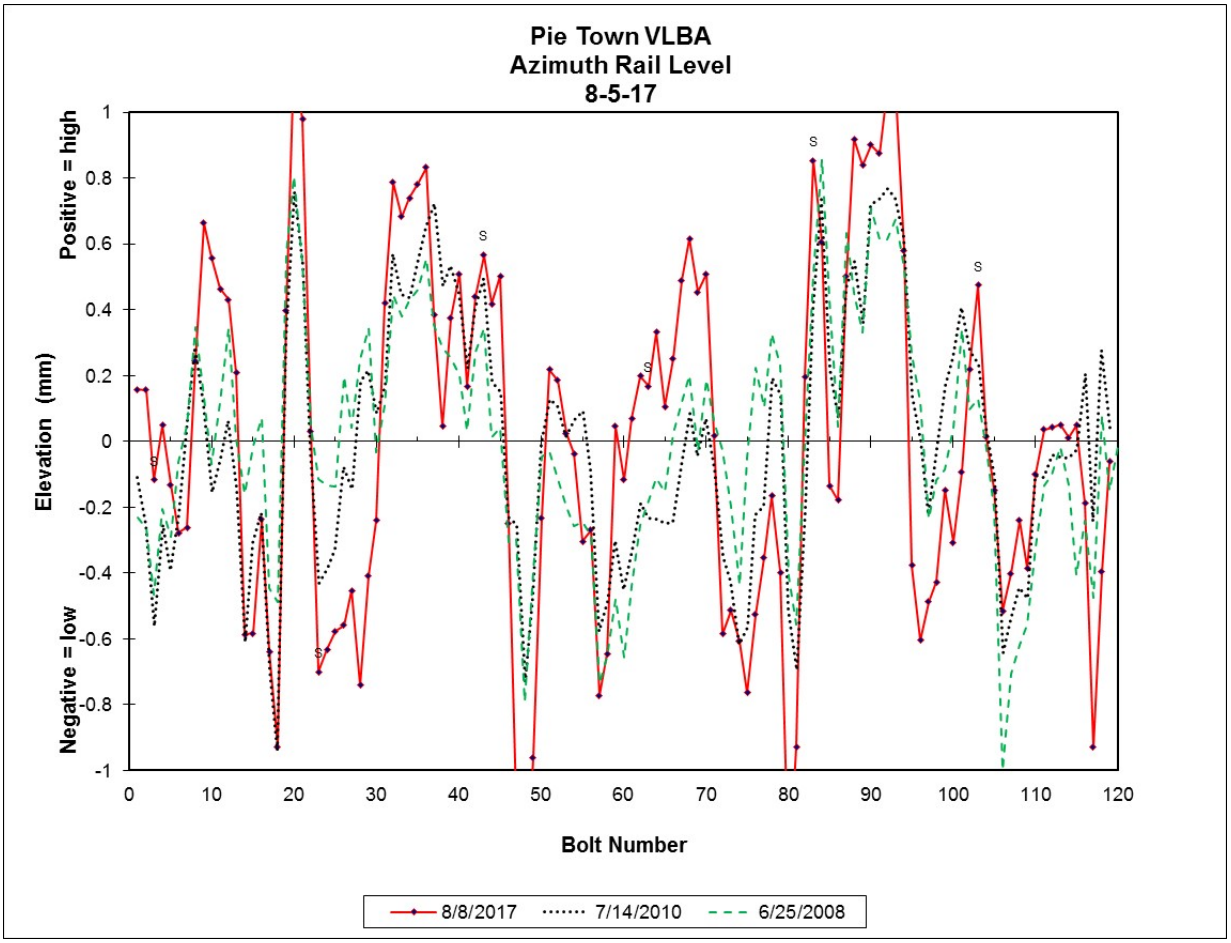

Figure 3.1.1 Rail Flatness

3.2 Demolition

The team removed the rail clips, splice bars and rail plate nuts on the damaged rail section. The rail clip nuts are recessed in a pocket that is too small for a traditional socket. Therefore we used a 1 ¼ “socket with the outer diameter turned down to a diameter of less than 1 13/16”. The 1”-8 unc studs that hold the rail plates down are sufficiently long that a traditional socket cannot be used. Fabricated long sockets were used. Figure 3.2.1 details the rail with clips removed.

Figure 3.2.1: Rail with Clips Removed.

After all rail clips and splice bars had been removed, the rail section was pried up until it was free for its entire length. The rail was then lifted away using the crane and rail clamps. Hand held electric demolition hammers were used to loosen and remove the rail plates. A hydraulic demolition hammer attached to the Case Skid Steer and used for the larger grout areas. The old grout came up in large chunks, completely separating from the concrete. This indicates a poor surface condition during the original grout pour. Figure 3.2.2 details the large pieces of old grout before being cleaned off.

Figure 3.2.2: Old Grout Removed.

The old grout was removed in its entirety and the modified section old grout was removed to a depth of at least 2" below the rail plates. Figure 3.2.3 details the section of grout removed with rail plates installed.

Figure 3.2.3: Rail Plates w/ Grout Removed

3.3 Cleanup

The Vulchem, old grout and rust was then cleaned from the rail clips and rail plates. The tops of the rail plates and clamps were then sanded smooth to facilitate alignment of the rail. Figure 3.3.1 shows a mechanic working hard to clean removed parts.

Figure 3.3.1: Cleaning Removed Components

The splice plates were replaced with new ones on both ends of rail. New style splice plates required the rail clamps to be cut down to avoid contact with splice plate. We removed the lower rail plate

nuts and chased damaged threads with a 1”-8 UNC die. Cutting oil was used to help preserve the threads.

3.4 Prepare Rail

The old rail was placed on top of the new rail piece to mark the angle. A gas powered hand held abrasive wheel saw was used to cut the rail. An adjustable angle guide was designed and used for this project. The adjustable angle guide was used for the start of each cut. The guide should be modified to be used for entire cut for future rail replacements. Figure 3.4.1 details the rail saw and angle fixture.

Figure 3.4.1: Rail Saw w/ Angle Fixture

After the first cut, the rail segment was placed against the adjacent angle to check fit. The process was repeated for the second cut on the other side of the rail. After both ends were cut, a hand held grinder was used to bring the rail to its final dimensions, carefully placing and checking during the process. The next step in the process was to use a hydraulic rail drill to bore the 1-3/16” holes needed to accommodate the splice bar bolts. The drill was connected to the skid loader’s hydraulic power. The loader bucket also aided in alignment and movement of the drill. The hydraulic fittings were not correct and required modifications. In the future, more care should be taken to ensure correct fittings, or at least ample adapters, are brought to the job. The figures below detail the drilling operation and drilled holes.

Figure 3.4.2: Drilling Operation

Figure 3.4.3: Splice Plate Holes

3.5 Reassembly

The rail plates were reinstalled and roughly leveled. The rail was then set in place. The splice bars and splice plate clamps were then tightened on the existing rail and loosely installed on the new rail. This allows movement along the rail as the rail was forced into the proper radius using two chains/binder systems to supply the driving force. Once the rail was properly positioned, the rail clips were installed and all the splice bar bolts and clamps were then properly torqued. Figures below detail the rail being attached to the rail plates and the chain/binders used to force the rail into position.

Figure 3.5.1: Rail Being Placed

Figure 3.5.2: Rail Alignment using Chains and Binders

3.6 Precision leveling

A precision optical level positioned near the pintle bearing and aimed at a target on the rail was used to set the rail to the proper height. A small magnetic level (Torpedo Level) was used to level the rail from side to side. Great care was used to ensure that the rail was set to the correct height before grouting. The rail measurements measured in Section 3.1 were input in an excel spreadsheet that used a least squares curve fit to generate the proper heights to minimize rail flatness with the overall rail tilt removed. Figures below detail rail leveling.

Figure 3.6.1: Level Target on Placed Rail

Figure 3.6.2: Leveling Rail

3.7 Setting forms

6” Masonite house trim coated with packing tape was used to create forms. The Masonite forms were then secured to the foundation using “Blue Screws” and wood wedges. Silicone caulk was used to seal the forms and prevent the grout from leaking out of the cracks. We found that we did not have sufficient time to allow the silicone caulk to dry. Caulk cord or another method of sealing the bottoms should be used in the future. Figures below detail setting of the forms.

3.8 Grouting

The Grout requires a clean surface free of all grease, oil and old material for proper bonding. Therefore, the surface was washed with water to remove all loose grout, dust and oil from the foundation prior to setting forms. After the forms were set the foundation was then thoroughly blown off using compressed air to remove dust and debris from form setting.

A mix of Dayton Superior Epoxy Grout J55 and EChem EP-15 Grout was used to bed the rail. Prior to pouring, it was verified that both epoxy grouts would be compatible and not cause adverse effects. Protective clothing, eye protection and gloves were used while mixing and pouring the epoxy grout. The grout is extremely sticky and we found it useful to tape our gloves to our sleeves with duct tape to prevent the grout from pulling our gloves off. Parts A and B of the grout were combined and thoroughly mixed before being combined with part C in a skid loader cement mixer. Two 2 cu ft. units of grout were mixed at a time. Figure 3.8.1 shows the mixing of the epoxy grout.

Figure 3.8.1: Mixing of Grout

After thoroughly mixing the grout, It was loaded into 5 gallon pails and poured into the forms. The grout was poured from one side of the rail and then allowed to flow under the rail and rail plates. This procedure was followed to ensure that air did not become trapped under the rail or rail plates. Figures below detail the method of pouring the grout into the form.

The cement mixer and all of the equipment had to be thoroughly cleaned soon after it was used.

3.9 Cure and remove forms.

Adhering to the manufactures guidelines, the grout was allowed to cure for 16 hours before the forms were removed and the antenna was allowed to roll over the azimuth rail. The Figure 3.9.1 details the rail bed with forms removed, the color change from the two different grout systems is clearly shown.

Figure 3.9.1: New Epoxy Grout Rail Bed.

4.0 RESULTS

A wild N2 precision optical level was used to measure the height of the antenna wheel as it traveled over the rail. The general rail tilt was then removed using a least squares curve fit and the rail flatness at the rail bolt positions (approximately every 3 degrees). Figure 4.0.1 details the rail flatness after the new rail segment was installed, the new rail segments are located between bolts 17 and 37, compare to results from 8/8/2017.

.

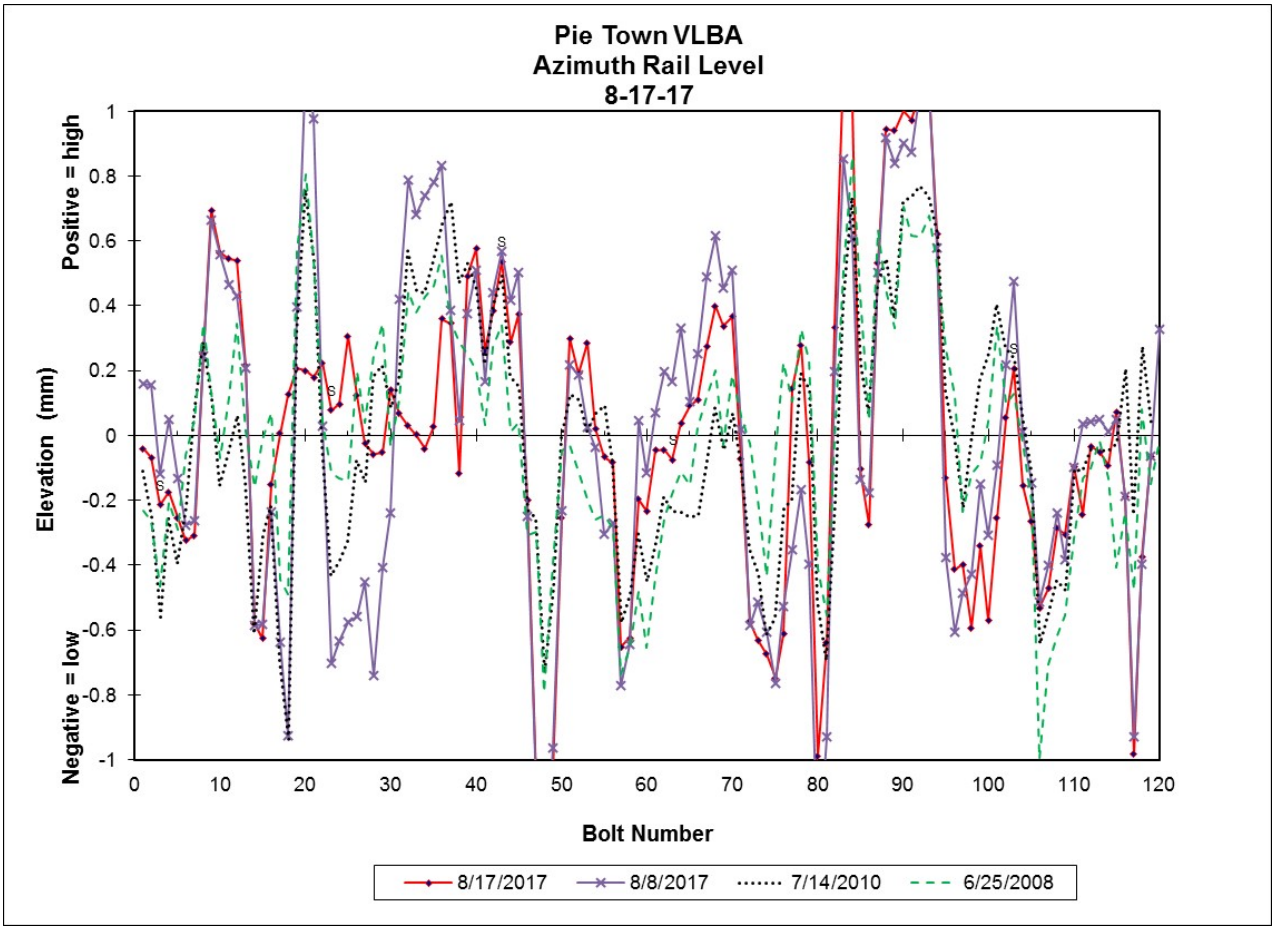

Figure 4.0.1: Rail Flatness After Repair

Figure 4.0.1 shows the magnitude of offset of the rail were reduced with the new section.

The figures below detail the rail splices after the replacement.

Figure 4.0.2: Bolt 17 Splice Gap.

Figure 4.0.3: Bolt 17, Splice Plate

The specification calls for the gap between the rails to be less than 1/16 of an inch. The gaps met this specification

Figure 4.0.4: Bolt 38 Splice Gap.

Figure 4.0.5: Bolt 38, Splice Plate

5.0 CONCLUSIONS AND RECOMMENDATIONS

During this repair, it was noticed that the splice bar on bolt 97 was cracked. The team replaced that splice bar with the old one from the broken rail section. The splice plate was still new style. The remaining splice plates are the old style and should be replaced in the future. Recommended the site techs keep an eye on the splice bars for cracks.

6.0 AKNOWLEDMENTS

Thanks to the VLA Antenna Mechanics and Transporter Operators, whose efforts were critical to the success of this repair.

APPENDIX A. Required tools and Material

Tool List

# #

Req

Material required to change one rail

Rail section and spare 2
Rail grinder & power unit 1
Rail saw 1
Rail saw adapter for angle cut on crane rail 1
Dayton Superior J55 Grout 2 cu ft units 7
Splice bars for all splices 6 pair
Splice bar bolts and nuts 1-1/8 - 7 unc x 6" long A490 36
Coupling nuts 10
Studs 1" -8 unc 10
1-8 unc nuts and washers 120
Tie plate bolts, nuts and washers 3/4-10 unc x 3 1/4 A325 80
Tap and Die for stud bolts 4
Skid steer 1
Skid steer demolition Hammer + spades & points 1
Hand demolition hammers 4
Extension cords 3
Form material 16' masonite 6" and 8" 64'
Blue screws 1 -1/4 and 2 1/2 inch long 100
Blue screw drill driver
Wood blocks to support forms 18
Form seal caulk 6
Caulk cord 10
Skill saw 1
Packing tape 12
Wild optical level and mag base target 1
Strait edge 1
Hand grinders 3
Grinding wheels 6
Crane 1
Rail tongs 2
Spreader bar for lifting rail 1
Tyvek suits 50
Gloves 12 pr

Face shields 6
Dust masks 24
Skid steer cement mixer 1
Wheel barrow 1
Garden hose and nozzle 2
Air compressor 1
Air hose 4
Air nozzles 2

Shovels 2
Brooms 2
Rail wrenches set
Impact wrench and sockets 2
Pressure washer 1
Precision level "starrett" 1
Combination square sets 2
Turned down socket for rail clips 3
1-1/2 deep socket for rail plate nuts 2
1-5/8 deep socket for rail plate nuts 2
Small pry bars for lifting rail clips 2
Hammer and cold chisels 1
Wrench set 1
Welder and leads for attaching lightning ground 1
Measuring tape for rail chord length 1
Large pry bars for lifting and moving rail 2
Tools for scraping Vulchem 4
Tool to clean Vulchem from rail clip counterbores 2
Torpedo level 1
Paint mixer 1
Drill motor for paint mixer 1
Chop Saw (for splice plate clamps) 1
Assortment of Hydraulic adapters