NATIONAL RADIO ASTRONOMY OBSERVATORY
Socorro, New Mexico

VLBA Antenna Memo Series No.76

St. Croix VLBA Antenna Painting and Surface Preparation

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March 31, 2009

1.0 INTRODUCTION

The need for repainting the St Croix antenna was documented in VLBA Antenna Memo Series No. 62 and 68. Funding to accomplish this painting became available in 2007. Two painters from the VLA, Carl Cano and Phillip Sanchez and the VLBA site technicians Ken Klose, Ray McFarlin and Greg Worrell helped complete the antenna preparation and painting. This task was performed from September to December 2007. The total area of steel that was painted was calculated to be approximately 36,000 ft^2. This report was delayed so that the new paint system performance could also be evaluated and documented.

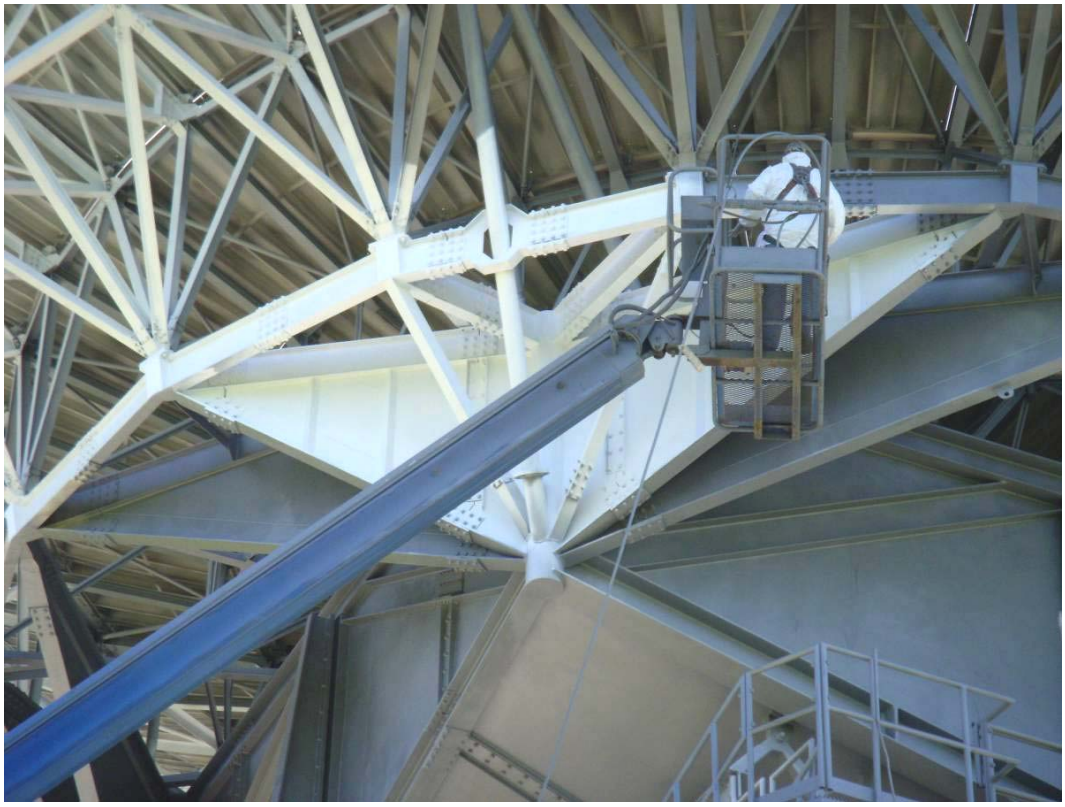

Figure 1, Applying Topcoat on Structure

2.0 HARDWARE REPLACEMENT

Several of the structural bolts holding the structure together had corroded so much that they had to be replaced. 1200 of these corroded bolts were replaced with hot dipped galvanized A325 structural bolts. These bolts were treated with Galvaprep® before they were installed to enhance paint adhesion.

3.0 COATING SELECTION

3.1 Prime Coat/Stripe Coat

Since the corrosion was most prominent on the backup structure trusses, Amercoat 68HS organic zinc epoxy was chosen for the prime coat on this part of the structure. This epoxy is highly loaded with zinc to provide galvanic protection for the steel substrate. The primary advantage of a zinc primer is that this type of coating will arrest rust creep, or undercutting of the coating surrounding a damaged area, and confine corrosion to the point of the damage. An organic epoxy was selected over inorganic because they are more tolerant to imperfect surface preparation and ambient weather conditions during application. In order for the zinc to provide galvanic protection, it must be in electrical contact with the steel. This requires a high level of surface prep.

Since the corrosion was not as prominent on the remaining structure the surface tolerant Amerlock 400AL was chosen as the prime coat. This product was chosen because it is compatible with the existing coating and it does not require as high a level of surface prep as the zinc rich epoxy.

3.2 Intermediate Coat

Amerlock 400AL surface tolerant epoxy was chosen as the intermediate coat for the entire antenna. Epoxy coatings generally provide protection to substrates by forming a barrier to the environment and essentially keeping the electrolyte necessary for corrosion at bay. Amerlock 400AL is similar to the Amerlock 400 used on the VLA antennas except that is has aluminum flakes added to the epoxy resin. These aluminum flakes are intended to create a labyrinth like path through the epoxy; thereby increasing its barrier properties.

3.3 Top Coat

One drawback of epoxy coatings is their poor resistance to ultra violet from sunlight. This leads to an erosion of the coatings film thickness, reducing the barrier protection of the system. Topcoats are generally required that have a high resistance to UV. PSX 1001 acrylic polysiloxane was chosen as the UV resistant topcoat. This product was chosen because it is a single component paint that is very easy to maintain.

4.0 SURFACE PREPARATION

The surface preparation requirements are rigidly specified on most painting projects. However, on the St Croix painting project, the budget was rigidly specified and the surface prep requirements were more flexible. Our goal was to get the best possible surface prep that could be obtained with our fixed budget. The surface prep contract was arranged so that the contractor (UHP Projects) charged for a fixed number of days on location. This allowed us the use of three men and one UHP pump capable of operating 2 lances simultaneously for a total of 45 ten hour days. Two thirds of this time was to be spent on the truss structure where the corrosion was the most prominent. UHP water jetting was chosen over abrasive blasting because it does not use an abrasive that could damage bearings and other sensitive equipment. This method was also desirable because it does an excellent job of removing the soluble salts in the lap joints and bolted connections where the corrosion was most prevalent. UHP waterjetting cannot generate the surface profile needed for adequate paint adhesion, although it can clean back to and refresh an existing profile. The existing surface profile was measured with Testex tape in several places after waterjetting. This existing profile was found to be adequate and measured between 2.2 - 3.4 mils at all tested locations.

Figure 2, Ultra High Pressure (UHP) Waterjetting Structure at 42,000 PSI

Zinc rich Amercoat 68HS was selected as the prime coat for the backup structure trusses. The Amercoat 68HS application instructions called for a minimum surface preparation of SSPC-SP 6 on steel without pits and SSPC-SP 10 on rusted or pitted steel. SSPC-SP 6 and SP 10 are standards for abrasive blasting. The coating company technical representative said that the equivalent standards for waterjetting SSPC-SP 12 WJ-3 and WJ-2 were acceptable.

Since coating performance, in general is proportional to the degree of surface preparation, we initially started out trying to achieve the more stringent WJ-2 level of surface preparation. It soon became evident that at this degree of surface preparation, we could not obtain production rates that would be consistent with our budget constraints. At this point, we relaxed the requirement to the manufacturer's minimum surface prep requirements of SSPC-SP 12 WJ-3 on the bulk of the truss structure. We still required the SSPC-SP 12 WJ-2 on the severely rusted areas of the structure. One advantage of the WJ-3 surface prep was that it left more of the original organic zinc coating intact. This thin coating of organic zinc helped keep the flash rust to a minimum and will provide additional galvanic protection to the steel.

Figure 3, SSPC-SP 12 WJ-3 Surface Prep.

Figure 4, SSPC-SP 12 WJ-4 Surface Prep.

The remainder of the antenna used the surface tolerant Amerlock 400AL as the prime coat. The Amerlock 400AL application instructions call for a minimum surface preparation of SSPC-SP 12 WJ-4. This is a very easy to obtain surface prep which basically just calls for removal of all foreign material and loose coating. The table below lists the square footage and degree of surface preparation for the various sections of the antenna.

Structure	**Surface Area (ft^2)**	**Surface Prep**
Backup Structure Trusses	11700	SSPC 12 WJ-3M
Cone and Box Sections, Vertex Room, Axle	8200	SSPC 12 WJ-4M
Gear Sector and Counterweights	1900	SSPC 12 WJ-4M
Quadrupod	900	SSPC 12 WJ-4M
Lower Base and Pintle Bearing Housing	5300	SSPC 12 WJ-4M
Platforms and Stairs	8000	SSPC 12 WJ-4M
TOTAL	**36000**	

The gearboxes, pillow blocks and areas near sensitive equipment were power tool cleaned using needle scalers and then pressure washed before painting.

Figure 5, Power Tool Surface Prep on Azimuth Drive Gearbox.

5.0 PAINT APPLICATION

In a marine environment, it is necessary to ensure that significant flash rust or chlorides do not accumulate on the prepared surface before the paint is applied. The surface of the steel was tested for chlorides several times during the painting process. The chloride level never exceeded 7 ppm. We were often unable to paint soon enough after waterjetting to prevent a buildup of flash rust. When the flash rust on the steel was beyond acceptable levels, the rust was removed by sweep blasting the area with the UHP waterjet. The following table lists the types of paint and total gallons used on this project.

Amercoat 68HS – Organic Zinc Epoxy	50 Gallons
Amerlock 400AL – Surface Tolerant Epoxy	275 Gallons
Ameron PSX 1001 - Single Pack Acrylic Polysiloxane	135 Gallons
Benjamin Moore P-74 - Aliphatic Acrylic Polyurethane Gloss	5 gallons

5.1 Stripe coat

A stripe coat of Amercoat 68HS primer was applied by brush at the bolted joints and welds on the backup structure trusses before the rest of the primer was sprayed on. Other areas on the structure that were highly corroded were also stripe coated with Amercoat 68HS.

Figure 6, Stripe Coat Applied by Brush at Connections.

5.2 Backup Structure Prime Coat

The backup structure was primed with Amercoat 68HS using conventional spray with mechanically agitated pressure pots. Conventional spray was chosen over airless spray on this part of the structure because of the complexity of the bolted connections. The paint had to be sprayed from several angles to get coverage on the complicated connections. Airless spray would have resulted in excess dry film paint thickness at the connections. The air supply to the pressure pots was filtered and dried with an after cooler and water separator.

Figure 7, Backup Structure Truss Primed with Organic Zinc Primer.

The dry film thickness was measured with a Type I thickness gauge and was found to be between 2-4 mils. This is consistent with the 3 mil recommendation on the Amercoat 68HS Product Data Sheet.

5.3 Backup Structure Intermediate Coat

The primed backup structure was painted with Amerlock 400AL using conventional spray as described previously. The outer portion of the backup structure's dry film thickness was 7-12 mills which is in line with the manufacturers recommended thickness of 4-8 mils of Amerlock 400AL plus the 2-4 mils of the prime coat. A different painter painted the inside portion of the backup structure. The dry film thickness on the inside portion of the structure was 4 - 6 mills. This means that the intermediate coat thickness was about half of the desired thickness of 4-8 mills. Since we did not have enough time to add a second intermediate coat to this part of the structure, we did not topcoat this part of the structure until we could evaluate the thin coating. The inside portion of the backup structure was evaluated during a maintenance period approximately one year later. The paint was holding up well except for some rust staining at the bolted connections. The structure was then pressure washed and the rust stained areas were then stripe coated by brush with Amerlock 400AL.

Figure 8, Backup Structure Truss Epoxy Intermediate Coat.

5.4 Remaining Structure Prime Coat

Amerlock 400AL was used as the prime coat on the remaining structure. This paint was applied with airless spray equipment with a dry film thickness of 4- 8 mils. A second coat of Amerlock 400AL was then applied bringing the total film thickness to 8-16 mills.

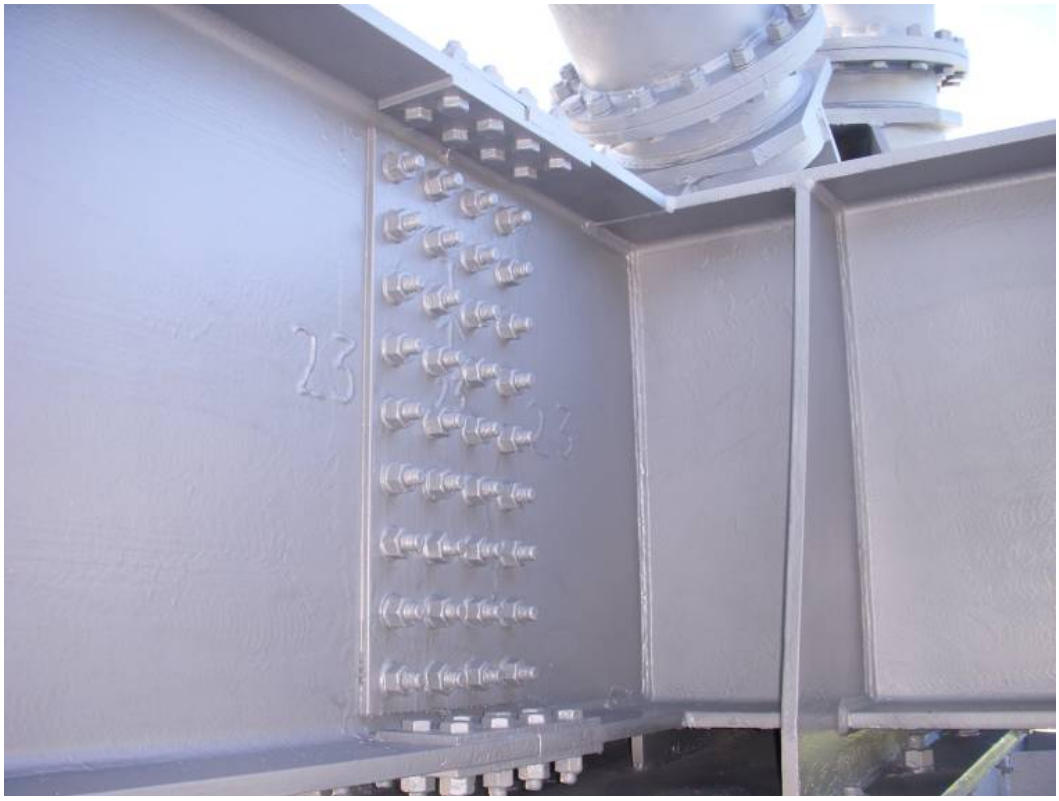

Figure 9, Epoxy Prime Coat on Remaining Structure.

5.5 Topcoat

The entire structure, with the exception of the inside portion of the backup structure, was coated with 2-3 mills of PSX 1001 Acrylic Polysiloxane. The inside portion of the upper backup structure was topcoated after one year with a white finish coat of aliphatic acrylic polyurethane gloss (Benjamin Moore P-74) applied at 1- 2 mil DFT.

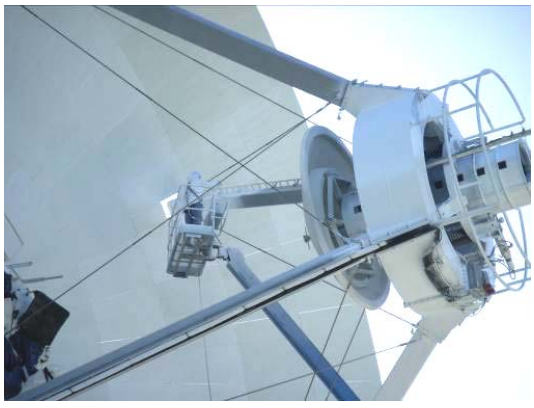

Figure 10, Painting FRM and Quad Legs.

Figure 11, Completed Antenna.

6.0 PAINT SYSTEM PERFORMANCE

Figure 12, Before Painting - January 2006.

Figure 13, After Painting - March 2009.

Figures 12 shows a photograph of a bolted connection on the backup structure truss before painting. Figure 13 shows the same connection approximately 1 ½ years after painting. As evinced in the photo, several of the severely corroded bolts were replaced. The rust staining in Figure 13 shows that there are several holidays in the paint where corrosion is beginning to take hold. These holidays are on the edges of the beams and places where it was hard to get paint coverage by spraying. There is very little rust staining along the beams and on the large flat surfaces.

7.0 CONCLUSION

The majority of the corrosion on the antenna is being inhibited by the new paint job. The paint adhesion is adequate and the paint system is performing well where it was applied properly. There are however, several holidays in the paint that will need to be addressed before the corrosion in these areas progresses to the point where additional surface prep will be required. These holidays should be encapsulated as soon possible with Amerlock 400 epoxy applied by brush. A small crew of NRAO or locally contracted painters should repair these holidays as soon as possible. After these holidays are repaired, only minimal paint system maintenance will be required for the next few years. The expected life of the paint job in the coastal environment, assuming the current holidays are repaired, is 10 – 12 years.