NATIONAL RADIO ASTRONOMY OBSERVATORY
POST OFFICE BOX 2
GREEN BANK, WEST VIRGINIA 24944
TELEPHONE 304-456-2011 TWX 710-938-1530

August 18, 1980

RFQ GB-176

ADDITIONAL BASELINE TO INTERFEROMETER
MEMO No. 125

Gentlemen:

AUI/NRAO, a non-profit educational corporation, operates the National Radio Astronomy Observatory under contract with the National Science Foundation - an agency of the US Government.

Our letter dated March 4, 1980 solicited your company for pre-qualification information and an expression of interest in the engineering, fabrication, and erection of a radio telescope antenna. Summary parameters were provided by this letter. We have now finalized our specifications and the basic parameters have been changed, particularly the diameter of the antenna. The completed specifications are enclosed.

We are now in the process of preparing a budgetary quotation for an antenna for a remote location to the Green Bank Observatory facility. We are requesting your quotation for the antenna as outlined in our specifications. We emphasize that it is desirable to utilize an existing design to the maximum extent, preferably a design that is in production or one that might be modified to meet the specifications. If your design has physical characteristics different from the specification and you could guarantee meeting the performance specifications so state in your quotation listing the exceptions for our consideration.

It is contemplated that your quotation may be used in our proposal and will form the basis of funding for the above described project. We suggest, therefore, that your request be as accurate as possible. We will regard such response as the maximum price for the delivered antenna and will negotiate with firms that are responsive to this request with the view of arriving at a fixed price for an antenna that generally meets the specifications attached. For purposes of estimating we contemplate that a contract award, if made, would be within 12 months or not later than 1 November 1981.

SUITE 100
2010 N. 1 ORBES BOULEVARD
TUCSON, ARIZONA 85705
TELEPHONE 602-882-8250

POST OFFICE BOX O
1000 BULLOCK BOULEVARD, N.W.
SOCORRO, NEW MEXICO 87801
TELEPHONE 505-835-2924 TWX 910-988-1710

EDGEMONT ROAD
CHARLOTTESVILLE, VIRGINIA 22901
TELEPHONE 804-296-0211
TWX 510-587-5482

We will appreciate receiving your response to this request no later than 30 September 1980. If you choose not to respond to the request with a budgetary estimate, we would appreciate your letting us know by card or letter by September 19, 1980. Any additional information that you can furnish on your company's facilities and products will be appreciated.

In the event you need further technical information you may contact G. M. Peery at 304-456-2201. Questions concerning administrative matters may be directed to the undersigned at 304-456-2231.

Sincerely,

Richard L. Fleming
Purchasing Officer

RLF/baw
Enclosures

August 18, 1980

SPECIFICATIONS
for
AN ANTENNA FOR A RADIO TELESCOPE

Introduction

General Statement of Work

The work described herein shall consist of the furnishing of all labor, materials, services, drawings, data and other items required for the detailed design, fabrication, shipping, erection at the subcontractor's plant and on site, alignment and testing of an antenna.

Objectives of the Program

The objectives of the effort under this subcontract are the following:

The design and manufacturing of an antenna that meets the operating parameters and requirements set forth in this specification.

It is the intent of the RFP to utilize an existing design of the subcontractor to maximum extent, preferably a design that is in production and operation, that might be modified to meet those specifications.

A design that takes into consideration ease of maintenance and the reliability of components to minimize maintenance.

Fabrication of antenna using the techniques and tooling developed and specified in the design effort.

Erection and alignment of the antenna according to the specifications and procedure.

Performance of tests to establish that antenna meets specified performance requirements.

Design and Performance Parameters

The antenna shall be an elevation over azimuth configuration with a solid surface paraboloid of revolution as the main reflector. The observing systems to be used shall be both Cassegrain and prime focus. Use of a prime focus observing system shall be considered the normal mode of operation.

Mechanical Parameters

Diameter - Min. 9.15 meters - Max. 15.25 meters

Focal Length - As determined by f/D

f/D - 0.36 minimum to 0.43 maximum

Sky Coverage - Elevation -10^{o} to $+90^{o}$; Azimuth $\pm 270^{o}$

Observing System - Cassegrain or prime focus (feeds and secondary reflector are not a part of this contract)

Operational Frequency - 2.70 GHz (11 cm) and 8.09 GHz (3.7 cm)

Surface Accuracy - Installed RMS of 0.76 mm (0.030 in.) including manufacturing, alignment, gravity, operating wind and thermal errors under the specified precision operating conditions. Peak deviation from best fit paraboloid shall not exceed 2.29 mm (0.090 in.) under the specified precision operating conditions.

Panel Gap - 1.5 mm ± 0.5 mm (0.060 in. ± 0.020 in.)

Axis Alignment -

Azimuth axis to plane of telescope base plates - 18 arc seconds

Orthogonality azimuth to elevation - 18 arc seconds

Orthogonality reflector axis to elevation - 18 arc seconds

Focal axis to reflector - The structure at the apex of the feed legs must locate the center of the opening coincident within 2.54 mm (0.10 in.) and parallel within 30 arc seconds of the axis of the reflector. The deflection of the focal point prime focus from the best fit axis of the parabola when the antenna is moved from the zenith to horizon shall not exceed 1.52 mm (.060 in.).

Counterbalancing - Overbalanced to allow the antenna to return to zenith with no drive power under no wind, no ice, no snow conditions.

Drive Requirements - Azimuth and elevation drives shall have a capability of driving the antenna at a velocity of 20^{o} per minute with the reflector in any attitude under the specified operating conditions. Azimuth and elevation drives shall drive the antenna at sidereal tracking rates with an accuracy as specified.

Pointing Error

The pointing error is defined as the difference between the commanded position of the antenna and the position of the main beam of the reflector. The repeatable pointing error is due to gravity deformation, axis alignment error, encoder offset, bearing runout and similar errors. The non-repeatable

pointing error is due to wind forces and gusts, acceleration forces, encoder resolution, servo and drive errors, and random errors.

The allowable repeatable pointing error for this antenna shall not exceed 3 minutes of arc. The allowable non-repeatable pointing error shall not exceed 15 seconds of arc RMS under operating conditions outlined below with the antenna in any attitude and while tracking a source at the specified tracking rates. The non-repeatable error contribution of the servo system shall be based on wind gusting 15 $\pm$ 3 miles/hour.

Slewing Motion

Slewing motion is defined as rapid movement of the antenna about either axis simultaneously or independently. The antenna shall be capable of driving at a rate of 20^{o}/minute of time about the elevation and azimuth axis in winds to 45 mile/hour with the reflector in any attitude. It shall be possible to slew each axis independently while the other axis is stationary or moving at the tracking rate or to slew both axes simultaneously.

Tracking Motion

The antenna shall be capable of tracking a stellar source at the azimuth and elevation rates which correspond to the sidereal rate for the star position. The antenna shall be capable of azimuth and elevation accelerations of $0.25^{o}/sec^{2}$. The cone of avoidance near the zenith when in the tracking mode shall have a half-angle less than 2.5^{o}.

Operating Parameters and Conditions

General

The antenna will be exposed to the elements on a site 4000 feet above sea level. The antenna is to be designed for a life expectancy of 20 years. No damage to the operating components of the antenna must occur due to airborne sand or dust or accumulation of frozen or liquid water.

Requirements to be met for precision operation

Precision operation requires that the antenna meets the surface and pointing accuracies stated above. Precision operation must be achieved under the following conditions:

Temperature range - -15^{o} - $+80^{o}$F

Maximum temperature difference between any parts of the antenna structure - 5^{o}F

Relative humidity - 0 - 50%

Rain rate - Maximum rate up to 0.2 in./hour

Ice or snow load - None

Wind (measured at 40-ft. elevation) - Up to 15 miles/hour with gusts of $\pm$ 3 miles per hour superimposed. Wind from any direction, reflector in any position.

Requirements to be met for normal operation

Normal operation means that the antenna will continue to be fully operable, but with reduced (less than a factor of 2) pointing and surface accuracies. Normal operation must be possible under the following

conditions:

Temperature range - -22°F to 123°F

Relative humidity - 0 - 98%

Rain rate - Maximum rate up to 2 in./hour

Ice or snow load - None

Wind (measured at 40-ft elevation) - Up to 40 miles/hour, with gusts of ± 5 miles/hour superimposed. Wind from any direction; reflector in any position.

Requirements to be met in moving to stow and in the stowed position

Slew to stow - The antenna shall be capable of being slewed to the stow position in winds of 60 miles/hour with all exposed surfaces of the structure coated with 1-cm radial thickness of ice. The slew rate may fall to 10°/minute.

Slew to dump snow - The antenna shall be capable of dumping snow by slewing at 20°/minute to any position 5° above the horizon with a wind of 25 miles/hour blowing from any direction and with an original uniform snow load in the reflector of 4 lbs/ft^2. No damage or overload shall occur to either structure or drives.

Survival - The antenna is to be designed to survive in the zenith position in winds of 110 miles/hour with 1 cm of radial ice on all exposed surfaces or when loaded with 20 lbs/ft^2 snow. When loaded under these conditions, yield stresses of materials shall not be exceeded and no permanent deformation shall occur. Stow brakes shall be provided capable of holding the antenna in the zenith position when subjected to the design survival loading.

All components of the antenna shall be properly designed for the loads and operating conditions to which they will be subjected. Design shall be based on a normal operating life of 20 years. The design shall provide adequate protection for all parts of the antenna against rain, dust, weathering and the accumulation of frozen or liquid water. The entire pedestal shall be environmentally protected. Blowers shall be provided to cool motors and ventilate pedestal housing if required.

Structural and Mechanical Features

Reflector Assembly

Surface - The reflecting surface shall be a paraboloid of revolution comprised of individually adjustable, double curved, solid surface aluminum panels. The spacing between panels shall be nominally 1.5 mm (0.060 in.) with a tolerance of 0.5 mm (0.020 in.). The installed RMS deviation of the surface from a best fit paraboloid shall not exceed 0.75 mm (0.030 in.) including manufacturing, installation and alignment, gravity, and thermal errors with the antenna in any operating attitude and with winds not exceeding 18 miles/hour. An error budget shall be prepared showing distribution and projected levels of each error contribution.

Panels shall be designed to withstand either a 20 lbs./ft^2 uniform load or a concentrated load of 250 lbs. over a 6 inch square area located at any point without exceeding the allowable design stresses for the material.

Manufacturing accuracy of 90% of the individual panels to be .012 inches RMS, with no panel to exceed .015 inches RMS, as determined by measurement of a representative number of points with reference to the design parabola passing through panel corner points as control points. Each individual panel shall be permanently marked numerically or alphabetically at a location easily viewable from top of panel. Each panel shall have an individual log prepared by Vendor showing history of assembly such as date of assembly, date of tests, temperature at tests, weight, dimensions (periphery, diagonal and elevation) and measured RMS.

Control points for adjustment shall be permanently located on reflector surface of each panel at or near its adjustment mechanism to be used during the acceptance test and for final setting of the panels on the telescope. The control points shall be such that they are viewable from the vertex and shall be specific points on the design parabola. The number of points measured on each panel shall be such that each point represents approximately 120 square inches of area. Wind effects on the antenna at any operating attitude in winds up to 25 mph shall not degrade the reflector to more than .032 inches RMS.

Feed Legs and Apex - The feed leg supports shall be designed to support either an adjustable feed support system weighing approximately 800 lbs. and a prime focus feed of approximately the same weight, a total of 1600 lbs. The feed legs shall also be designed to support a cable weight of 8 lbs. per foot on each leg.

The apex structure shall be so designed that a clearance of 18 to 24 in. (with 20 in. preferred) exists between the bottom of the apex structure and the focal point of the main reflector. Its configuration shall be such that an opening of approximately 48 in. diameter exists on the centerline of symmetry for the location and attachment of adjustment mechanism and support of the prime focus feed. Requirements for the mounting of the adjustment mechanism will be provided by AUI at the time of manufacturing. The feed legs and apex structure, including the prime focus feed shall not cause RF blockage in excess of 6 percent of the total aperture area.

Back-up Structure - The reflector back-up structure shall provide the rigidity required to achieve the specified reflector tolerance and shall be designed so as to achieve the highest practical stiffness to weight ratio.

Panel Supports - Each surface panel shall be supported at a minimum of four points by means which will allow field adjustment. The panel supports shall be designed to allow one 250 pound man to walk on the panel without causing permanent deformation.

Antenna Pedestal

Structure - The pedestal structure shall be designed to provide the stiffness and strength required to meet the operating and survival requirements and to provide the range of motion as specified. Components of the pedestal structure shall be designed to facilitate field erection and assembly to the required tolerances. Field assembly shall preferably be by use of high strength bolting. Adjustment provisions shall be provided for alignment of bearings, gear racks and supported drives and gear boxes. The antenna shall

be so designed and erected that the azimuth and elevation axes intersect and are orthogonal within the tolerances specified. The axis of symmetry of the paraboloid shall intersect the elevation and aximuth axes and shall be orthogonal to the elevation axis within the tolerance specified. Appropriate openings and guides shall be provided to protect the signal and control cables. AUI will advise of the number and size of cables and recommended routing.

Drive Equipment - Electrical drives using DC servo motors are the preferred drive system for each axis. The drive systems shall be supplied in pairs and torque biasing shall be provided so that paired gear trains oppose each other during operational function so as to minimize backlash. Motors selected shall have a base speed not to exceed 1750 RPM. The drive motors shall be able to withstand the following current load conditions:

100% rated	continuous
150% rated	2 minutes out of every 20 minutes
200% rated	instantaneous, 0.5 seconds, repeated once every minute.

The reducer ratio from motor to antenna axis shall be sized to deliver the torque required and to meet the speed requirement. All enclosed gearing shall be lubricated with oil or run in an oil bath and shall be heavy duty class III gearing.

Brakes - Brakes that actuate with the power off shall be provided on each axis. Brakes on each axis shall have the capacity of three times rated motor torque. Brakes must have the capacity to hold the antenna in any position in winds to 60 miles/hour and to hold the antenna in the stow position in winds to 110 miles/hour.

Brakes may be provided in either of two configurations:

Operating brakes mounted on the motors and braking through the gear train plus stow brakes which act on the main section gear. This is the preferred configuration.

Brakes which serve both as operating and stow brakes which operate through the gear train.

Remotely controlled stow locking devices, such as stow pins, shall not be used as an operating feature.

A manually operated stow pin shall be provided on the elevation axis for use in maintenance.

Bearing and Gears - All main axis bearings and power train gearing shall be conservatively designed with a minimum 20 year expected life period. Running friction and breakaway friction for the drive system shall be held to levels which satisfy the non-repeatable pointing error budget.

Cable Wraps - Access shall be provided at the azimuth axis in the form of a cable wrap through the axis which will accommodate a minimum of 20 cables of 1.5 in. in diameter with connectors of 3 in. outside diameter. Arrangement shall be such that cables are neither stressed by twisting or damaged by pulling over edges of fixed structure. Cables may pass the elevation axis by means of a cable loop.

Lubrication - Provision shall be made in the design for proper lubrication of all components. Gear boxes, gear trains, couplings, bearings, motors and similar equipment provided by the Subcontractor

shall have easily accessible lubrication fittings, drain fittings and be provided with vents where advisable. The design Subcontractor shall prepare a list of recommended lubricants and lubrication schedule. Lubricants shall be adequate to meet the performance and environmental requirements specified herein. The use of different types of lubricants and the frequency of lubrication shall be held to a minimum.

Grounding - The antenna requires safety and equipment grounds. A station ground will be provided by AUI for the antenna structure. The Subcontractor shall ground the antenna structure, and its equipment, in accordance with National Electrical Code Specifications to this station ground. All bearings shall have a by-pass grounding connection.

Miscellaneous Requirements

All operating components of the antennas, such as motors, bearings, drive units, brakes, gear boxes, switches, breakers, etc., shall to the extent possible be of standard design, and proven operating life.

Access ladders, walkways and platforms for service, access and maintenance to bearings, motors, and drives and all equipment shall be designed according to best antenna practice, shall meet the requirements of the Occupational Safety and Health Act and shall have sufficient strength to support at least a concentrated load of 400 lbs. at any point.

Safety devices shall be provided for protection of the antenna in the event of servo or mechanical failure, consisting of mechanical stops and bumpers or shock absorbers.

Limit switches shall be provided for each axis of the antenna.

All machinery shall be covered or protected in such a way that working personnel are not subject to hazards.

Limit switches, cables, connectors used on telescope drives, brakes, motors, gear boxes, interlocks, etc., are to be weather-tight.

Foundations

The Subcontractor shall provide the design of a typical foundation. Final design and detailing of the foundations and construction of these foundations will not be the responsibility of the Subcontractor but the Subcontractor shall supply all data needed to design the foundations to provide the stiffness and the pointing accuracy required.

Control System

Control and pointing of the antenna will be by AUI, using a computer to convert from polar coordinates to the telescope coordinates.

The antenna subcontractor shall supply all necessary parameters for the design of the servo control system, including load inertias, motor characteristics and gear train data. The provision of this servo system is not a part of this contract.

Provision shall be made in the design for mounting of direct drive shaft angle readout equipment. The elevation and azimuth axes of the antenna shall be equipped with these mountings. Requirements for these systems will be provided by AUI at time of manufacturing the antenna . The furnishing of these readout systems and their associated readouts and connection to servo system or computer is not a part of this contract. The position indication will be by inductosyns.

Erection

The antenna shall be finally erected, on foundations provided by AUI, on its permanent site near Monterville, West Virgina. The site is located just off paved State Route 15. An access road capable of handling tractor trailers and cranes needed for erection, will be provided to the site by AUI. Storage space will be available at the site for equipment and materials. The Subcontractor shall furnish all materials, plant and equipment, tools and all labor, services and supervision necessary to complete the erection, assembly, alignment and testing of the antenna.

The antenna shall be completely assemblied, at the subcontractor's plant, before shipment to the site for the permanent installation.

Protective Coatings and Finishes

The reflector surface of the antenna shall receive a protective coating which will provide diffuse reflection of the solar rays. Material, preparation, application and quality control testing shall be as set forth in National Radio Astronomy Observatory Process Specification dated August 30, 1972, entitled "Application of Diffuse

Reflecting Coating for Solid Faced Antenna Reflectors", attached hereto.

To limit the effect of solar heating and associated differential expansion of structural members and to protect the structure against atmospheric corrosion, the antenna structure, with the exception of the reflecting surface, shall be painted with a white solar reflecting paint. Material, preparation, application and quality control testing shall be as set forth in National Radio Astronomy Observatory Process Specification dated August 30, 1972, entitled "Exterior Protective Coating for all Exposed Metalic Surfaces other than Reflector Surfaces", attached hereto.

Engineering, Design and Shop Drawings

One reproducible copy of engineering, design and detailed drawings of all components and assemblies and any working drawings which the subcontractor may require to detail or illustrate any part of the work, supplementing the information in this Job Specification, shall be furnished at no additional cost to AUI. Such working drawings shall be consistent with the purpose and intent of the Job Specification, and shall be subject to approval of AUI's Engineer. Approval will be granted within five days of receipt of drawings and if not approved, the reason for non-approval will be specified. AUI approval of the drawings will be granted unless it can be demonstrated that the subcontractor's drawings are contrary to a provision of the specification. AUI will recognize these drawings as in some instances containing proprietary information and agrees not to submit these drawings to outside concerns or to

use them in any fashion which might adversely affect the subcontractor's position.

Detail drawings, sketches, specifications and purchase orders of all purchased manufactured components shall, to the extent that this data is made available by vendors (a) without increase in the price of the purchased components and (b) without limitation on further distribution by subcontractor, be submitted by the subcontractor to AUI prior to manufacture or assembly of the antenna. This submittal shall be for information only. Pricing data appearing on purchase orders may be deleted.

All drawings, specifications, purchase orders and other pertinent papers submitted by subcontractor of its vendors pursuant to this contract may be used by AUI only for the (1) repair and maintenance of this antenna system and (2) replacement of purchased manufactured components direct from the original source.

In the performance of the work, the subcontractor shall submit monthly reports to AUI on the progress of the work, shall secure AUI approval of the concepts of the design as the work progresses, and shall make such changes to the design as AUI and the subcontractor shall jointly agree upon. AUI approval of the design will be granted unless it can be demonstrated that the subcontractor's design is contrary to a provision of the specification. Approval or disapproval will be granted within five (5) days after receipt by AUI, and if not approved, the reason for disapproval will be stated.

Inspection and Acceptance

AUI may inspect or test any component or assembly, either visually, optically, manually or mechanically during or after fabrication at the site of fabrication or wherever fabricated or assembled.

Quality assurance tests shall be performed by the subcontractor or his subcontractors on the various components of the antenna. AUI will identify to the subcontractor such tests as it desires to witness and shall be notified by the subcontractor prior to the performance of these tests. Test facilities shall be provided by the subcontractor. Subcontractor shall submit during the design stage a recommended Quality Assurance plan for AUI approval.

Final acceptance will be after final erection and testing at the permanent site.

Special Tooling

Any special tooling which has been fabricated, purchased or otherwise received, and whose total cost has been charged to this job and whose function is unique to the job, shall become the property of AUI after completion of the work specified herein. Optical tools, clinometers, levels theodolites, and similar tooling which are not purchased specifically for this job, and whose purchase price was not included in the proposal price, are excepted from this requirement.

Operation and Maintenance Manuals

The antenna subcontractor shall deliver at the time of final testing of the antenna four (4) copies of an Operation and Maintenance Manual. This Operation and Maintenance Manual shall contain the following information:

Manufacturer's drawings, exploded view assembly drawings, parts lists and recommended lubrication procedures for all purchased mechanical components. Manufacturer's drawings, parts lists, specifications, wiring diagrams and testing procedures for all purchased electrical or electronic components. A lubrication schedule showing lubrication points, types of lubrication and recommended lubricant, frequency of lubrication.

A maintenance section which describes method of removal of mechanical components, methods and control to be used in re-assembly and re-alignment and components which might reasonably be expected to be replaced because of wear characteristics. Assembly and sub-assembly drawings which include mechanical setting dimensions such as bearing pre-loads, year runouts, gear backlash settings, torque bias settings, drive train alignment requirements and weight of components.

NATIONAL RADIO ASTRONOMY OBSERVATORY

PROCESS SPECIFICATION

APPLICATION OF DIFFUSE REFLECTING COATING FOR SOLID FACED ANTENNA REFLECTORS

August 30, 1972

SCOPE

1.0. This specification establishes the procedure for material acceptance, preparation, application, and quality control testing of diffuse reflecting organic coating systems for solid face micro-wave antenna reflector surfaces.

MATERIALS

2.0. Solvants used as cleaners.

2.1. Naptha, Petroleum Aliphatic T-T-N-95.

2.2. Methyl Ethyl Ketons TT-M-261.

2.3. Toluene TT-T-548 or Jan-T-171 Grade A.

AQUEOUS CLEANERS

2.4. Vel - Colgate-Polmolive Company.

2.5. Kelite L-17 - Kelite Products Company.

THINNERS

2.6. Sol Cal No. 1 - Standard Oil Company.

2.7. Xylol - TT-X-916 Grade B.

TOP COAT

2.8. Hi-Reflectance Flat White No. 6 - Triangle Paint Co., 2222 Third Street, Berkeley 10, California.

PRIMERS

2.10. Mil-C-8514 Coating Compound Metal Pretreatment.

2.11. Mil-P-8585 Primer Coating, Low Moisture Sensitivity.

PURCHASING

2.12. Purchase orders shall require that materials procured to Government Specifications conform to the applicable requirements. Purchase orders for proprietary materials shall require identification per Federal Test Standard 141 Method 1031.1. A copy of the supplier's record of batch production data and test results shall be required when ordering proprietary top coating. The supplier's record of batch production data shall be retained in file for a period of three years.

2.13. Materials shall be procured only from suppliers listed in current Qualified Product Lists. Substitutions of proprietary or commercial products or procurement from suppliers not listed in this specification is not allowed without Engineering approval. Finish coatings shall be purchased in 5 gallon or smaller containers.

RECEIVING

2.14. Receiving Inspection shall examine all incoming materials to insure conformance to Purchase Orders and applicable specifications.

2.15. Incoming acceptance testing of materials not covered by specification shall consist of any test by the Quality Control Laboratory which will assure maintenance of quality but shall at least consist of the following.

2.16. Federal Test Standard 141 Method 6101; Gardener 60 degree Specular Gloss Meter, specular gloss shall be two or less, specimens shall be prepared in accordance with paragraph 3.0. Wash primer may be omitted.

2.17. Federal Test Standard 141 Method 4041; volatile content. Volatile content shall be 33.5 percent $\pm$ 1.0 percent.

2.18. Weight per gallon as received shall be 11.6 lbs. $\pm$ 0.2 lbs.

STORAGE AND CONTROL

2.19. Paint type materials shall be stored under shelter at temperatures between 45° F and 80° F. Short periods above or below these limits shall not be cause for rejection. Paint subjected to prolonged periods outside the above temperature limits shall be inspected by Quality Control Laboratory for deterioration.

2.20. Issue of paint shall be on a first-in-first-out basis. Material shall be warmed to paint room temperature before use.

EQUIPMENT

2.21. Equipment, application technique, handling and mixing shall conform to Mil-F-18264 and as instructed by specific details in this specification.

2.22. Appropriate safety precautions applicable to handling of toxic and flammable materials shall be observed during all operations.

2.23. Cleanliness of spray guns and equipment is necessary to produce high quality coatings. Application of finish coatings shall be conducted in clean, dust free spray booths.

PROCESS APPLICATION

3.0. The coating system shall consist of the following:

1 coat Mil-C-8514 Wash Primer	- 0.1 - 0.3 mils thick dry
1 coat Mil-P-8585 Primer	- 0.3 - 0.7 mil thick dry
2 coats Triangle No. 6	- 1.2 - 1.5 mils thick dry each

Total dry film thickness shall be 3.1 to 4.0 mils unless otherwise specified on Engineering Drawing.

PREPARATION OF PRIMERS AND COATINGS

3.1. All paint shall be well mixed prior to use. Agitation for 15 to 30 minutes on a Red Devil paint shaker is recommended. Continuous mechanical agitation during use is mandatory.

3.2. Primers shall be thinned to spraying consistency by addition of thinner in ratios up to one to one.

3.3. Coating, Triangle No. 6, shall be thinned in the ratio of two parts paint to one or less parts thinner.

3.4. So Cal No. 1, Item 2.6, thinner shall be used to reduce Triangle No. 6 when spraying indoors. Xylol, Item 2.7, shall be used when application of coating is made in direct sunlight in the field or when ambient air temperatures are over 100° F. Xylol may also be used indoors.

SURFACE PREPARATION

3.5. All surfaces shall be clean and dry at the time of application of any organic coating.

3.6. After cleaning or surface treatment, parts must not be contaminated by handling or other means before painting.

3.7. Aluminum alloy assemblies containing faying surfaces which might retain liquids shall not be subjected to any acid or alkaline etching process.

3.8. Priming and painting shall be discontinued when the relative humidity of ambient air is greater than 75 percent or temperatures less than 50° F.

3.9. To insure that surfaces to be painted are free from dust and handling contamination they shall be tack-ragged immediately before priming or painting. Tack-rags shall be prepared by dampening a piece of clean cheese cloth with toluene.

CLEANING OF ALUMINUM SURFACES

3.10. Reflecting surfaces of panels which have been manufactured by structural bonding require only degreasing prior to wash primer application.

3.11. Wipe surfaces to be painted with clean cheese cloth dampened with toluene. Wipe dry with second clean cloth before solvent evaporates. Repeat until second cloth shows no soil.

3.12. Aluminum surfaces fabricated by riveting or welding shall be cleaned as follows unless parts have been cleaned in detail prior to assembly.

3.13. Degrease by washing with any solvent listed in Item 2 using clean cheese cloth. Remove water soluble soil by sponging with detergent Item 2.4, until clean.

3.14. Apply deoxidizer, Item 2.5, while surface is still wet from previous washing by sponging or mopping. Continue until surface appears clean and bright but no longer than 10 minutes. Remove deoxidizer with water wash and dry with clean rags.

3.15. One wet thin coat of wash primer, Item 2.10, shall be applied to all surfaces requiring paint. Dry for 30 minutes minimum before applying additional coats. When relative humidity is between 70-75 percent drying time shall be extended to 2 hours and extreme care must be exercised that primer does not blush. If blushing should occur, primer shall be removed. If primer appearance is doubtful, test for adhesion by scraping surface with the sharp edge of a piece of 1/8" thick plexiglas. If primer can be removed to bare metal, the primer shall be removed and reapplied.

3.16. Apply one full box coat of zinc chromate primer, Item 2.11, and allow to dry for 1.5 hours to 24 hours. Air dry 2 to 24 hours if air temperature is less than 70° F. Primer may be force dried for 45 minutes at 140° to 160° F. Apply final top coating within 72 hours. If primer is older than 72 hours, reactivate the surface by sanding lightly with 320 mesh or finer wet or dry paper lubricated with toluene. Dry with clean cloth and apply top coat within four hours.

3.17. The dry film thickness of entire primer system shall be 0.4 to 1.0 mils.

APPLICATION OF TOP COAT

3.18. Surfaces to be top coated shall be free from dust, dirt, lint or other contaminates. Primer which is rough or grainy shall be sanded smooth with 280 abrasive paper or finer. Remove sanding dust and shop soil with tack rags per Item 3.9.

3.19. Apply two or more cross coats of Triangle No. 6 per Item 2.8 to form a dry film thickness of 1.2 to 1.5 mils. The paint film shall be uniform in appearance and thickness.

3.20. Dry a minimum of 6 hours at 72° F and relative humdity 80 percent or less. When ambient temperature is between 50° F and 60° F, dry for 12 hours before recoating.

3.21. Apply two or more cross coats to provide a finish coat 1.2 to 1.5 mils dry film thickness. Dry for a minimum of 6 hours before handling.

TOUCH UP AND REPAIR

3.22. Clean the entire area around the damaged portion with solvent cleaners per Item 2, followed by a thorough wash with detergent and water. Rinse well and dry with clean cheese cloth. Do not recoat for 30 minutes or until surface is completely dry.

3.23. Damaged coating may be repaired by fairing the edges of damaged areas into surrounding areas with 320 mesh paper or finer. Reapply primer system per Item 3.15 and Item 3.16 when damage extends to the bare metal.

3.24. If recoating is to be accomplished in hot sunlight or ambient temperatures higher than 100° F, top coating shall be thinned with Xylol. If coating appears too dry or grainy, add up to 50 percent mineral spirits to slow the evaporation rate.

QUALITY CONTROL

4.0. The Inspection Department shall determine that cleaning and surface preparation, mixing, application of coatings and film thickness is in compliance with this specification.

In addition, they shall insure that coatings are uniform in appearance and free from runs, sags, blisters, holes, cracks, dirt, orange peal or other defects.

4.1. Adhesion shall be determined by means of a tape test as follows:

Firmly press a 6-inch piece of 1-inch paper tape per UU-T-106 to the area to be tested. After loosening one end of the tape remove it in one quick single jerk. If no paint is removed by the tape, adhesion is adequate. A slight whitening of the tape is not cause for rejection.

4.2. Total film thickness shall be measured on the concave face at each corner of the panel and over the surface, at intervals no greater than 2 feet. Film shall dry for 6 hours minimum prior to thickness measurements.

Rust bloom ?

NATIONAL RADIO ASTRONOMY OBSERVATORY

PROCESS SPECIFICATIONS

EXTERIOR PROTECTIVE COATING

FOR ALL EXPOSED METALIC SURFACES OTHER THAN REFLECTOR SURFACES

August 30, 1972

GENERAL CONDITIONS

1. All coating materials to be used, including solvents, thinners, etc., are specifically to be Sherwin-Williams products or (Wisconsin Protective Coating Corporation Products) as specified in the specifications made a part of this Scope of Work.

2. The work must be done in a manner and sequence that no coated parts will be damaged by subsequent coating operations, that is, all coated areas or parts must be protected from damage by rigging or other operations required for coating later parts of the unit; similarly, parts to be coated later in sequence must be properly cleaned of any materials splashed or dropped from previous operations.

3. No painting is to be performed when the surface to be painted is wet, nor when the air temperature is less than 50° F, nor when the relative humidity exceeds 70 percent.

4. Wire brushing for the removal of all mill scale, rust, etc., must be performed on all steel surfaces to be painted--simple <u>spot</u> brushing is not sufficient. All steel surfaces must be prime painted the same day as the wire brushing is done.

I. ALUMINUM

A. <u>Surface Preparation</u>

Aluminum Oxide provides an excellent substrate for painting materials. Therefore, the general requirements of cleanliness and dryness only need apply. Aluminum surfaces should be steam cleaned or detergent washed followed by thorough rinsing and drying.

B. Primer

Spray a wet coat of Sherwin-Williams Zinc Chromate Primer, B50Y1, reduced up to 12-1/2 percent with mineral spirits. This material is very similar to Government Spec. MIL-P-8585. Primer should be applied to obtain a minimum dry film thickness of 1.5 mils and should dry 18 hours before recoating.

C. Second Coat (Intermediate)

Spray Sherwin-Williams Metalistic Undercoat "B50A2" according to manufacturers instructions, in a manner to obtain a minimum dry film thickness of 1.5 mils. This is a white rust inhibiting primer and is recommended to insure complete metal coverage. Holidays and metal peaks provide areas susceptible to early corrosion. This coat insures complete metal primer contact and provides an ideal surface for topcoating. Intermediate coat shall be tinted with lamp black or carbon black to a contrasting shade so that complete coverage by the final coat is readily determined. Minimum time before recoating is overnight.

As an alternate to Item I-C above, Subcontractor may apply an intermediate coat of "Plasite 2050 Primer" according to the manufacturers instructions (Wisconsin Protective Coating Corporation). The minimum dry film thickness of the intermediate coat shall be 1.5 mils.

D. Third Coat

Spray Sherwin-Williams G&C White Enamel, B54WC4, reduced up to 12-1/2 percent with V.M.&P. Naphtha, in as heavy a wet coat as possible without running and sagging. Minimum dry film thickness - 2 mils.

As an alternate to Item I-D, Subcontractor may apply a top coat or coats of "Plasite 2050 Top Coat" Color White, according to the manufacturers instructions. Minimum dry film thickness of top coat shall be 2 mils.

E. A minimum of 5 mils (0.005) of dry paint thickness is required for durability. The ability to achieve this thickness will vary because of many factors: Application, thinners, surface, temperature, etc. Measurements must be made to insure proper film thickness and if this is not achieved in three coats a fourth coat (second coat of G&C Enamel White, B54WC4) shall be applied.

II. STEEL

A. Surface Preparation

Surfaces should be as clean and dry as possible. Power wiring brushing is recommended to remove all loose rust and dirt. If oil and grease are present these should be removed by solvent washing. On several areas of the steel mill

scale may still be attached. Mill scale should not be left on the surface as it is not permanently adherent to the base steel. Specifications for surface preparation should include its removal. Any stratified rust or blisters shall be removed by power impact tools, rotary scalers, or by use of power grinding equipment.

B. Primer

In order to achieve intimate metal-primer contact, Sherwin-Williams E41N1 Kromik Primer should be applied full body by brush. Although spraying under normal conditions, a full wet coat of a long oil primer will usually yield satisfactory results. Actual application methods and conditions fall far short of the ideal, and intimate metal-primer contact is not attained. Where it is not attained, the electrochemical properties are mostly lost and the physical barrier remains as the only corrosion deterrent.

1. Zinc Chromate Primer, B50Y1, may be used on the steel as well as on the aluminum surfaces, but the requirement of brushing would apply for the steel surfaces.

C. Second Coat

Same as aluminum second coat. See I-C.

D. Third Coat

Same as aluminum third coat. See I-D.

E. The same comments apply as for aluminum in I-E.

VENDOR LIST

Rockwell International
4300 E. 5th Avenue
P.O. Box 1259
Columbus, Ohio 43216

Philco-Ford Corporation
Market Operations & Planning
3939 Fabian Way
Palo Alto, California 94303

RCA Corporation
MSRD
Borton Landing Road
Moorestown, New Jersey 08057

Raytheon, Inc.
Missile System Division
Bedford, Massachusetts 01730

Radiation Systems, Inc.
1755 Old Meadow Road
McLean, Virginia 22101

ROCKWELL INTERNATIONAL
North American Aviation
Antenna Systems Div.
4300 E. Fifth Ave.
Columbus, Ohio 43216

Motorola, Inc.
1120 Connecticut Ave., N.W.
Washington, D.C. 20036

Datron Systems, Inc.
20700 Plummer Street
Chatsworth, California 91311

Lockheed Electronics Co.U. S. Highway 22
Plainfield, New Jersey 07061

International T&T Corp.
F L Communications
500 Washington Avenue
Nutley, New Jersey 07110

Hughes Aircraft Co.
Florence & Teale Streets
Culver City, California 90230

Harris Corporation
Electronics Systems Div.
P.O. Box 37
Melbourne, Florida 32905

GTE Products
1 Stamford Forum
Stamford, Connecticut 06904

Gruman Aircraft Eng. Corp.
Bethpage
Long Island, New York 11714

Goodyear Aerospace Corp.
1210 Massillon Road
Akron, Ohio 44309

General Electric Company
777 14th St., N.W.
Washington, D. C. 20005

General Dynamics
Electronics Div.
3090 Pacific Highway
P.O. Box 127
San Diego, Calif. 92112

Ford Aerospace & Comm. Corp.
3939 Fabian Way
Palo Alto, Calif. 94303

Fairchild Stratos Corp.
Hagerstown, Md. 21740

E-Systems
Antenna Structures
Garland Div.
P.O. Box 6118
Dallas, Texas 75222

ESSCO
Old Power Mill Road
Concord, Mass. 01742

Comtec Industries, Inc.
P.O. Box 250-A
Irwin, Pennsylvania 15624

Communications Technology Group, Inc.
448-T Merrick Road
Oceanside, New York 11572

Collins Radio Company
Central Bid Registry
1200 Alma Road
Dallas, Texas 75207

The Boeing Company
P.O. Box 3999
Seattle, Washington 98124

Blaw-Knox Equipment Division
~~P.O. Box 1198~~ Blaw Ave
~~Pittsburgh, Pa.~~ 15230 Blawnox, PA. 15238

The Bendix Corporation
Communications Division
Dept. 470
Baltimore, Md. 21204

Bendix Communications Division
East Jappa Road
Towson, Maryland 21204

Westinghouse Aerospace & Electronic Systems Div.
Antenna Systems
P.O. Box 746
Baltimore, Maryland 21203

Sperry Rand Corporation
Sperry Gyroscope Co.
Great Neck, Long Island, New York 11022

Scientific-Atlanta, Inc.
3845 Pleasantdale Road
Atlanta, Georgia 30340

Rohr Industries, Inc.
Antenna Division
P.O. Box 878
Chula Vista, California 92012