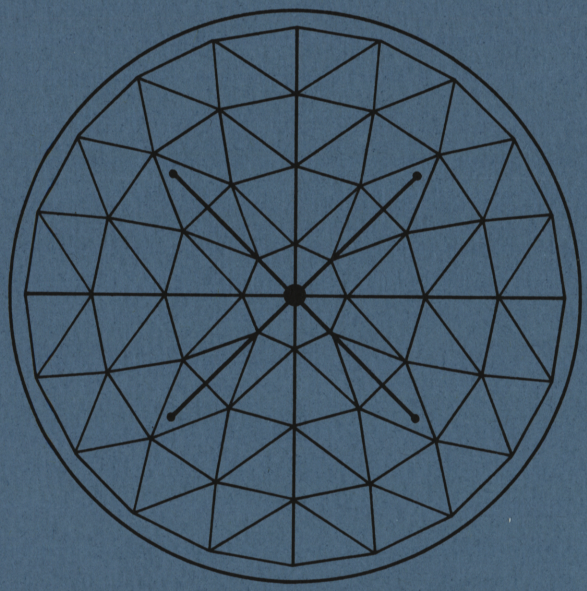

SECTION 7.0

NATIONAL RADIO ASTRONOMY OBSERVATORY
POST OFFICE BOX 2
GREEN BANK, WEST VIRGINIA 24944
TELEPHONE ARBOVALE 456-2011

PROJECT: 300 FT. DIA. HOMOLOGY TELESCOPE

SUBJECT: POSITION REFERENCE PLATFORM

APPENDIX III

7.0 SPECIFICATION (DESIGN)

PREPARED BY O. R. Heine APPROVED BY _____ SUBMITTED BY S.D.L.

7.1 GENERAL

7.1.1 SCOPE

This specification defines the performance and design requirements for the development of an "optical position reference system" for the 300 ft. dia. homology radio telescope. The requirements contained herein are based upon the functional requirements of the radio telescope, seen as a whole, of which this position reference system is a part.

7.1.2 PURPOSE

The purpose of this position reference system is as follows:

a) To provide continuous azimuth and elevation position readout in both analog and digital form.

b) To provide a continuous error signal to the drive servos of both azimuth and elevation axes for position correction.

c) To eliminate the position errors caused by wind or thermal forces or other external structural deformations or displacements of the telescope structure between the ground plane and the point of intersection of the azimuth and elevation axes.

7.1.3 DESCRIPTION

The position reference system shall basically consist of:

a) A precision, 7-sided polygon mirror. This mirror shall be located at the theoretical intersection of the telescope azimuth and elevation axis within the back-up structure of the reflector and shall be protected against the environment by means of a suitable housing. The mirror shall be mounted on a position controlled two axis platform whose axes shall coincide with the azimuth and elevation axes of the telescope. The platform and mirror combination shall be positioned in such way that the mirror remains fixed in space in respect to the ground plane and north-south direction regardless of the position of the telescope during tracking or slewing operations.

b) Seven "laser auto collimating alignment systems" which shall be evenly spaced and located on suitable pedestal on the ground. At equal distances from the theoretical azimuth axis of the telescope; the distance between the mirror and laser source shall be approximately 260 ft. The horizontal distance between the origin of the laser beams and the polygon mirror shall be such that minimum structural interference is assured (approximately 40° elevation).

c) A precision two axis encoding and reference system.

d) A collimator selector system.

e) Electronics required for control of secondary functions (temperature, signal conditioning, etc.).

f) Racks and displays to be located inside an air conditioned control building.

g) Power supplies, servo amplifiers and digitizing equipment.

h) 16 bit coarse encoders and data boxes to be mechanically coupled to the antenna axes.

7.1.4 FUNCTION

The position reference system shall function as follows: The seven sided polygon mirror mounted to the servo controlled positioning platform shall be "slaved" to the fixed signal sources (laser auto collimators) located on the ground so as to establish north-south and "level" reference planes from which the reflector position can be obtained. This shall be accomplished by using the signals generated by readout transmitters located at the platform axes for comparison and feedback purpose in combination with laser auto collimating alignment signals generated by the sources on the ground.

7.2 APPLICABLE DOCUMENTS

The following documents form a part of this specification insofar as applicable.

Wherever this specification conflicts with the below itemized specifications, standards and other publications, the requirements of this specification shall govern.

7.2.1 SPECIFICATIONS

MIL - 16910 (Ships) Radio Interference

7.2.2 STANDARDS

A.G.M.A.
J.I.C.

7.2.3 OTHER PUBLICATIONS

American Institute of Steel Construction, (A.I.S.C.)
N.R.A.O., "A 300 Ft. High Radio Telescope,"

7.3 REQUIREMENTS

7.3.1 SERVICE CONDITIONS

7.3.1.1 EQUIPMENT NON-OPERATING

The equipment shall be designed to comply with the operational requirements of 7.3.1.2 after subjection of any probable combination of ambient conditions while the telescope is in stow position.

a) Temperature

Ambient temperature range is -22°F to +122°F (-30°C to +50°C).

b) Relative Humidity

Up to 97% for an indefinite period of time.

c) Sand and Dust

Wind carrying sand and dust particles.

d) Rain

Two inches of continuous rainfall per hour.

e) Wind and Ice Loads

The equipment shall survive without permanent damage to any of its structural, mechanical or electronic components under the following conditions:

1) Average winds up to 60 MPH with 1 cm ice accumulation.
2) Average winds up to 100 MPH without ice

f) Altitude

Up to 8000 ft.

7.3.1.2 EQUIPMENT OPERATING

Within a period of one hour from a non-operating condition (7.3.1.1) the equipment shall meet the performance requirement of this specification while subject to any probable combination of the following ambient conditions:

a) Operation

Continuous.

b) Temperature

Ambient temperature in the range from -22°F to +122°F, plus the effect of incident solar radiation.

c) Relative Humidity

Up to 97%.

d) Rain

Degradation of performance acceptable.

e) Sand and Dust

Wind carrying sand and dust particles.

f) Wind

Full accuracy shall be attainable at 20 MPH average wind velocity.

g) Altitude

Up to 8000 ft.

7.3.3 LIFE EXPECTANCY

The structural, mechanical and electrical design shall be based on an expected useful life of 20 years. The power components, bearings and gear trains shall be designed to operate over a period of 5000 hours of use or a calendar (elapsed) time of 10 years (whichever comes first) with an average downtime not exceeding 2% of operating time. This shall be substantiated by means of a reliability analysis.

7.3.4 PERFORMANCE REQUIREMENTS

7.3.4.1 VELOCITY AND ACCELERATION

The equipment shall be designed for a maximum slew speed of .105°/sec. and a maximum acceleration of .33°/sec.^{2} per axis.

7.3.4.2 ACCURACY AND RESOLUTION

The accuracy of the system shall be at least ±2.6 arc. sec. R.S.S. per axis under operating conditions of 7.3.1.2. The resolution of the system shall be 2^{21} counts per revolution.

7.3.5 SERVICE REQUIREMENTS

7.3.6 MAINTENANCE AND REPAIR

Achievement of ease of maintenance, adjustment and repair shall be observed in the course of the design effort. Electronic components and subsystems shall, whenever possible, be "plug-in" type. Standard industrial components and hardware shall be used whenever possible.

7.3.7 ACCESS

Ease of access to all components and subsystems shall be a design goal.

7.3.8 MATERIAL

Materials to be used shall have adequate strength and durability and shall furthermore be fungus proof. The material selected shall be available anywhere in the United States.

7.3.9 SAFETY

The auto collimating alignment laser shall be designed and manufactured to assure minimum risk of injury from laser light. The laser beam shall not produce immediate or latent injury to the eyes of bystanders except for direct viewing into the oncoming laser beam.

7.4 CONCEPT

The concept of the optical position reference system shall in general be per S.D.L. Report H79-7 entitled "Position Reference Platform for 300 ft. dia. Homology Radio Telescope," unless otherwise described in this specification.

In addition to the precision encoding and retransmission system which are part of this reference system, mechanically coupled coarse encoders and synchro data boxes shall be incorporated on each axis so that the telescope may be positioned in case of an eventual failure of the precision system.

These coarse encoders shall have a 12 in. dia. access hole for passage of cabling and coax lines.

7.5 INTERFACE

7.5.1 POWER

3 phase, 220 V, 60 CPS. Power will be available.

7.5.2 COMPUTER

Rise and fall time of digital output signals, interrogation rate and method and signal strength shall be compatible with the digital computer to be selected by NRAO. The system shall be capable of random measurement of both azimuth and elevation angles by application of a pulsing signal.

7.5.3 STRUCTURAL

A mounting base will be provided for the platform assembly within the back-up structure of the reflector. Concrete mounting pads will be provided for the mounting of the laser auto collimating units. The design of the mounting pads for the collimators and the mounting base for the platform assembly shall be subject to coordination by NRAO project personnel.

7.5.4 ENCODER

7.5.4.1 OUTPUT

Separate output registers shall be provided for azimuth and elevation and shall retain such information between measurements of the corresponding angle. Increasing count shall correspond to increasing elevation (from horizon pointing to zenith pointing) and to increasing azimuth (clockwise as viewed from above).

7.5.4.2 VISUAL READOUT

Straight binary and decimal visual readout shall be provided for each output register. These shall be incandescent type indicators.

7.5.4.3 EQUIPMENT LOCATION

The digitizing equipment shall be located in the control room in the vicinity of the computing equipment.

7.5.4.4 ZERO SETTING

The digitizing electronics shall incorporate for each axis zero setting of the digital output through manually operated switches to any angle within system resolution.

7.5.4.5 CONTROL RACKS

The digitizing equipment for the encoding system shall be mounted in vertical enclosures using an EMCOR FR-126A frame or equivalent.

7.5.5 COLLIMATOR SELECTOR

The collimation selection shall be achieved by means of an adjustable mechanical memory (cams) and shall be "non-volatile."

The selection sequence shall be a function of both azimuth and elevation position of the telescope and shall have sufficient resolution to cover any possible combination of structural blockage of the laser beams.

7.6 ENGINEERING

7.6.1 DESIGN

The design of the optical reference system shall be performed with attainment of high reliability, maintainability and serviceability in mind. Selection of hardware and equipment shall be based on functional requirement, availability and cost, in that order. Prime consideration shall be given to maximum reliability of operational function, ease of adjustment and checkout and safety of operation.

7.6.2 ANALYSIS

Care shall be taken in the analytical efforts required for the development of the optical reference system to predict and account for important factors, perturbances, long-term drifts, etc., that could affect the overall accuracy and performance of the system.

7.6.3 DOCUMENTATION

Each analytical effort shall be submitted to NRAO for evaluation and review and shall be properly documented on vellum or other reproducible material. Related efforts shall be combined into numbered engineering reports, which shall indicate purpose, preparation date, explanation of approach, formulas used, references, etc., in a conscientious, professional manner. If computer programs are used, they shall be described in sufficient detail. Copies of input and output data shall be included in the applicable engineering report.

7.7 DELIVERABLE ITEMS

Design, detail drawings and engineering reports shall be sufficiently complete and shall include all changes made during the fabrication, assembly, testing and final installation of the system.

10 copies and one reproducible copy of the above shall be furnished.

A test procedure and maintenance manual (10 copies, one reproducible) shall be furnished.

All drawings, studies, designs, calculations and other data produced or utilized in performance of the work shall be provided to and shall become property of NRAO with the exception of previously developed background or reference data.

A comprehensive progress report, including schedules of activities, shall be furnished monthly (10 copies).

Design difficulties, labor relation problems, etc., shall be reported within three days of occurrence (3 copies).

7.8 PROJECT MANAGEMENT

The project manager assigned to this project by NRAO will direct the design contract for the optical reference system. Any proposed change of schedule, cost increase or modification of design approach must be submitted to the project manager in writing for approval prior to commencement. No change of schedule, cost increase or design modification will be accepted without prior approval in writing by the NRAO project manager.

All claims for additional costs and/or fees must be forwarded to NRAO in writing within 30 days following receipt of a written request for change initiated by the NRAO project manager.

The NRAO project manager will assign project engineers to monitor and coordinate individual tasks or portions of the design.

NRAO personnel assigned to this project shall have unrestricted access to technical information generated in the course of this design/development effort and shall have freedom to contact contractors' engineering personnel working on this project and being responsible for all or a portion of the task, for the purpose of reviewing design progress, engineering approach and for technical discussions. The work shall be considered unclassified and carried out in non-restricted areas of the contractors' facilities so that NRAO personnel will not require security clearance in order to gain access to the location at which work on this project is performed or monitored.

The contractor shall assign a project engineer as a primary contact for all efforts under contract.

All required approvals will be made in writing by the NRAO project manager; verbal approvals shall not be valid.

NRAO project personnel may include qualified outside consultants which shall be considered part of the NRAO staff.