FEASIBILITY REPORT

300 FOOT TRANSIT RADIO TELESCOPE

PART I - OBJECTIVES AND SCOPE

The ensueing report and accompanying drawings are intended to establish and present the following:

1. Definitive drawings complete to the extent that a workable structural and mechanical configuration for a 300 foot transit radio telescope is established for an instrument capable of satisfactory 3000 Mc/s operation in accordance with A.U.I. design and operating requirements.
2. An estimate of all major costs for the manufacture and erection of the instrument.

The following sections of this report will be found to contain structural computations for stresses and deflections and the sizing of the structural members, mechanical computations, weight computations, discussion of the design, estimates by this office as well as by industrial firms, and conclusions by the writer.

PART II - DESIGN SPECIFICATIONS

The following design parameters have been specified by A.U.I. for the instrument:

(a) Service conditions

Location -- Green Bank, West Virginia, 38° 26' N 79° 50' W. Elevation 2700 feet.

Ambient temperature -- Operate 0°F - 105°F. Withstand -20°F- +120°F.

Wind loads -- Operate in winds 0 - 25 MPH, with no snow or ice loading.

Be capable of moving from any position back to the stow position with a 50 MPH wind from any direction, but with no snow or ice load.

Withstand 100 MPH wind from any direction, when carrying no snow or ice load, when telescope is stowed.

Withstand a coating of 1/2" of ice and a simultaneous 50 MPH wind from any direction when stowed.

Withstand a 15 lbs/sq. foot snow load uniformly over surface when in the stow position with no wind.

(b) Sky coverage

A transit telescope with its elevation axis on an E-W line. The telescope should move 52° from the zenith towards the north, and 72° from the zenith towards the south. The design should not require deep excavation of the ground to achieve this southerly cover.

(c) Reflector and feed support

The present choice for reflector material is 5/8" x .091 aluminum squarex or equivalent.

The reflector should have an f/d ratio very close to 3/7. Thus a focal length of 128.5 feet would be reasonable.

The instrument is intended to work at 10 cm. From experience in designing the 300-foot, this criterion should be met if the following conditions are satisfied by the reflector surface and its support structure.

(i) Dish at zenith. The reflector surface should not have an RMS deviation from a best fit parabolic surface of focal length F_o of more than 0.5 cm (.197 inches). The value of F_o shall be 128.5 feet $\pm$1 inch.

(ii) Dish at any other elevation angle. The reflector surface should still have a RMS deviation from a best fit paraboloid of not more than 0.5 cm. The best fit paraboloid should have a focal length equal to F_o $\pm$1 inch.

(iii) The feed support. The feed support should carry an observing platform or enclosure about 12 feet square, with its floor about 2 feet above the focal point. Details of this will be worked out with NRAO staff.

The feed support should be capable of carrying 1500 lbs of added weight over and above both the platform or enclosure weight and the weight of the hoist in paragraph 3 (d). With this total load the focal point should not move more than 2 inches in a direction perpendicular to the dish axis, nor more than 1 inch parallel to this axis, as the telescope moves from the zenith to 72° south.

(d) Drive system

The drive should provide a variable rate from 20°/minute to 1°/ minute. The drive system chosen should permit of a servo control of the drive rate, although this servo system need not be designed in Phase I.

(e) Position indicators

The telescope position shall be indicated by digital encoder disks mounted at the elevation bearing, reading to 10" of arc digit interval. The Observatory will provide drawings on such encoders and couplings. The design should show how they will be mounted.

Although the structure will deflect,and careful calibration of the position of the radio beam in the sky will be necessary, it is desirable that such calibrations will be repeatable (in no wind, ice or snow, and with the focal point load the same) to 20" of arc.

At the judgment of the writer the above criteris has been modified as follows:

a. The snow loading at zenith has been increased from 15 p.s.f. to 20 p.s.f.

b. N.R.L. wind loading criteria for pressure distribution on the surface has been used for the computation of drive components. This data is similar to that being used by this office for wind loadings on the N.R.L. 300' Alt-Az design currently in progress. This data has been adapted from the A & W 600 foot design with the permission of N.R.L.

PART III- DESIGN

A. FOUNDATIONS

The foundation design is based upon maximum overturning mements developed by the N.R.L. wind criteria noted in Part II of this report. Rock is assumed to occur at 12.0 feet below grade (there is good evidence to substantiate this figure because of known rock elevations in the immediate vacinity.) Foundations for towers and drive pier are exceedingly massive for overturning resistance and it is also necessary to pin all foundations into the rock with long steel rods or beams grouted into deep drill holes.

B. STRUCTURE

The structural configuration presented has been so selected as to correct the obvious sources of unwanted deflections in the existing 300 foot instrument. The design presented is radically different in the following respects:

1. Dish is supported on a symmetrical back up frame which in turn is symmetrically supported by a conical structure. This configuration represents a far stronger support of the dish than the square frame design.
2. Rib trusses are all identical and have much shorter cantilever, no auxiliary ribs are used.
3. Bipod feed has approximately four times the stiffeness.
4. Towers are higher, but rim will still be required to go into about a 9 foot deep pit for declination of 72° South of zenith.
5. The center of the dish is supported on a tower rising from the bottom of the conical structure (1).

It is proposed to fabricate this instrument from ASTM-A36 with the following exceptions noted as a result of a conference with W.S. Pellini and P.P. Puzak of N.R.L. on January 20, 1964 relative

to brittle fracture as related to the design of a 150 foot alt-az antenna. In as much as the areas in question are of somewhat similar nature for both antenna the advice of Pellini & Puzak will be considered as applying.

1. Cone weldments and main bearing weldments to be fabricated from Navy HTS or Lukens LT-75 steel in normalized condition for plates of 3/4" or less in thickness.
2. For any plates in thickness from 3/4" to 2" the N.R.L. drop weight test, ASTM-E208-63T, should be specified.
3. The question of availability of heavy structural shapes in a fracture safe steel has not as yet been resolved but further meetings with Pellini (N.R.L) and Melloy (Bethlehem Steel Corporation-Homer Research Laboratory) are scheduled. Bethlehem "V" steel and U.S.S. "T-1" both appear to meet the required fracture safe criteria, but N.R.L. questions the weldability because of the presence of .02% and .04% venadium respectively.

In general, all aluminum on the structure is proposed to be alloy 6061T6 with the exception of the welded tubular structure for the feed support which shall be 5058H112, this on the advice of W.S. Pellini.

The American Institute of Steel Construction code has been allowed to govern the entire design with the exception of the areas requiring the use of a fracture safe steel.

C. DRIVE

An examination of the drive drawings shows basically the same scheme as is used on the existing 300 foot transit radic telescope. Selection of the drive motor is to be made by A.U.I. although the computations have been made to select the proper torque VS R.P.M. requirements. Deceleration is to be made through the electrical or hydraulic characteristics of the motor and a standard magnetic brake has been provided for holding purposes. All drive components have been sized to withstand maximum loadings due to wind and acceleration.

D. SURFACE

The surface suggested is completely adjustable at the time of installation and can readjusted at future dates if so necessary. This surface is much more elaborate in concept than the one previously used. The estimated cost is 2.68 times larger than the cost of the present 300' instrument. A measurement program should be conducted on the steel structure prior to setting the aluminum surface support structure.

PART IV - ESTIMATE

No.	ITEMS	
1.	Foundations	$ 77,400.00
2.	Structural Steel	1,015,000.00
3.	Feed Support	42,000.00
4.	Main Bearings	80,000.00
5.	Erect & Align Main Bearings	2,200.00
6.	Drive (Lock Device, Take Up, Chain Machinery)	106,000.00
7.	Erect & Align Drive	8,400.00
8.	Antenna Surface	268,000.00
9.	SKF Bracings 230/600 - CA	11,300.00
10.	Pneumatic System	5,000.00
		1,615,300.00

Item 1 was estimated by the writer using unit prices for the major items as supplied by W.W. Pleasants, modified to suit the applicable conditions. Item 10 was also estimated by the writer. All other prices are from estimates supplied this office by manufacturers. The price developed is believed to be accurate within 1% in as much as Link Belt Company, Bristol Steel and K.R. Wilson have all stated that they would "take an order today" at the prices they have quoted.

PART V - CONCLUSION

The material herein developed, along with the accompanying drawings, is complete to the extent that the writer can state that no major changes need be made

during the development of the entire design into bid packages. The calculated rim deflection of about .1 inches at zenith, due to a 2 p.s.f. snow load being applied, is indicative of a dish well within 3000 Mc/s capabilities. Note that if foundations can be ready for the fabricator to commence erection by 15 April, 1965, that the entire instrument including the surface can be completely erected by 15 November, 1965. It is interesting to note that, as compared to the existing 300 foot instrument, doubling the frequency has also doubled the price. If the estimate presented will fall within the budgetary limitations of the project, this instrument should be built and will perform as required.