Interoffice

National Radio Astronomy Observatory

April 10, 1981

To: H. Hvatum

From: W.G. Horne

25 METER MILLIMETER WAVE TELESCOPE
MEMO No. 143

Subject: Design and Development Tasks for 25M Projects 1981

Given the decision that project funding will not be available before fiscal year 1983 (4th quarter 1982) I have been asked to itemize and describe those areas of 25 meter project which I consider should be developed and in which design work should be performed in 1981. I shall also include at the end of the list an enumeration and discussion of certain areas of work which should be performed prior to funding but which could be convenently performed in calendar 1982.

1. Determination of wind parameters the telescope will be subjected to and the forces exerted on the telescope with the dome door open. This involves 2 separate and distinct research areas both of which are presently underway. The first involves gathering of wind data at the chosen site and wind velocity, direction, gusts and recording the amount of time and the time of occurence. The second area involves actual forces on the antenna with a given wind velocity and wind azimuth with respect to the dome opening. Data relative to the second problem is presently being gathered at Tucson and after accumlation of a sufficient amount of data hopefully we will be able to make an approximate prediction of the shielding effect of the astrodome on the antenna when the dome doors are open. As you know the present calculated antenna pointing errors due to wind are calculated based on full force of the wind applied to an exposed antenna.

2. There are several features of the antenna structure which need to be reviewed for design and manufacturing practicality. These include:

   a. The use of cables in the telescope structure should be examined carefully because of the effect of a cables very high tensile strength, inability to take any compressive strength if distortion should change its length, lower modules of elasticity than majority of telescope material, lower thermal coefficient of expansion than bulk of telescope material and totally different vibration response due to stiffness.

   b. Review of the small intersection angels of several of the joints of the lattice structure which will make fabrication quite difficult. We might consider fabricating a module of the lattice structure in Green Bank in either late 1981 or maybe 1982 just to evaluate the fabrication difficulty.

c. Configuration and mechanical assembly of the azimuth pintle bearing and the elevation bearings. The antenna design assumes certain conditions of support, restraint or freedom of motion existing at these bearings. The detailed mounting configuration for these bearings has not been worked out to assure that those conditions can be fulfilled. W.Y. Wong has been working on the pintle bearing but to date I have not seen the drawings which confirm the mounting.

3. Continuing study of surface plates, surface setting and surface plate finish should be conducted. As you are aware a measuring machine has been built at Green Bank to determine; (1) the accuracy and repeatability which can be attained for checking panel manufacturing and (2) the conditions under which panel acceptance testing must be conducted. John Findlay and Associates have proven the repeatability of the machine (very satisfactory) but I don't think John is content with a system of absolute measurements yet. This machine will be used in a continuing study of the thermal effects on panels and the thermal characteristics of different types of panels.

If we had to select a plate manufacturing method today, having no further information, studies or research, I think we would all agree that the safeest selection would be the machined cast aluminum plates. The 2 holes which exist in our cast platework are that we made one set of plates (the 65 meter Philco-Ford plates) which met our weight requirements but did not meet our accuracy requirements and a second set (the Aeronutronic Ford plates) which met the accuracy requirements but which are far too heavy. We are convinced however by our analysis that a cast machined plate can be made which will meet both the accuracy and weight requirements. It may be possible to prove this without having additional plates cast in that AUI possesses 2 cast blanks of the Aeronutronic-Ford design. I would propose that we reduce, the weight of these plates by removing material from the crossribs between rib intersections (leaving haunched ribs) and by removing additional material from surface of the plate (perhaps at G.B.) before final machining is done.

We are of course not committed to cast machined aluminum plates as the spectre of molded plates has haunted us in the past and will continue to haunt us. Logically molded plates, either of aluminum or some other material, should be appreciably cheaper then the cast machined plates. Certainly we should at least contact possible suppliers to remain aware of current capabilities in this area, in particular we must keep in contact with ESSCO as they seem to have the closest approach to our goal. John Findlay's discussion with ESSCO relative to the 36 foot (12M) work will hopefully bring us up to date on Al Cohens progress in molded plate manufacture and ESCO's chances of meeting our design goals. If indeed we go ahead with the 36 ft. reflector replacement the results of the surface plate selection for that job will certainly improve our knowledge of the proper surface for the 25 meter.

As you are aware from reading Memos 137, 138 and 139 the problem of whether to paint the surface plates or not and if painted what paint to use is still not resolved. I have contacted Mr. Henry of Triangle Paint Co., discussed with him the apparent power reflectively loss and sent to him the NPL report

on tests of the paint. He has offered to (free) study the problem, develop several paints which might answer the problem, recommend the method and thickness of application, formulate and manufacture a number of samples of paint and send them to us for application and testing. Either Mark Gordon or John Payne has told me that they have equipment of Tucson with which they could perform similar tests to those which the English performed. When Mr. Henry sends me samples of the paint I'll get test specimens painted here and send to John Payne for testing.

4. The pointing error budget needs to be finalized and a decision arrived at as to the method by which antenna position is measured. After results of the wind parameter measurements covered in (1) preceding are analyzed an assumption will be made as to wind velocity we will operate the antenna in with the dome doors open and a complete pointing error budget will be published which will include those item which I have previously pointed out as omitted. This will give the 25 meter steering committee an opportunity to evaluate the operating forecast of the instrument.

As you are aware I have expressed doubt as to the adequacy of the proposed position indicating system to provide the pointing accuracy we require. A position reference system would have several advantages in that since the reference system is related to some fixed external reference the following sources of error are eliminated.

a. The effect of thermal distortion of the azimuth base frame and towers is eliminated from the pointing error since these distortions are part of the position measurement.

b. Any mechanical wind up of the elevation shaft due to driving and wind forces are compensated for.

c. Error due to wind-up of the azimuth structure caused by friction at the pintle bearing will be eliminated, also error due to driving forces at the trucks.

d. Error due to uneveness of the azimuth track will be eliminated.

The possibility of using an inertial guidance system as a position reference system rather than the auto-collimation ground based system proposal for the 65 meter antenna results from the work done by the Draper Lab of MIT in which such a system was tested for a 48 inch optical telescope and in which peak errors of 0.3 arc second were reported with drift erros in the range 0.1 arc seconds per hour. We could calibrate or correct drift erros by use of a single fixed auto-collimetor. The design of an inertial guidance system will probably be handled best by a consultant but unless we are sure of the 25 meter it is probably wise not to expend the money at present.

As for the use of a position indicating system I am sure you recognized in the conversation between John Payne and myself a difference of opinion concerning

accuracy and resolution. Since both of us are reasonable people I am sure that John and I can get together on a common agreement as to how many bits will yield what accuracy. I have previously contacted Farrand Controls with a specification for a position transducer which meets my interpretation of the accuracy required. I haven't received a response from Farrand yet but did phone their marketing manager recently and he promised a response shortly. If we should decide to use a position indicating system the choise of a 22 bit or 24 bit transducer will need to be resolved soon.

5. It appears from my discussions with Lee and Woon-Yin that a design of the feed legs has not been done. A design should be prepared to assure that a proper error figure can be assigned to the error budget.

6. The surface setting system as presently developed by John Findlay is far enough along that success seems certain. Actual details such as a laser ranger system and certain procedural steps which I have discussed with John in a letter of April 8, 1980 remain to be accomplished or resolved but do not seem to me to be items which doubt exsists as to their applicability. We should be prepared however to provide the necessary funds and technician help to John for development of the laser ranger should he decide to proceed with it this year.

The above items are those areas of the 25 meter which I think should be targeted for design effort in 1981. As I said earlier in this memo there is certain effort which can be postponed to 1982, in particular tasks which require expenditures of appreciable sums of money. I shall list these with somewhat less discussion than above.

7. The site survey need not be performed until some certainly exists as to authorization of the project. I have notified those survey firms who I previously contacted that the project was suspended. Based on authorization for 1983 we would need to perform the survey in the 3rd quarter of 1982.

8. The Foundation investigation should be conducted in either the last of the 3rd quarter of 1982 or early in the 4th quarter of 1983 in order to complete site work prior to adverse weather and to have the foundation report available for the final design effort.

9. Study of a position reference/inertial guidance platform position system.

10. Preliminory servo design which dould be performed early in 1982 if funds are not available in 1982. Design information (weight, inertia, drive rates, required torques, stiffness, natural frequency) would be gathered for the servo design in 1982.

11. Vertex Cabin and Feed layout should be agreed to and prepared by end of 1982.