

# National Radio Astronomy Observatory

Very Large Array

24 January 1980

To: H. Hvatum, G. M. Peery

Telecopied to H. Hvatum 1/25/80

From: W. G. Horne

**25 METER MILLIMETER WAVE TELESCOPE**  
**MEMO No. 130**

Subject: Estimate of Costs - 25 Meter Antenna

Recently (approximately January 10) Buck Peery requested that if I have any comments concerning the funding plan for the 25 meter, that I get them to H. Hvatum by February 1, since there was a review scheduled about that time to which they might be applicable. I was further informed by Buck that Funding Plan No. 18 of a summary of 8/6/79 was the one which seemed to be receiving the most emphasis and to which I should address my comments.

The following comments are the result of a very limited review of the information at my disposal and will hopefully be excused if I take exception to some statements, plans or estimates which have already been modified but the documentations for which I have either not received or have not read yet. My comments will be based primarily on the estimate of costs contained in Volume II proposal dated July 1977, since that is the only document I have which breaks the estimate down by element.

## A) Engineering Costs - Antenna Design

As I understand the present planned approach to this project, It is anticipated that a contract will be negotiated for the engineering and detailed design of the antenna prior to and separate from procurement of any hardware. This design contract would include (1) the detailed design and analysis for all features of the antenna with the exception of the surface plates; (2) the preparation of fabrication and construction drawings for the antenna; (3) the preparation of procurement specifications, specification control drawings and design information needed by specialty subcontractors; (4) the preparation of assembly plans, specifications, alignment and control specifications and test and acceptance documents.

Since this contract will be only for engineering, I am fairly certain that due to the uniqueness of this antenna we will not be able to get a firm price contract for the performance of the engineering from any bidder and that we will pay for the full cost of work performed under a time, materials, burden and profit type of contract.

In reviewing the estimate, I gather that the cost of engineering was estimated at 12% of construction cost. In my opinion the use of a percentage of cost for estimating engineering for something unique

24 January 1980

like an antenna (let alone this particular antenna) can be very incorrect. Consider the following:

Average cost of a VLA antenna	\$625,000
Engineering at 12%	75,000
Cost of a VLA antenna sold to English 1977	1,100,000
Engineering at 12%	132,000
Cost of each of 2 VLA antenna sole to English, 1977	1,200,000
Engineering at 12%	144,000

Yet the contract for VLA Engineering (1974 dollars) was \$225,000 plus a servo engineering charge of \$45,000 and panel engineering charge of \$30,000, for a total of \$300,000. E-Systems actual engineering cost which they charged internally (from their project accounting sheets) amounted to \$267,000, which again does not include servo and panel engineering, making an actual engineering cost of \$344,000 (this does not include any profit). Using a 9% escalation factor would make the engineering cost of a VLA antenna something in the order of \$630,000 if an engineering contract were placed in 1980. A VLA antenna is, of course, not directly comparable to the homology 25 meter in that many features of the VLA antenna were similar to existing antennas, while the millimeter antenna will be a quite unique antenna. While it could be argued that due to the extensive analysis already performed by AUI, a contract designer's time would be greatly reduced, in fact it will not in that any prudent designer will review and confirm AUI's work, and a very large amount of design still remains to be done. In my view, what has been done by AUI to date is a conceptual design and a very good structural analysis.

As a further evaluation of the applicability of a figure of 12% of construction cost as an engineering cost, consider the case of a 65 meter antenna. If we were proposing a 65 meter antenna, the construction cost would be some 4.5 to 5 times the cost of the 25 meter (considering only the antenna). Would the engineering cost be 4.5 to 5 times as great? Obviously it would not, since we would be designing the same antenna, only the magnitude of loads, torques, weights, forces, member sizes, deflections, etc. would be changed.

Memo No. 124, dated 7/31/79, funding plan 18, carries the engineering at \$770,000 which I assume is escalation of the \$477,000 estimate of 1977 (1976 dollars) to 1981. I did a rather hurried estimate of the number of engineering hours required to do analysis, detailed engineering, design drafting, preparation of procurement specifications, preparation of assembly documents and preparations of acceptance test specifications and come up with a total of 25,450 hours of direct engineering, not including program management and clerical time which would lead to an engineering cost for antenna alone of approximately \$1,200,000. I have not reviewed the estimated engineering costs for the astrodome (I have

previously no information on it) but since it was arrived at by using the 12% figure, it might deserve some review.

The point, however, is that if I am approximately correct as to engineering costs for the antenna, it will put a sizeable crimp in your \$1,700,000 budget for the first year.

B) Costs - Servo and Controls

I have previously expressed verbally my reservations as to the adequacy of the presently planned direct mounted position indicating system with the astrodome and whether we might not have to go back to the position reference system in order to meet the accuracy requirements which will impact the cost of the servo system. I did make an estimate of costs of the servo and control, assuming the proposed system is adequate and came up with a cost of \$516,000 as opposed to the \$257,000 set forth in the 1977 estimate. It might be that I have included components which were included elsewhere in the previous estimate.

C) Four Year Funding - Reference Memo #125 dated April 4, 1979

I note that with the planned four year funding that antenna assembly is planned over a two year span (1983,1984) and that astrodome construction is planned for a three year span (1982, 1983, 1984). If incremental construction of these features is planned, we will have contractor move on-move-off problems, storage problems, equipment protection problems and painting problems. It would appear that parallel erection of the telescope and astrodome is being planned probably by two different contracts which would certainly lead to interference between the two activities with the limited space available within the astrodome.

I have not had time or information adequate to review with any degree of thoroughness the remainder of the cost estimate, but certain of the items would appear to be understated. The subreflector is set out at \$46,000 (1977), but I estimate a positioning system and mounting support at \$70,000 with a subreflector at about \$30,000, painting would appear to me to cost about \$120,000 for the antenna, maybe more if done in increments. No painting is mentioned in the astrodome section but should be included. The astrodome section estimates a crane at \$30,000 but does not set forth the requirements for the crane (i.e., vehicle mounted, lift capacity, reach, height, etc.), but the derrick presently being mounted on Transporter No. 2, which has 60 ft. reach when mounted on a base about 8 ft. above ground, is priced at \$46,000 and does not contain hydraulic reservoir or hydraulic pumps as these are on the transporter, load capacity at maximum reach is 2500 lbs. A fixed crane satisfactory for servicing the proposed antenna would cost approximately \$60,000, of truck mounted, add another \$18,000-\$24,000.

H. Hvatum  
G. M. Peery

-4-

24 January 1980

These are the first comments I have on the funding plan and estimate of costs. I will have more as I have the opportunity to review the status of the antenna project and the documentation available.

WGH/d1