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Dr. Merle A. Tuve, Director  
Department of Terrestrial Magnetism  
Carnegie Institution of Washington  
5241 Broad Branch Road, N. W.  
Washington 15, D. C.

Dear Merle:

I am glad to have your thoughtful letter on the matter of a design for the 140-foot telescope. Because we are hard-pressed to get material duplicated before the March 26-27 meeting, I too shall forego an original typed letter to you; mimeographed copies of this letter are being sent simultaneously to all those listed at the end.

First, I will dispose of a few administrative matters or arrangements. In this category, the most important item is your attendance at the March 26-27 meeting. The agenda for that meeting should be in your hands by now, and you will note that many items will require our attention in addition to a full discussion of the radio telescope program. I therefore urge that you arrange to come. Next, I have had nothing from the Foundation in recent weeks (except confirmation that the second section of the Palomar atlas had arrived), but a few days ago Bart Bok informed me of the gist of your letter to Ray Seeger, with copies to your Panel; I am glad to have the tabulation directly from you. Next, I understand your worries about a general broadcast of the Carnegie Institution equatorial design. As you suggested, I am giving one copy of your letter with complete enclosures to Dr. Feld; I have given a copy of your design also only to Mr. Karelitz. Not all things that come to me are widely distributed. For example, the proposals we received last summer from commercial firms had similar direct or implied distribution limitations; although the designs were examined by many people at the July meeting of the Steering Committee and subsequently here in the office, not a single copy has been made and distributed. You have probably noticed a copyright stamp on the Feld and Husband material recently sent to you. This was done not to limit distribution, but with the intent of giving some measure of protection to the Government if these same designs reappear at a later time, at a different place, and for different purposes.

Turning now to more technical matters, the first paragraph of your letter appears to be based on two misunderstandings. First, to be fair with Dr. Feld, he has never claimed to be a servomechanism expert. At the July meeting, when it was decided to ask him to develop a 140-foot design, incorporating many of his ideas from the 600-foot study, it was quite clear that he would estimate the required driving power, provide places for motors, design appropriate gear

trains, etc., but not the control and indicator components to make up a complete drive and control system. The letter of agreement with him specifically excluded this responsibility. You may recall that at our Monday evening meeting on December 12, Dr. Feld repeated that he was not attempting a complete system; this was again repeated at the July 13 meeting. In fact, this was one of the contributing factors in our decision to ask the MIT Servomechanism Laboratory to undertake a study for us. I hope that few people are now surprised to find that his design does not include a complete drive and control system. I might inject, at this point, that we expected something on a drive and control system to accompany both the Husband and Kennedy designs. By now you will have received a folio of material from Mr. Husband, and you note that he gives an encouraging but very brief statement of the drive and control system on page 25 of the descriptive booklet. Whilst there was no expectation that we would receive a detailed, dimensional layout for the control console, complete mechanical drawings and all circuit diagrams, I had expected a description of the system with an itemization of standard components that could be used and of those that would require special development or construction. I have written to Mr. Husband in this regard and hope to have something from him soon.

The second misunderstanding or difficulty probably results from the fact that I have been slower than I would like to be in distributing material in advance of the March 26-27 meeting. The first and second progress reports from the MIT Servo. Lab. are part of this delayed material; copies are enclosed, because the distribution of this reply to you is the same as I had planned for the progress reports. The first progress report does indeed tell me that the desired drive and control precision probably cannot be had from an analogue system. But the second report goes on to say that there are other ways to attack the problem. Almost everyone agrees that a precision of 30" could be easily achieved. On the other hand, 10" accuracy may be near the limit of our present capabilities, in view of the huge moments and unsheltered mechanism. I am not ready to abandon the 10" goal because I am continually receiving completely independent indications that the 10" goal may be reached, e.g. from discussions with representatives of two companies whose business is drive and control systems and from a recent letter from Dr. Strewinski. Bart Bok tells me that Dr. Strewinski is the outstanding designer of astronomical mounts and drives in West Germany; he is responsible for the semi-automatic system for the new Hamburg telescope that Dr. Otto Heckmann described in the November 1955 issue of Sky and Telescope. A copy of Dr. Strewinski's letter is enclosed. Note on page 3 that he believes a 10" accuracy to be feasible, and also that he is now constructing a radio telescope and will probably use a semi-automatic drive and control system for it, similar to the one he designed for the Hamburg Schmidt telescope. The latter, of course, is an equatorial instrument.

With expert engineers available to us, I would prefer to let them comment on many of the points made in your second, long paragraph and on the design (Type 7, that you credit largely to Howard

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Tatel), which appears to me to have many ingenuous features. I certainly agree, and in fact would insist that the same standards should be used in judging the relative merits of the alt-azimuth and equatorial mounts. If a structurally stiff mount and a programmed drive, without feedback, is assumed for one, we must assume it for the other. If we retain a requirement for the possibility of motion in galactic coordinates, both types require a programmer capable of coordinate conversion. If the galactic coordinate requirement is abolished (and I have heard of no need for alt-azimuth coordinates explicitly), the equatorial programmer becomes one of constant rates while the alt-azimuth programmer must still provide coordinate conversion. If we shall ask the drive and control system to supply instantaneous corrections for wind gust deflections for one mount, we must ask it for the other. If we shall ask for one type of mount that the physical center of the antenna feed be independently corrected to remain within a stipulated distance of the true focal point, we must ask it of the other type of mount. If we ask a given precision (reflector surface and tracking) of one mount, we must ask it of the other. I hope that discussions on March 26-27 will clarify some of these matters for us.

Winds produce problems for all types of mounts. I now have some frequency analyses of high speed records of winds at Oak Ridge, Tennessee, where the general terrain is more like that of the radio astronomy sites than the flat area around Brookhaven. These results are part of the material I had planned to distribute at the forthcoming meeting. I am enclosing a copy herewith.

I have written far longer than I originally intended. Our exchange of letters is certainly a good start toward better understanding and clarification of our problems (I am assuming that the other Committee members will have the patience to read all of this), but more needs to be done at our forthcoming meeting. Again, I hope you can arrange to come on March 26-27.

Sincerely,

Richard M. Emberson  
Assistant to the President.

Enclosures: Progress Reports #1 and 2, MIT Servo, Lab. Study.  
Letter from Dr. Walter Strewinski, dated 2/28/56.  
Memo on Wind Gust Frequencies, 3/19/56.

Distribution: AUI Advisory Committee  
Drs. Greenstein, Minkowski and Purcell  
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Dr. Feld  
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