July 25, 1956

Mr. A. M. Jackson, Vice Pres.
Blaw-Knox Company
P. O. Box 1198
Pittsburgh 30, Pa.

Dear Mr. Jackson:

As Chairman of the Advisory Panel on Radio Astronomy of the National Science Foundation I was instructed by the Panel at our meetings of July 12 and July 23 to indicate to the Blaw-Knox Company the fact that the NSF has made provision in its funded program for this year to underwrite the construction of a National Facility for Radio Astronomy, and that both our Panel and the officers of the NSF will be greatly interested to have an estimate or quotation from the Blaw-Knox Company on the construction of a parabolic reflector 140 feet in diameter, complete with mount, based on the "Carnegie design." It is hoped that, as a basis for initiating serious negotiations with your Company, it might be feasible for you to give the NSF a rather firm estimate or "not to exceed" price on such an instrument (within say 15%). If necessary, the firm estimate can be made on those fabricated parts of the apparatus with which your firm is especially familiar, leaving as less firmly estimated such items as cost of foundations, cost of erection and testing at the site (Greenbank, West Virginia; 50 miles south of Elkins), and details of the control console and indicating mechanisms for the direction the dish is pointing in the sky. Appropriate gears and reduction gear drives, together with hurricane stops or safety devices, should be included in your construction estimates.

As I have advised Mr. Needham, Mr. Hall, and yourself, the NSF has had difficulty in obtaining suitably firm estimates on a dish and mount of the alt-azimuth design, complete with computer and servo drives. The Associated Universities, Inc., has been handling this through several engineering firms, but an integrated design complete with servo drives, has not been worked out, in part perhaps because the initial performance specifications were too rigid. Our Panel is convinced that a "not to exceed" estimate on a 140 foot dish with equatorial mount would be exceedingly timely if it could come within the next couple of months. For most purposes an equatorial mount is to be preferred, but estimates have not been obtained because the equatorial design was considered (by the AUI) as probably not feasible or too expensive in the 140 foot size. Our discussions with Mr. Hall and Mr. Needham, as well as our own calculations, have encouraged us to believe that the general design of an equatorial mount evolved here, largely by Dr. Howard Tatel, is a practical one for the 140 foot size, and that the design of the dish itself, along the lines discussed by Tatel, Hall, and Marshall, does not call for unusual materials or extremely complicated calculations, even though the additional stiffness arising from "hoop strength

is neglected. It seems clear that with any one of several types of articulation of the dish trusses the deflections will be reduced (and strength increased) by the "hoop strength," and calculations can be made using these simple trusses and ignoring this added stiffness.

One very important provision was made by our Advisory Panel on Radio Astronomy for the NSF. The specifications used by the AUI have appeared to us as excessively tight. If Blaw-Knox can be persuaded to make an estimate it should be based on what the Panel considers realistic specifications, and the details of this we can work out with Mr. Hall. However, the Panel indicated that it would welcome an estimate or quotation based on a guaranteed tolerance in the figure of the dish of $\pm 1/2$ inch, with an expectation (based on design and construction procedures) that the figure should be as good as $\pm 1/4$ inch, but not requiring a guarantee of such a rigid specification. The figure should be within these limits for all hour angles within 30° of the meridian, and for all declinations from the north pole to the southern horizon. Similarly, the specification for the drive calls for errors not exceeding ± 30 seconds of arc, both in pointing and in following a sidereal object, but again with the built-in expectation (based on design and construction features) of reaching tolerances of ± 20 seconds of arc. Thus the quotation would be based on performance specifications considerably less rigid than the expectations of the manufacturer and designer. Our Panel recognises that construction of an instrument of this kind is a new venture for any manufacturer, as well as for the Panel, and hence specifications for performance should be considerably less rigid than the honest expectations of the designer, fabricator, and the Panel. I should add that the sky coverage should include horizon to horizon from a horizon point 15 or 20° north of a point directly east to 15 or 20° north of a horizon point directly west, and should include the north pole, of course. This sky coverage is largely a matter of the height of the foundation for the Carnegie type of mount, although attention must be paid to possible interference between counterweights and the supports.

I should also add that our Panel wishes to inquire whether this relaxed set of specifications might permit construction of an instrument 170 or 180 feet in diameter without extreme increase in costs. For many astronomical problems the increased aperture is of more importance than extreme attention to the figure of the parabola. The Panel also indicated its willingness to consider a dish with a minimum amount of compensation against gravity, if this appears highly desirable to your designers. Most astronomical objects of interest lie rather south of the zenith, and the center of the galaxy is (in this latitude) about 23° above the southern horizon, for example. It might be reasonable to incorporate some compensation against sagging, which would normally be operative (and unchanged) while the dish was pointing from 45° south down to 0° south, but which could be relaxed, stepwise or completely, when the dish is pointing closer to the zenith than 45°. Some very simple compensation procedures based on the tightening of guy wires behind the dish is an example of what was meant. It is my personal hope that compensation can be omitted and the expected tolerances still met.

If you are willing for your men to undertake an estimate of this kind, the drawings made for us by our engineering firm, Keller and Loewer and Associates, Silver Spring, Maryland, are completely available to you, along with calculations and consultation by Dr. Loewer, with whom we have discussed this 140 foot dish.

It is our sincere hope that, in addition to our expectation of proceeding on a Carnegie dish (or two) in the 60 foot range, it will be possible for you to make some firm proposals regarding the expected 140 foot construction for the NSF National Facility.

In closing, it may be appropriate for me to point out that, although the university contractor to whom the grant will be made has not yet been selected, funds are in the hands of the NSF for the purchase of an instrument such as we have described above. This is not a request for free engineering advice, nor a request to purchase the services of your engineering department, but a serious request by our Panel for actual cost figures on which such an instrument can be purchased. The legal mechanisms for bids and purchase of such a special item as this are matters with which you are more familiar than, of course, our Panel.

Sincerely yours,

M. A. Tuve, Director, Department of
Terrestrial Magnetism
Chairman, NSF Advisory Panel on
Radio Astronomy

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