

ASSOCIATED UNIVERSITIES, INC.

10 COLUMBUS CIRCLE  
NEW YORK 19, NEW YORK  
COLUMBUS 5-2090

December 30, 1957

MEMO TO: F.J. Callender  
J.J. Carroll  
J.W. Findlay  
D.S. Heeschen

← THIS COPY FOR

FROM: Richard M. Emberson *RME*

SUBJECT: AUI Advisory Committee Meeting - Saturday, January 18, 1958

1. Before Lloyd Berkner left, he reminded me that we should have a meeting of the Advisory Committee in January. I wrote to Don Menzel and suggested that we have the meeting after the week of January 13. Don replied, suggesting Saturday, January 18, in the event any of our Trustees might wish to stay on after the January 16-17 meeting at Brookhaven. So far, Leo Goldberg, Carl Seyfert, and Otto Struve have indicated they will plan to attend such a meeting, so the date is now set for the 18th, at 9:30 AM in the New York office
2. A number of things will need to be done in preparation for the meeting. Each of you should plan to attend and we will make hotel reservations for you, with the Trustees and Advisory Committee members at the Park Sheraton Hotel, 7th Ave., & 55th St.-CI 7-8000, for Friday night, January 17.
3. The Advisory Committee will like to have brief progress reports on the following:
  - 3.1 Site (acquisition, temporary space, power, etc.) - FJC
  - 3.2 Telescopes (completion schedule for 85-foot; progress on 140-foot contract) - JJC
  - 3.3 Receivers (AIL; TWT; any other instrumentation) - JWF
  - 3.4 RF-problems (Report on 10/24/57 Conference and subsequent developments) - JWF
- ④ Policy Statement on Research Programs. This document should be edited and in final form. - DSH
  - ✓ 4.1 Plans for visitors (what we can offer next summer and fall)-DSH

Dr. Neastor

ASSOCIATED UNIVERSITIES, INC.

10 Columbus Circle  
New York 19, New York

February 3, 1958

MEMO TO: AUI Trustees' Committee on Radio Astronomy  
AUI Advisory Committee on Radio Astronomy

FROM: Richard M. Emberson

SUBJECT: NSF Reply to Resolutions Adopted January 18, 1958

1. At the January 18 Meeting of the AUI Advisory Committee on Radio Astronomy, three resolutions were adopted concerning programs related to the (a) 85-foot and 140-foot telescopes, (b) a Very Large Antenna, and (c) a space station. These resolutions were forwarded by telegram on January 20, 1958; a reply from the Director of the National Science Foundation has been received and is attached for your information.
2. A staff meeting was held with the NSF on January 31, at which time we were advised that Dr. Detlev W. Bronk, Chairman of the National Science Board, was establishing an Ad Hoc Committee of that Board to consider the Very Large Antenna and other matters related to the development of the National Radio Astronomy Observatory. The Ad Hoc Group was tentatively scheduled to meet February 10 or 11th.

Encls.  
ATW Ltr 1/29/58  
to RME

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NATIONAL SCIENCE FOUNDATION  
Office of the Director  
Washington 25, D.C.

January 29, 1958

Dr. Richard M. Emberson  
Assistant to the President  
Associated Universities, Inc.  
10 Columbus Circle  
New York 19, N.Y.

Dear Dr. Emberson:

I appreciate your telegram of January 20, passing on to me the actions taken by the Advisory Committee of Associated Universities, Inc. with respect to the Radio Astronomy Observatory at Green Bank, West Virginia, and studies which the Advisory Committee feels should be initiated at an early date.

The National Science Board discussed in some detail the proposals which you have submitted for additional funds in connection with the construction of the Radio Astronomy Observatory. The Board was concerned that no additional funds be requested other than those needed to complete construction of the 140-foot telescope and the buildings and equipment required to assure the effective operation of the 85-foot and 140-foot telescopes. The Board authorized Dr. Bronk, Chairman of the Board, and me to submit a request to the Bureau of the Budget for additional funds with the understanding that the amounts proposed will be based on the above-stated considerations.

I think you can understand that the Board did not have the opportunity to discuss in a comprehensive way the suggestions of your Advisory Committee for studies which they feel to be necessary. However, these suggestions will be considered carefully by the Foundation staff and I will give you further information concerning our reaction to them at a later date. I believe you are aware that the Board had previously authorized me to consider with AUI the need for studies to determine future facilities requirements in order for this country to maintain leadership in radio astronomy and related fields. I will look forward to discussing this with you at some time in the near future.

Sincerely yours,

orig/sgd by Alan T. Waterman  
Director

Dr Heesch

file

ASSOCIATED UNIVERSITIES, INC.  
10 Columbus Circle  
New York 19, New York

March 27, 1958

Minutes of the Meeting of the  
AUI Advisory Committee of the National Radio Astronomy Observatory  
Saturday, January 18, 1958

The Committee met at the AUI office, 1750 Coliseum Tower, at 9:30 a.m., Saturday, January 18, 1958. Those present for all or part of the meeting were:

- |                |                                |
|----------------|--------------------------------|
| L.V. Berkner   | D.S. Heesch                    |
| F.J. Callender | G. Keller                      |
| J.J. Carroll   | F.A. Long                      |
| C.C. Chambers  | P.S. Macaulay                  |
| F.D. Drake     | *C.H. Mayer (for E.F. McClain) |
| R.M. Emberson  | *G.C. McVittie                 |
| J.W. Findlay   | *A.B. Meinel                   |
| L. Goldberg    | *D.H. Menzel                   |
| *W.E. Gordon   | E. Reynolds                    |
| *F.T. Haddock  | C.K. Seyfert                   |
|                | O. Struve                      |

Dr. Menzel opened the meeting with the announcement that Dr. Berkner had some general introductory remarks. Dr. Berkner indicated that the AUI Trustees had decided to place the Committee on an October-to-October basis, as is true of all other corporate organizational affairs, rather than on a calendar-year basis. Further, he asked Professor Menzel to continue as Chairman until October, 1958. He then proceeded to discuss two matters of great importance to the future of the National Radio Astronomy Observatory, and indicated that he would like to have comments from the Committee before the close of the day.

First, he mentioned the very large antenna, which had been discussed briefly at the May and October meetings of the Committee, and which was on the agenda previously distributed for this meeting. Second, he noted that there was a high probability that the Federal Government might establish a space agency this year which would be responsible for satellites, rockets and similar space problems. He continued with the observation that the space agency would probably assume responsibility for the design of the necessary facilities and for the launching of satellite stations, but that it was highly doubtful that the space agency would or should undertake the instrumentation of the space stations for the various kinds of research that might be carried on with such facilities. It was his thought that

the astronomers should take some specific action in planning for the utilization of space stations, and he believed it timely to introduce this new matter and to request comments from the Committee. This introduction evoked a lively discussion that continued for almost two hours.

It was the consensus that such a space station would permit observation of the complete electromagnetic spectrum, as well as the corpuscular radiation, and that with proper design and engineering, there were no apparent limitations on the size of the antenna systems that could be employed. There were numerous suggestions that a comprehensive study should be made of these possibilities, in addition to the desirability of a number of individual studies of the experimental equipment that might be employed. During the luncheon break, a resolution was drafted. This was reviewed in detail, and after a few additional revisions, was unanimously adopted by the Committee in the following final form.

Resolved: The Advisory Committee of the National Radio Astronomy Observatory has discussed the trends of astronomical research from stations outside the earth's atmosphere. Satellite platforms, instrumented by optical, radio and other techniques, offer unprecedented opportunities for astronomical research. The development of space vehicles makes possible the study of scientific phenomena completely unobservable from the surface of the earth. The full spectrum of electromagnetic radiation, from x-rays to long radio waves, becomes accessible. The corpuscular component of radiation likewise becomes available for direct study.

Professor Menzel returned to the prepared agenda and Mr. Callender reported on the status of the site acquisition and development. As of January 1, 1958, we had legal possession to 1500 acres, and access to the entire site of 2600 acres. It is expected that legal title will be had to the entire site by March 1, 1958. Six families are still living on the site and it is expected that they will move away during the coming summer. It appears that the total acquisition costs will not exceed the \$650,000 earmarked for this purpose. Ten buildings will be renovated on the site; two have already been completed, namely the Field Office on Route 28, and the Moro Beard house near the site of the 85-foot telescope. Drs. Findlay and Heeschen have moved their laboratory to this new location. Other houses will be renovated to provide temporary living quarters. It is expected that by September a guest house will be ready with dormitory quarters for at least six persons.

Mr. Carroll reported that the 85-foot telescope was progressing according to schedule with the Blaw-Knox Company, and every expecta-

tion is that the telescope will be completed by mid-July, 1958. A contract for the control building and the foundation has been let separately by AUI. This latter work will be completed by late Spring, and in advance of the Blaw-Knox erection schedule.

Mr. Carroll reviewed briefly the nine prime proposals received on the 140-foot telescope, and the fact that after lengthy conferences, it had been determined that the best and most advantageous proposal was from the E.W. Bliss Co. for a total of \$4.75 million. Inasmuch as this exceeded the available funds, the National Science Foundation had authorized our proceeding with a two-step contract, the detailed engineering and shop drawings to be prepared for \$145,000; the option for the fabrication and erection of the telescope to be contingent on the availability of sufficient funds. Dr. Berkner pointed out that the NSF Board, in taking this action, had understood that drastic modifications in the design would have been necessary if we had attempted to construct a telescope with existing funds, and the Board had decided that we should go ahead with the excellent design now at hand. He further reported on the development of an improved drive and control system that would enhance the value of the telescope as a research tool.

The Committee reviewed the summary budgets that had been submitted to the NSF. It included the following items: for site acquisition and development, a decrease of \$113,000 over FY 1957-58 estimates; for buildings (laboratory, work area, etc.) other than telescope construction, an increase of \$1.189 million; for the radio telescopes receivers, rf- and other electronic equipment, an increase of \$4.155 million; for other Observatory equipment, including office, housing, furniture and machinery required for maintenance of the site, an increase of \$174,000; for architect-engineer services not previously budgeted, \$150,000. In discussing this matter, the Committee was further advised that approximately \$3 million was still available from previously appropriated funds; that in addition to the \$4.75 million lump sum figure quoted by E.W. Bliss for the 140-foot telescope, other non-contract items, such as the AUI engineering work, inspection and tests, provision of stand-by generator, etc., would bring the total cost of the installation, plus all necessary auxiliary provisions and facilities, to \$5.249 million. The provision for receivers and other electronic equipment would be \$530,000. Concerning the proposed buildings on the site, Professor Haddock raised the question of the need for housing and a cafeteria. This evolved into a discussion on the estimated growth of the staff and the number of scientific visitors at Green Bank. The consensus seemed to be that the estimated trend and levels were all right, but that the dates attached to the specific values might be in error by one or two years. The Committee adopted without dissent, and with Professor Haddock abstaining, the following resolution supporting the 140-foot telescope program, and specifically, the budget required for the tele-

scope and auxiliary equipment, and for the site development:

Resolved: The Advisory Committee of the National Radio Astronomy Observatory strongly endorses the appropriation of the funds necessary to complete the 140-foot radio telescope. To make the scientific equipment of the National Radio Astronomy Observatory effective in the extreme isolation of Green Bank, West Virginia, the Committee also urges that construction of the supporting Observatory facilities, i.e. laboratories, living quarters, shop facilities, etc., be started at once. Without these facilities, efficient maintenance and operation of the National radio telescopes will be extremely difficult and their use by visiting scientists seriously restricted. Also, a significant reduction in aggregate costs can be realized if these supporting facilities are constructed simultaneously with the major scientific equipment, instead of in a series of separate smaller undertakings.

Dr. Findlay reviewed briefly the status of the rf equipment and receivers on order for the telescopes. The Airborne Instruments Laboratory hydrogen receiver, covering from 1170 to 1420 mc/s at \$29,000 is moving ahead on schedule, and it is expected to be completed by the end of May, 1958. A traveling-wave-tube receiver has been ordered from the Ewen-Knight Corp. This receiver, which will operate at approximately a 4 centimeter wave length, with a bandwidth of 1000 mc/s, and capable of detecting signals of  $0.01^{\circ}\text{K}$ , will cost \$72,000. The receiver is scheduled for August, 1958 delivery. The horn feeds being designed by Mr. Henry Jasik would permit the operating schedule on 4 and 21 cm to be conducted with an absolute minimum of lost time during change-over from one experiment to the other. At this point Dr. Heeschen noted that the National Radio Astronomy Observatory would be ready for visitors on the 85-foot telescope next Fall. This led to a discussion on procedures. Dr. Findlay pointed out that if a visitor wished to bring equipment of his own, some advance arrangements would be necessary, and probably it would be desirable that someone from the NRAO inspect the visitor's equipment well in advance, in order that any necessary adaptations might be completed prior to moving the equipment to Green Bank.

In response to questions from several Committee members, Dr. Heeschen indicated that Messrs. Lilley, Field, Menon, Fleischer and Weaver had indicated interest in 21-cm observations at the NRAO, and Mr. Mayer had indicated interest in 4-cm observations. Concerning his program with the traveling-wave-tube receiver, Mr. Drake reported that he planned to spend most of the first year with measurements of the positions and absolute fluxes of radio sources. For the

final positioning, the position-indicating equipment to be supplied by Blaw-Knox would not offer the desired precision, and an auxiliary system incorporating inductosyns will be added. Messrs Haddock and Findlay discussed the desirability of standardization of all flux measurements at the NRAO, and the desirability of the construction of a series of horns and intermediate-size reflectors for calibrating purposes.

Dr. Findlay briefly discussed the longer-range rf problems of the Observatory. He indicated that he had plans for studying primary feeds of paraboloids, and the effect on side lobes of the feed supports. He mentioned that some work on these subjects was already underway at other institutions. Professor Menzel suggested that a cooperative study be initiated on a broader basis, to which support would be contributed by several institutions interested in radio astronomy. He emphasized that the existing radio telescopes were suffering because of the deficiencies of the present feed systems. Dr. Findlay indicated that the proposed cooperative study at a \$50,000 level could not receive much support from the limited funds now available at the NRAO for such work. The Committee took no position on this matter, and the matter of cooperation was left to independent initiative among the interested parties.

Dr. Findlay described the monitoring truck being designed for the Observatory. Professor Haddock pointed out that such mobile equipment could be of great value to other institutions, both to survey sites that might be selected, and also to standardize sites now in operation. In reply to the question from Professor McVittie, Dr. Findlay said he hoped the truck would be ready by the end of the summer of 1958.

In conclusion, Dr. Findlay reported that Professor Kraus had had considerable success at Ohio State in the application of photogrammetric methods to the survey of parabolic reflectors. It is believed, however, that the work at Ohio State is consistent with the earlier NRAO findings, and that if the photogrammetric methods were scaled up to the 140-foot telescope, the precision would not be sufficient for the overall 1/4" tolerance expected for the reflector.

Dr. Heeschen reported that the Policy Statement on research at Green Bank had been circulated with the minutes of the October meeting of the Committee, and that no comments had been received. He therefore proposed that the document be edited and published in its present form. It was suggested that the statement might be published in some or all of the following journals:

Astronomical Journal	Science
Sky & Telescope	Physics Today
Publications of the Astronomical Society of the Pacific	

The Committee further approved the list of U.S. radio astronomy activities given in Appendix B of the October minutes. The consensus was, however, that this list should not be published.

The Committee next turned its attention to suggestions for a very large antenna at Green Bank, which was the second matter on which comments had been requested by Dr. Berkner in his introductory remarks. The consensus was that such an instrument should be built. Dr. Berkner outlined his thoughts on the best procedures, namely that several independent studies should be initiated promptly, with the expectation that these studies would provide general comparisons between the many possible structural and electronic solutions that would be equivalent to a paraboloid, 1000 or more feet in diameter, and capable of tracking celestial objects at or near the zenith. He hoped that the results of the survey studies would be available by April, 1958, and that after review, engineering studies could be initiated on the most promising ideas. He explained that members of the AUI staff were working with Mr. Lilley at Yale University on one such survey study. He further indicated that he had had conversations with members of the National Science Foundation staff and that the entire program would, of course, have to be subject to NSF approval and the provision of the necessary supporting funds.

Professor Haddock pointed out that he felt it would be very unwise to limit the equivalent aperture to a 1,000 foot diameter. He noted that present observational information at 21-cm indicates that the limitations imposed by the earth's atmosphere were not reached until the aperture was almost a mile. The Committee members conceded that some minimum specifications for design parameters (e.g. the wavelength band for which the antenna would be effective, the diameter or aperture and the sky coverage) might be desirable, but the members were not prepared to establish minimum specifications. It was suggested that an ad hoc group be formed under the chairmanship of Professor Haddock to review research requirements and attempt to arrive at the suggested specifications. It was further suggested that the membership of the group might be drawn from Messrs. Gold, Bolton, Swenson, Kraus, Stanely and Trexler, in addition to the members of the Advisory Committee. The Committee then unanimously adopted the following resolution concerning the very large antenna program:

Resolved: The Advisory Committee of the National Radio Astronomy Observatory has reviewed the plans for the Observatory and the steps towards its establishment. The Committee unanimously concurs that the Observatory must be provided with a very large antenna. The Committee is aware of the time required for the study, design, and construction of such equipment and, therefore, strongly urges that steps toward the very large antenna be initiated

without delay. An ad hoc committee, under the chairmanship of Professor Fred T. Haddock, University of Michigan, has been appointed to outline the problem. The Advisory Committee recommends that the National Science Foundation make available sufficient funds for the survey, to carry out feasibility studies, and eventually to yield the alternative preliminary engineering designs, that will form the basis of comparative performance and estimates of construction costs.

Dr. Findlay advised the Committee that the FCC was favorably inclined to establish a protective zone, such that pre-consultation with the NRAO would be required of all persons applying for transmitting licenses within the zone. It is possible that the FCC will establish a single zone that will encompass both Green Bank and the Navy's installation at Sugar Grove, approximately 35 miles east of Green Bank. He further reported that a CAA plan to establish an airline ground station at Buckeye had been modified, and that the station was now planned for Manning Knob, approximately 25 miles further to the west and south. This planned station would be at a greater distance than the airport at Elkins, and it is hoped that there would not be any interference from this ground station, but tests were scheduled for late Spring. Whether or not airplanes flying over the check station will cause interference remains to be seen. Reference was made to the 1959 international conference on the allocation of radio frequencies. The Committee members expressed interest in this matter, but no action was taken.

Professor Menzel adjourned the meeting at about 4 p.m.

cc: AUI Trustees  
All attendees  
Advisory Committee