Interoffice

National Radio Astronomy Observatory

Very Large Array

January 9, 1981

To: H. Hvatum

From: W. G. Horne

Subject: Upgrading the 36' Reflector

In the fall of 1980 you requested that I (with the support of other AUI engineers) review the possible outfitting of the 36' telescope in Tucson with a Leigton or Leighton type reflector with the objective of upgrading the performance of that telescope. As you know, after some perturbations it has seemingly become apparent that Leighton does not have a reflector which he can make available to NRAO. In order to make an evaluation of Leightons reflector however, Lee King and I on Nov. 14 met with Bob Leighton and secured from him the necessary data concerning configuration, weights and member sizes to perform a computer analysis of the reflector. Lee has now completed an analysis with respect to gravity and temperature effects of the Leighton reflector (summary attached). It will be noted that no wind effects are included as we have made assumption that wind effects will be quite similar for various types of structure and have performed no wind analysis.

Some comments on the summary might be appropriate. It will be noted that the existing 36 ft. reflector would seem to perform better than either Leightons reflector or the 1972 design of NRAO with respect to gravity (total of 32 microns versus 86 microns and 91 microns) which is not really surprising when one considers the rigidity contributed by the solid surface plate of the existing 36 ft. The manufacturing inaccuracy, long focal length and thermal response are the factors which make replacement of this reflector desirable.

You will note from the summary the variation between the gravity effects as calculated by Leightons program (4b.) and as calculated by Lee King (4c). Without making a value judgement I would simply say that based on performance vs analysis of existing NRAO antennas I would trust Lee's analysis. I would also suggest that we not express widespread comments on Leightons analysis other than to Leighton himself. Some of our analysis, particularly that respecting pointing error due to thermal differentials, may be useful to Bob. You will note that the RMS change due to thermal differentials of Leightons dish is not particularly bad. I have included as attachments 2 and 3 the diagrams showing how the thermal differentials were applied. In the thermal analysis a 5°F differential has been used arbitrarily, quite likely for desert or high mountain locations with the light members used in Leightons configuration a greater thermal differential can exist.

As can be seen from the summary of surface errors a Leighton dish (if one were available essentially without fabrication charge) would improve the surface of the 36 ft. and if consideration were given to time of operation and source position in order to reduce the impact of thermal pointing errors I would recommend the installation of such a dish on the 36 ft. mount.

Since however, a Leighton dish is not available without charge I would not recommend the procurement at AUI expense of this type of dish. You will note from the surface RMS error table that the advantages of such a dish are limited to two elements (1) Panel manufacturing, and (2) Panel setting, and even in panel setting since the panels must be removed for surface skin installation and for transportation to the site I would question the use of zero error for panel setting of a Leighton dish.

My recommendations then are that if it is desired to replace the existing 36' reflector we design our own reflector structure to fit the existing pedestal and elevation wheel, that we plan on using cast aluminum machined panels of the type procured from Philco-Ford as the reflecting surface element and that we design a feed support structure to fit the proposed new focal ratio of approximately 0.43.

The disadvantages of procuring a Leighton type reflector for installation on the existing 36' pedestal are as I see them (and based on NRAO paying full cost for either reflector chosen) are:

1. The necessity for providing an adapter structure between a Leighton reflector and our existing mount.
2. A Leighton reflector fabricated by a commercial fabricator would require that either NRAO or someone else prepare extensive design engineering drawings prior to fabrication since such drawings evidently do not exist.
3. The fabrication by a commercial fabricator will be more expensive because of the greater number of members required, the more complex joints involved, the smaller size of the members involved and the somewhat greater number of different types of members.
4. The sensitivity of the Leighton dish to thermal differentials with reference to both surface RMS and pointing error which would require NRAO to curtail or modify its daytime operation of the antenna.
5. The more extensive tooling required by the reflector fabricator since the reflector must be used (rotated) to manufacture the reflector panels where as cast aluminum panels can be cast and machined by a different subcontractor. Time might be a factor here as the reflector manufacture and assembly and panel manufacture are sequential operations whereas with a standard reflector using cast panels the manufacturing operations are parallel. Either surface requires panel installation and alignment to be done in the field.

Engineering tasks which must be done should the decision be made to replace the existing reflector with a new one consists of the following:

1. Measurement of azimuth and elevation natural frequencies of the existing telescope.
2. Configuration and control drawings of the proposed antenna prepared.
3. Design and specifications prepared for the surface panels for the new antenna.
4. Structural analysis and design drawings for the new reflector structure prepared.
5. Feed support structure, feed mounting arrangement design and design drawings prepared.

6. Present drive and servo analyzed for the new configuration and any drive changes designed and specified.
7. Counterweight changes determined.
8. Necessary contract specifications prepared for procurement purposes.
9. Performance specifications for the new antenna prepared.
10. Field installation and alignment plans and specifications prepared.
11. Review of performances of present dome and cover.

c.c. Lee King
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