NATIONAL RADIO ASTRONOMY OBSERVATORY
Tucson, Arizona

March 8, 1982

MEMORANDUM

TO: P. R. Rhodes

FROM: M. A. Gordon

SUBJECT: The Story of the Azimuth Bearing of the 36-ft Telescope

For years, I've heard conflicting stories about the azimuth bearing. Here's a history pieced together from conversations with Ned Conklin, George Grove, Bill Horne and Hein Hvatum.

I. History:

The azimuth bearing was made especially for the 36-ft telescope by the Kadon Corporation, according to specifications provided by the Rohr Corporation.

During the initial testing of the antenna, someone noticed that the bearing was not moving as expected. (Hein recalls making a flippant remark about the assembler not putting grease into it.) NRAO's John Hungerbuhler later tried to put grease into the bearing and discovered that grease went in but none came out! Evidently, the bearing had not been packed properly.

Rohr Corporation subsequently flushed the bearing and repacked it with the proper lubricant. The flushing process showed grit, some paint flakes, but no metal particles--according to Bill Horne. Measurements of tilt angles and run-out showed that the bearing probably had not been damaged.

Also during this time, the bearing's rotational drag occasionally mysteriously increased. An engineering inspection by Rohr's Cecil Bainbridge showed that the cause lay in the heating of the inner race by the azimuth torque motor. A corresponding heating the outer race solved that problem.

Because NRAO believed that the bearing might have been damaged, they purchased a spare azimuth bearing from Kadon. This has been checked but never used.

In 1972, Ned Conklin and Gene Wetmore were concerned about what they believed to be poor drive performance in azimuth. NRAO's Duane Madron (who had been employed by Rohr during the telescope's construction) came from Green Bank to flush and repack the bearing again. Also at this time, he removed the azimuth torque motor and sent it to Pennsylvania for inspection. The factory found it to meet the design specifications and sent it back for reinstallation.

II. Should the Azimuth Bearing be Replaced?

Bill Horne tells me that the principal design criterion for this bearing is stiffness. Rohr specified that the bearing exhibit minimal angular deflection against a turning moment in the vertical plane. This specification leads to a bearing capacity perhaps 10 times that required by the gravity thrust loading and the rotation speed of the telescope. Because the lifetime of a bearing varies approximately as the cube of the relative load and speed factors, the lifetime of this azimuth bearing is theoretically many times that of the telescope itself. In short, the bearing should never wear out in normal use.

Bill also noted the phenomenon of "infant mortality" in bearing lifetimes. For reasons not understood (but well-documented), something like 10% of bearings fail in the first 5% of their theoretical lifetimes. The present bearing has survived this critical period. Hence, replacement of the present azimuth bearing would expose the telescope to a new risk of failure from infant mortality of the new bearing.

Evidently, measurements of bearing run out, variations in angular tilt, and in drag are all that are required to check a bearing's performance. Tests of our azimuth bearing show it to be operating properly.

III. The Azimuth Pointing Problem:

Our major motivation for changing the azimuth bearing arose because of the azimuth pointing characteristics of the telescope. For years the pointing corrections for the 36-ft telescope have changed abruptly and unpredictable once or twice each year. The change occurs primarily in azimuth and does not appear to be correlated either with season or with temperature.

Bill Horne told me that this effect may be a result of a loose or broken hold-down bolt for the azimuth bearing. The British have recently experienced this effect with one of their VLA-type antennas. In short, he felt that the effect could indeed be associated with the azimuth bearing, but in the hold-down system rather than internal to the bearing.

IV. Conclusion:

There appears to be no reason to change the azimuth bearing during the resurfacing of the telescope. In fact, changing the azimuth bearing could introduce risk because of the infant mortality phenomenon. A more likely cause of the abrupt change in the pointing corrections is a loose or broken bolt.

c: W. G. Horne
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