NATIONAL RADIO ASTRONOMY OBSERVATORY
SOCORRO, NEW MEXICO

VLBA Antenna Memo Series No. 49

Recommended Strategy for VLBA Elevation Bearing Replacement

Mark McKinnon, Jon Thunborg, Jim Ruff

OCTOBER 17, 2003

SUMMARY

The elevation bearing on the VLBA antenna in St. Croix failed because of an excessive axial load on the bearing. The axial load was most likely induced when the bearing was first installed. The condition of elevation bearings on all VLBA antennas will continue to be monitored by collecting bearing grease samples on a routine basis. Bearings showing excessive wear will be replaced with a bearing that is designed to accommodate both axial and radial loads.

BEARING FAILURE MODE

During a maintenance visit to the St. Croix VLBA antenna in March 2003, metal flakes were found in grease samples taken from the "condenser-side" elevation bearing. The damaged bearing was successfully replaced during a subsequent maintenance visit in July 2003. The details of the bearing replacement procedure are documented in VLBA Antenna Memorandum 48 by Jon Thunborg.

The elevation bearing on a VLBA antenna is set inside a pillow block, which is bolted to the antenna's elevation platform. The bolt hole slots in the pillow block and elevation platform are parallel to each other, but perpendicular to the antenna's elevation axis. At the time an elevation bearing is installed, this geometry can accommodate a slight misalignment of the pillow block and elevation platform perpendicular to the antenna's elevation axis, but requires their precise alignment along the axis. In practice, the precise alignment is difficult to achieve because the antenna's elevation axle must also be inserted in the bearing as the pillow block is installed. As the pillow block is secured to the platform by tightening the bolts, any inevitable, slight, axial misalignment causes an axial load on the elevation bearing, which is designed for radial loads only. Inside the bearing, the axial load forces the inner set of bearing rollers into the center flange that separates the two roller races, breaking the flange in the process. The metal flakes found in the bearing grease are pieces of the center flange.

In retrospect, the bolt hole slots in the pillow block should have been cut perpendicular to those in the elevation platform. This slot geometry would give more flexibility in the bearing installation process, accommodate any misalignments both perpendicular and parallel to the antenna's elevation axis, and minimize the axial load on the elevation bearings.

The elevation bearing at Los Alamos failed in a similar manner in 2001. Since all VLBA antennas are basically identical, we can expect similar bearing failures at other VLBA antennas in the future.

STRATEGY FOR BEARING REPLACEMENTS

The recommended strategy for replacing elevation bearings is to continue monitoring bearing grease samples and to replace those bearings that show excessive metal flakes in the grease samples. The replacement bearings will be of a new design that can accommodate both axial and radial loads (e.g. a CARB bearing manufactured by SKF). This strategy extracts maximum use of the existing bearings and minimizes bearing replacement costs. The cost of a bearing replacement is dominated by travel, labor, and equipment rental. The cost of a bearing is about $2.5K, while the cost of a typical maintenance visit ranges between $15K and $25K, depending upon the site.

A very aggressive program to replace bearings or to modify the antenna pillow blocks is not warranted at this time because bearing wear can be detected prior to a catastrophic failure. For example, the grease samples taken at St. Croix suggested that the bearing was damaged, but the antenna showed no degradation in its pointing performance.