

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia 22903

December 5, 1984

MEMORANDUM:

TO: VLBA
FROM: H. Dill
SUBJECT: Model 22 Refrigerators

On November 26 I visited the CTI plant in Waltham, MA. In addition to opening a new line of communication with CTI, I was able to check on the progress of the four units we had returned for rework. There were three basic meetings between myself and CTI. The first with Leon Audette, Quality Control, involved a plant tour and introductions. The second was with Jim Harrington, production engineer for the Model 22, where we discussed the status of the current units and his findings. The third was a quick meeting with John Harvell, Product Manager, and Don McLean, Manager of Product Services, where we discussed service options.

The four units that we have returned to CTI plus a unit from Bendix are being evaluated and reworked by the Production Engineering group rather than Field Service. This will allow Production to analyze where the unit needs improving. Jim Harrington is responsible for this task. He is keeping records of the units returned, their initial conditions and reworked conditions. This data pertaining to our first four units should be available in the next few weeks.

Harrington covered several topics including our mounting, our assembly and testing procedures, the yoke drive situation and some specifics of the Model 22. Two of our units and the Bendix unit will be completed early this month; the remaining two units require mounting rework.

Our original mounting required modification of the mounting plate. This created problems for CTI in testing and may potentially create problems for our units. It is in our best interest to change the mounting to one similar to CTI's recommended mounting. The one exception is to use a slightly larger o-ring to reduce the chance of leakage. The mounting modification will also be done to the older units already in the field.

CTI stressed several service and assembly points after examining our returned units. One of the units had a damaged yoke bushing and yoke pin from using a hammer and punch to remove the yoke pin. CTI recommends the use of a pressing action tool as opposed to an impact tool. CTI also heats the head assemblies, 250 F, to press new bushings in place. This compresses the bushing and allows for a tighter tolerance between the bushings and the shaft. They also do fairly extensive testing of the units during assembly. These include pressure leak tests and timing tests.

The shaft and bushing situation has been studied by CTI. They have tightened the tolerances on the bushings and also corrected many of their drawings to reduce potential tolerance problems. The top radius of the shaft has been corrected to reduce wear. CTI cautions against seating the top bushing since the lower part of it becomes unsupported and prone to breakage due to stress concentrations.

CTI is aware of the other options for bushing materials, but they first want to determine what is causing problems with the carbon bushings. The new carbon bushings will have tighter tolerances and have a better fit with the shafts. The shafts are being better inspected to conform to the proper finish. The alignment is being checked and CTI is investigating line reaming the bushing.

The heavy bushing wear in the Model 22 is due in part to its drive system. The Model 1020 drive loading is designed to pass through the axis of the drive shaft. This creates a two point, side-to-side loading. As the shaft wears against the bearing, it seats itself to reduce unit area loading. In the Model 22 the drive loading is offset from the drive shaft axis. The shaft is always in contact with the bearing as the load shifts from side to side. As the tolerance between the shaft and the bearing opens, the contact area becomes a moving line of contact which can never seat itself. If the unit loading is great enough, increased by misalignment loading, then rapid wear will take place.

Berkeley has been using Model 21's on their telescopes for three years now. They are still getting 15 months of running time for their units. Servicing of the Berkeley units is done by CTI's west coast field office. The west coast office has not seen any specific problem with the Model 22's this past year. They have serviced only 8 units this year with well over 50 units in their territory (one company has 40 units currently operating). When they do see failures, they are likely to occur in the first 48 hours to a month of the unit's life, and these problems are mostly random defective parts. The Berkeley units are using the carbon bushings, and they have not seen signs of heavy wear as we have.

CTI claims that the Model 22 is more sensitive to servicing than the Model 1020 units. There is an infancy period in assembly where the unit needs to be tested for timing and leakage. Once the unit is tuned and sealed, it should then run properly. Even if the unit is opened and inspected, CTI feels it could be detrimental to the units operation. Their areas of concern include dirt into the valves or upsetting the timing. The units that we returned were functional, but failed the timing check. I am currently waiting for some information from CTI on exactly how critical the timing is to performance.

One option that might be considered for the VLBA project is to have a service option with CTI. With 90 units and 10,000 hour life, there will be one requiring servicing every 4.5 days. CTI's current service costs \$1,100 per unit plus shipping. The unit is either replaced or rebuilt. The replace option can be as fast as overnight, where as the rebuilding takes up to four weeks. At present their service is under warranty for 6 months or the rest of the original warranty, which ever is greater, but does not include service records. If we were to use this option, we would want a longer warranty and unit service records to be kept.

Looking at field use of the units, it seems that they are capable of over 10,000 hour service lives. CTI is working on what we have found as faults with our units, and they are also willing to assist us in maintaining our own units. The bushing and seal wear we are seeing seems to be a combination of tolerancing, assembly and mounting problems. Working with CTI we need to establish a specification of maintenance, operation and performance. This will define an operational unit and ensure that working units are sent into the field.