

VLBA Acquisition Memo #151.1
Mark IV Memo #267

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

January 13, 1999

Telephone: 978-692-4764
Fax: 781-981-0590

To: Mark IIIA, MarkIV, and VLBA Tape Recorder Operators

From: Alan E.E. Rogers & Dan L. Smythe

Subject: Tape Recorder Performance Tests

TESTS AND ADJUSTMENTS

This section covers adjustments and tests needed to insure that a) the tape drive is working properly, or b) the installation of new parts and modifications to the tape drive have been done properly and meet specifications.

These tests have been designed to verify the performance of the tape recorder and to help diagnose problems. Some of the tests should be performed frequently and on a regular basis, while others can be performed only occasionally. This memo supersedes VLBA memo #151 and includes additional tests that were described in subsequent memos.

If you record thin tape on a regular basis, use thin tape for these tests. In particular, using thick tape for the vacuum shift test will damage a headstack contoured for thin tape usage.

1. Tape path inspection (VLBA Acquisition Memo #301)

Load a tape and set the vacuum to 10 inches. Run the tape in the forward direction and perform the following checks.

1. Check that the tape edge is not touching the precision plate or entrance to the vacuum column door; i.e. the edges should touch only the reel flanges, I/O flanges, edge guiding points (inside vacuum columns), and front door at turn-around.
2. Check that the tape runs over the input-output rollers without any problems, such as folding or damaging the tape.
3. Repeat steps 1. and 2. in the reverse direction.
4. Use a light to inspect the tape path to check for large forward-reverse offset. Hold the light to view the separation between the tape edge and the precision plate in the areas of the capstan, headblock, and idler roller. Reverse the direction of tape motion while observing this separation and note if there is a large forward-reverse offset. (A finer

check will be done later.)

5. Play back and peak on any recording in the forward direction and carefully slide a feeler gauge between the precision plate and the tape near the idler where the tape leaves the upper vacuum column. Find the gauge that just shifts the tracking. The distance between the tape edge and the precision plate near the vacuum column should be between.

.001 and .004 inch (0.02-0.1 mm) without the thin-tape upgrade
.008 and .014 inch (0.25-0.35 mm) with the thin-tape upgrade

Repeat with the tape moving in the reverse direction and measuring where the tape leaves the lower vacuum column. This measurement should meet the above specification and should be within 0.002 inch (0.05 mm) of the previous measurement.

2. Tests

1. **Forward-reverse shift test** Measure the tape position by issuing a pass command after peaking on a recorded track while moving the tape in the forward direction. Repeat in the reverse direction. The difference between these two readings must be less than 50 micrometers. Occasionally (approximately monthly, or after calibrating the head positioner), repeat this test at the beginning, middle, and end of the tape.
2. **Speed shift test.** Use 'peak' and 'pass' to measure the shift in tape position between normal (80 or 135) and double (160 or 270) speed. This shift should be less than 20 micrometers. Check in both directions. Perform this test once per observing day.
3. **Vacuum shift test.** Perform this test only occasionally, unless you can easily control the vacuum under computer control. **DO NOT USE THICK TAPE FOR THIS TEST ON A THICK-THIN TAPE RECORDER.** Measure the shift in position when changing the vacuum from 5 to 15 inches. This shift should be less than 15 micrometers. Repeat in the other direction. Reset vacuum to 10 inches when done.
4. **Door shim test** (VLBA Acquisition Memo #330). Set vacuum to 10 inches. Peak on a recorded track and watch the eye pattern on the oscilloscope while opening the vacuum column door slightly. The eye pattern should not change at all when the vacuum column door is opened by 6 mils (0.15mm). (Since it is difficult to measure the door opening at the left hand side, this is equivalent to measuring an opening of 3 mils (0.08 mm) halfway across the door from the opening to the hinge.) Also, at less than 15 mils (0.38 mm) of opening the eye pattern should be affected.

You can use two layers of paper (~80 um per layer) for a shim. Thread the tape and close the door on the shim. Peak up on a recorded track and remove the shim. The eye pattern should not change when removing a 0.15 mm (0.006-inch) shim (two layers of paper) placed near the top left, or bottom left, corner of the vacuum column. The eye pattern should change, or disappear, when removing a 0.4 mm (0.015-inch) shim.

5. **Tape shift with write stack position.** Peak up on a recorded track and move the write stack to $\pm 700 \mu\text{m}$. The tracking should change by less than $10 \mu\text{m}$.
6. **Read stack calibration test.** Record 1000 feet with heads 14, 15, and 16 with 'tapeformc' 'pass=13,13'. (For a VLBA or Mark IV recorder, use 'tracks=17, 18, 19' and 'form=m'.) Reproduce with head 15 (VLBA 18), move the read stack with 'stack=,698.5,,f ' and 'stack=,-698.5,,f ' to find the tracks near $\pm 700 \mu\text{m}$. Use 'peak' and 'stack' to verify that these tracks are at $\pm 698.5 \pm 10 \mu\text{m}$.
7. **Write stack calibration test** (for Mark IIA/IV only). Record 1000 feet with head 15 (VLBA/MK4 head 18) enabled at 'stack = 0, , f '. Back up the tape 1000 feet and repeat with 'stack = -700,, f ' and with 'stack = 700,,f '. Use 'stack=, ± 700 ,,f ', 'peak', and 'stack' to verify that these tracks are at $\pm 700 \pm 10 \mu\text{m}$.
8. **Record margin check.** Record a forward Mode C pass followed by the next reverse pass. Measure the error rates on all 14 tracks in both directions after the reverse pass. If the forward recording is worse than the reverse recording, reduce the head voltage in 1 volt steps until the error rates for forward and reverse passes are approximately equal.

3. THE THEORY BEHIND THE TESTS

Visual inspection.

The tape path is designed to keep the tape from touching the precision plate or the door of the vacuum column. A properly aligned tape path will keep the tape edge away from the precision plate by a specified amount in the region between the idler roller and the capstan. Measuring this spacing provides a check on the mechanical alignment of the tape path. The most common misalignments are due to:

- a. A tilted idler roller.
- b. A tilted head stack.
- c. A tapered or tilted capstan.
- d. A strained or bent precision plate.

Forward-reverse shift.

Asymmetries in mechanical alignment are the primary cause of a forward-reverse shift, although anisotropies in the tape's elastic constants can also produce a significant forward-reverse shift. Components before the capstan affect the forward shift, while components after the capstan affect the reverse shift.

Speed shift.

At high speed, the tape is subject to additional forces due to air entrapment. Any shift in tracking with speed is a measure of tension variations across the tape that result in asymmetries in the air entrapment. These tension variations can be caused by alignment errors or capstan taper.

Vacuum shift.

A shift in tracking with vacuum is another indication of tension variation across the tape. Also, changing the vacuum moves the position of the loop in the vacuum column (since the reel servo is a first-order servo) and produces a small shift that can be greatly magnified by dirt or grooves in critical areas.

Door shim test.

Failure of the door shim test can be caused by a vacuum leak, which can be caused by a poorly adjusted vacuum door hinge, or by deep grooves in the aluminum plate attached to the vacuum door.

To adjust the vacuum door hinge: With vacuum on, loosen the 4 screws holding the hinge, push on the door, and re-tighten the screws.

The depth of the grooves in the tape edge contact areas on the tape edge bearing plate mounted on the vacuum door can be measured with a sliver of paper about the size of the fortune from a Chinese fortune cookie, or with two thicknesses of thick tape about the same size. These grooves can be allowed to wear to a depth of .002 inches. The bearing plate should then be turned 180 degrees, followed by 2 additional wear cycles on the other side. After 4 wear cycles the bearing plate must be replaced. A replacement plate can be made from .062-inch-thick #6061-T6 aluminum with a flatness better than .002 inches per inch (or 0.02 mm per cm). (See Haystack DWG No. 6310-109.)

LOG RESULTS

Recorder Serial # _____ Station _____

Date of Tests _____ Performed by _____

0. Visual Inspection: O.K. Y N

Tape angle: Distance from tape edge to plate _____mils

1. Forward-reverse shift: _____microns

2. 270-135 speed shift: (or 80-160) Forward _____microns

Reverse _____microns

3. 15" - 5" vacuum shift: Forward _____microns

Reverse _____microns

4. Door shim test Maximum _____mils

5. LVDT cal. Test Read LVDT error _____microns

Write LVDT error _____microns

6. Record margin check: Worst Track Per _____

Worst Track # _____

Speed _____inches/sec

Direction _____

Vacuum _____inches

Write voltage _____volts

7. Tape shift: By read stack motion _____microns

By write stack motion _____microns

Calibration constants: Please attach a copy of the HEAD.CTL file