VLBA ACQUISITION MEMO #170

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To: VLBA Data Acquisition Group

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Subject: Measurements of head wear rates - preliminary results

A] Method

1] Run 13 μm tape for long enough (at least 10 days) to contour the heads with a stable contour (see Acquisition Memo #141).

2] Record a white noise 4 MHz bandpass using 8 MHz sample rate at 160 IPS.

3] Playback at 160 IPS and measure spectrum and note the signal level at 4 MHz (wavelength of 1 micron) relative to a baseline level between 0 and 500 KHz.

4] Run 25 micron tape for one hour - this will take about 0.1 μm of the headstack's depth of gap.

5] Now run 13 μm tape and measure the recovery rate of the spectrum at 4 MHz relative to the low frequency baseline. Since the spacing loss is 55 dB per wavelength a wear rate of 0.018 microns/hour corresponds to 1 dB/hour signal recovery rate. [A 5000 hour head life for 38 μm depth of gap corresponds to 0.008 μm/hr].

B] Theory

After running 13 μm tape for substantial time a circular profile is formed - see Figure 1. Running with 25 micron tape rapidly flattens the top of the profile as illustrated in Figure 1. Now running with 13 micron tape slowly wears a new arc. If the following assumptions/approximations are made:

1] The total material wear rate (in volume of material per hour) is independent of the profile.

2] The region of flattening with 25 micron tape is small and the reduction in depth of gap is small (<0.25 μm).

Then the signal recovery rate can be used with a simple linear relation of

1 dB/hour = 0.018 microns/hour

to compute the headstack wear rate. If the region of flattening is large then the relation is not linear and the headstack wear rate have to be computed from specific profiles involved.

C] Measurements

Under the following conditions:

a] Room air temperature 75°F
b] Tape and transport deck plate temperature 77°F
c] Relative humidity of room air 65%
d] Relative humidity in vicinity of headstack 60%
e] Vacuum setting of 10 inches
f] Speed 160 IPS

Tape	Measurement	Computed Wear Rate um/hour	Computed Headstack Lifetime Hours	Comments
Fuji H621	8 dB lost in 22 min	0.03	1300	Computed from Flattening
Sony D1K	1 DB/hour recovery	0.018	2000	
Ampex D1	0.5 dB/hour recovery	0.009	4000	DTR 02158
3M5198	1 dB lost in 12 hours	0.0001	380,000	Computed from Flattening
Sony V16B	8 dB lost in 10 min	0.06	600	Type already known to be very abrasive

Table 1. Wear rates at 60% relative humidity

The wear rate for 3M5198 was so low that perhaps this tape contains no abrasive. [If the wear rate is in fact consistently low it might be possible to use this tape interchangeably with 0.5 mil tape since only the 0.5 mil D1 will contour the headstack.]

In order to determine the dependence on relative humidity I ran wear tests in which I changed the temperature of the tape and deck plate. The following results were obtained for Sony D1K:

Tape/Deck Plate Temperature	Measurement	Computed Wear rate um/hour	Computed Relative Humidity
50°F	5 dB/hour	0.09	100%
77°F	1 dB/hour	0.018	60%
88°F	0.2 dB/hour	0.004	30%

Table 2.

The relative humidity in the region where the tape contacts the head is computed on the assumption that the dew point stays fixed (i.e., the amount of water per cubic meter of air is constant). Since accurate measurements of the relative humidity is difficult these results should be regarded as preliminary. More accurate measurements will be made with a better method of controlling the humidity.

D] Comparison with other reported measurements

There are some wear rate measurements by others - but comparison of absolute numbers are difficult since they used different heads and different tape. The extreme dependence on humidity has been previously reported by JPL and RCA. RCA reports a factor of 11 increase in wear rate from 35 to 60% relative humidity and JPL reported about the same factor. Also there are reports that abrasive wear in general (Larsen-Basse, Wear vol. 31, pg. 373 (1975)) increases with humidity for a variety of materials including glass.

E] Conclusions

The method outlined allows very rapid measurement of wear rates. If the extreme dependence on humidity is verified with more measurements it might explain why we have experienced long head life on the processor whose transports operate at 100°F (and hence relatively low humidity in a 60% humid control room) and much shorter lifetime in the field on acquisition transports which run much cooler.

The physics (or chemistry) of the effect of humidity on abrasive wear needs to be understood in order to determine what other environmental parameters (like SO_2 levels) should be investigated.

YOUNG'S MODULUS = 7E05 LBS/SQ
TAPE WRAP = 10 DEG FULL ANGLE

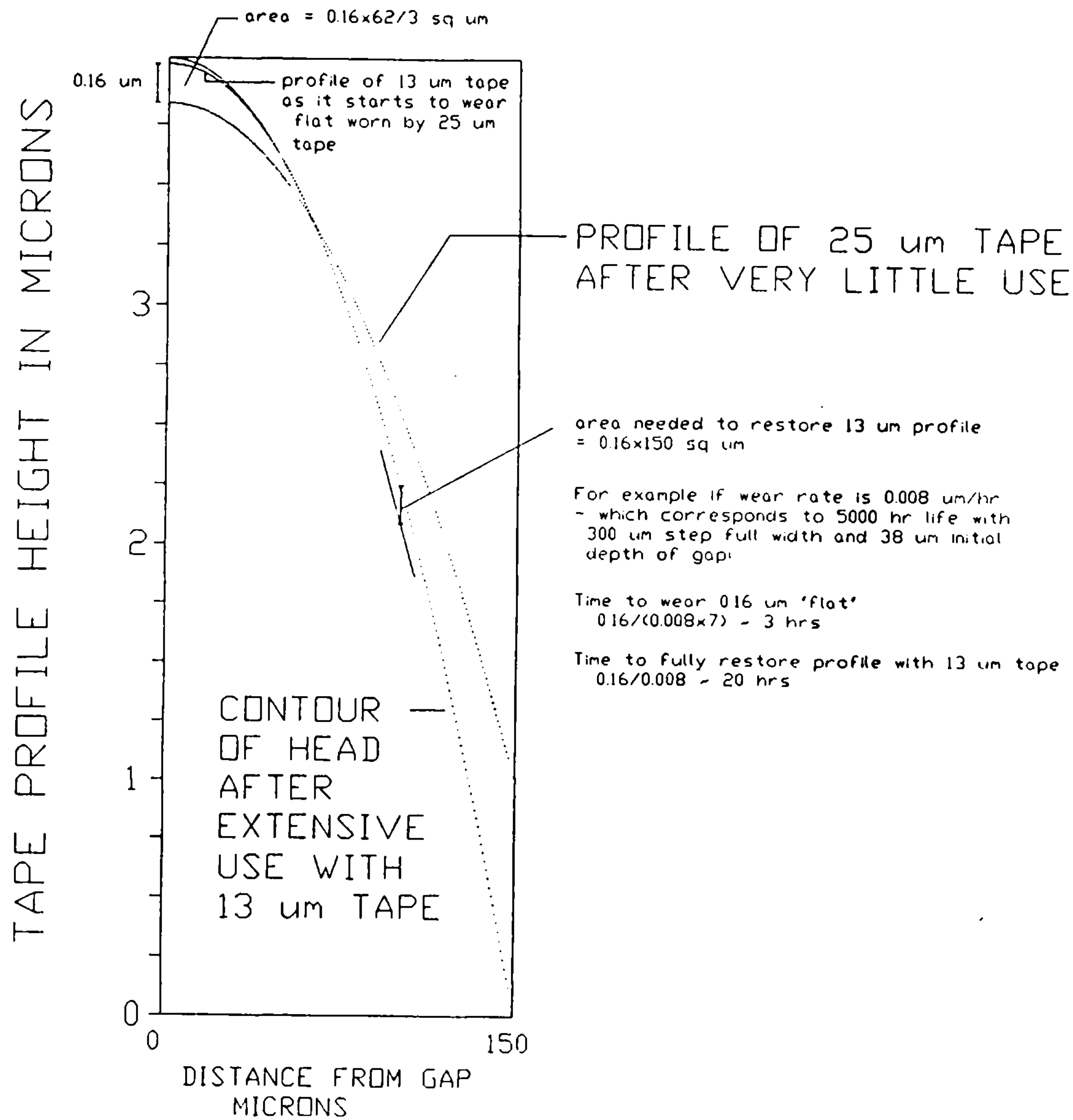

FIG 1 WEAR OF GAP AREA OF TAPE BY 25 UM TAPE AFTER REACHING STABLE PROFILE WITH 13 UM TAPE