VLBA ACQUISITION MEMO #134

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To: VLBA Data Recording Group

From: Alan E.E. Rogers

Subject: Tape reel pack - computer simulations

The packing of tape on a reel is complicated by the highly anisotropic properties of the PET film from which most tapes are manufactured.

The equations of the tape pack (See Acquisition Memo #129) are hard to solve analytically so I have resorted to a computer model. The model is based upon the following steps:

1] Add a turn to the pack.

2] Store the radius of this turn.

3] Compute the radial pressure from this turn.

4] Starting from the first turn recompute the total radial pressure on each turn by adding all the turns to the last turn.

5] Compute the radial strain for each turn from the radial pressure.

6] Recompute the tangential tension in each turn from the reduced radius (which reduces the tangential tension).

7] Add another turn.

The effect of the relatively low modulus of the tape in the thickness direction makes the tangential tension slump at a few thousand feet at which point the "packed" radius has been reduced by the pressure of turns further away from the reel center. The radial strain builds up from zero at the outer turn to a maximum at the hub.

The NSA (U.S. Government) has specified a programmed tension (rather than the approximately constant winding tension of the recorder) as a means of reducing the tension slump and preparing the tape for storage or shipment. The Government specified winding tension vs footage is shown in Figure 1 and is apparently based upon some empirical study. I have tested the Government spec. in the tape pack simulation program and find that while it is in the right direction it is not as good as the simple expression (at least as far as the "slump" - but other factors may be important).

$$PT = 0.8 + ((F/Fm) - 1)^2$$

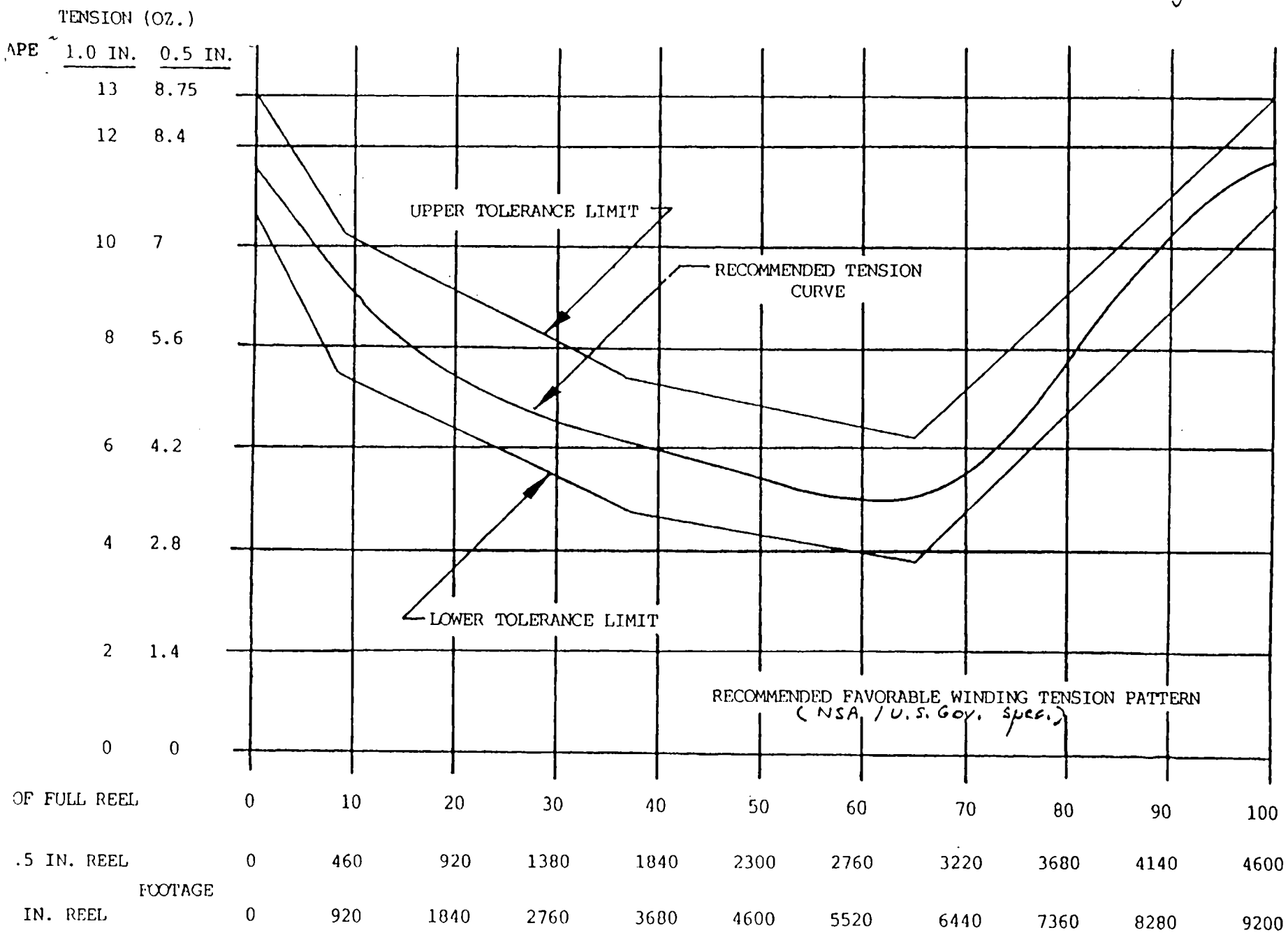
where PT = relative tension

F = footage

Fm = 7500 feet (for 9200 ft. reel)

The results of the comparison of this expression with the Government spec. is shown in Figure 2. Figure 3 shows the tape spiral (the figure draw-out if a radial straight line (drawn across the pack in an initial state) is allowed to be deformed by repacking the tape) for a constant change in tape tension.

(Figure from BOW industries inc. Chantilly, Va.)



"FIGURE T - PROGRAM TENSION CURVE"

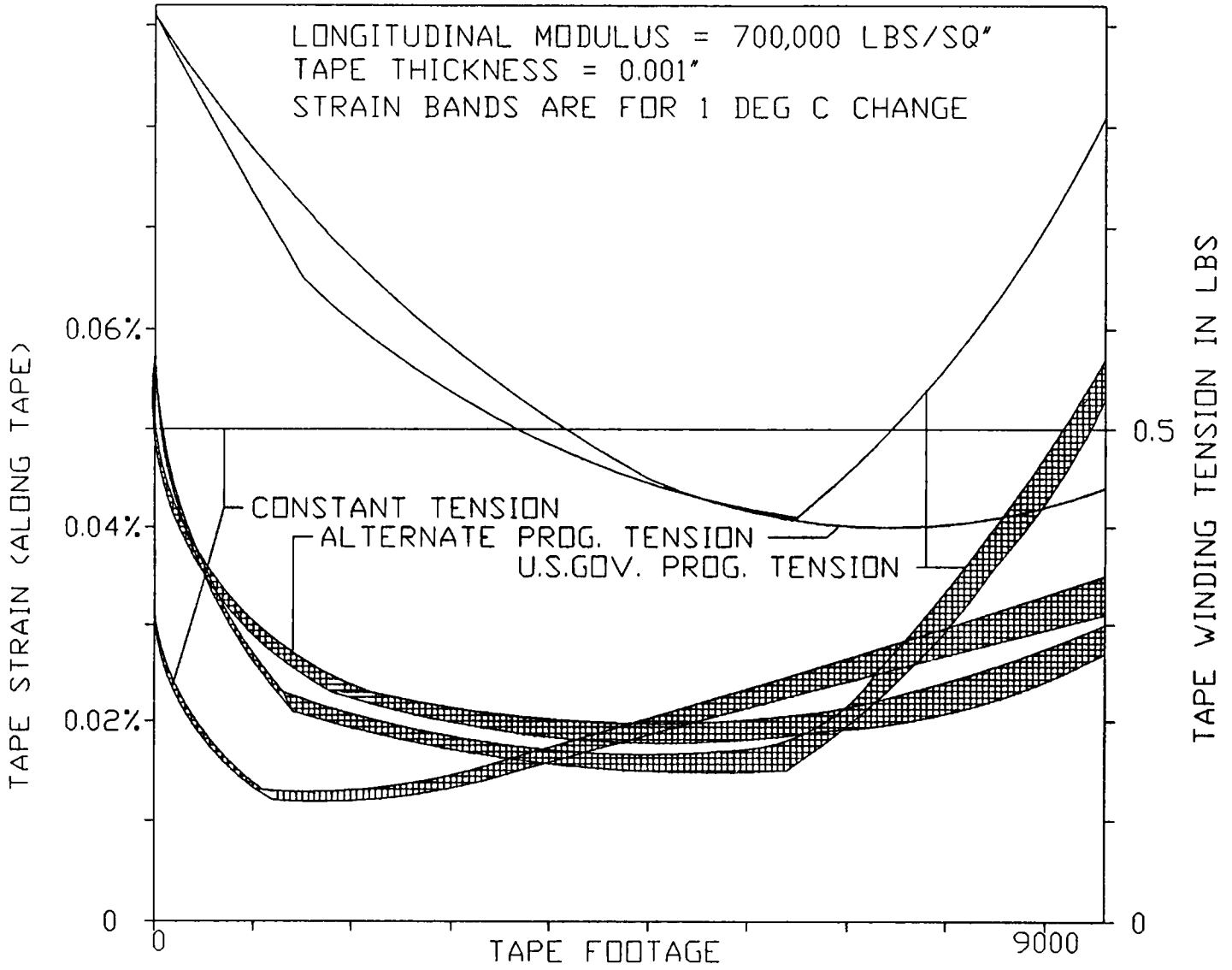


FIG. 2. LONGITUDINAL TAPE STRAIN IN TAPE PACK FOR VARIOUS PROGRAMMED WINDING TENSION CURVES

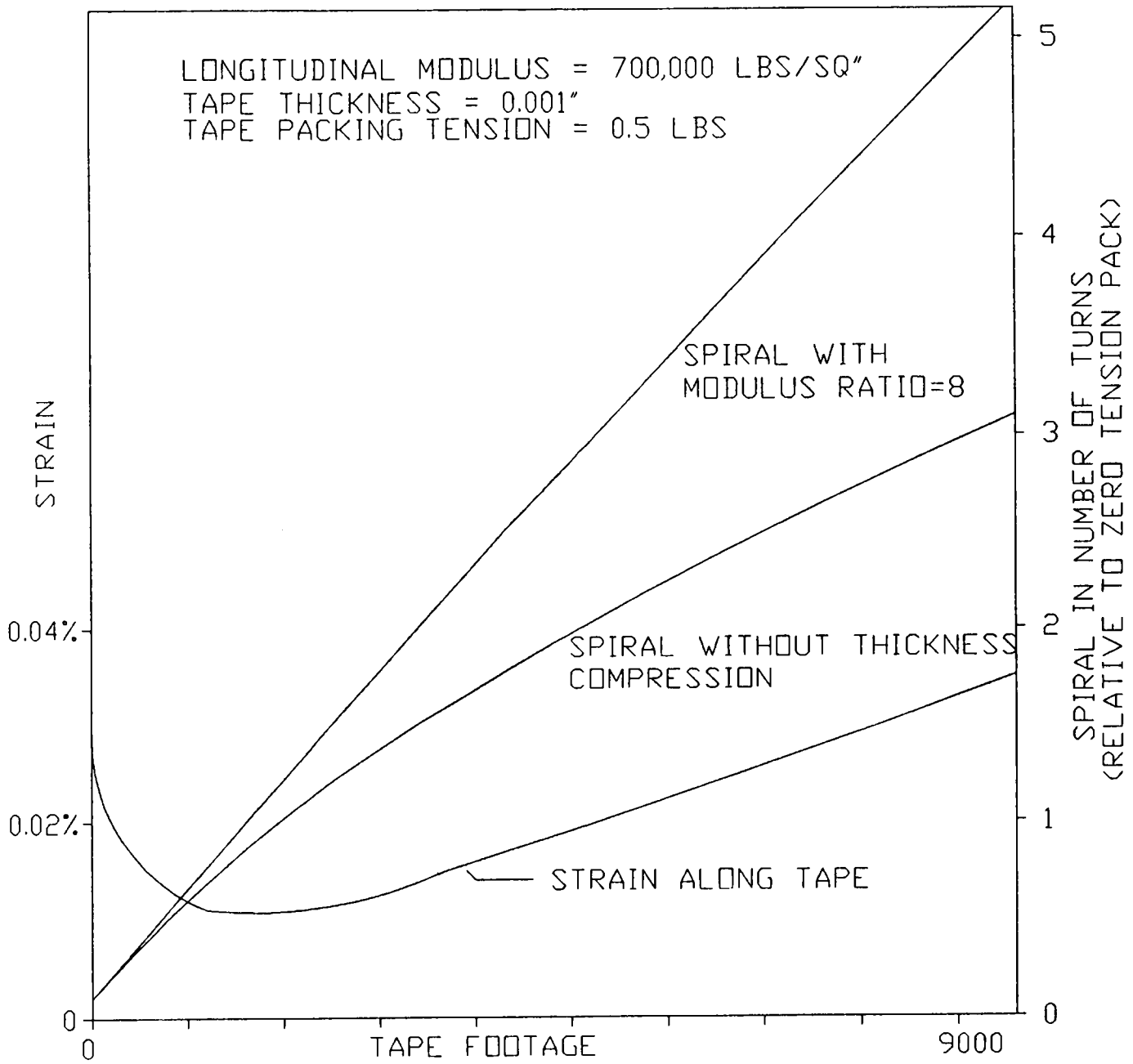


FIG. 3 SPIRAL MOTION OF FIXED POINTS ON THE TAPE VS FOOTAGE AND ELASTICITY