National Radio Astronomy Observatory

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To: VLBA Data Acquisition Group

From: C. Janes

Subject: Thin Tape Transfer Status

I. Introduction

NRAO purchased 475 thin tapes starting fall 1992. Here is the experience so far in receiving the tapes and putting them into service.

II. Procedure

The thin tapes were shipped from the vendors on metal reels, so that the new tape had to be transferred to Acrometal glass self-packing reels. The transfer procedure defined by Haystack called for some minor testing of the tape in the transfer process.

First, the new self-packing reel was cleaned and inspected for burrs and other defects. The new tape was visually examined for defect, and a sample clipped from the end. The tape drive tape path was cleaned.

The tape was first transferred to a glass self-packing reel at high tension in order to test the tape. The tape path was cleaned again at this point, the tape inspected for damage, and a second tape sample clipped from what was now the opposite end. Both tape samples were stored together in a glassine envelope for use later in sorting out what problems may have been present on receipt and which ones resulted from use. The tape was then rewound to a self-packing reel at 330 ips and 10" of water vacuum. The procedure required about 75 minutes per tape, so that 5 tapes could be transferred per drive per 8 hour shift.

There were two vendors, Sony and 3M. A sample of tapes from both vendors, 18 from 3M and 12 from Sony, were transferred to Acrometal reels at Haystack in an attempt to identify problem areas before the bulk of the tapes were transferred. Haystack kept a few of the sample tapes for "lifetime" testing and other tests.

The transfer procedure will be modified for future transfers to rewind at 160 ips and 7.5" of water vacuum to address the flange forcing / exposed edge problem discussed later. This change extends the transfer time per tape to 95 min, so that only 4 tapes can be transferred per drive per 8 hour shift.

Details of the hub and tape acceptance procedure are given in Appendix A.

III. Problems encountered

1. Acrometal reels

Early in the transfer process, tapes were bumping up and edges folding, a problem traced to insufficient reel hub width. Initially, the hub width was specified to be 0.999" -0 +0.001", leaving little or no clearance for the 1" tape which is specified to be up to 0.999" wide. Measurements showed hub widths on some of the Acrometal reels to be a shade under 0.999", but even with a hub width of 0.999", there was an occasional problem with edges folding over during the initial transfer. In consultation with Hans Hinteregger at Haystack, the width specification was increased to 1.001" -0, +0.001", and 74 reels were returned to Acrometal for hub replacement. Not all the reels received with the narrow hubs were returned to the vendor; once tape has been successfully transferred to a reel, the epoxy between the hub and flange is expected to provide sufficient elasticity to accommodate the actual tape width. The wider hub width specification begins with Acrometal reel serial number 490. Returned reels were assigned new serial numbers so that all reels remaining with serial numbers less than 490 have the narrow hub.

Widths on a sample of 3M and Sony tapes were measured accurately while the hub-width problem was being studied to see if a difference existed between manufacturer. The results in Appendix B show no apparent difference.

Some of the hubs received in the early shipments showed tool marks; although no problem was directly traced to a burr on a hub, these reels were returned for hub replacement, and are part of the 74 reels mentioned earlier.

A burr on the inside edge of the flange will cause a spiral pattern to appear on the tape pack. Burrs occurred rarely and were removed with a sharp blade when encountered.

The self-packing reel specification, VLBA Data Acquisition Memo 345, calls for the minimum opening width at the "mouth" of the reel to be between 0.986" and 0.996", narrower than the hub and even the tape. The two glass flanges used to make up a self-packing reel are concave to provide the narrowing. Measurements on a granite table show a difference in curvature between flanges on most reels; one flange on a reel may be nearly flat while the curvature of the other provides all of the narrowing. Apparently, the reel manufacturer matches flanges so that the opening meets specification; there is no specification on actual flange curvature. No problem has been traced so far to reels with one "flat" flange. The flatter flange was found to be the outside flange in 29 samples measured. For contrast, non-self-packing reels have flat flanges with flange separation and hub width of about 1.020".

The reel specification also limits the difference between the minimum and maxium reel width opening to be no greater than 0.006". Also called runout, this is a measure of how badly one or the other of the flanges is warped. If the runout is too great, a mechanical modulation of pressure on the edges of the tape while

the tape is in motion reportedly can cause packing problems. Hans Hinteregger conducted tests on several reels having the maximum runout of 0.006" and found no problem.

The glass flange edges are normally ground down smooth during the manufacturing process, but one reel was received with unusually rough edges. Intuitively, the roughness could contribute to tape edge wear, but tests at Haystack with this reel did not show a problem.

2. Tape pack shift

The purpose of the self-packing-reel is to prevent tape scatter which could result in edge damage during shipping and handling. That purpose seemed to be compromised in some instances during the transfer process, either by "excessive scatter" throughout the pack, by the exposure of an edge or two in the pack, or by a shift of the pack, especially at the low tape sense.

Scatter is the shifting of tape axially from one layer to the other or, in other words, unevenness in the side of the tape pack. When this happens, the exposed edge is easily crushed when the reel band is installed. The crushed edge has on occasion caused the tape to bump up when the tape is next used. In this case, the tape with the damaged edge must be cut out, and the remaining tape spliced. The problem is easily detected by examining the tape pack under a strong light. The exposed edges reflect the light and appear as a silvery streak in the tape pack.

A related problem occurs on some packs between the Low Tape Sense and the end of the tape. When the tape drops from the 330 ips normal rewind speed to the 90 ips unload speed at the Low Tape Sense, the pack on occasion shifts to one side. Since the length of tape shifted is only about 100', about 30 turns of tape have edges shifted from the main body of the tape pack, and these turns are easily crushed by the tape band. Although there is no documented case yet where this damage has resulted in a bumpy pack, the damaged edges pack against the hub when the tape is on the take-up reel, so that one can reasonably assume that the pack could eventually become disturbed.

It appears that the pack shift problem is a subset of a more frequent problem in which some tape packs force one or the other of the flanges to one side, leaving a gap between the opposite flange and the tape pack. Since the reel bands are weaker than what was specified, they fail to close the gap where it exceeds 9 mils. As long as no edges shift into the gap, the gap in itself is not a hazard to the tape pack; but the gap appears to be an invitation for the more severe pack shift problem.

The "exposed edge" and "flange-forcing" problems seem to occur repeatedly on some packs and not at all on others, leading to the belief that the problem is tape related rather than procedure or drive related. Flange forcing occurs on about 15% of the 3M tapes, and of these about 1/3 demonstrate the pack shift problem where an edge shifts into the gap. The problems were seen seldom if at all on the Sony tapes. This writer sent a list of serial numbers of problem tapes to 3M to see if flange-forcing

could be traced to web location, but 3M reported finding no pattern.

Haystack Observatory has agreed to study the flange-forcing / exposed edge problem further; in the interim, NRAO is planning to "post-pass" thin tapes by rewinding them at 160 ips before shipment. NRAO already is operating thin tapes at the lower tension of 7.5" of water vacuum.

During the next tape procurement cycle, fewer problems and improved record keeping should help put better numbers on the problem. Since the origin of the flange-forcing problem is not clearly understood, the concern is that the problem could be much more prevalent in a future shipment of tape.

3. Reel bands

The reel bands specially procured for the thin tape are defective, and will eventually need to be replaced. The clamping strength of the band edges is insufficient to pull the reel flanges together tightly against the tape pack. Also, washers were omitted on the clamp rivets, so that the rivets pull through and the clamp breaks off when fastening the band to the reel. Though annoying, the problems are not sufficiently severe to warrant replacement so that the current thinking is to use the defective bands until they have all broken. Acrometal has agreed to manufacture a replacement when the existing supply from a different vendor runs out.

4. Adhesion

Faulty procedure early in the transfer process allowed alcohol to drip on the tape. The alcohol causes the tape layers to adhere when pressed tightly together so that when the tape is next used, it breaks in two. When the problem was discovered, all the tapes done to date were inspected and several spliced. One tape bumped up from damage thought to stem from an adhesion problem, and defied efforts to recover it.

5. Corning "NASA" self-packing reels

An effort was made to use a number of Corning self-packing reels left over from a previous project, but measurements of the reel openings showed that the reels were not within specification. These reels had been stored for a number of years with a reel band that forced the flanges apart, perhaps causing the epoxy bond between hub and flange to deform so that the flanges would not relax to their original state. In an attempt to recover, the reels were stored for several months at an elevated temperature with the flanges clamped closer together than required by the specification, but measurements afterward showed the runout to be out of specification indicating the flanges had warped. Apparently, the epoxy bond did not restore uniformly. The reels were returned to Haystack.

6. Clouding of glass flanges

Dr. Veronica Mungai, a chemist at 3M, reports a problem with the Acrometal self-packing glass reels in which a white cloud of salts appears on the exposed glass surface, the surface which interfaces with the tape. According to Mungai, the formation of the cloud is independent of tape type and occurs slowly over a period of many months.

Veronica is concerned about possible interaction between lubricants in the 3M tape formula and CAT ions in the salts. Other possible problems are opacity of the salt film preventing visual inspection of the tape pack, and migration of the salts into the tape path.

The film has not appeared on any of the reels procured so far by NRAO. Since the cloud wipes off, it is presumed that any deposit on the flange would be wiped away by the tape when the reel is used.

7. Record keeping

What started off as a hand-written log for the tape transfer showing tape serial number, reel serial number, and VSN evolved into a montage of text entries in a computer file, and finally no log at all. Recently, the various bits of information were transferred to a database shown in Appendix D. This record shows 5 pairs of tapes with the same reel number, 14 pairs of tapes with the same tape serial number, 41 tapes with no tape serial number, 26 with no reel serial number, and 52 with no reel data. Of the 4 failed tapes, only 1 is documented. Much of the confusion resulted from having to switch so much tape between reels when both the flange-forcing and hub width problems surfaced at the same time.

Carl Bignell presents a proposal for keeping track of future shipments of new tape in Appendix C; this writer recommends a hand-written log from which computer entries can be made later.

V. Results

415 tapes transferred successfully and available for observing
5 tapes withdrawn by Haystack for life-time testing
51 tapes not yet transferred waiting for self-packing reels
4 tapes failed during transfer process
475 total

VI. Summary

Three significant problems were encountered while transferring the new thin tape to self-packing reels: narrow hub width, flange-forcing, and record keeping. The hub specification was widened to correct the first problem. The tape speed and tension during rewind before shipment have been reduced as a

temporary solution to the flange-forcing problem until that problem is better understood. With start-up problems out of the way, record keeping on the next shipment should be easier, and better procedures are recommended in this report.

The tape transfer procedure other than record keeping appears to be adequate to uncover tape problems: the only tape failures encountered in the field to date have been breaks, and they all traced to non-tape problems.

Appendix A.

Hub and tape acceptance and tape transfer procedure

I. A hub acceptance procedure

a. Measure the flange separation at the hub to determine the minimum and maximum separations. The hub width should be 1.001" to 1.002".
b. Measure the flange separation at the perimeter, again to determine the minimum and maximum separations. These measurements should compare closely with those marked on the reel by Acrometal.
c. Inspect the surface of the hub that interfaces with the tape to reject any that have burrs or other tool marks that might damage the tape.
d. Feel of the flange edges all the way around to find and remove any bumps that might cause damage to the tape.
e. Mount the reel on a drive and clean the inside of the reel with an alcohol-wetted swab while turning the reel. Clean out any debris on the hub and in the corner between the hub and the flange.
Do not allow alcohol to contact any tape.
f. Wipe the outside flanges free of dust, and air dust any remaining dust particles from the inside of the flange.

Measurement tolerances are specified in VLBA Data Acquisition Memo 345.

II. The tape transfer / acceptance procedure

a. Visually inspect the new tape for damage to the shipping reel or tape pack. Damage at this point should be reported to the shipper and/or vendor.

b. Clean the tape path on the drive to be used for the transfer.

c. Wash hands thoroughly before handling tape. Do not eat, drink, or smoke when handling tape.

d. Place the new tape securely on the supply reel hub and clip off about 6" of tape from the end. Cut the tape diagonally so that the inside edge, the edge in contact with the flange that mounts towards the drive, is the longer edge. Place the tape

sample in a glassine envelope and mark the envelope with the tape manufacturer's serial number. Note the tape serial number in the log.

e. Thread the tape to a self-packing reel. Do not allow the end of the tape to fold over on the takeup reel. The hub on the self-packing reel is non-adhesive. To thread the tape, wet the end of the tape slightly with water from a clean sponge and pull the tape across the hub until the end adheres. Use an orange stick if necessary to hold the end in place and wind three or four turns of tape onto the hub. Keep tension on the tape to make sure that the turns are tight, and do not let the tape end fold over.

f. Select a vacuum of 15" and a drive speed of 80 ips. Transfer the tape to the takeup reel. Watch the tape for the first minute to make sure no bumps or other problems develop. If necessary use an orange stick with a feather light touch to feel for bumps in the tape pack. Point the stick in the direction of motion to avoid snagging the tape. Do not touch the tape with your hands. It is necessary to turn LTSENSE off to remove all tape from the supply reel.

g. Inspect the tape pack on the take-up reel for bumps, spokes, exposed edges or other damage. If any problem occurs, refer to recovery procedures.

h. Check to make sure the tape manufacturer's serial number on the metal reel has been recorded correctly on the tape sample and in the log, then remove the metal reel. Keep 3M reels; they can be recycled when more tape is ordered.

i. Cut a sample of tape from the tape end; make the cut diagonally so that the inside edge is the longer edge, and put the sample in the envelope with the other sample.

j. Clean the tape path again.

k. Install a clean and inspected glass self-packing reel as the new supply reel. Note the reel serial number, flange separation, and runout in the log.

l. Again, the hub on the self-packing reel is non-adhesive. To thread the tape, wet the end of the tape slightly with water from a clean sponge and pull the tape across the hub until the end adheres. Use an orange stick if necessary to hold the end in place and wind three or four turns of tape onto the hub. Keep tension on the tape to make sure that the turns are tight, and do not let the tape end fold over.

m. Set the vacuum for 7.5" and the drive speed at 160 ips, and wind the tape onto the new reel. Again, watch the tape for the first minute to make sure no bumps or other problems develop. Use the orange stick if necessary to feel the smoothness of the pack.

n. Inspect the tape pack for bumps, spokes, exposed edges, pack shift, or other damage. If any appear, refer to recovery procedures. If not, unload the tape completely onto the supply reel and place a piece of Zebra tape over the tape end. Form a pull tab on the end of the Zebra tape that adheres to the tape end to simplify later removal. With a feeler gauge check the gap between the tape pack and both flanges. Note the two gaps on the log.

o. Place a black reel band on the tape reel, install the proper labelling, and release the tape to the tape pool. Record the VSN in the log along with the manufacturers' serial numbers and other information.

III. Recovery procedures

a. If a problem occurs with a Sony tape during the initial transfer, and the tape is suspect, it may be returned to the manufacturer.

b. Note any damage that is evident in the log, being very specific while the evidence is available.

c. Wind the tape back to the manufacturer's metal reel or a glass non-self-packing reel until there is time available to inspect the problem in more detail. Do not leave a damaged tape on a self-packing reel overnight or install a black reelband.

d. If a tape is broken, it must be spliced.

e. Some tapes can be recovered by winding the tape back and forth between non-self-packing reels at low tension and low speed. After a number of shuttles proportional to the extent of damage, try transferring the tape again to a self-packing reel at low tension. If that works, try transferring between self-packing reels at high tension to test the tape. A tape that transfers at normal tension, but not high tension is marginal and may not be placed into service for data collection.

f. Make the necessary entries in the log so that the particular tape can be traced from reel to reel, and so that the final VSN used will reflect the correct reel and tape serial numbers.

Appendix B

Tape widths of 6" samples

Supplier	Sn	Width Max "	Width Min "
Sony	115 120 01	0.99840	0.99819
Sony	107 120 U1	0.99889	0.99868

Sony	107 120 S1	0.99875	0.99869
Sony	107 120 Q1	0.99868	0.99857
Sony	109 120 M1	0.99866	0.99834
3M	54300-007-1-016	0.99890	0.99879
3M	54300-007-1-008	0.99882	0.99875
3M	54300-008-1-015	0.99899	0.99885
3M	54300-001-1-019	0.99887	0.99885
3M	54300-008-1-018	0.99877	0.99851

Appendix C

Record Keeping Requirements for Thin Tapes
- 19931007 RCB ----------

The acquisition of expensive thin tapes has necessitated implementing a reasonably extensive record keeping procedure. The inspection and procedures for handling tapes (from original acquisition through normal tape usage is covered elsewhere). This addresses only what notes to keep and when to keep them. It will be desirable to incorporate some of these notes in the tape database at some point in the near future. The following is only an initial attempt at identifying what information to collect and when. Please give me you feed back as soon as is practical.

Original Acquisition

When the thin tapes are originally received from the manufacturer there is an extensive procedure to follow of inspecting, testing and transferring the magnetic tape from the metal reels onto self-packing reels.

(a) When the original tape is unpacked it is inspected. The information to be recorded at this stage is the following:

- manufacturer
- manufacturer's serial number (TSN)
- manufacturer's product number
- Tape type and thickness (other parameters?)
- date of inspection and unpacking
- employee name (initials)
- notes on the condition of the tape (see C Janes memos) and and any initial testing

(b) Unpacking and inspection of self-packing reels. Notes should be kept on

- manufacturer
- manufacturer product number
- manufacturer serial number (RSN)
- measured gap and runnout [does this belong under (c) ?]
- date of inspection and unpacking
- employee name (initials)
- notes on the condition of the reel

(c) The assignment of tape to self-packing reel. The following needs to be recorded:

- assigned NRAO volume serial number (VSN)
- manufacturer's serial number of tape (TSN)
- manufacturer serial number of reel (RSN)
- employee name (initials)
- date of assignment
- notes on any testing of the tape on the self-packing reel
- initial library shelf location

Inspection of Tapes/Reels

All tapes should be inspected prior to shipment out of the AOC and upon receipt of shipments into the AOC for damage and general condition of tape and reel. In addition if some damage happens while being handled, while being used on the correlator or a recorder the information should be recorded. When ANY unusual condition is discovered the following information should be recorded:

- tape volume serial number (VSN)
- date of inspection
- inspector's name (initials)
- circumstances (while recording, getting ready for ship., receipt, ...)
- notes on condition of tape and reel
- notes on any action taken (clean reel, ...) or to be taken
  (replace reel, splice tape, trim leader, ...etc)
- notes on changes in length of tape, ...

Change of Reel/Tape Configuration

Whenever a tape or reel is retired (put out of service) or if the association of tape/reel is changed the following information should be recorded:

- tape volume serial number (VSN)
- manufacturer serial number of reel (RSN)
- manufacturer of reel (if necessary)
- date of action

inspector's name (initials)
actions taken (eg retire tape, ...) indicating final dispositions
any new associations of VSN/RSN/TSN
notes on reasons for actions taken and any relevant information

Assignment of NRAO Volume Serial Numbers (VSN)

Since it is not possible to keep track of the original manufacturer's serial number after transfer to the self-packing reels (without extensive and 100 percent accurate records), I propose that when a tape is physically retired from service for whatever reason that we do not reassign the VSN. Although this is not necessary it will make future book keeping as regards performance analysis of the tapes and reels easier.

Appendix D Thin Tape Inventory

VSN	Reel	Min sep	Runout	Sn	
[redacted]	279	0.988	0.004		3M 54300-003-1-025 last used on this reel before ret
VLB[redacted]82	576			3M 72051-03-20	Accel Tape Test I on NASA reel; II on 576
83	580			3M 72051-03-21	Accel Tape Test I on NASA reel; II on reel 580
84	579			3M 72051-03-06	Accel Tape Test on NASA reel
85	116	0.986	0.006	3M 72051-04-16	
86	102	0.988	0.003	3M 72051-04-12	
87	115	0.989	0.004	3M 72051-04-22	
88	567			3M 72051-03-13	Accel Tape Test I on NASA reel; II on reel 567
89	111	0.989	0.001	3M 72051-03-16	
90	105	0.986	0.004	3M 72051-03-17	
91	104	0.986	0.003	3M 72051-03-15	
92	110	0.99	0.002	3M 72051-04-15	
93	107	0.989	0.004	3M 72051-04-17	
94	106	0.987	0.005	3M 72051-04-9	
95	103	0.986	0.003	3M 72051-04-13	
96	109	0.988	0.004	3M 72051-04-11	
97	112	0.989	0.004	3M 72051-03-24	
98	120	0.989	0.003	3M 72051-03-9	
99	119	0.986	0.003	3M 72051-03-5	
100				3M 72051-04-24	Haystack life test
101	113	0.989	0.004	3M 72051-03-23	
102				3M 72051-04-1	Haystack testing
103	114	0.986	0.005	3M 72051-04-25	
104	118	0.986	0.005	3M 72051-04-2	
105	117	0.987	0.003	3M 72051-04-8	
106				3M 72051-04-7	Haystack testing
107	157	0.992	0.004	3M 54301-10-1-16	
108	155	0.989	0.006	3M 54301-10-1-25	
109	156	0.992	0.004	3M 54301-4-1-15	
110	153	0.99	0.004	3M 54301-6-1-19	
111	154	0.988	0.006	3M 54301-8-1-22	
112	161	0.989	0.004	3M 54301-4-1-24	pack shift; exposed edge
113	152	0.991	0.003	3M 54301-4-1-21	
114	158	0.989	0.006	3M 54301-6-1-23	
115	160	0.987	0.006	3M 54301-4-1-5	
116	127	0.992	0.003	3M 54301-4-1-12	
117	125	0.989	0.004	3M 54301-6-1-25	
118	126	0.991	0.005	3M 54301-10-1-6	
119	128	0.989	0.003	3M 54301-10-1-18	
120	129	0.994	0.002	3M 54301-6-1-18	
121	130	0.992	0.003	3M 54301-6-1-3	
122	131	0.99	0.005	3M 54301-6-1-7	
123	122	0.988	0.006	3M 54301-8-1-24	
124	123	0.992	0.004	3M 54301-4-1-4	edge problem after first use
125	124	0.991	0.002	3M 54301-10-1-21	
126	211	0.989	0.003	3M 54301-4-1-7	
127	210	0.99	0.006	3M 54301-4-1-8	
128	202	0.989	0.003	3M 54301-4-1-10	
129	207	0.989	0.005	3M 54301-4-1-26	
130	203	0.991	0.003	3M 54301-10-1-19	
131	204	0.99	0.004	3M 54301-4-1-19	
132	304	0.991	0.004	3M 54301-6-1-26	excess gap; transferred from reel 208; VLBA0498?
133	209	0.988	0.006	3M 54301-8-1-15	
134	205	0.987	0.004	3M 54301-10-1-2	gap problem
135	206	0.987	0.005	3M 54301-6-1-10	
136	215	0.987	0.004	3M 54301-8-1-5	
137	214	0.989	0.005	3M 54301-5-1-10	
138	213	0.988	0.005	3M 54301-8-1-21	
139	212	0.992	0.004	3M 54301-5-1-6	
140	496			3M 54301-8-1-23	transferred from 22, then reel 496; prob with excess
141	219	0.993	0.003	3M 54301-5-1-23	
142	218	0.99	0.005	3M 54301-8-1-6	
143	217	0.99	0.006	3M 54301-5-1-20	
144	139	0.988	0.006	3M 54301-008-1-120	
145	140	0.99	0.005	3M 54301-5-1-16	
146	421	0.988	0.006	Sony 121-120-F1	was reel 216 and 3M 54301-5-1-18
147	221	0.991	0.005	3M 54301-5-1-18	
148	137	0.989	0.005	3M 54301-5-1-8	
149	138	0.988	0.003	3M 54301-5-1-21	
150	132	0.989	0.005	3M 54301-5-1-4	
151	135	0.99	0.005	3M 54301-5-1-17	
152	133	0.991	0.005	3M 54301-6-1-11	
153	141	0.989	0.006	3M 54301-8-1-18	
154	428	0.99	0.004	Sony 108-120-01	was reel 134 and 3M 54301-8-1-11
155	199	0.988	0.005	3M 54301-7-1-23	
156	200	0.989	0.005	3M 54301-8-1-11	
157	196	0.988	0.005	3M 54301-6-1-23	
158	197	0.989	0.002	3M 54301-4-1-18	
159	198	0.99	0.003	3M 54301-4-1-9	
160	195	0.993	0.003	3M 54301-5-1-20	
161	201	0.99	0.003	3M 54301-6-1-3	
162	176	0.988	0.005	3M 54301-6-1-2	
163	192	0.99	0.004	3M 54301-6-1-22	
164	193	0.992	0.003	3M 54301-7-1-4	
165	194	0.991	0.003	3M 54301-6-1-25	
166	430	0.989	0.005	Sony 107-120-G1	was reel 173 and 3M 54301-9-1-24
167	174	0.989	0.003	3M 54301-6-1-21	

168	175	0.99	0.006	3M 54301-8-1-16	
169	181	0.99	0.005	3M 54301-8-1-10	
170	180	0.992	0.004	3M 54301-4-1-16	edge problem after first use
171	172	0.992	0.002	3M 54301-4-1-20	
172	178	0.988	0.005	3M 54301-10-1-19	
173	179	0.99	0.005	3M 54301-9-1-25	
174	177	0.992	0.003	3M 54301-10-1-17	
175	148	0.99	0.004	3M 54301-4-1-11	
176	146	0.99	0.006	3M 54301-4-1-9	
177	147	0.989	0.005	3M 54301-6-1-22	
178	151	0.989	0.004	3M 54301-3-1-10	
179	145	0.99	0.003	3M 54301-10-1-11	
180	150	0.992	0.004	3M 54301-4-1-3	
181	407			Sony	was reel 144; gap problem with original 3M tape
182	149	0.988	0.005	3M 54301-4-1-22	
183	143	0.989	0.005	3M 54301-4-1-18	
184	162	0.99	0.005	3M 54301-8-1-3	
185	142	0.989	0.005	3M 54301-6-1-4	
186	171	0.992	0.003	3M 54301-8-1-7	
187	169			3M 54301-5-1-24	transferred to 405 and back to 169 to solve excess g
188	163	0.989	0.004	3M 54301-8-1-17	
189	168	0.987	0.003	3M 54301-5-1-2	
190	170	0.991	0.003	3M 54301-5-1-4	
191					
192	306	0.988	0.005	3M 54301-8-1-4	
193	305	0.988	0.005	3M 54301-10-1-22	excessive scatter
194	411	0.988	0.002	Sony 105-120-V1	was 3M 54301-10-1-22 reel 304, then 3M 54300-005-1-2
195	303	0.991	0.005	3M 54301-5-1-12	
196	302	0.994	0.002	3M 54301-8-1-26	
197				Sony 105-120-V1	transferred from 233 to 311 after tape bumped up, th
198	324	0.988	0.004	3M 54301-5-1-7	transferred from reel 310 after edge problem
199	309	0.987	0.005	3M 54301-8-1-19	
200	308	0.99	0.005	3M 54301-10-1-13	
201	307	0.987	0.006	3M 54301-10-1-7	
202	256	0.99	0.004	3M 54301-5-1-22	
203	255	0.993	0.003	3M 54301-4-1-1	
204	254	0.991	0.002	3M 54301-4-1-22	
205	253	0.991	0.003	3M 54301-1-1-14	
206	252	0.99	0.004	3M 54301-10-1-24	edge problem
207	261	0.988	0.004	3M 54301-4-1-4	edge problem
208	260	0.994	0.002	3M 54301-10-1-5	
209	259	0.988	0.003	3M 54301-8-1-8	
210	422				bumps, transferred from 258
211	257	0.991	0.003	3M 54301-10-1-20	
212	297	0.987	0.002	3M 54301-10-1-8	
213	298	0.988	0.005	3M 54301-8-1-2	edge problem after first use
214	296	0.99	0.004	3M 54301-4-1-2	edge problem after first use
215	295	0.991	0.004	3M 54300-4-1-23	
216	294	0.988	0.003	3M 54300-4-1-2	edge problem after first use
217	293	0.988	0.004	3M 54301-6-1-21	edge probem after first use
218	292	0.991	0.005	3M 54300-7-1-21	
219	301	0.987	0.005	3M 54301-4-1-25	
220	300	0.991	0.003	3M 54301-4-1-17	
221	299	0.99	0.002	3M 54301-10-1-3	
222	287	0.988	0.006	3M 54300-5-1-10	
223	424	0.987	0.002	Sony 119-120-C1	was reel 288
224	289	0.993	0.003	3M 54300-4-1-7	
225	290	0.993	0.002	3M 54300-7-1-1	edge problem; spoked up
226	455	0.99	0.004	Sony 104-120-C1	was reel 291 and 3M 54301-6-1-8
227	282	0.988	0.003	3M 54301-8-1-12	edge problem
228	283	0.992	0.003	3M 54301-1-1-10	
229	284	0.99	0.005	3M 54301-8-1-9	
230	285	0.987	0.005	3M 54300-4-1-25	
231	286	0.988	0.004	3M54300-005-1-024	tape bumped up; edge problems
232	262	0.992	0.004	3M 54301-6-1-6	
233	263	0.991	0.005	3M 54300-5-1-16	edge problem after first use
234	264	0.991	0.002	3M 54300-5-1-21	
235	265	0.989	0.005	3M 54300-5-1-25	
236	266	0.991	0.003	3M 54300-4-1-24	
237	267	0.992	0.002	3M 54300-1-1-18	
238	268	0.989	0.004	3M 54300-3-1-11	
239	269	0.992	0.004	3M 54300-5-1-12	
240	270	0.986	0.005	3M 54300-5-1-8	
241	271	0.988	0.004	3M 54300-3-1-3	
242	241	0.99	0.003	3M 54300-5-1-6	edge problem
243	321	0.989	0.005	3M 54300-5-1-22	transferred from reel 240 after excess scatter
244	239	0.993	0.003	3M 54300-3-1-21	
245	238	0.989	0.004	3M 54300-5-1-21	
246	237	0.989	0.003	3M 54300-3-1-19	
247	364	0.989	0.004	Sony 109-120-E1	transferred from reel 236
248	232			Sony 115-128-K1	transferred from reel 235
249	376	0.988	0.004	Sony 109-120-F1	transferred from reel 234
250	423	0.987	0.003	Sony 108-120-G1	transferred from reel 233
251	325	0.989	0.004	3M 54300-5-1-7	transferred from reel 232; accel test II, edge and s
252	231	0.988	0.006	3M 54300-5-1-11	
253	230	0.988	0.006	3M 54300-7-1-22	
254	229	0.989	0.003	3M 54300-5-1-19	spliced out folded over area
255	228	0.994	0.002	3M 54300-7-1-17	
256	227	0.991	0.003	3M 54300-8-1-22	
257	400	0.987	0.005	Sony 115-120-F1	transferred from reel 226
258	442	0.991	0.003	Sony 105-120-M1	was reel 225, tape 3M 54300-003-1-23; folded and sea
259	224	0.988	0.006	3M 54300-3-1-20	
260	223	0.988	0.005	3M 54300-9-1-24	
261	222	0.991	0.004	3M 54300-8-1-5	
262	272	0.991	0.003	3M 54300-7-1-7	exposed edge after first use
263	273	0.988	0.003	3M 54300-1-1-15	
264	274	0.99	0.004	3M 54300-7-1-5	
265	403	0.987	0.003	3M 54300-1-1-24	transferred from 275 after edge problem; transferred

266					transferred from reel 276
267	277	0.99	0.005	3M 54300-S-1-18	
268	392	0.991	0.005		transferred from reel 278
270	366	0.988	0.002	Sony 105-120-U1	transferred from reel 280
271	281	0.991	0.002	3M 54300-003-1-018	
272	407	0.989	0.003	3M 54301-004-1-014	tape from reel 0144 (VLBA0181); also was reel 246 3M
273	404	0.989	0.004	Sony 109-120-I1	transferred from reel 245
274	244	0.989	0.005	3M 54300-3-1-24	edge problem; pack shift
275	243	0.992	0.003	Sony 113-120-U1	packing problems; was 3M 54300-8-1-24
276	242	0.993	0.003	3M 54300-7-1-11	
277	366	0.987	0.006	Sony 104-120-N1	
278	247	0.993	0.002	3M 54300-3-1-7	packing problems
280	249	0.987	0.004	Sony 107-120-W1	
281	250	0.987	0.004	Sony 109-120-L1	
282	425	0.987	0.004	Sony 108-120-F1	
283	426	0.989	0.001	Sony 110-120-M1	
284	470	0.991	0.005	Sony 116-120-O1	
285	429	0.989	0.003	Sony 116-120-L1	
286	465	0.991	0.002	Sony 106-120-H1	
287	453	0.99	0.004	Sony 116-120-I1	
288	452	0.991	0.005	Sony 124-120-F1	
289	466	0.99	0.004	Sony 104-120-M1	
290	454	0.987	0.004	Sony 104-120-G1	
291	456	0.991	0.004	Sony 110-120-T1	
292	402	0.987	0.005	Sony 118-120-W1	
293	234	0.992	0.003	Sony 124-120-R1	
294	466	0.993	0.003	Sony 110-120-S1	
295	447	0.99	0.004	Sony 110-120-C1	
296	445	0.989	0.005	Sony 110-120-F1	
297	417	0.989	0.005	Sony 110-120-R1	
298	418	0.987	0.004	Sony 110-120-P1	
299	419	0.988	0.004	Sony 110-120-O1	
300	189			Sony 136-114-I1	
301	188			Sony 116-120-F1	
302	187			Sony 117-120-F1	Bumped up
303	190			Sony 117-120-E1	
304	191			Sony 106-120-I1	
305	108			Sony 115-120-B1	
306	184			Sony 103-120-D1	Bumped up
307	185			Sony 115-120-A1	Bumped up; Haystack testing
308	183			Sony 115-120-G1	
309	186			Sony 136-114-K1	Wrinkled area near litsense from thread error
310	166			Sony 136-114-G1	Haystack testing
311	164			Sony 136-114-F1	transferred from reel 163
312	369	0.991	0.004		
313	378	0.991	0.003		
314	383	0.993	0.003		
315	379	0.989	0.004		
316	334	0.989	0.004		
317	394	0.988	0.004		
318	443	0.989	0.005		
319	384	0.991	0.002		
320	332	0.988	0.003		
321	362	0.993	0.001		
322	333	0.988	0.004		Accel Test II, spokes once
323	390	0.991	0.003		
324	340	0.988	0.003		
325	398	0.986	0.004		
326	367	0.989	0.002		
327	337	0.988	0.004		
328	401	0.987	0.004		
329	381	0.988	0.005		
330	448	0.992	0.004		
331	450	0.991	0.003		
332	468	0.99	0.003		
333	458	0.993	0.002	Sony 121-120-K1	
334	460	0.992	0.004	Sony 121-120-G1	
335	459	0.993	0.003	Sony 121-120-I1	
336	159	0.989	0.004	Sony 118-120-P1	
337	361	0.99	0.006	Sony 121-120-E1	
338	320	0.991	0.003	Sony 118-120-J1	
339	461	0.991	0.004	Sony 119-120-F1	
340	354	0.989	0.005	Sony 119-120-L1	
341	433	0.991	0.005	Sony 106-120-R1	
342	363	0.99	0.004	Sony 106-120-P1	
343	251	0.992	0.002	Sony 106-120-S1	
344	319	0.991	0.005	Sony 106-120-O1	
345	314	0.991	0.003	Sony 118-120-R1	
346	317	0.986	0.005	Sony 105-120-P1	
347	467	0.988	0.004	Sony 121-120-B1	
348	457	0.991	0.005	Sony 121-120-A1	
349	462	0.993	0.002	Sony 121-120-H1	
350	347	0.988	0.004	Sony 115-120-W1	
351	346	0.993	0.003	Sony 121-120-C1	
352	351	0.99	0.005	Sony 109-120-V1	
353	350	0.99	0.004	Sony 108-120-T1	
354	348	0.991	0.005	Sony 105-120-B1	
355	345	0.991	0.003	Sony 108-120-R1	
356	322	0.991	0.005	Sony 108-120-U1	
357	325	0.99	0.006	Sony 108-120-P1	
358	343	0.989	0.003	Sony 116-120-O1	
359	373	0.986	0.003	Sony 118-120-U1	transferred from reel 318 which was broken
360	434	0.99	0.003	Sony 106-120-A1	
361	353	0.991	0.002	Sony 108-120-W1	
362	359			Sony 109-120-Q1	
363	356	0.989	0.004	Sony 105-120-K1	
364	360	0.992	0.003	Sony 105-120-Q1	
365	432	0.989	0.003	Sony 104-120-Q1	
366	412	0.992	0.003	Sony 116-120-W1	
367	436	0.998	0.005	Sony 116-120-T1	
368	439	0.989	0.004	Sony 118-120-H1	might be Corning reel and Sony 124-120-Q1
369	440	0.991	0.001	Sony 118-120-W1	

370	441	0.989	0.003	Sony 118-120-01	
371	451	0.989	0.004	Sony 118-120-F1	
372	415	Corning		Sony 103-120-01	
373	5	Corning		Sony 103-120-L1	
374	4	Corning		Sony 103-120-H1	
375	6	Corning		Sony 103-120-F1	
376	10	Corning		Sony 118-120-E1	
377	27	Corning		Sony 124-120-C1	
378	17	Corning		Sony 124-120-T1	
379	19	Corning		Sony 103-120-M1	
380	20	Corning		Sony 107-120-D1	badly scattered after first use
381	21	Corning		Sony 103-120-E1	
382	22	Corning		Sony 103-120-G1	
383	16	Corning		Sony 107-120-L1	
384	15	Corning		Sony 107-120-F1	
385	18	Corning		Sony 115-120-H1	
386				Sony	
387	395	0.986	0.005	Sony 119-120-P1	
388	368	0.988	0.005	Sony 115-120-Q1	
389	374	0.99	0.006	Sony 113-120-M1	
390	393	0.99	0.002	Sony 117-120-S1	
391	26	Corning		Sony 124-120-E1	
392	375	0.99	0.005	Sony 136-114-W1	
393	25	Corning		Sony 107-120-C1	
394	24	Corning		Sony 115-120-S1	
395	23	Corning		Sony 103-120-11	
396	396	0.986	0.006	Sony 119-120-S1	
397	370	0.994	0.002	Sony 109-120-G1	
398	449	0.993	0.002	Sony 109-120-C1	
399	493	0.991	0.003	Sony 116-120-S1	
400	489	0.989	0.005	Sony 116-120-U1	
401	492	0.989	0.004	Sony 116-120-V1	
402	494	0.991	0.005	Sony 116-120-R1	
403	491	0.988	0.004	Sony 114-120-N1	
404	490	0.991	0.002	Sony 103-120-W1	
405	480	0.992	0.003	Sony 103-120-P1	
406	479			Sony 103-120-U1	
407	482	0.989	0.002	Sony 104-120-L1	
408	483	0.994	0.002	Sony 104-120-D1	
409	485	0.99	0.003	Sony 104-120-K1	
410	486	0.991	0.003	Sony 110-120-U1	
411	487	0.991	0.003	Sony 106-120-I1	
412	403	0.987	0.003	Sony 106-120-M1	
413	481	0.991	0.002	Sony 106-120-F1	
414	488	0.989	0.005	Sony 106-120-G1	
415	372	0.992	0.003	Sony 113-120-N1	
416	407	0.989	0.003	Sony 118-120-Q1	
417	28	Corning		Sony 118-120-L1	
418	29	Corning		Sony 118-120-K1	
419	30	Corning		3M 54300-8-1-11	
420	536	0.988	0.005	Sony 116-120-C1	
421	558	0.993	0.003	Sony 114-120-I1	
422	519	0.992	0.004	Sony 114-120-E1	was Sony 108-120-C1 and reel 422
423	520	0.994	0.002	Sony 114-120-G1	
424	522	0.986	0.004	Sony 114-120-L1	
425	521	0.99	0.004	Sony 116-120-E1	
426	523	0.991	0.003	Sony 117-120-H1	
427	514	0.99	0.003	Sony 117-120-M1	
428	516	0.992	0.003	Sony 117-120-I1	
429	515	0.991	0.004	Sony 106-120-C1	
430	542	0.99	0.004	Sony 106-120-E1	
431	517	0.987	0.003	Sony 104-120-B1	
432	518	0.989	0.005	Sony 106-120-D1	
433	592	0.992	0.004	Sony 136-114-R1	
434	540	0.991	0.004	Sony 136-114-T1	
435	539	0.991	0.003	Sony 136-114-U1	
436	543	0.988	0.003	Sony 136-114-V1	
437	534	0.991	0.003	Sony 116-120-B1	
438	535	0.989	0.006	Sony 116-120-A1	
439	537	0.99	0.005	Sony 117-120-G1	
440	555	0.989	0.003	Sony 119-120-M1	
441	564	0.99	0.004	Sony 110-120-K1	
442	565	0.989	0.001	Sony 110-120-I1	
443	556	0.991	0.004	Sony 110-120-H1	
444	557	0.988	0.004	Sony 110-120-G1	
445	559	0.991	0.005	Sony 108-120-M1	
446	560	0.991	0.003	Sony 109-120-U1	
447	561	0.989	0.003	Sony 108-120-01	
448	562	0.991	0.005	Sony 108-120-B1	
449	563	0.987	0.003	Sony 108-120-J1	
450	554	0.989	0.004	Sony 119-120-K1	
451				Sony	
452				Sony	
453				Sony	
454	569			Sony	Accel Test II; operator error during transfer
455				Sony	
456	31	Corning		3M 54300-6-1-20	
457	32	Corning		3M 54300-6-1-10	
458	33	Corning		3M 54300-6-1-14	
459	34	Corning		3M 54300-8-1-18	
460	35	Corning		3M 54300-1-1-19	
461	511	0.989	0.002	3M 54300-7-1-16	
462	500	0.992	0.002	3M 54300-8-1-14	
463	510	0.991	0.001	3M 54300-8-1-15	
464	501	0.992	0.002	3M 54300-7-1-20	
465	502	0.988	0.003	3M 54300-7-1-18	
466	513	0.992	0.002	3M 54300-4-1-6	
467	504	0.992	0.003	3M 54300-8-1-23	
468	505	0.99	0.004	3M 54300-1-1-21	
469	507	0.989	0.003	3M 54300-8-1-3	
470	506	0.988	0.003	3M 54300-4-1-[illegible]	

475	477	0.993	0.003 3M 54300-6-1-9	
476	478	0.992	0.003 3M 54300-6-1-21	
477	475	0.993	0.003 3M 54300-1-1-17	
478	578	0.989	0.003 3M 54300-1-1-20	
479	526	0.986	0.004 3M 54300-7-1-19	
[redacted]	524	0.99	0.005 3M 54300-3-1-16	
[redacted]	530	0.987	0.002 3M 54300-7-1-25	Accel Test II
482	531	0.986	0.003 3M 54300-5-1-13	
483	532	0.99	0.003 3M 54300-7-1-3	
484	533	0.992	0.003 3M 54300-4-1-16	
485	549	0.987	0.004 3M 54300-1-1-23	
486	550	0.988	0.006 3M 54300-8-1-10	
487	551	0.99	0.006 3M 54300-4-1-11	
488	552	0.99	0.003 3M 54300-8-1-17	
489	544	0.991	0.005 3M 54300-4-1-10	
490	553	0.992	0.003 3M 54300-1-1-25	
491	546	0.988	0.006 3M 54300-3-1-17	
492	547	0.993	0.003 3M 54300-3-1-22	
493	548	0.993	0.003 3M 54300-8-1-7	
494	538	0.994	0.002 3M 54300-1-1-5	
495	545	0.989	0.003 3M 54300-5-1-17	
496				
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