GBT MEMO 118

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, WV

MEMORANDUM December 29, 1994

TO: File
FROM: R. Lacasse
SUBJ: **Actuator Short Step Life Tests**

Introduction

At the October 1994 GBT Advisory Committee Meeting, it was pointed out that actuator life tests to date had consisted of running the actuator from one end of its travel range to the other in one continuous motion. This method of testing yields one start/stop cycle per 1.7 inches of travel. In actual operation, many more start/stop cycles per inch are expected. Motor wear, which is expected to limit actuator life in most cases, is a function of both the number of rotor revolutions and start/stop cycles. It was recommended that NRAO set up an experiment to measure the effect of start/stop cycles on motor life. This memo reports on that experiment.

Experimental Set-up

The 4-panel, 9-actuator mock up near the Interferometer Control Building was used as the test bed for this experiment. A sketch is shown in Figure 1. The actuators in this test-bed are driven electrically in exactly the same way that they will be on the telescope, over a similar length of cable (about 300 ft.). The actuators are subject to the Green Bank outdoor environment. Panels and wind provide loading. In this test-bed it is not possible to move the actuators over large angles, as they would be on the telescope; however this was not seen as a serious limitation.

The top three actuators (labeled 1, 2, and 3 on Figure 1) were used as controls. They traveled 1.7" (near full stroke) in one continuous motion while the bottom three actuators (7, 8, and 9) traveled the same distance, but in small steps. The top three actuators are referred to below as the stroked actuators, the bottom three actuators as the stepped actuators and the 1.7" of motion is referred to as a stroke. The stroked actuators had 1 start/stop cycle per stroke. The stepped actuators were turned on for 0.8 sec and off for 0.8 sec resulting in steps of approximately 12 mils or 300 microns. It was verified that the stepped actuator motors experienced a negligible temperature rise (< 1 degree C). The calibration of the LVDT position transducers was checked with dial gauges; they were found to be within +/-1% of one another. Thus, during the course of the experiment, all actuators were moved 7488 strokes or approximately 12,730", and accumulated approximately 238 hours of running time. The stroked actuators experienced 7488 start stop cycles while the stepped actuators

experienced about 1,000,000 each (actuator 7: 1,057,836; actuator 8: 1,073,07; actuator 9: 1,099,888). The selection of 1,000,000 steps as a goal for the experiment was based on a variety of estimates of operational requirements. A memo by Lockman will give further details on this. In any case the ratio of start/stop cycles for the stepped versus the stroked actuators is large enough (133) that the dependence of brush wear on start/stop cycles should be elicited.

Brush Wear Results

Data on brush wear is shown in Table 1. The data is also depicted graphically in Figures 2 through 7. At best, there appears to be only a slight dependence of brush wear on the number of start/stop cycles. Average brush wear for 7488 start/stop cycles was 6.42 mils; average brush wear for 1,000,000 start/stop cycles was 7.58 mils. Brush wear of over 100 mils is required to make the motor fail.

Commutator Wear Results

Data on commutator wear is shown in Table 2. The average stroked actuator wore 0.67 mils. The average stepped actuator wore 3.3 mils. There seems to be a significant result here. However, it should not seriously impact motor life. Commutator bars are 40 mils thick and thus it would take 80 mils of wear (measured as a diameter) to go entirely through them. We have had motors work well with 15 to 25 mils of wear.

Other Results

One result of the experiment that was not anticipated was the accumulation of grease in the motor. Two of the three stepped actuators had to be cleaned during the course of the experiment as grease was interrupting contact of the brushes with the commutator. One of the three stroked motors was found to have some grease on its windings after the experiment. This potentially serious problem is being discussed with the actuator manufacturer and will be the subject of a future memo.

Acknowledgements

Many thanks to Dwayne Schiebel who helped with the set-up, measurements, and sanity checks throughout the experiment.

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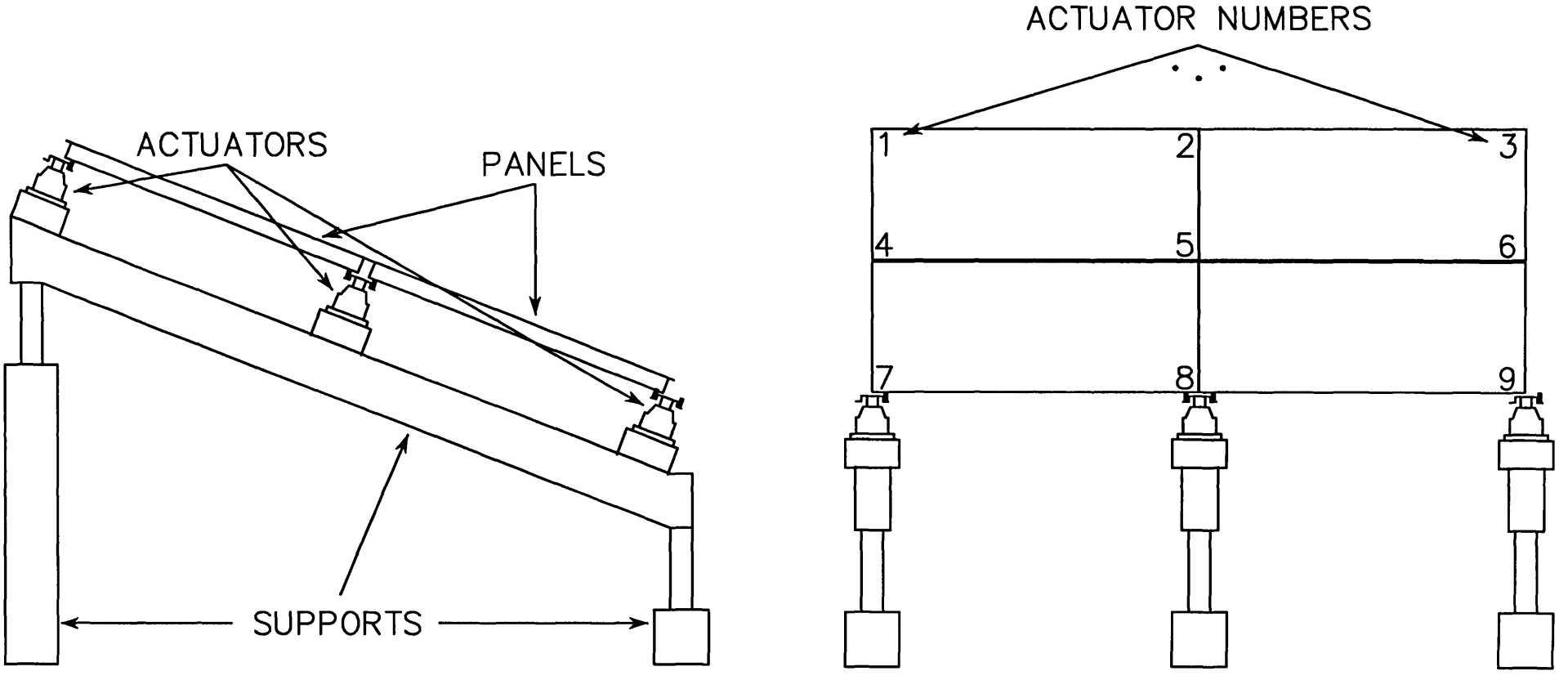

Figure 1: Sketch of 9–actuator test set.

Actuator #	Type	Brush #	Brush Lenght (mils) Before	After	Delta
1	stroked	1	136	130	6
		2	140	132	8
		3	137	138	−1
		4	135	132	3
2	stroked	1	141	134	7
		2	140	136	4
		3	142	137	5
		4	142	138	4
3	stroked	1	137	127	10
		2	140	129	11
		3	140	128	12
		4	141	133	8
	Average stroked		139.25	132.83	6.42
7	stepped	1	137	132	5
		2	144	144	0
		3	139	132	7
		4	137	132	5
8	stepped	1	140	130	10
		2	142	138	4
		3	138	131	7
		4	140	133	7
9	stepped	1	140	130	10
		2	144	130	14
		3	138	128	10
		4	144	132	12
	Average stepped		140.25	132.67	7.58

Locations of actuators on the 9 actuator test jig

1	Top left
2	Top middle
3	Top right
7	Bottom left
8	Bottom middle
9	Bottom right

Table 1: Brush wear data.

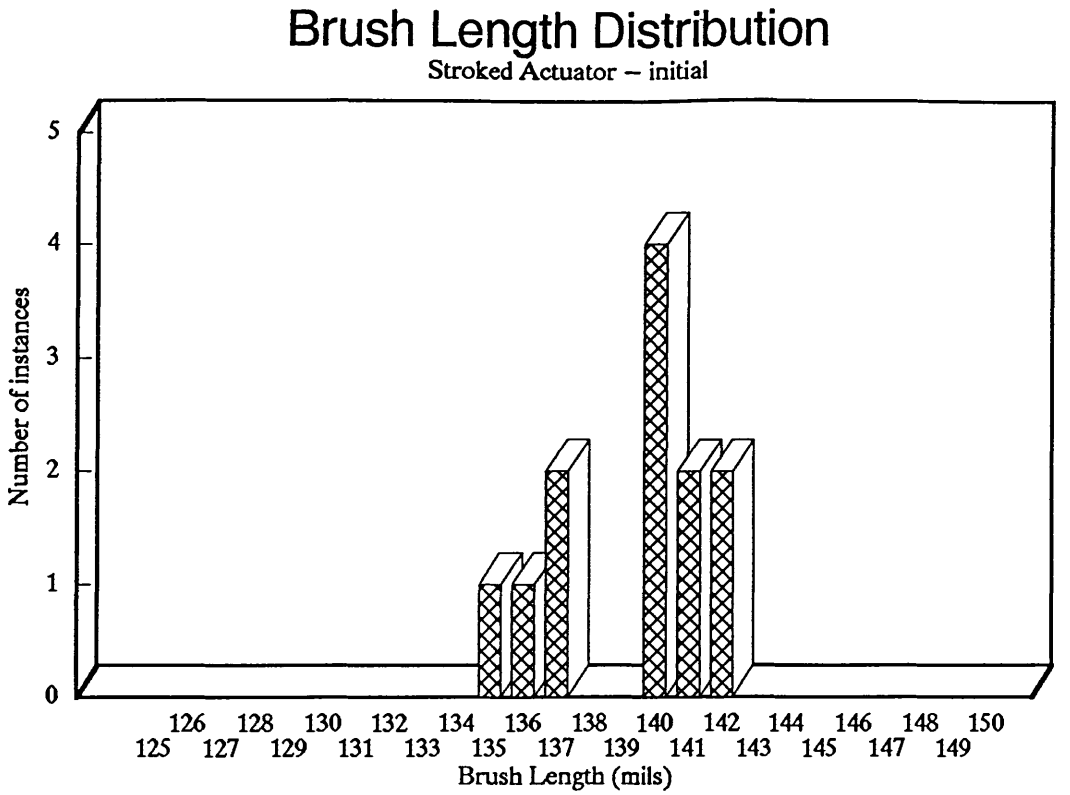

Figure 2

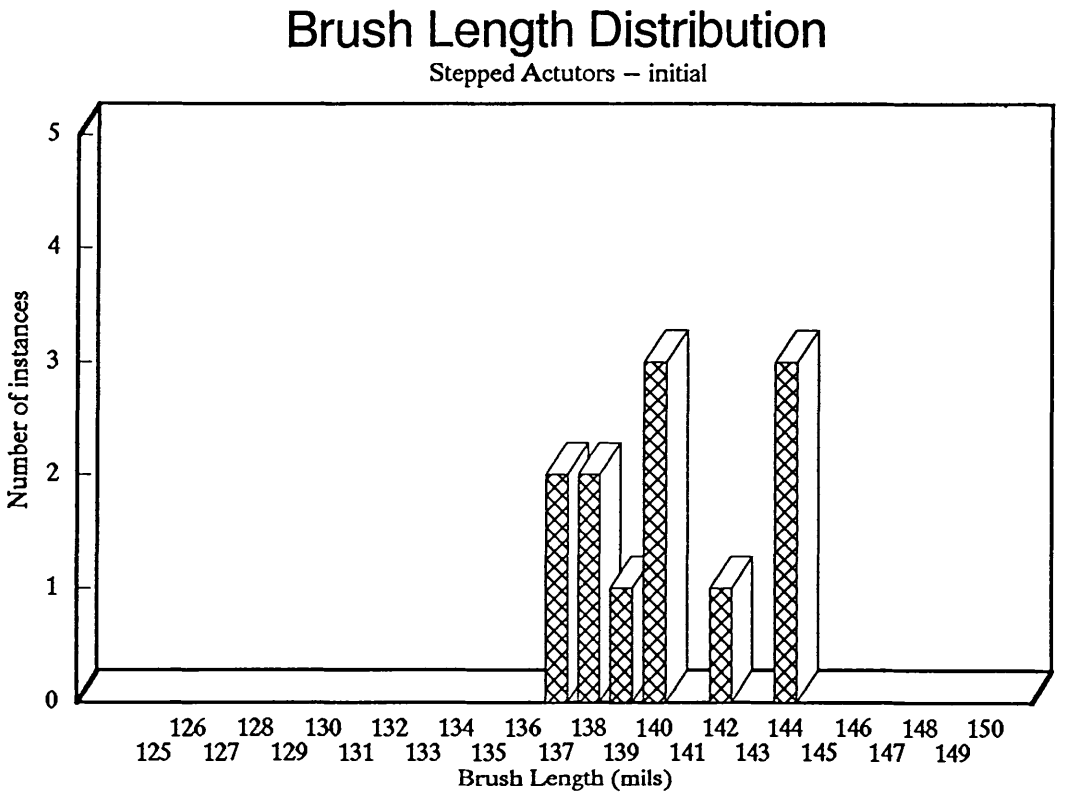

Figure 3

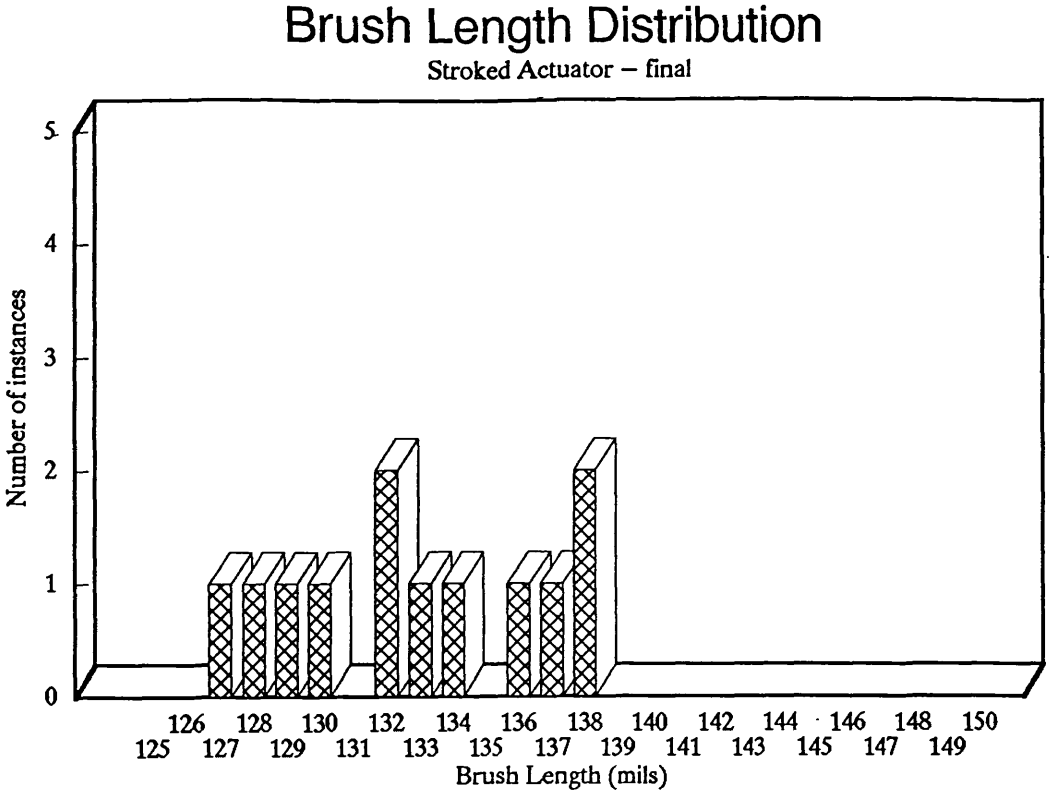

Figure 4

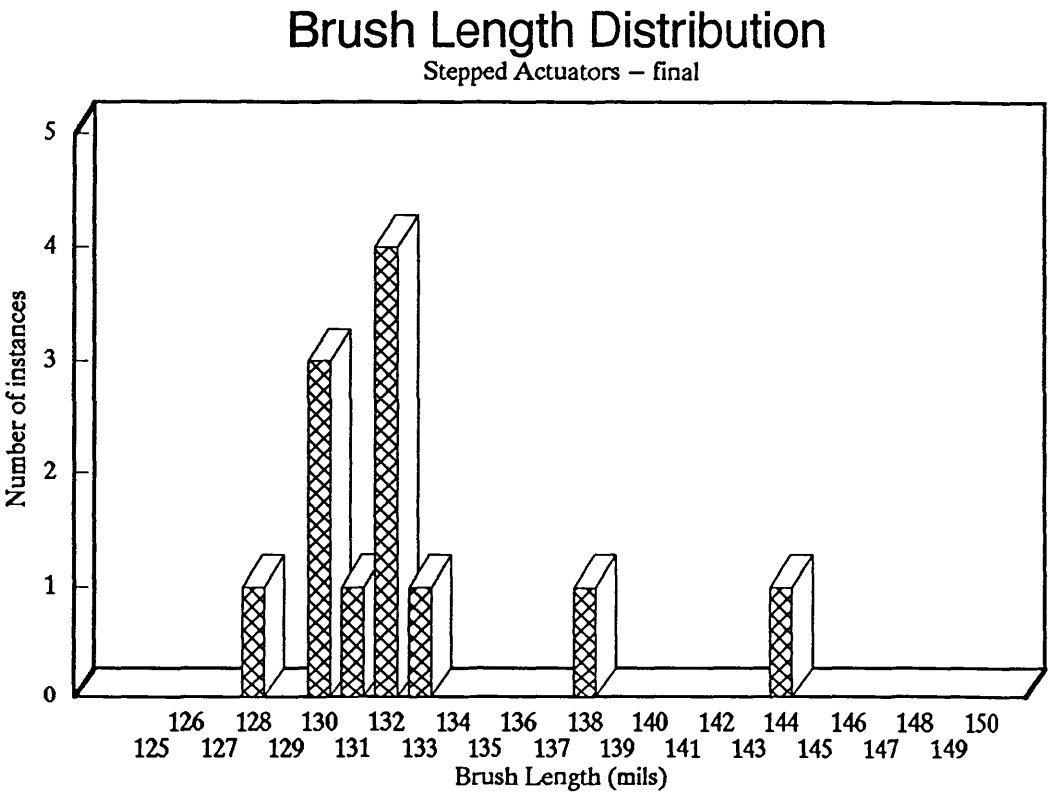

Figure 5

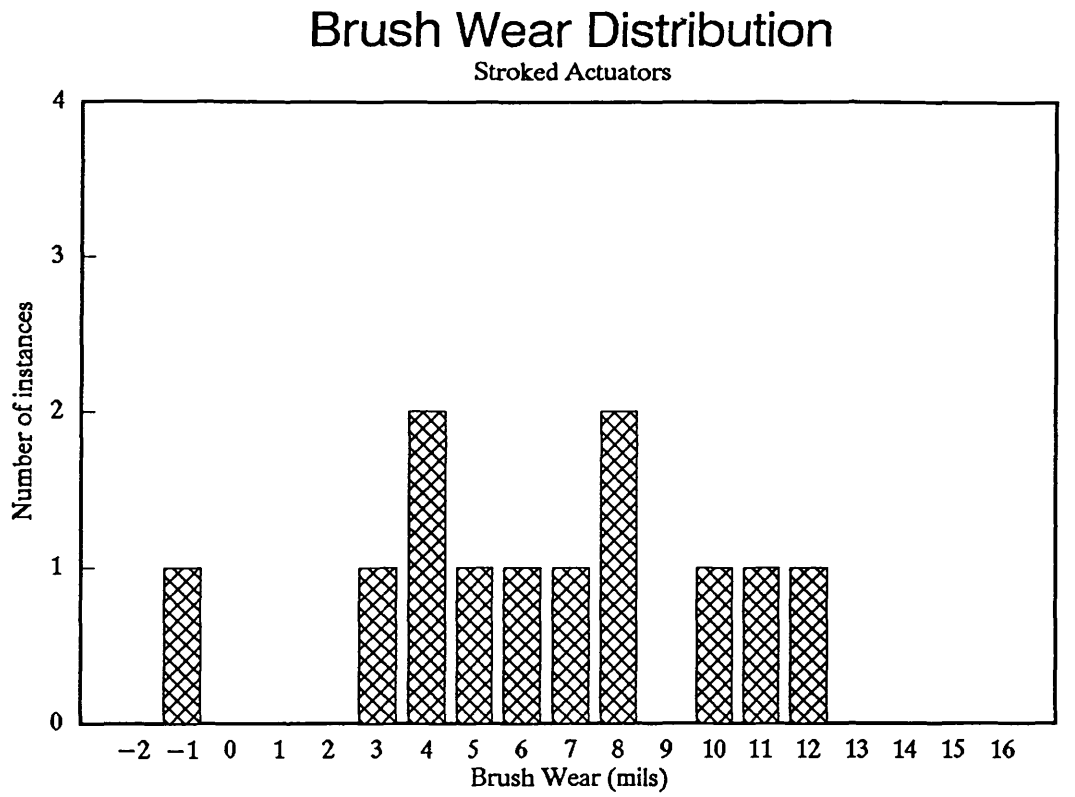

Figure 6

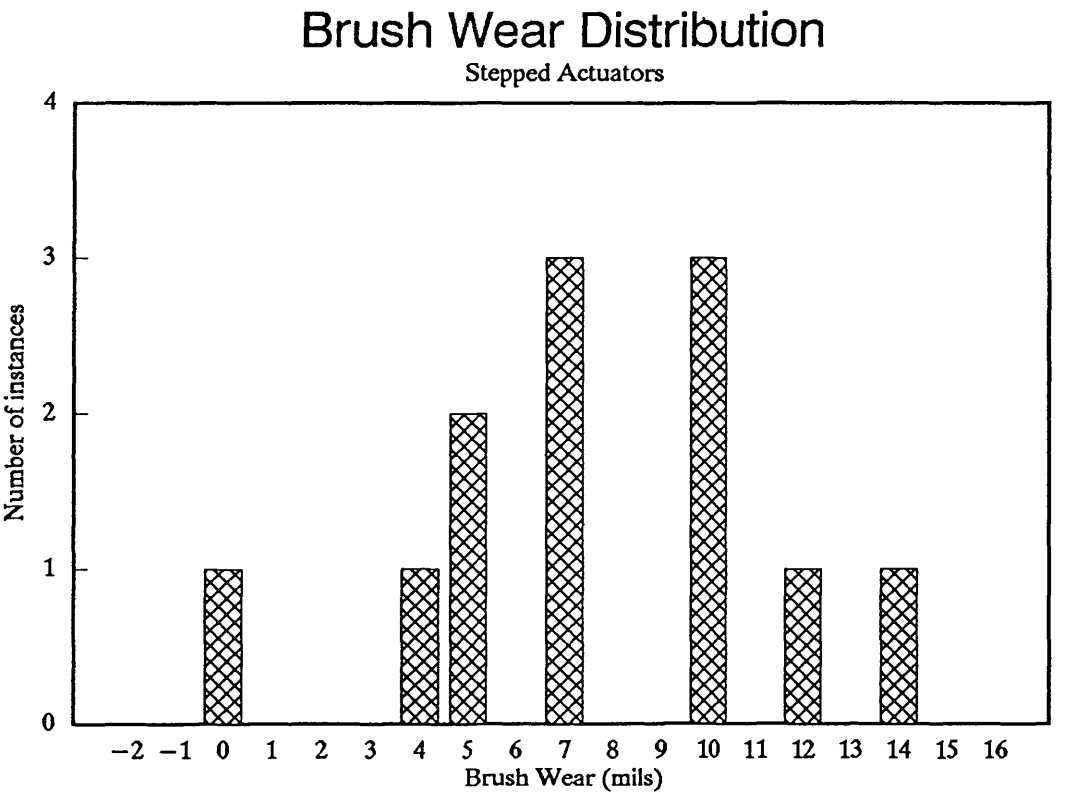

Figure 7

Actuator #	Type	Commutator Diameter (mils) Initial	Final	Delta
1	stroked	1096	1096	0
2	stroked	1090	1089	1
3	stroked	1090	1089	1
	Average stroked	1092.00	1091.33	0.67
7	stepped	1095	1091	4
8	stepped	1090	1086	4
9	stepped	1090	1088	2
	Average stepped	1091.67	1088.33	3.33

Locations of actuators on the 9 actuator test jig

1	Top left
2	Top middle
3	Top right
7	Bottom left
8	Bottom middle
9	Bottom right

Table 2: Commutator wear data.