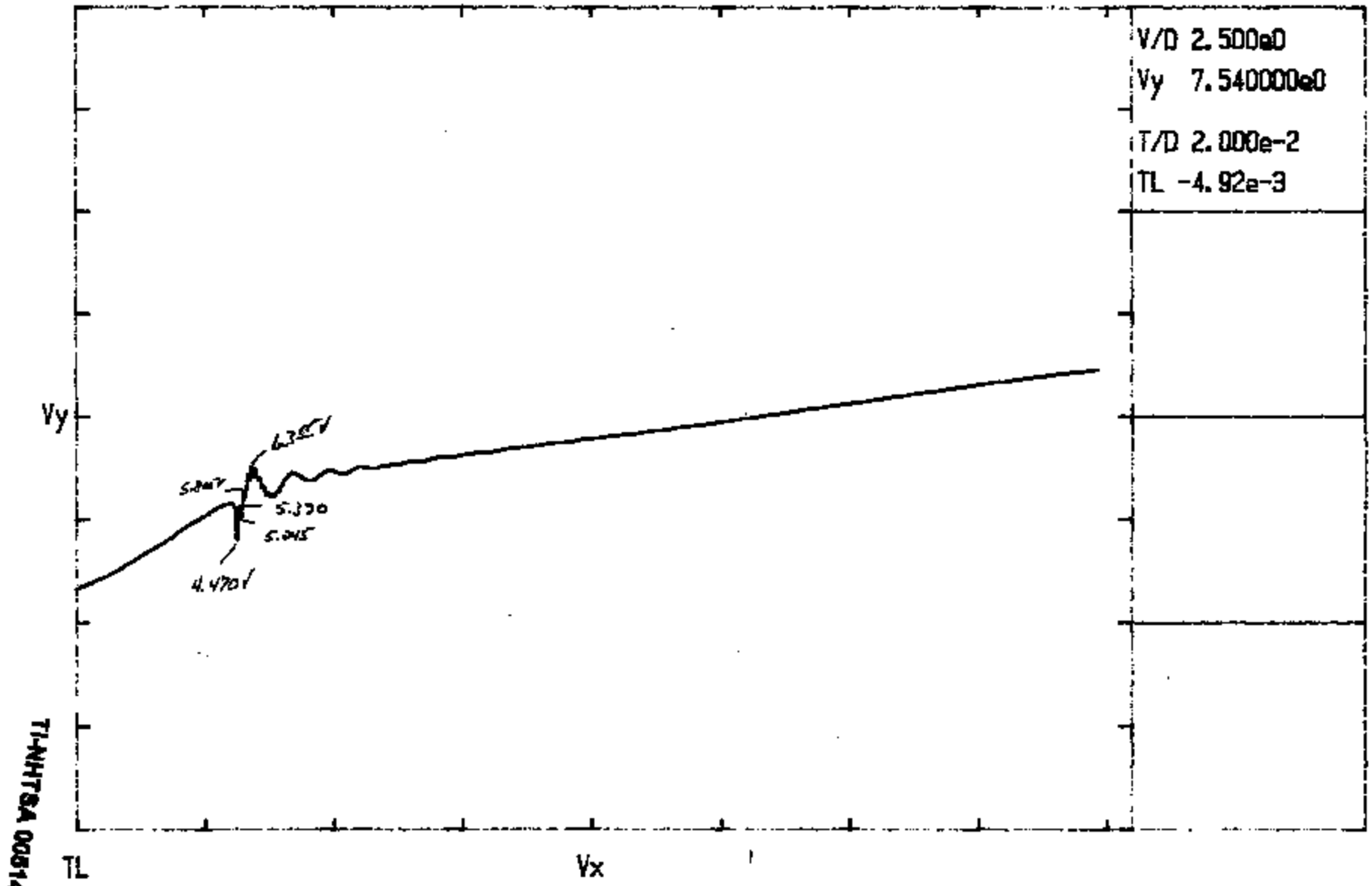
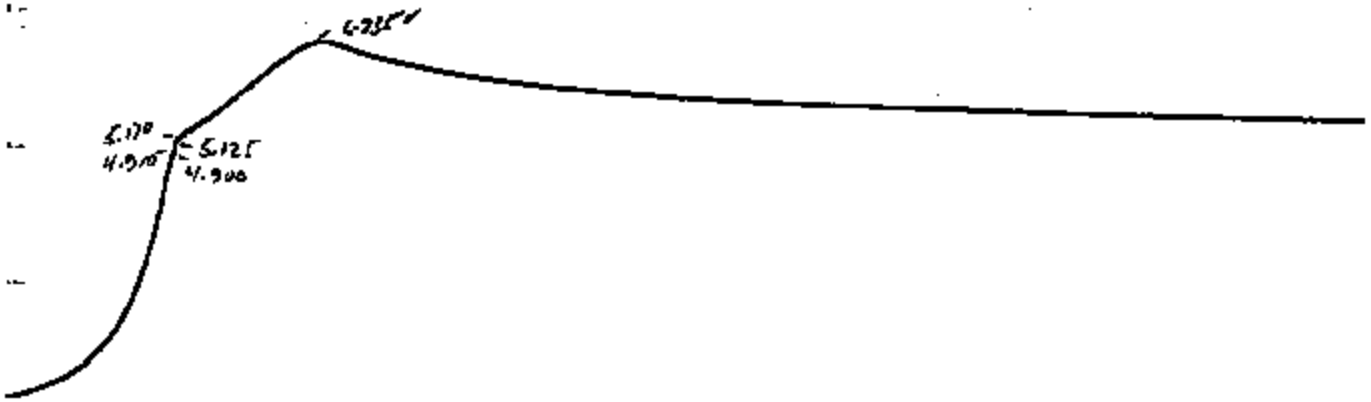
#1

Dwg 2



V/D 2.500e0
Vy 7.545000e0

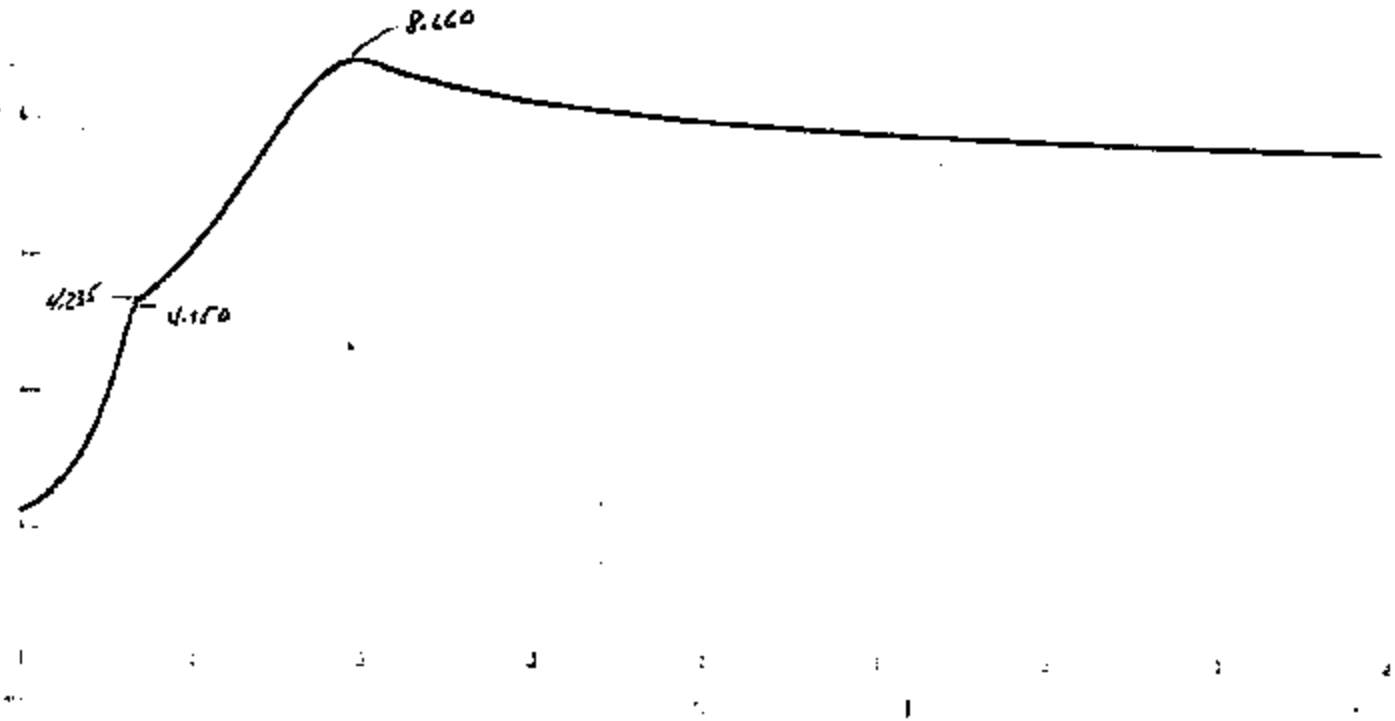
T/D 2.000e-1
TL -1.968e-1



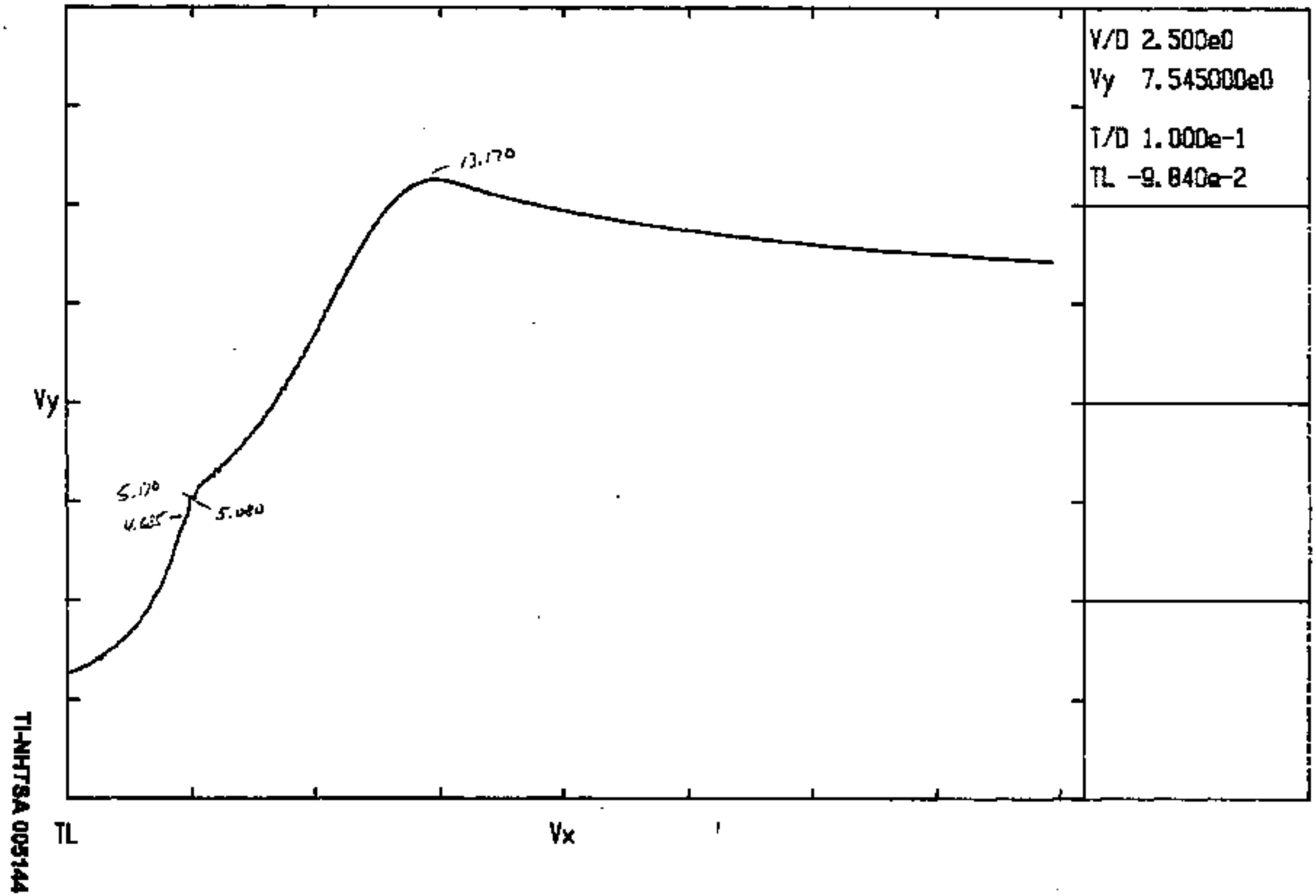
#3
Test 2

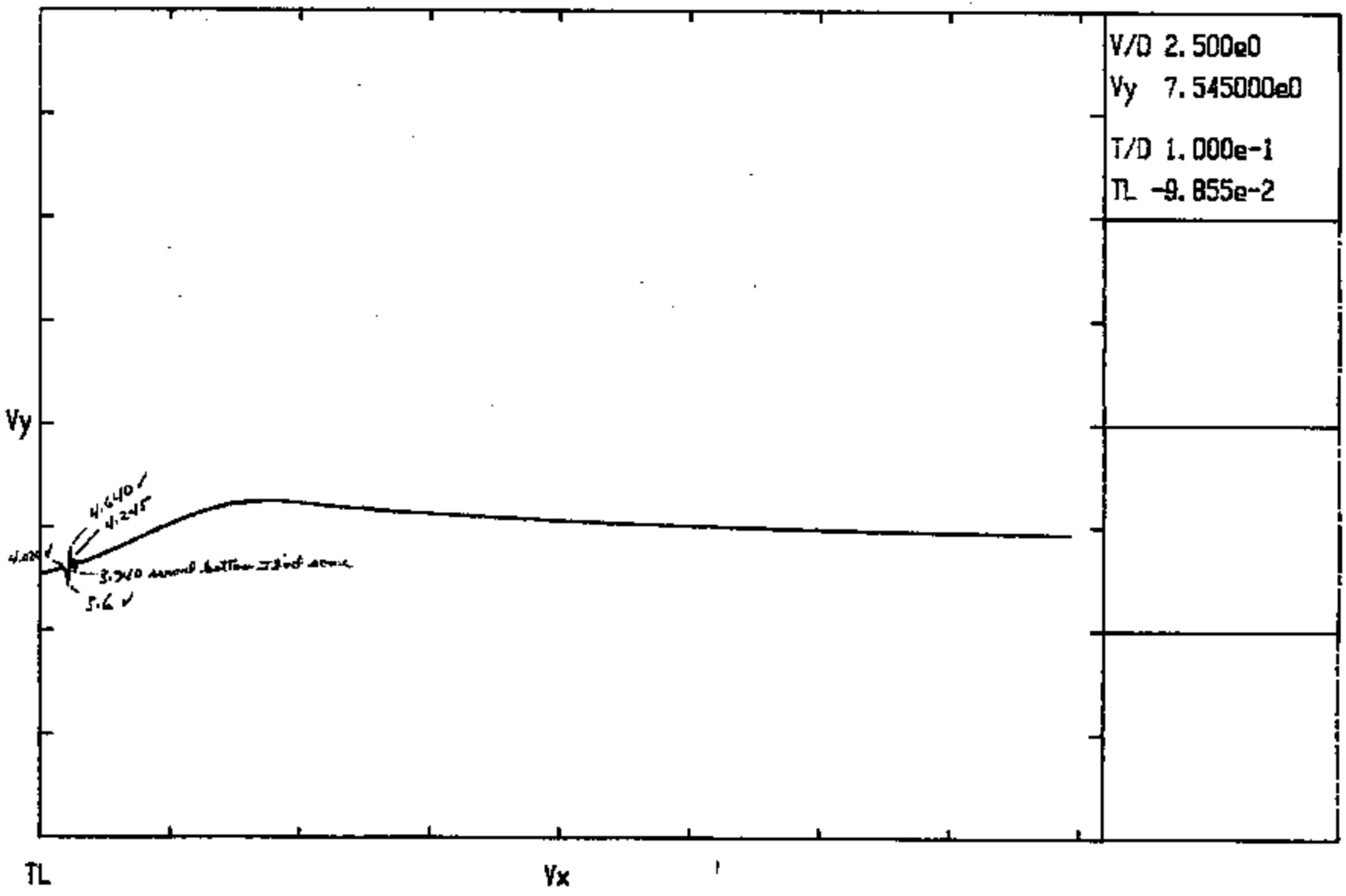
V/D 2.500e0
Vy 7.550000e0

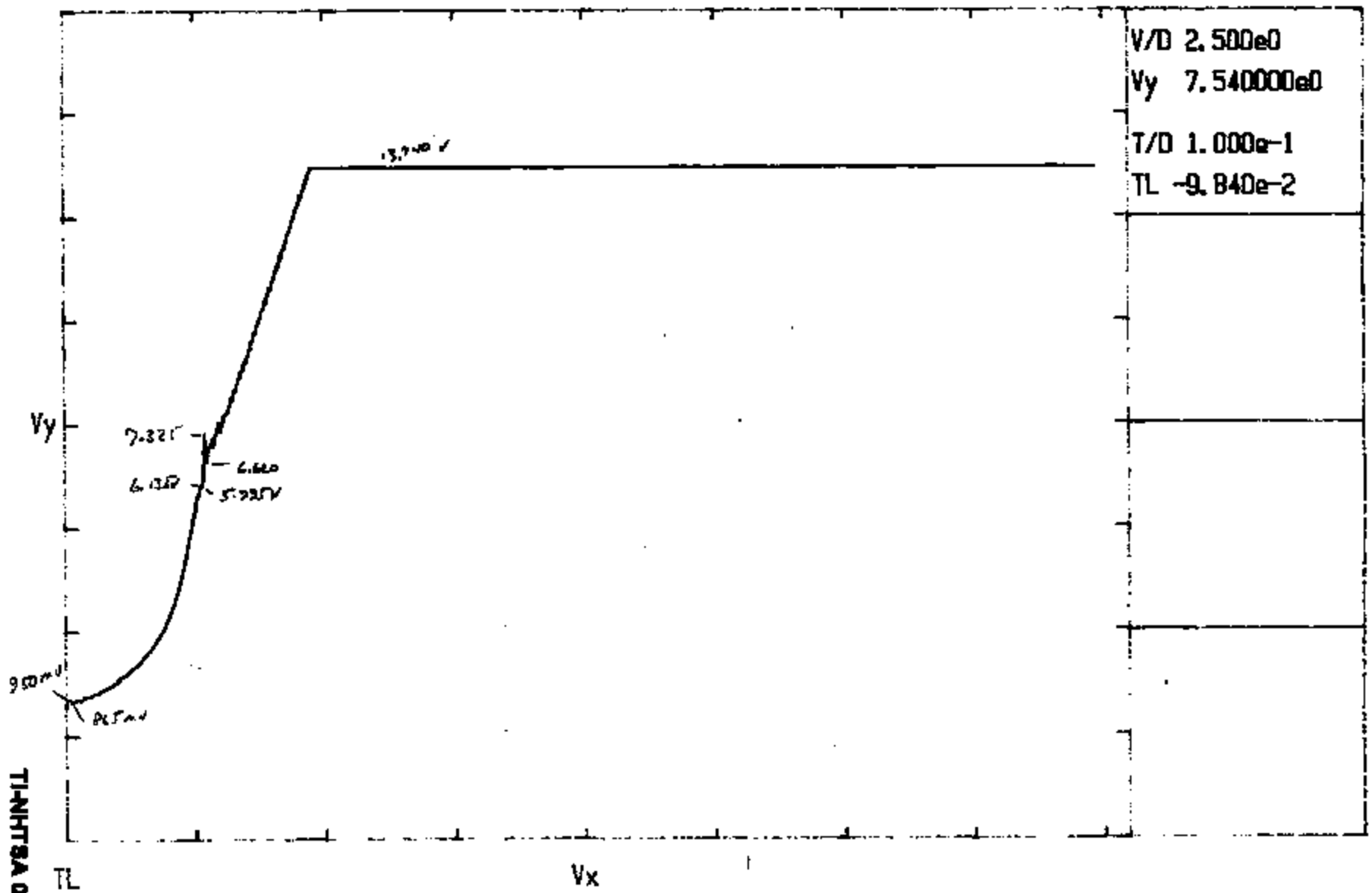
T/D 2.000e-1
TL -4.92e-2

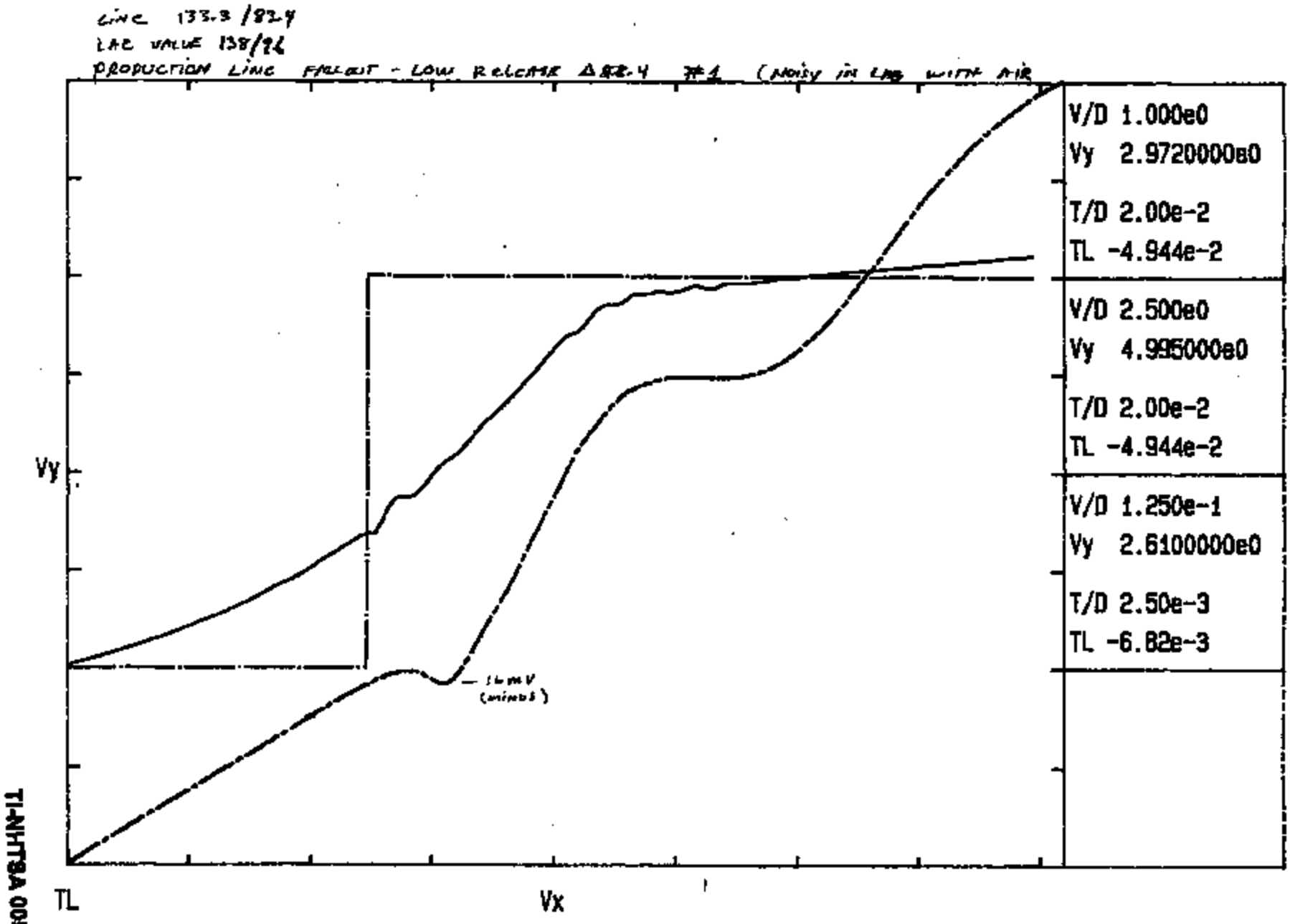


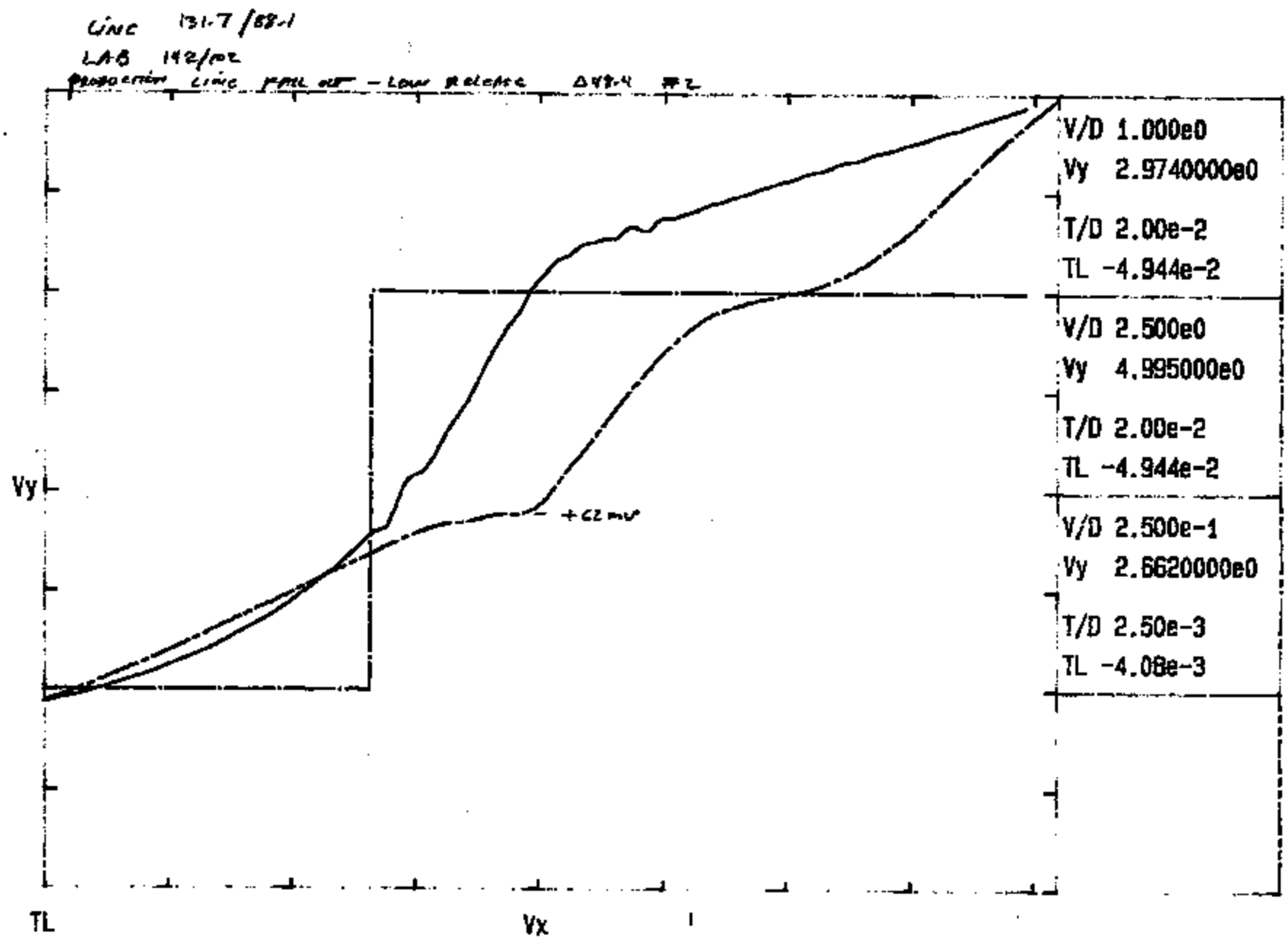
TI-NHTSA 005143

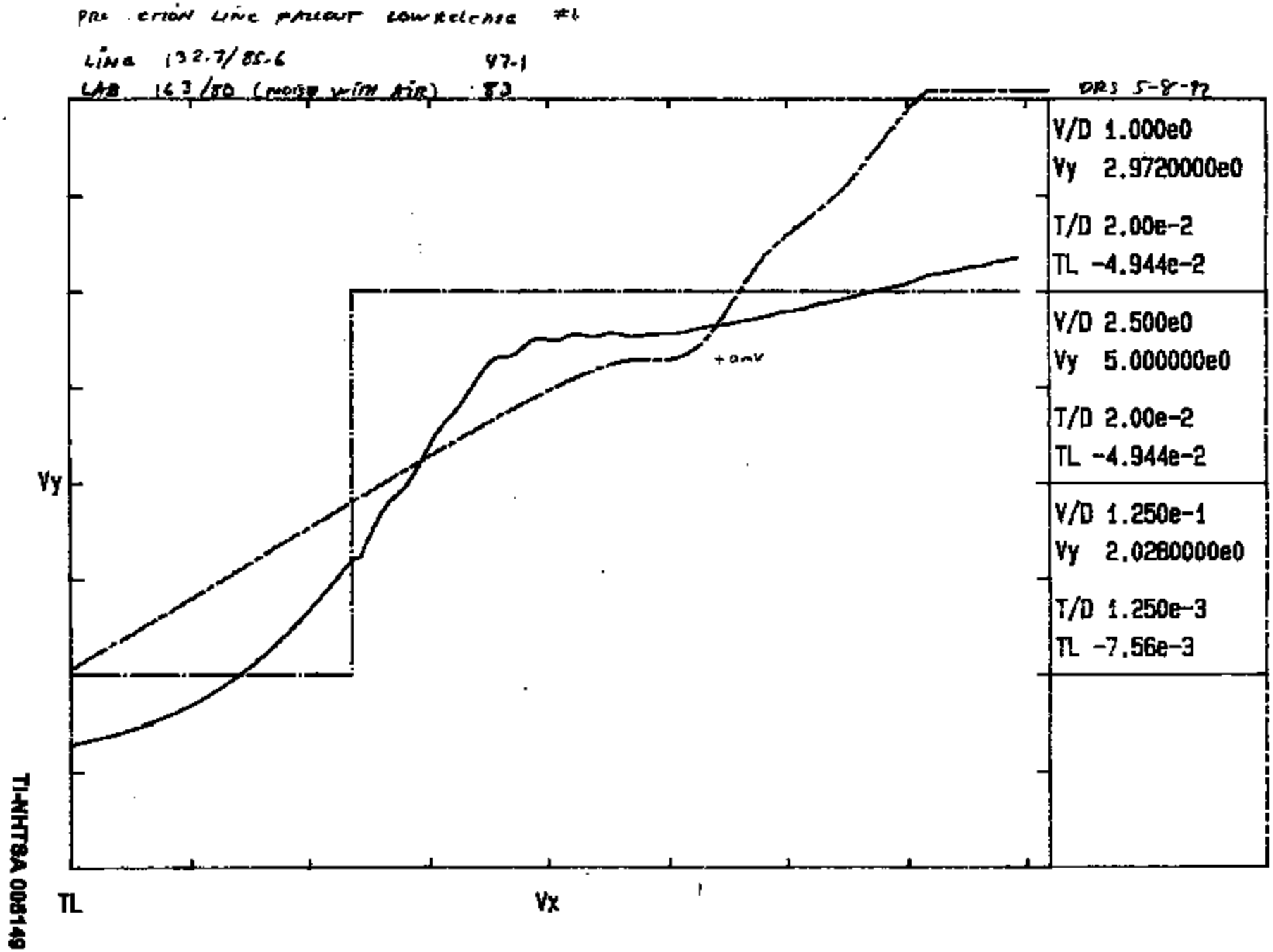

V/D 2.500e0
Vy 7.545000e0
T/D 1.000e-1
TL -9.840e-2
13.170
5.170
4.685
5.080
Vy
TL
Vx
TLNHTSA 009144






LINE 133.3 /82.4
LAC VALUE 138/92
PRODUCTION LINE FALLOUT - LOW RELEASE Δ82.4 #4 (NOISY IN LAG WITH AIR
V/D 1.000e0
Vy 2.9720000e0
T/D 2.00e-2
TL -4.944e-2
V/D 2.500e0
Vy 4.995000e0
T/D 2.00e-2
TL -4.944e-2
V/D 1.250e-1
Vy 2.6100000e0
T/D 2.50e-3
TL -6.82e-3
Vy
TL
Vx
TI-NHTBA 009147

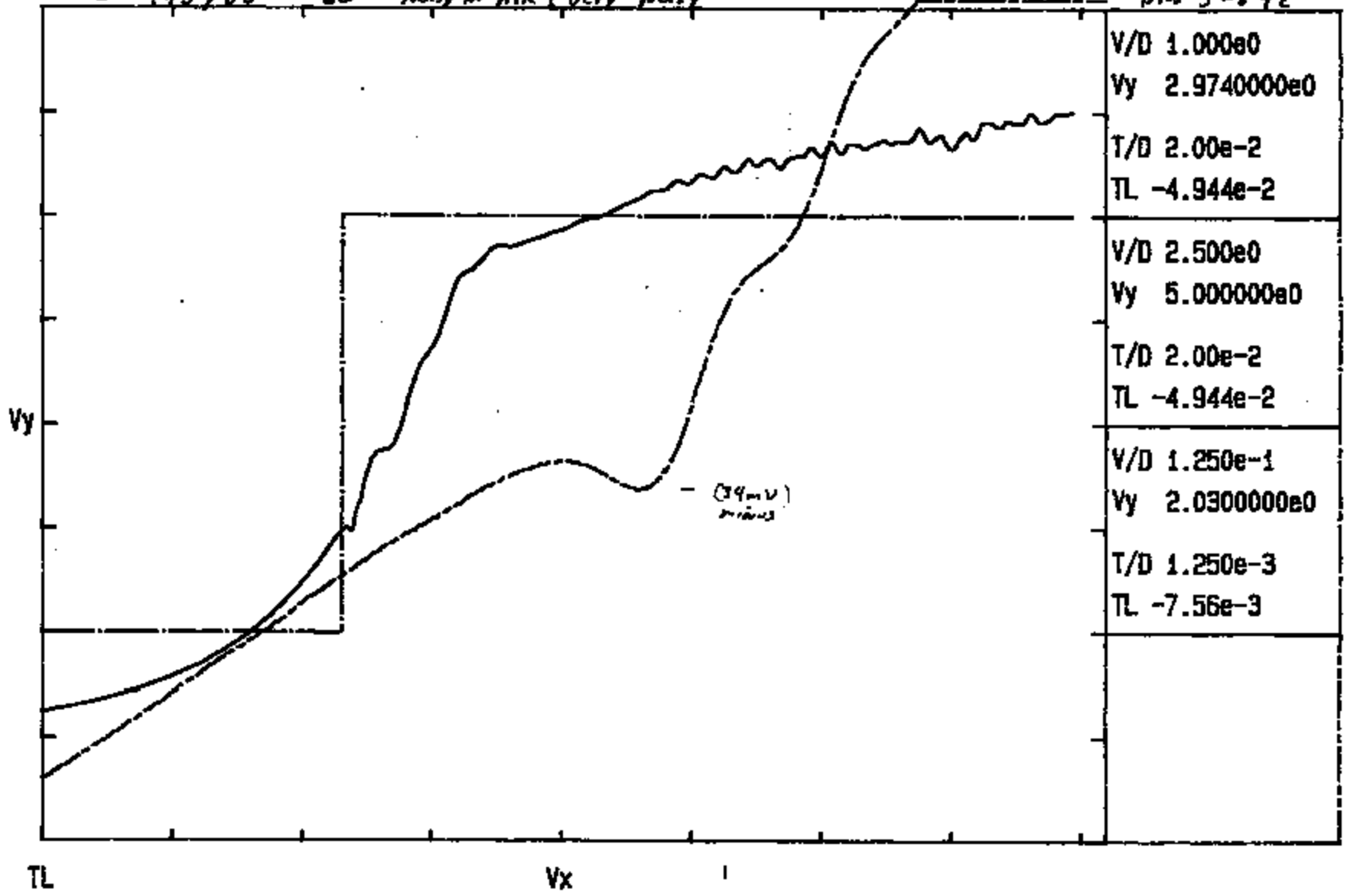




TI-NHTSA 008149

PR ICTION LINE FALLOUT LOW RELEASE #2

LINE 129-7/34-8 44.9
LAB 145/85 60 NOISY IN AIR (VERY NOISY



GM GAGE STUDY FOR REPEATABILITY AND REPRODUCIBILITY (LONG METHOD
~~02-JAN-80~~ MAY 12, 1982
SOUND PULSE SILENT SWITCHES

NUMBER OF OPERATORS	2	MIN SPEC	-200
NUMBER OF PARTS	10	MAX SPEC	500
NUMBER OF TRIALS	2	TOLERANCE	700

DATA SUMMARY

OPERATOR	AVERAGE	RANGE
JEFF	38.95	16.5
HOWARD	44.9	27.8
3	NA	NA
4	NA	NA
5	NA	NA
6	NA	NA
7	NA	NA
8	NA	NA
9	NA	NA
10	NA	NA
AVERAGE	41.925	22.15

(in mV's)

MIN XBAR	38.95
MAX XBAR	44.9
XBARDIFF	5.95

	MEASUREMENT UNIT ANALYSIS	%TOLERANCE
REPEATABILITY:	101.1281	14.45%
REPRODUCIBILITY:	0	0.00%
RPT & REPR (R&R):	101.1281	14.45%

NOTE: ALL CALCULATIONS BASED ON 5.15 SIGMA (99%)

ENTER STUDY TITLES IN CELLS A8,A9,A10, MIN/MAX SPEC IN B12, B13
SOUND PULSE SILENT SWITCHES

MIN SPEC
MAX SPEC
TOLERANCE 0

DATA FOR OPERATOR JEFF

		mV TRIAL		psi			
PART	1	2	3	4	5	AVG	RANGE
1	37	52		1.85	2.6	44.5	15
2	-12	-7		-.6	-.35	-9.5	5
3	33	0		1.65	0	16.5	33
4	-22	-13		-1.1	-.65	-17.5	9
5	39	10		1.95	0.5	24.5	29
6	205	223		10.25	11.15	214	18
7	-13	-4		-.65	-.2	-8.5	9
8	0	30		0	1.5	15	30
9	59	53		2.95	2.65	56	6
10	49	60		2.45	3.00	54.5	11
11	37.5	40.4		$\bar{X}$ = 1.875	$\bar{R}$ = 2.02	NA	0
12						NA	0
13	σ_{n-1} = 45.5	σ_{n-1} = 49.7		σ_{n-1} = 3.28	σ_{n-1} = 3.985	NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 38.95 AVG RNGE: 16.8
UCL FOR INDIVIDUAL RANGES 72.36405

$UCL_{\bar{x}} = \bar{\bar{X}} + A_2 \bar{R}$

$41.825 + .308(22.15)$

$= 48.74$

$6\sigma_{\bar{x}} = \sqrt{n}\, 2 A_2 \bar{R}$

$= \sqrt{10}\, 2\,(.308)(22.15)$

$= 43.14$

$C_{pk} = \dfrac{(USL - \bar{\bar{X}})}{3\sigma_{\bar{x}}}$

$USL = \bar{\bar{X}} + 3\sigma_{\bar{x}} C_{pk}$

$= 41.9 + 3(41)(1.33)$

$= 317.21$

$LSL = -233.41$

DATA FOR OPERATOR HOWARD

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	40	68				54	28
2	40	26				33	14
3	20	53				36.5	33
4	23	-19				2	42
5	17	9				13	8
6	181	155				168	26
7	-8	22				7	30
8	0	33				16.5	33
9	70	19				44.5	51
10	81	68				74.5	13
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 44.9 AVG RNGE: 27.8
UCL FOR INDIVIDUAL RANGES 72.36405

GM GAGE STUDY FOR REPEATABILITY AND REPRODUCIBILITY (LONG METHOD
~~0%-gain=80~~ mV 12/88
NOISY SWITCH PULSE LEVEL

NUMBER OF OPERATORS	2	MIN SPEC	-1500
NUMBER OF PARTS	10	MAX SPEC	2000
NUMBER OF TRIALS	2	TOLERANCE	3500

DATA SUMMARY

OPERATOR	AVERAGE	RANGE
JEFF	814.9	494.8
HOWARD	1110.55	87.7
3	NA	NA
4	NA	NA
5	NA	NA
6	NA	NA
7	NA	NA
8	NA	NA
9	NA	NA
10	NA	NA
AVERAGE	962.725	291.25

($\bar{x}$ in mV's)

MIN XBAR	814.9
MAX XBAR	1110.55
XBARDIFF	295.65

	MEASUREMENT UNIT ANALYSIS	%TOLERANCE
REPEATABILITY:	1329.731	37.99%
REPRODUCIBILITY:	1038.113	29.66%
RPT & REPR (R&R):	1686.969	48.20%

NOTE: ALL CALCULATIONS BASED ON 5.15 SIGMA (99%)

$C_{pk} = \frac{USL - \bar{\bar{x}}}{3\sigma_{\bar{x}}}$

$USL = \bar{\bar{x}} + 3\sigma_{\bar{x}} C_{pk}$

$= 962.75 + 3(161)(1.33$

$= 1605$

DATA FOR OPERATOR HOWARD

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	938	1085				1011.5	147
2	1130	994				1062	136
3	960	1000				980	40
4	1310	1350				1330	40
5	1280	1290				1285	10
6	960	1040				1000	80
7	825	1123				974	298
8	1220	1280				1250	60
9	1150	1140				1145	10
10	1040	1096				1068	56
11	$\bar{x} = 1081.3$	$\bar{x} = 1139.8$				NA	0
12						NA	0
13	$\sigma_{n-1} = 122.75$	$\sigma_{n-1} = 125.7$				NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 1110.55 AVG RNGE: 87.7
UCL FOR INDIVIDUAL RANGES 951.5137

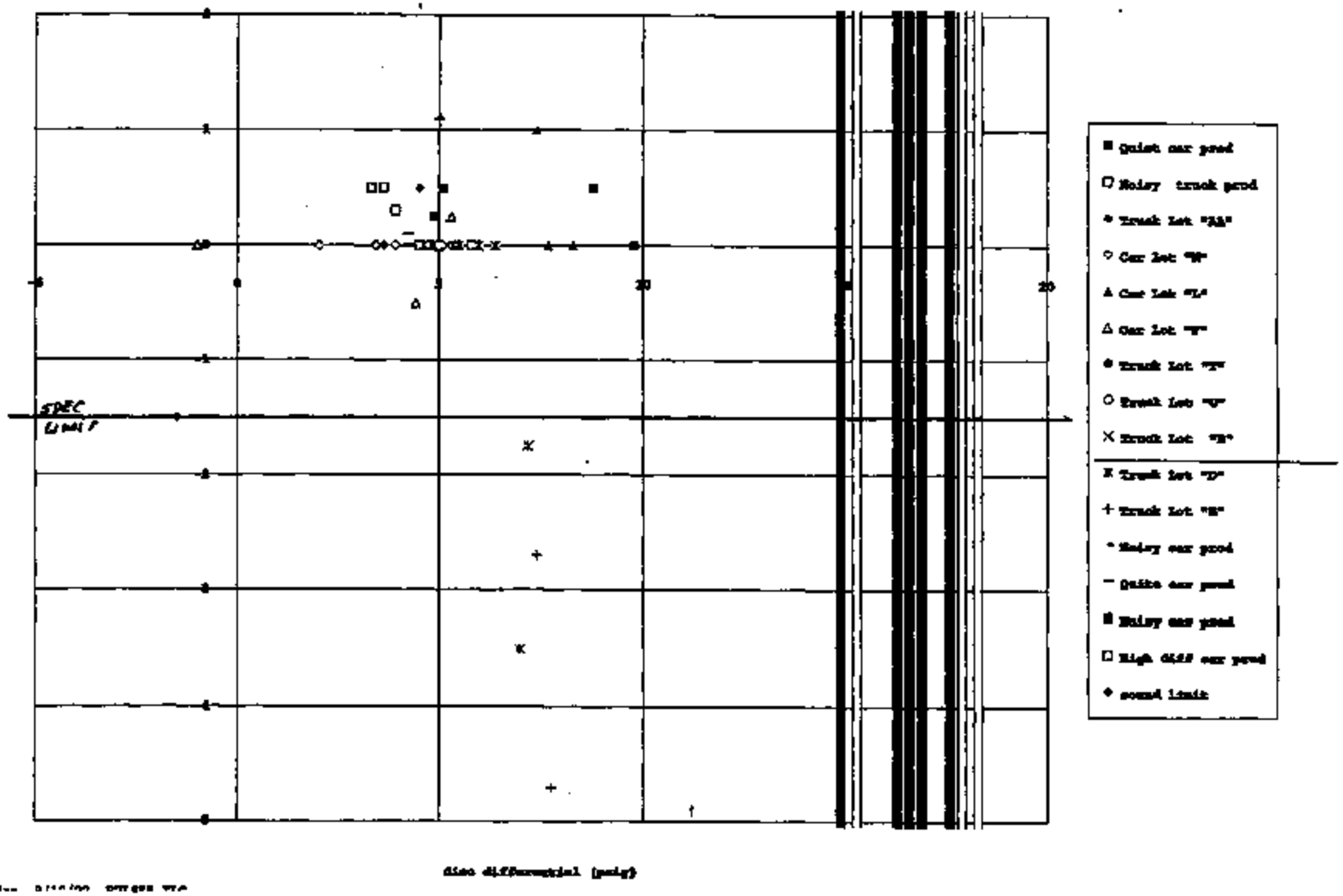
ENTER STUDY TITLES IN CELLS A8,A9,A10, MIN/MAX SPEC IN B12, B13
NOISY SWITCH PULSE LEVEL

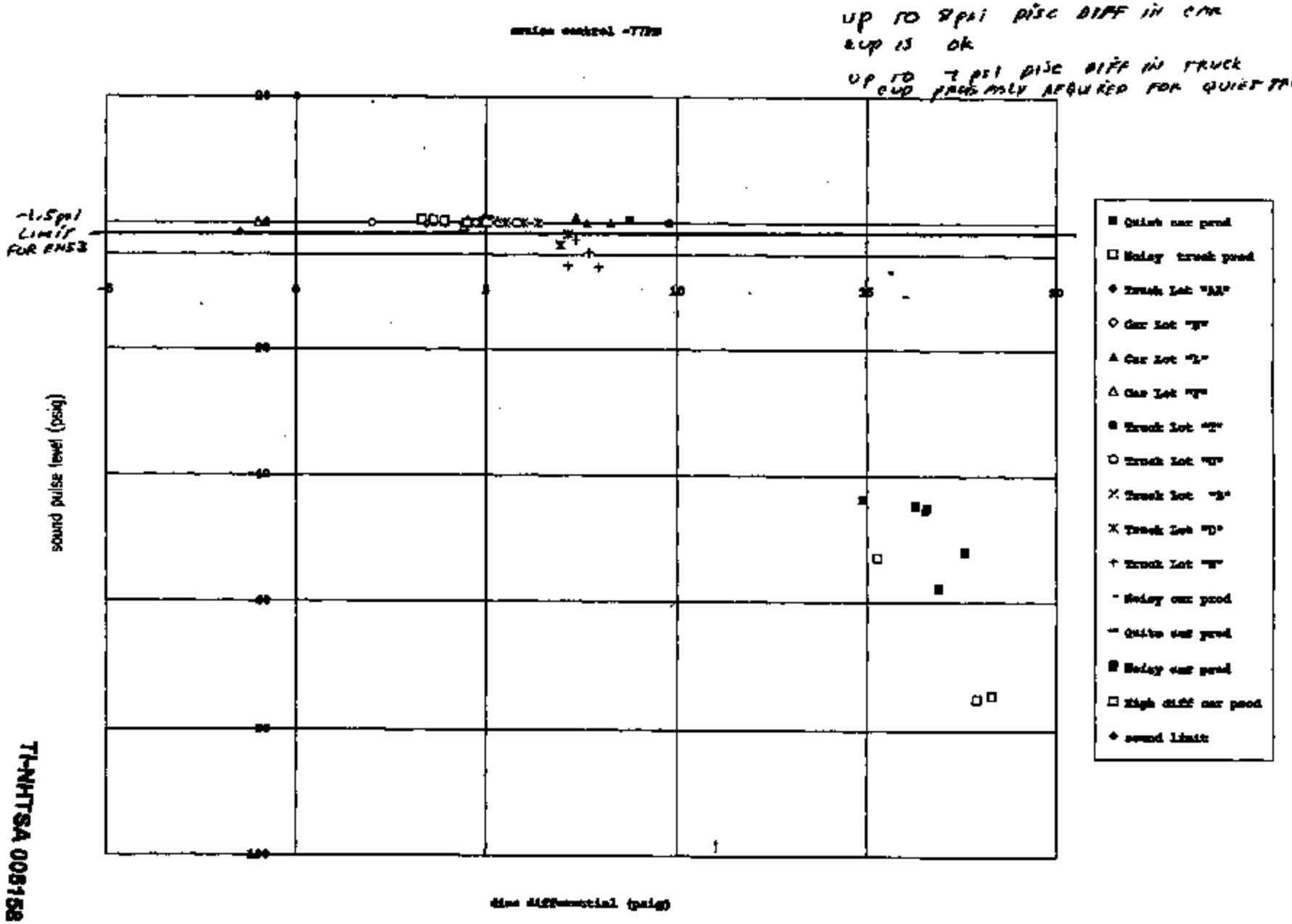
MIN SPEC
MAX SPEC
TOLERANCE 0

DATA FOR OPERATOR JEFF

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	671	1000				835.5	329
2	694	1091				892.5	397
3	657	1005				831	348
4	177	1321				749	1144
5	775	1102				938.5	327
6	173	1090				631.5	917
7	723	1117				920	394
8	707	1256				981.5	549
9	665	383				524	282
10	715	976				845.5	261
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 814.9 AVG RNGE: 494.8
UCL FOR INDIVIDUAL RANGES 951.5137





TI-NHTSA 006158

	A	B	C	D	E	F	G	H	I	J	K	L
20	770813-1	TEST ID 280-12-06										
21	NOISE EVALUATION ON BASIS OF DEVICES WITH VARYING DIFFERENTIALS											
22		Gray Type C				Devices	Diff	Diff		PEAK LEVEL IN PSI		
23	DEVICE #	CAR/TRUCK	TIRE TYPE	LOW/ACC	LOW/DEC	Differential	=	Between		1ST HARMONIC	difference 1-2nd	
24	80-12-01	CAR	Quiet cor pave	141	114	27				7		1.5
25	-2			134	111	23				8		1.5
26	-3			122	110	12				1		0.75
27	-4			144	112	32				1.15		0.69
28	-5			136	113	23				0.86		0.86
29	AVERAGE		8.75	137.8	113.4	24.4				1.4		1.4
30	STD DEVIATION			4.21909	2.073644	4.1883248859				0.5878784		0.5878784
31												0
32	6	TRUCK	Noisy trunk p	262	86	176				87.5		169.1
33	7			230	114	116				19.225		72.225
34	8			257	93	164				27.625		103.625
35	9			248	109	142				63		137.5
36	10			252	104	148				67.5		82.7
37	AVERAGE		13	245.2	98	147.2				82.31		82.91
38	STD DEVIATION			13.92796	13.0858	31.441884481				28.867885108		28.867885
39												-0.5
40	11	TRUCK	Trunk Lot "AA"	230	218	45				0		0
41	12			268	222	44				0		0
42	13			262	194	68				0.4125		-0.0875
43	14			270	219	51				0.58375		0.89375
44	15			249	229	36				0		0
45	AVERAGE		4.8	264.6	216.2	48.4				0.20125		0.20125
46	STD DEVIATION			9.8479377	13.29796	13.198748826				0.282923564		0.282923
47												0
48	16	CAR	Car Lot "F"	153	141	12				0		0
49	17			140	116	22				0		0
50	18			198	167	26				0		0
51	19			192	170	22				0		0
52	20			154	133	21				0		0
53	AVERAGE		8	172.4	150.6	21.8				0		0
54	STD DEVIATION			24.05797	23.86901	3.0413644213				0		0
55												0
56	21	CAR	Car Lot "I"	197	164	33				0		-1
57	22			198	180	28				0.0438		0.0625
58	23			211	181	30				0.14378		0.14375
59	24			183	128	25				6.38		6.38
60	25			184	129	23				6.2625		10.5125
61	AVERAGE		11	189	161	32				2.87236		2.87236
62	STD DEVIATION			16.61796	24.72653	5.0990195914				3.4866564278		3.4388857

	A	B	C	D	E	F	G	H	I	J	K	L
20	TTEST-1	TEST NO 250-12-56										
21	ROUGH EVALUATION OF EFFECT OF DEVICES WITH VARYING DIFFERENTIALS											
22		CAR/TRUCK				Device	Disc	Disc		PULSE INPUT IN PSI		
23	DEVICE #	CAR/TRUCK	DISC TYPE	KSB/ACT	KSB/REL	Differential	A	Balance		182 READING	difference 1-2nd	
42												0
64	26	CAR	Car Lot "F"	133	109	24				0.68		1.35
65	27			148	121	34				0		0
66	28			143	115	28				0		0
67	29			141	113	28				0		0
68	30			135	107	28				0		-0.25
69	AVERAGE		6.7%	139.4	113	26.4				0.17		0.17
70	STD DEVIATION			5.176872	5.477226	3.190465023				0.380131366		0.380192
71												0
72	31	TRUCK	Truck Lot "E"	227	184	43				0.984375		0.984375
73	32			241	179	62				0		0
74	33			215	172	43				0		0
75	34			223	191	32				0		0
76	35			233	198	35				0		0
77	AVERAGE		5.6	227.8	184.6	43				0.196875		0.196875
78	STD DEVIATION			9.859006	10.1341	11.88119148				0.440228883		0.440226
79												0
80	36	TRUCK	Truck Lot "D"	230	186	43				0		0
81	37			223	187	36				0		0
82	38			167	188	49				0		0
83	39			217	167	50				0		1.5
84	40			218	196	22				0		0
85	AVERAGE		5.6	228.8	186.6	40				0		0
86	STD DEVIATION			13.461108	12.81124	11.91066443				0		0
87												0
88	41	TRUCK	Truck Lot "E"	261	242	19				0		0
89	42			306	266	40				0		0
90	43			304	293	11				0		0
91	44			290	279	11				0		0
92	45			293	286	7				0		0
93	AVERAGE		0	295.8	277.2	18.6				0		0
94	STD DEVIATION			7.890063	13.18363	14.24078885				0		0
95												0
96	46	TRUCK	Truck Lot "D"	281	272	8				0		0
97	47			276	259	17				0		1.75
98	48			308	296	12				0		0
99	49			281	270	11				0		3.5
100	50			284	261	23				0		0
101	AVERAGE		3.8	286.4	276.8	12.6				0		0
102	STD DEVIATION			13.3778	13.77316	3.507136063				0		0
103												0
104	51	TRUCK	Truck Lot "E"	275	261	14				5		7
105	52			293	276	17				0		5.75
106	53			281	284	23				0		0.5
107	54			295	278	17				0		2.7
108	55			275	259	16				0		6.7
109	AVERAGE		6.2	283.8	266	17.8				0		0
110	STD DEVIATION			8.634618	10.22251	4.207136794				0		0

	A	B	C	D	E	F	G	H	I	J	K	L
39	TITLE-1	TEST NO 150-12-86										
41	NOTE: EVALUATION ON BASIS OF DEVICES WITH VARYING DIFFERENTIALS											
42						Device	Diff.	Diff.		PEAK LEVEL IN DAY		
43	DEVICE #	CAR/TRUCK	TIRE TYPE	LBS/AXLE	LBS/RIM	Differential	x	Balance		1ST FREQUENCY	difference 1-2nd	
111												0
112	56	CAR	Heavy car panel	137	78	79				33.55		40.13
113	57			148	89	86				84.7		43.4
114	58			140	67	83				32.63		44.48
115	59			144	88	86				3.88		80.28
116	60			148	81	97				36.78		84.78
117	AVERAGE		13	148.6	82.6	86				38.74		28.74
118	STD DEVIATION			5.1288589	10.210719	6.8190940848				11.89918064		11.89918
119												0
120	61	CAR	Quite car panel	139	93	96				3.05		3.05
121	62			135	134	18				-0.4		-0.4
122	63			138	111	27				0		0
123	64			134	96	38				3.8		3
124	65			141	101	40				6.08		2.88
125	AVERAGE		9.75	138.2	108	31.2				3.34		3.34
126	STD DEVIATION			4.7844827	13.629331	10.329548821				2.8183239916		3.818331
127												0
128	66	CAR	Heavy car good	143	33	88				8.68		82.48
129	67			134	32	103				36.18		82.98
130	68			132	31	101				28.38		87.38
131	69			131	35	96				39.28		74.38
132	70			146	56	90				38.75		80.55
133	AVERAGE		11	140.2	82.8	98.4				29.83		29.83
134	STD DEVIATION			4.8497316	2.167968	6.3087316118				11.89272587		11.89273
135												0
136	71	CAR	High diff car	134	73	113				0		0
137	72		345psi on	133	94	89				0		-0.3
138	73		good tester	137	86	79				0		-0.3
139	74			148.6	87	61.8				0		#N/A
140	75			136	101	53				0		-0.8
141	AVERAGE		sound limit	101.7	88.8	72.9				0		1.8
142	STD DEVIATION			14.21001	11.3446	23.801882277				0		1.8
143												
144												

TI-NHTSA 005161

CORRELATION PLOT

20											
21											
22											
23											
24								Sound Pulse (psi)		Dive differential	ed reading
25						10		0.5	0.5	#N/A	0.5
26						10		0.5	0.5	5.1	0.5
27						5		0.25	0.25	4.8	0.25
28						10		0.5	0.5	5.6	0.5
29						0		0	0	4.7	0
30										0	
31										0	
32								0	0	0	0
33						-1610		-81	-81	#N/A	-81
34						-1060		-53	-53	18.2	-53
35						-1500		-75	-75	17.9	-75
36						-1480		-74.5	-74.5	18.2	-74.5
37						-524		-26.2	-26.2	#N/A	-26.2
38						0				0	
39						0				0	
40						10		0.5	0.5	0	0.5
41						0		0	0	4.8	0
42						0		0	0	5.2	0
43						10		0.5	0.5	4.5	0.5
44						0		0	0	4.9	0
45						0		0	0	3.6	0
46						0				0	
47										0	
48										0	
49						0		0	0	#N/A	0
50						0		0	0	5.2	0
51						0		0	0	5.4	0
52						0		0	0	3.9	0
53						0		0	0	2	0
54						0				0	
55						0				0	
56										0	
57						20		1	1	7.4	1
58						0		0	0	8.3	0
59						0		0	0	7.7	0
60						0		0	0	8.3	0
61						-82		-4.25	-4.25	#N/A	-4.25
62										0	
63										0	

$y = 4.6$

$r = 0.1$

	M	N	O	P	Q	R	S	T	U	V	W
20											
21											
22								Sound Pulse (psi)		Time differential	nd reading
23										0	
24						-10		-0.5	-0.5	4.4	-0.5
25						0		0	0	4.8	0
26						0		0	0	5	0
27						0		0	0	-1	0
28						3		0.25	0.25	5.3	0.25
69										0	
70										0	
71										0	
72						0		0	0	5.2	0
73						0		0	0	4.7	0
74						0		0	0	4.8	0
75						0		0	0	5.8	0
76						0		0	0	4.8	0
77										0	
78										0	
79										0	
80						0		0	0	5	0
81						0		0	0	5	0
82						0		0	0	5.8	0
83						-50		-2.5	-2.5	N/A	-2.5
84						0		0	0	4.7	0
85										0	
86										0	
87										0	
88						0		0	0	5.2	0
89						0		0	0	4.6	0
90						0		0	0	4.8	0
91						0		0	0	4.8	0
92						0		0	0	4.6	0
93										0	
94										0	
95										0	
96						0		0	0	5.8	0
97						-38		-1.75	-1.75	7.2	-1.75
98						0		0	0	6	0
99						-70		-3.5	-3.5	7	-3.5
100						0		0	0	5.4	0
101										0	
102										0	
103										0	
104						-140		-7	-7	8	-7
105						-135		-6.75	-6.75	7.2	-6.75
106						-180		-9.5	-9.5	N/A	-9.5
107						-54		-2.7	-2.7	7.4	-2.7
108						-94		-4.7	-4.7	7.75	-4.7
109										0	
110										0	

below limit

	M	N	O	P	Q	R	S	T	U	V	W
20											
21											
22											
23								Output Pulse (psi)		Disc differential	nd reading
110										0	
111						-132		-6.6	-6.6	#N/A	-6.6
112						-154		-7.7	-7.7	15.4	-7.7
113						-232		-11.6	-11.6	16	-11.6
114						-830		-41.4	-41.4	#N/A	-41.4
115						-899		-45	-45	16.8	-45
116						0				0	
117										0	
118										0	
119						0		0	0	4.2	0
120						2		0.1	0.1	4.2	0.1
121						0		0	0	4.2	0
122						30		1.5	1.5	#N/A	1.5
123						22		1.1	1.1	2	1.1
124										0	
125										0	
126										0	
127						-876		-43.8	-43.8	14.8	-43.8
128						-1186		-57.8	-57.8	16.8	-57.8
129						-1040		-52	-52	17.6	-52
130						-902		-49.1	-49.1	16.6	-49.1
131						-896		-44.8	-44.8	16.2	-44.8
132										0	
133										0	
134										0	
135						0		0	0	4.8	0
136						20		0.8	0.5	3.2	0.8
137						6		0.2	0.2	3.6	0.2
138						0		0	0	#N/A	#N/A
139						10		0.8	0.8	3.6	0.8
140										0	-1.5
141										20	-1.5
142											
143											
144											

RATTLE STUDY

+.0056
.0828
.0884

328

77PSL3-1 MAY 29, 1992

PROVIDE DES. ENG. WITH FINISHED DEVICES BUILT FROM SENSORS WHICH RATTLE (SENSOR READINGS OVER .050)

DEVICE #	PIN	BASE	SENSOR	PRELOAD	ACT	REL	DIFF	
1	0.1420	0.0882	0.0510	0.0028	131.0	88.5	39.9	1.758
2	0.1421	0.0884	0.0510	0.0027	131.0	95.6	35.4	1.789
3	0.1420	0.0880	0.0508	0.0032	124.8	98.4	26.4	1.799
4	0.1418	0.0886	0.0512	0.0018	121.1	89.4	31.7	1.769
5	0.1419	0.0878	0.0506	0.0035	130.1	85.4	44.7	1.768
6	0.1420	0.0880	0.0511	0.0029	123.9	96.2	27.7	1.76
7	0.1416	0.0881	0.0507	0.0028	123.4	91.9	31.5	1.766
8	0.1420	0.0886	0.0505	0.0029	126.1	99.3	26.9	1.776
9	0.1418	0.0881	0.0507	0.0030	123.1	96.2	26.9	1.76
10	0.1418	0.0885	0.0508	0.0025	127.4	95.6	31.8	1.769
11	0.1421	0.0882	0.0511	0.0028	126.2	95.4	30.8	1.760
12	0.1420	0.0883	0.0517	0.0020	126.2	80.0	46.0	DFHI 1.756

1) Low preload should cause high temp failure to open

2) Actuation should not be as high as it is unless crimping increased preload

3) should cause large contact gap at 200psi - therefore a large engagement

---

Results

- Before final assembly calculated values show low preloads yet acct rel values did not drop to 100gm/topm as expected

- engagement measurement after final test indicates preload in the range of 7 to 10 mils

- After aluminum crimp ring decrimped the parts were re-measured and the preload had shifted up to 7 to 10 mils and the devices did not rattle anymore, except #5 of 12. 5#12 still have deep sensors on low preload.

- Did not fail high temp continuity check

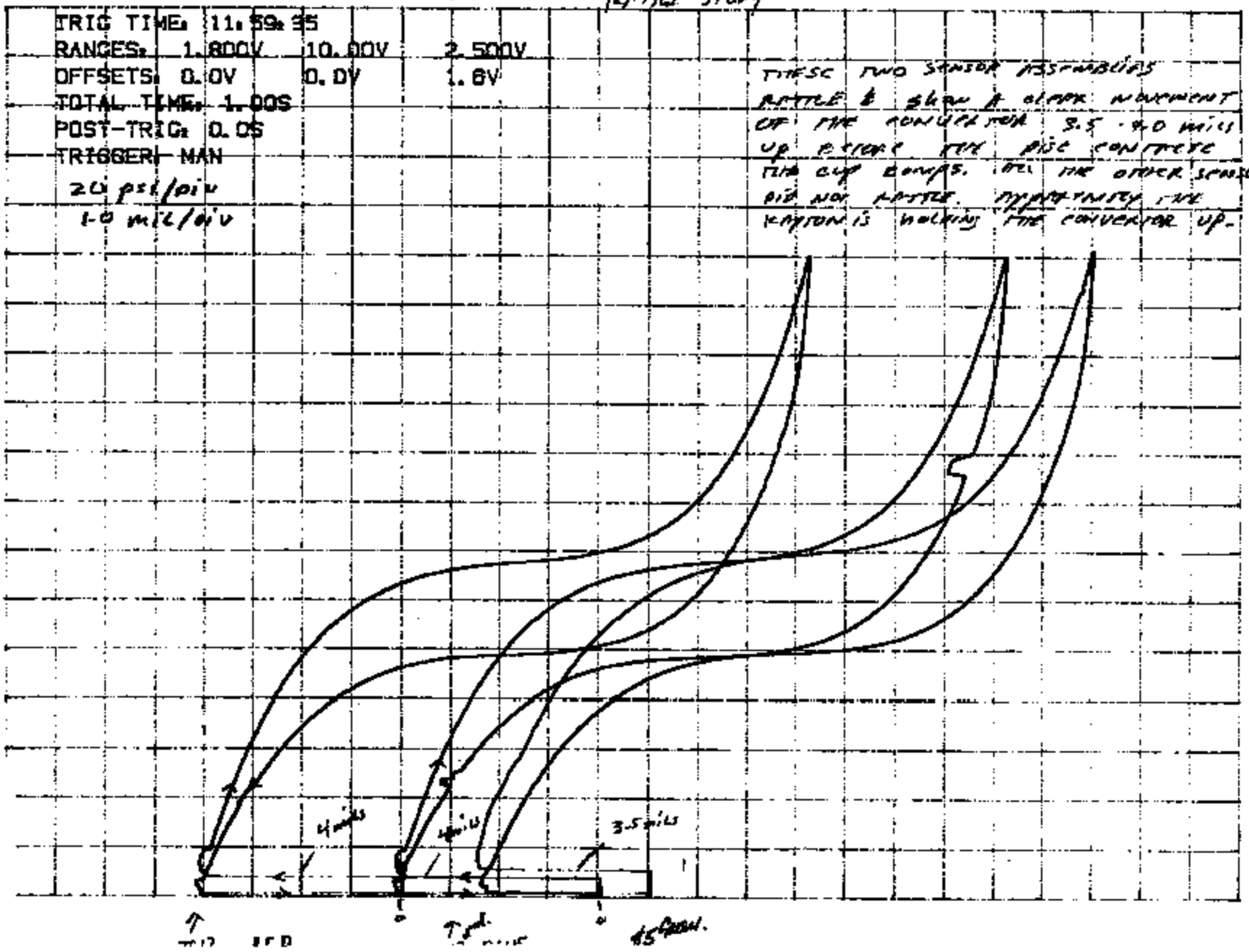
- Results suggest that some operation after sensor assembly is loading the parts such that the disc is pinned against the cup bumps.

- Most likely cause is overpressuring the kapton causing it to hold disc tight

- Rattlers have warped p-d curves showing lack of preload See attached.

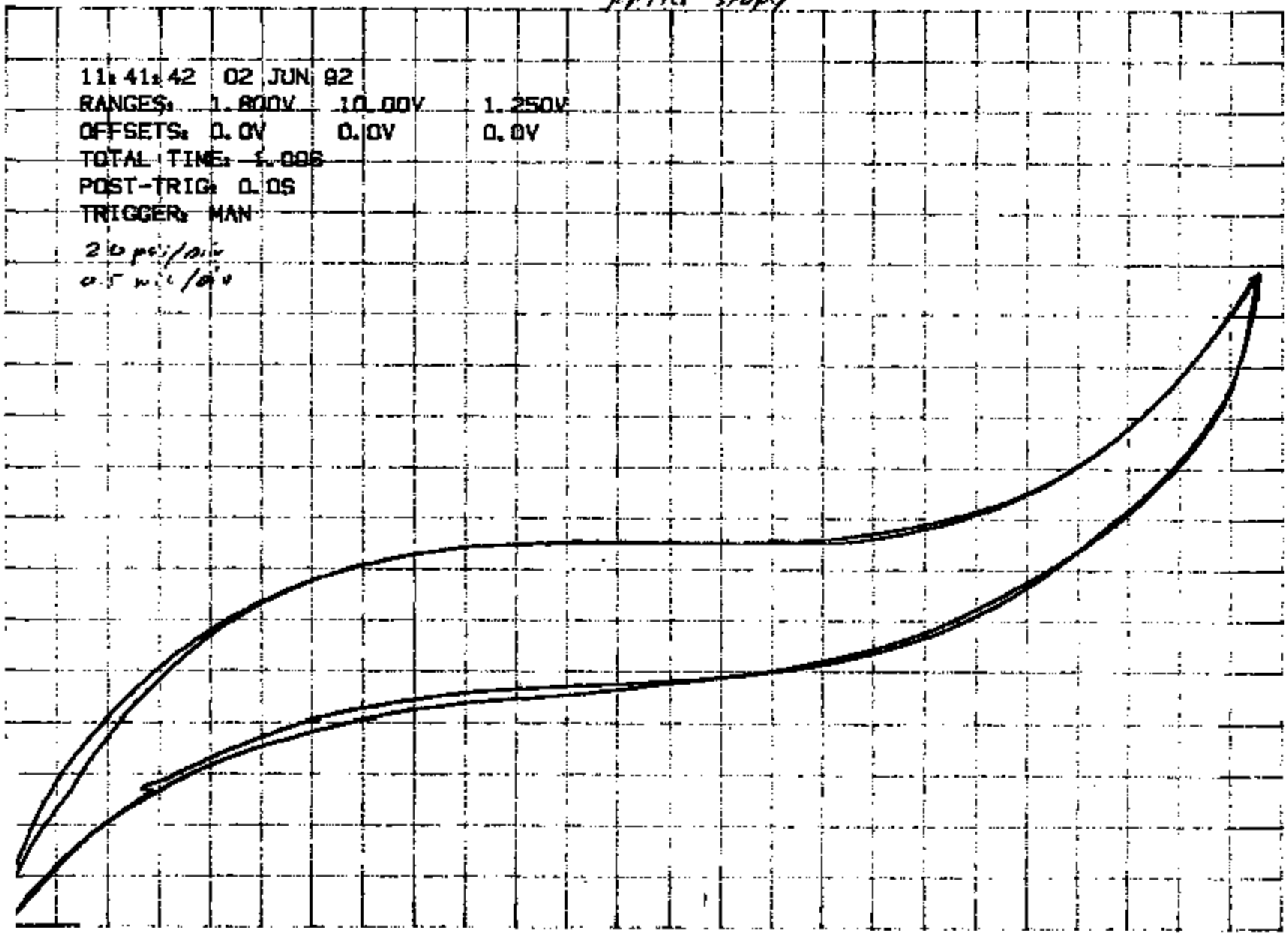
#12 of A-

BATTLE STUDY



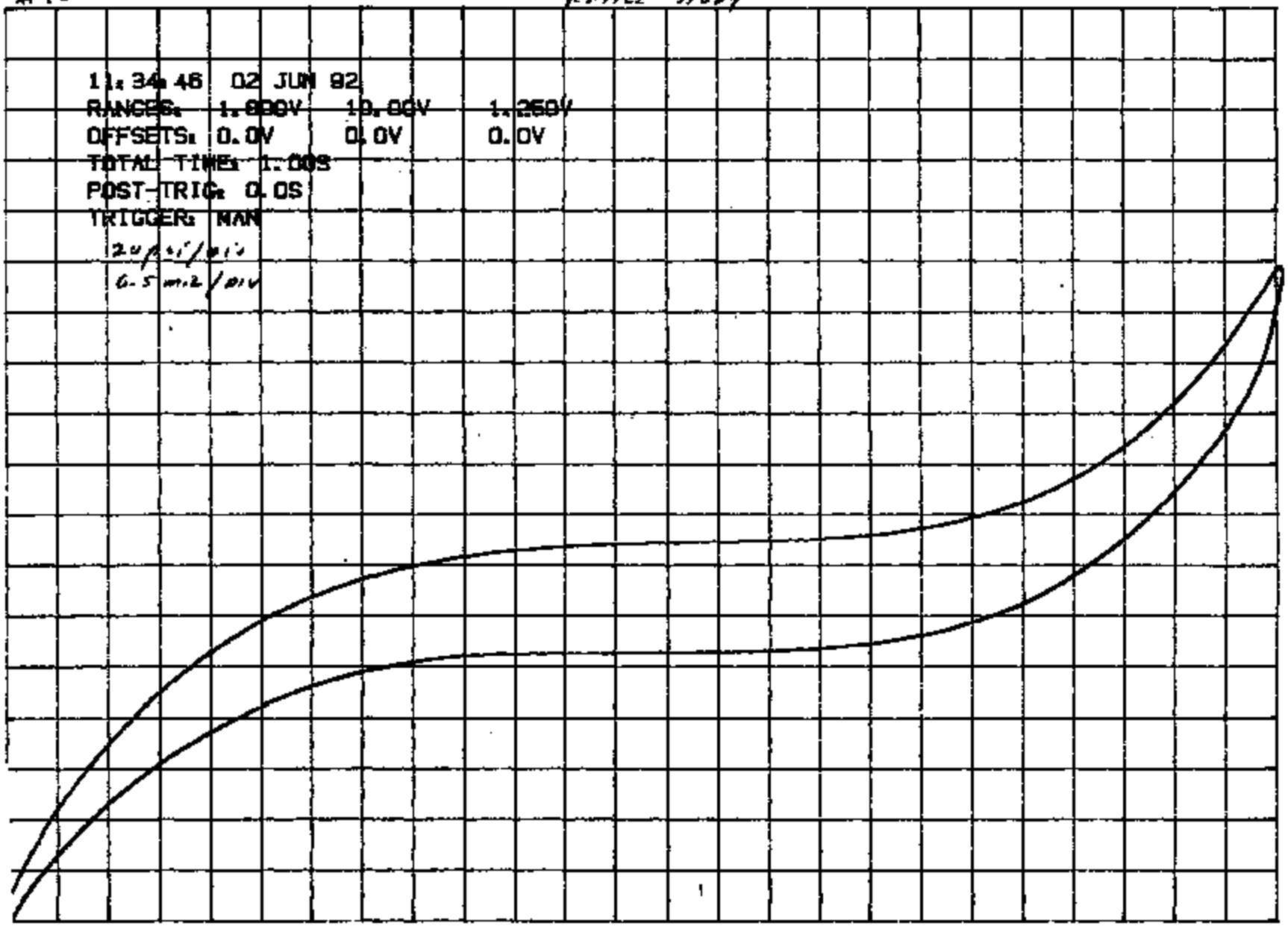
#11

pinto study



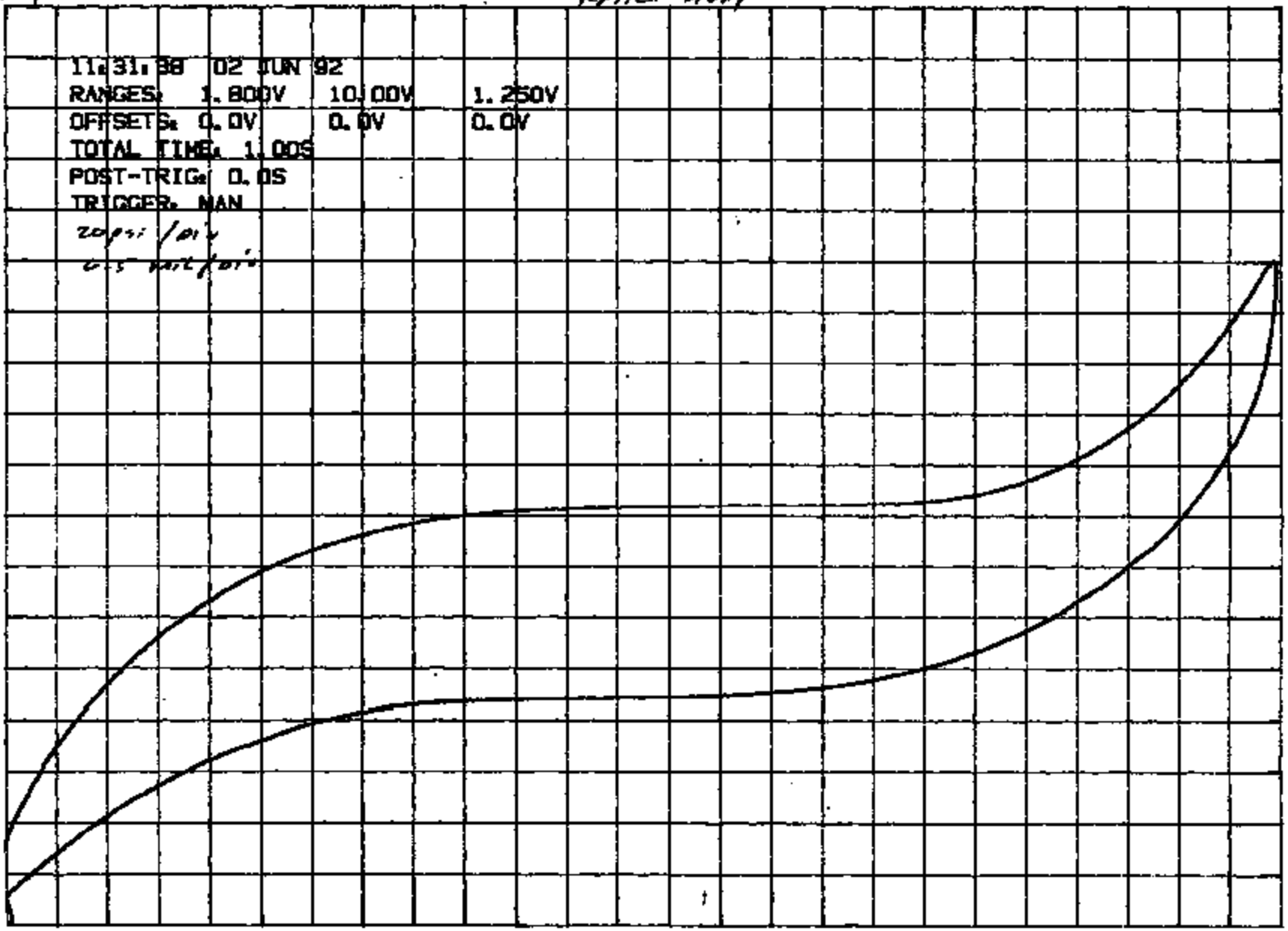
#16

RATTLE STUDY

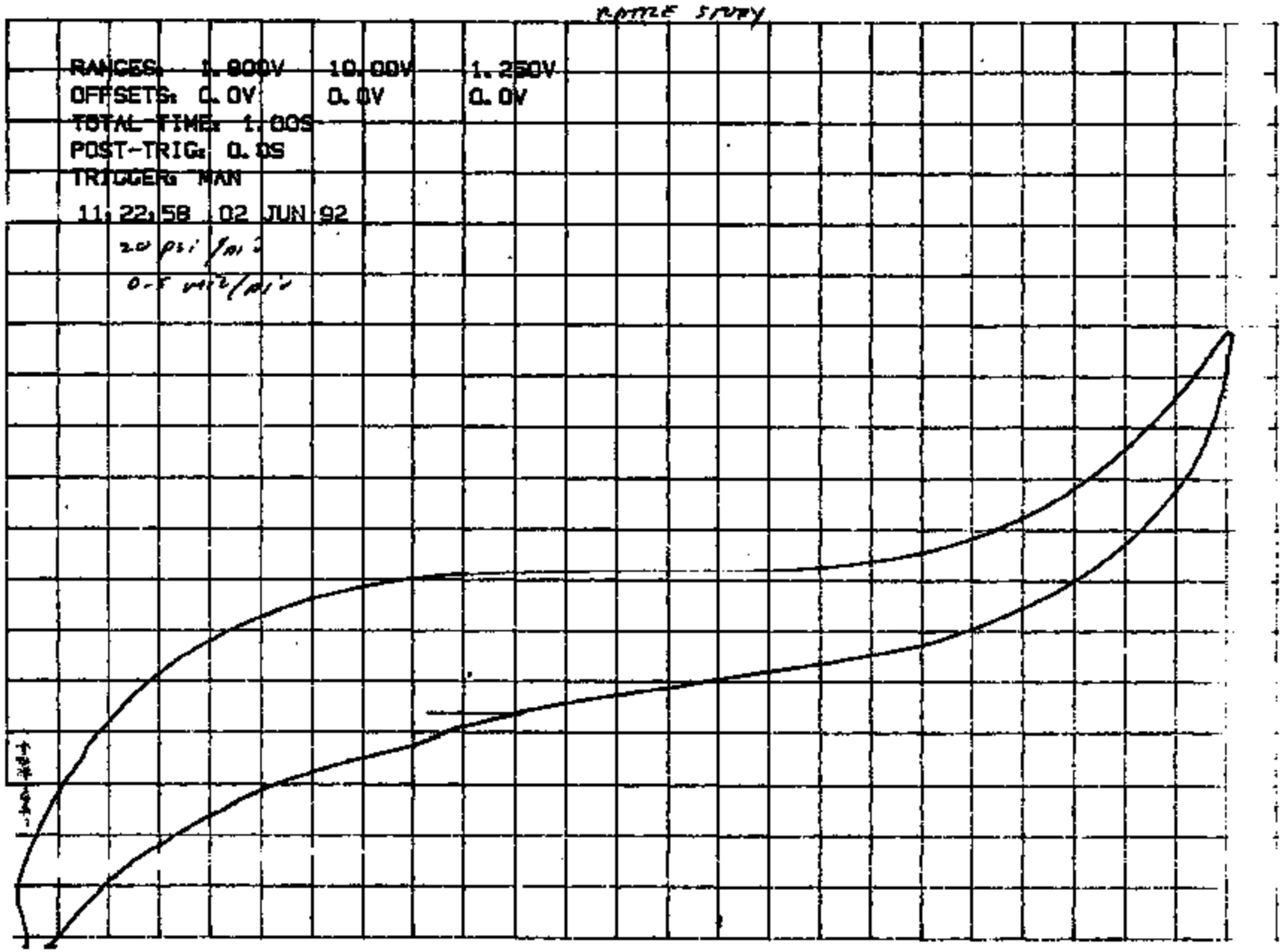


#9

BETTER STUDY

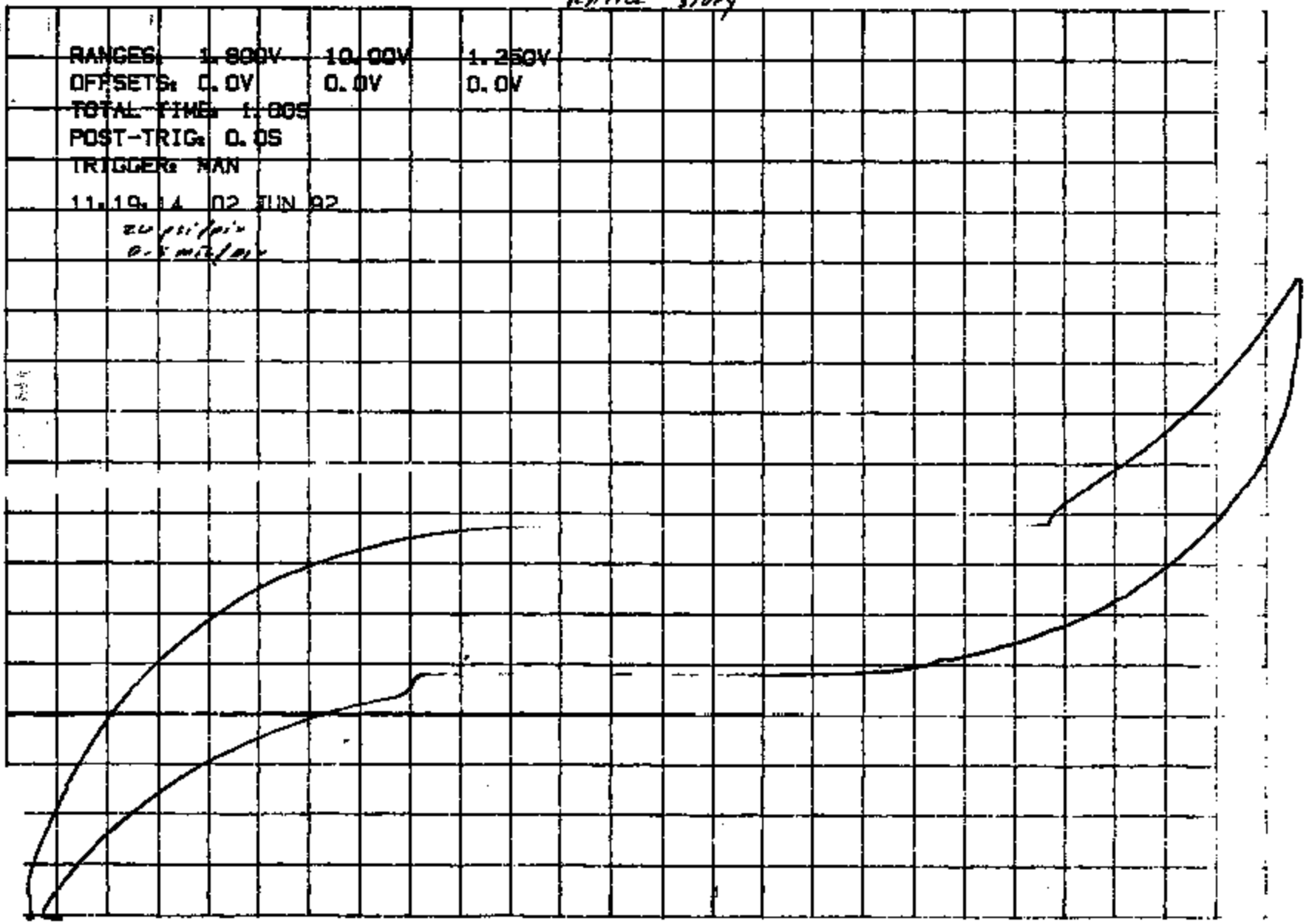


#8



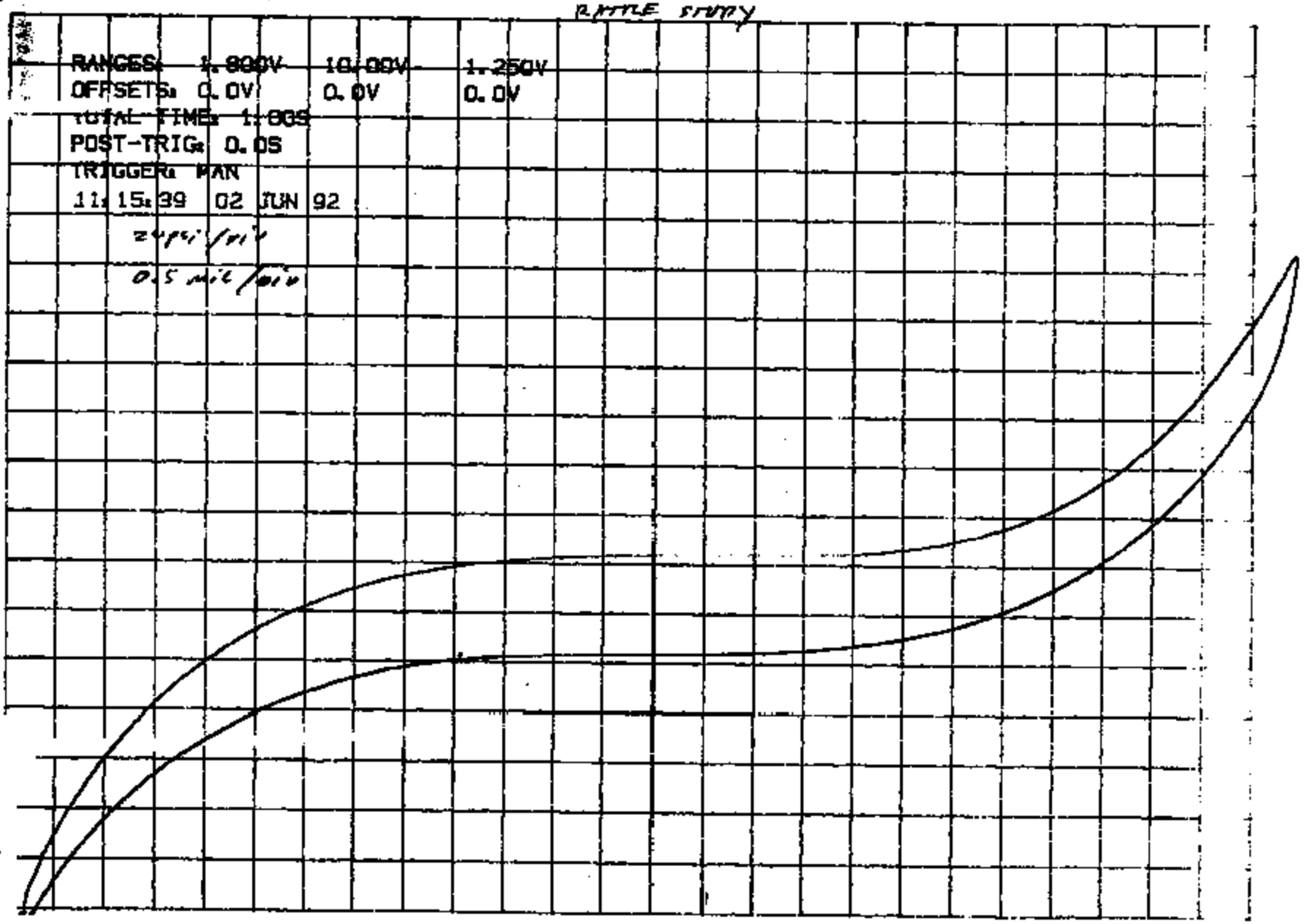
#7

RATTLE SNAKE



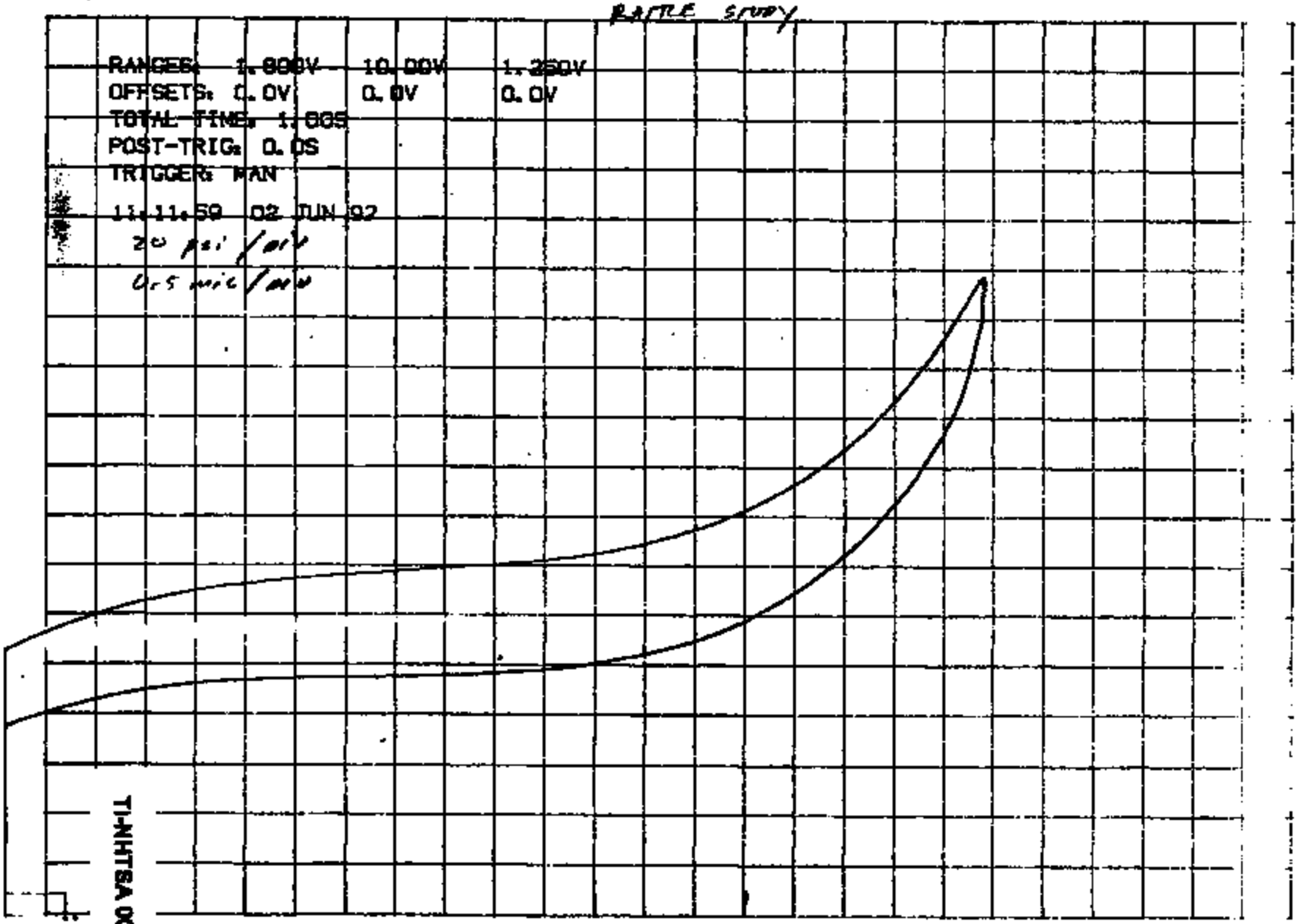
#L

BATTLE STUDY

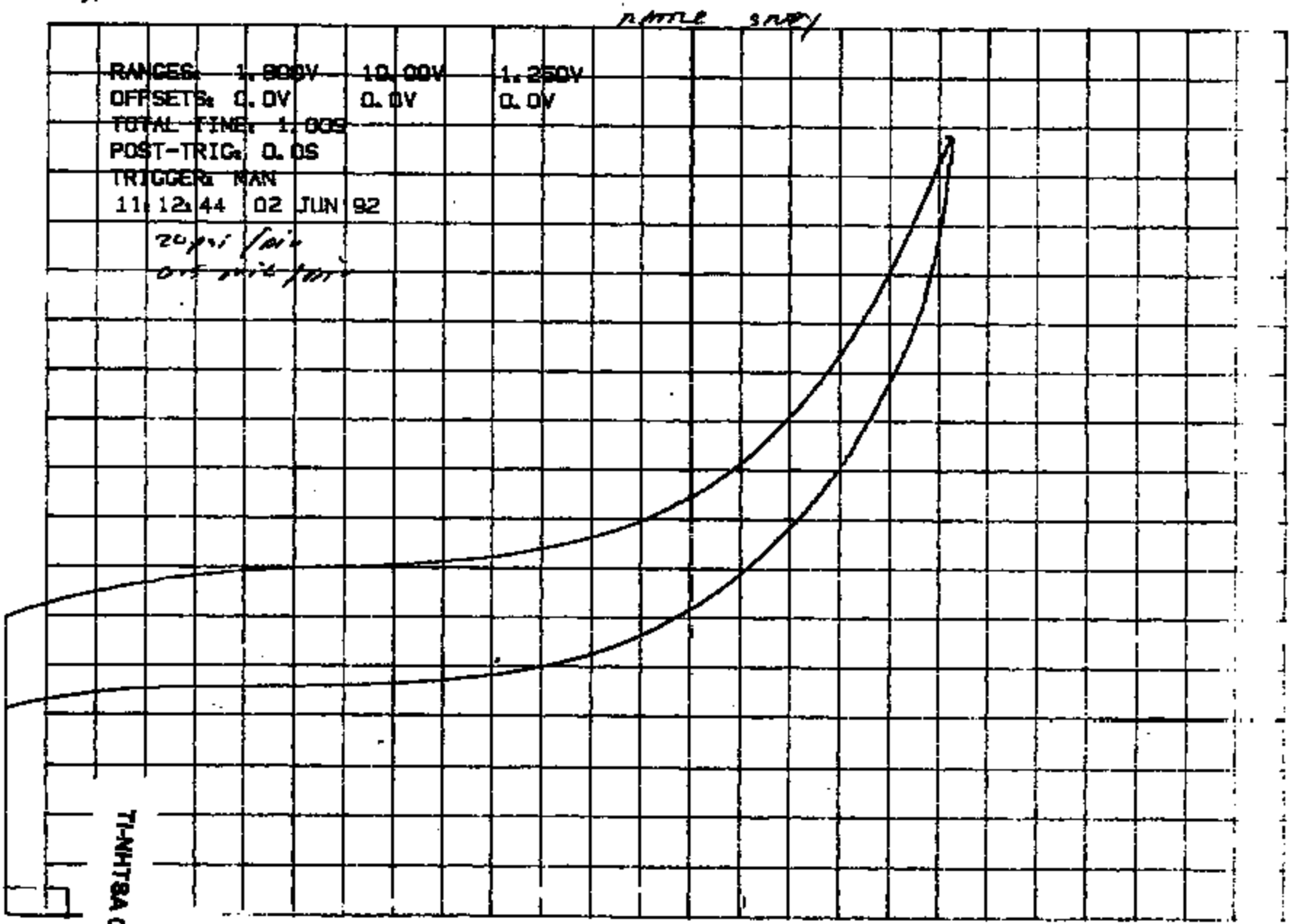


#5

BATTLE STUDY

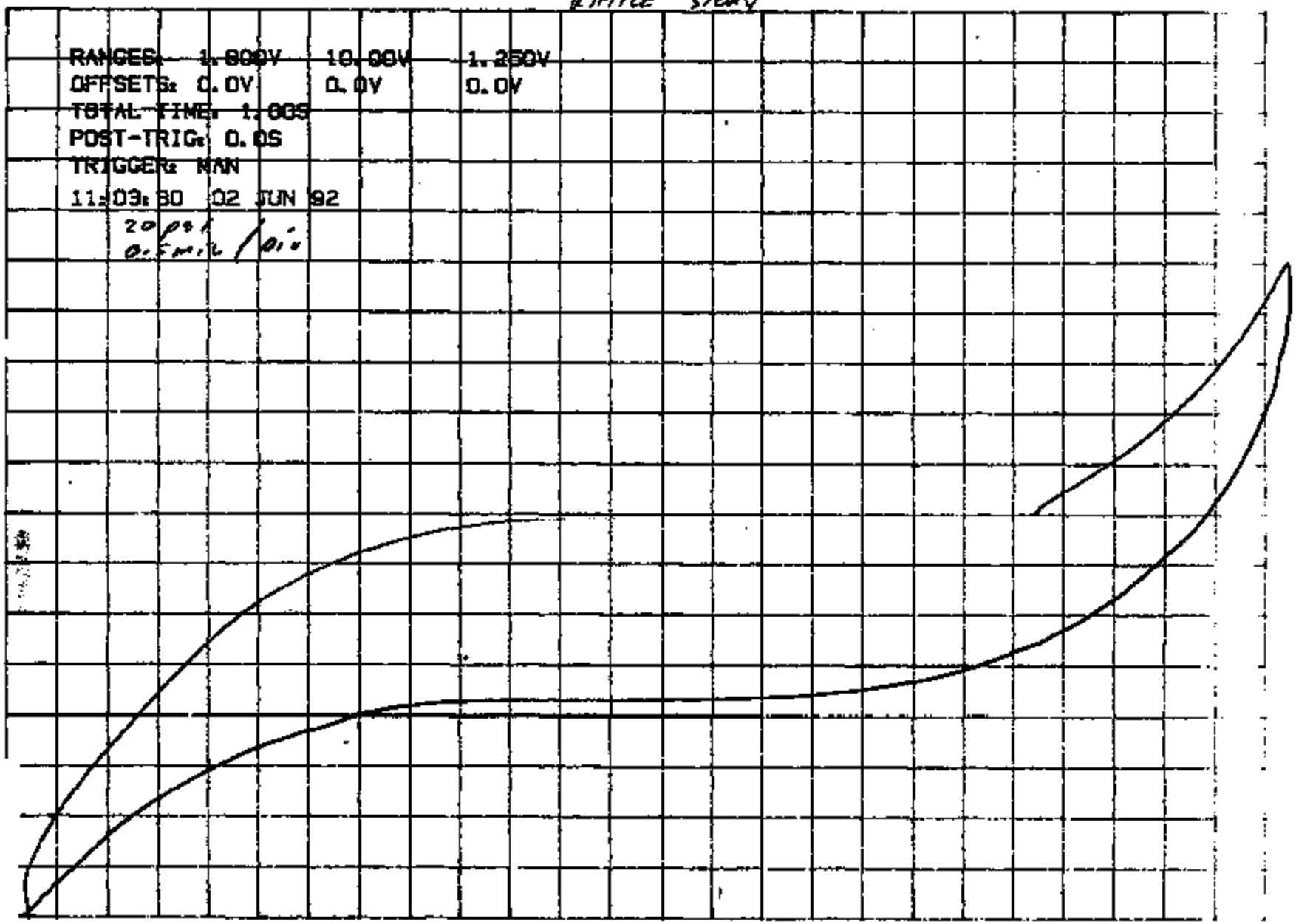


#5


RANGES: 1.000V 10.00V 1.250V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 1.00S
POST-TRIG: 0.0S
TRIGGER: MAN
11:12:44 02 JUN 92
20 psi / div
0 psi psi
TL-NHT&A 005174

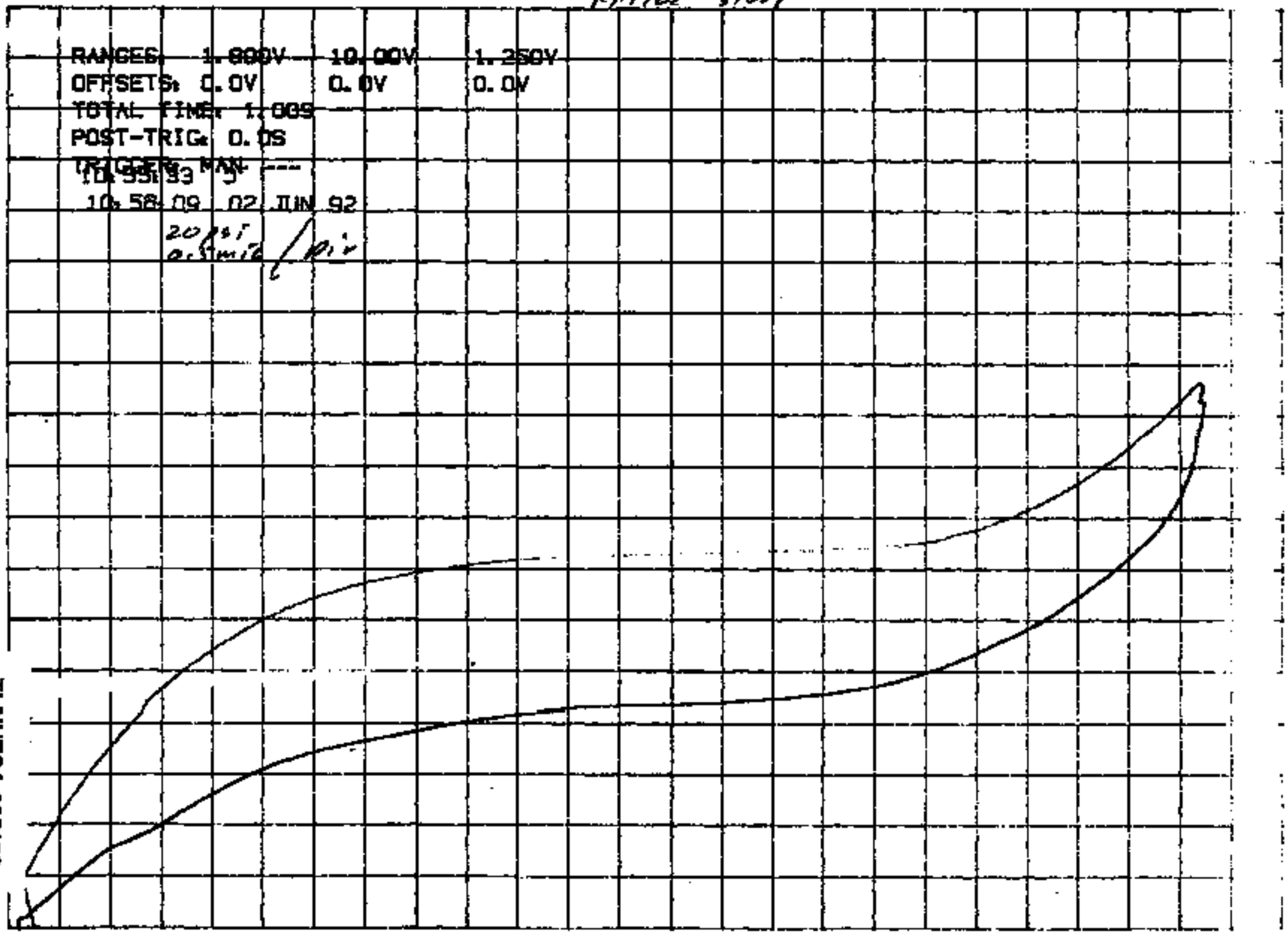
#4

LITTLE STORY



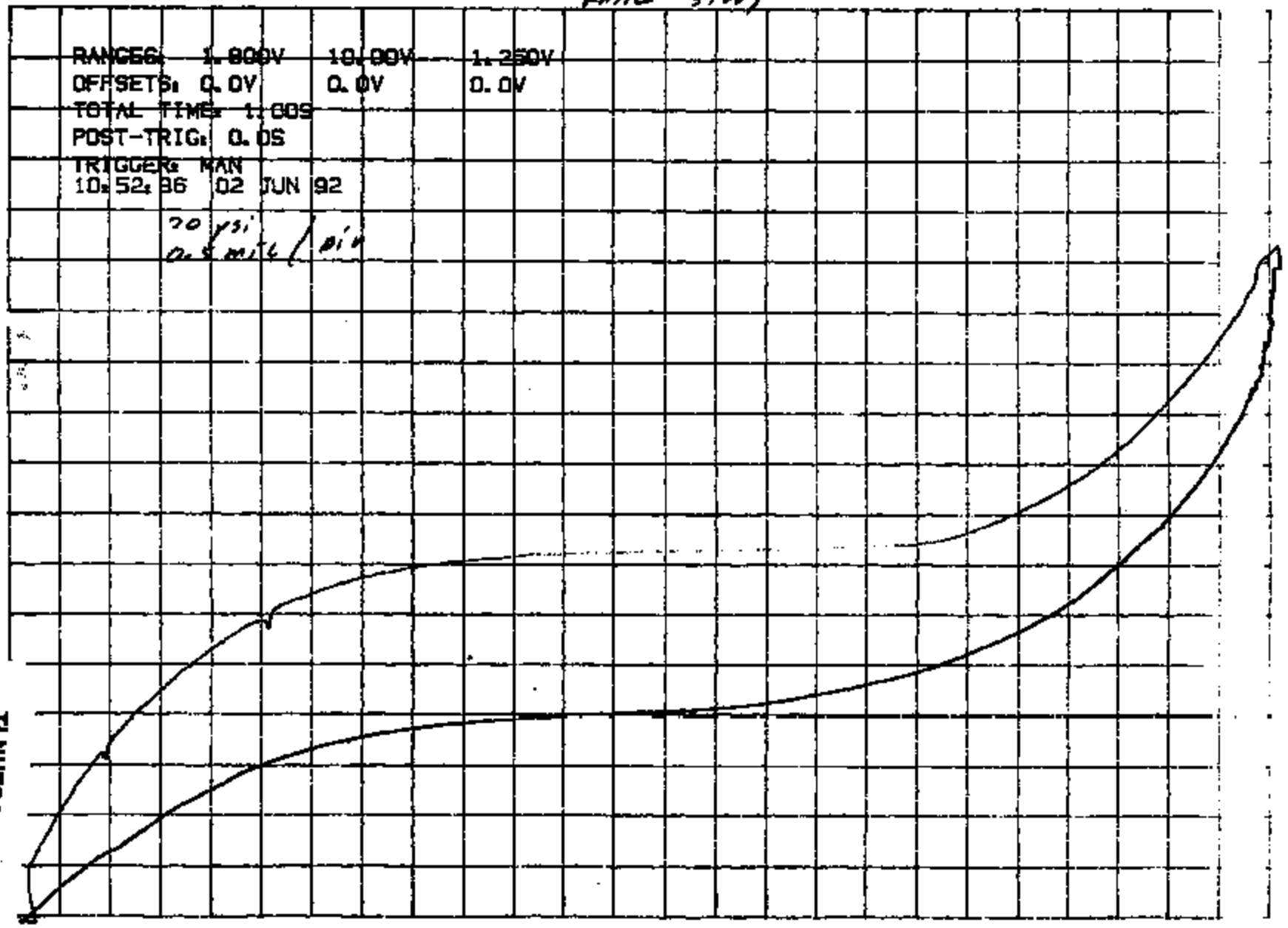
#3

RATTLE STUDY



#3

RATTLE STUDY

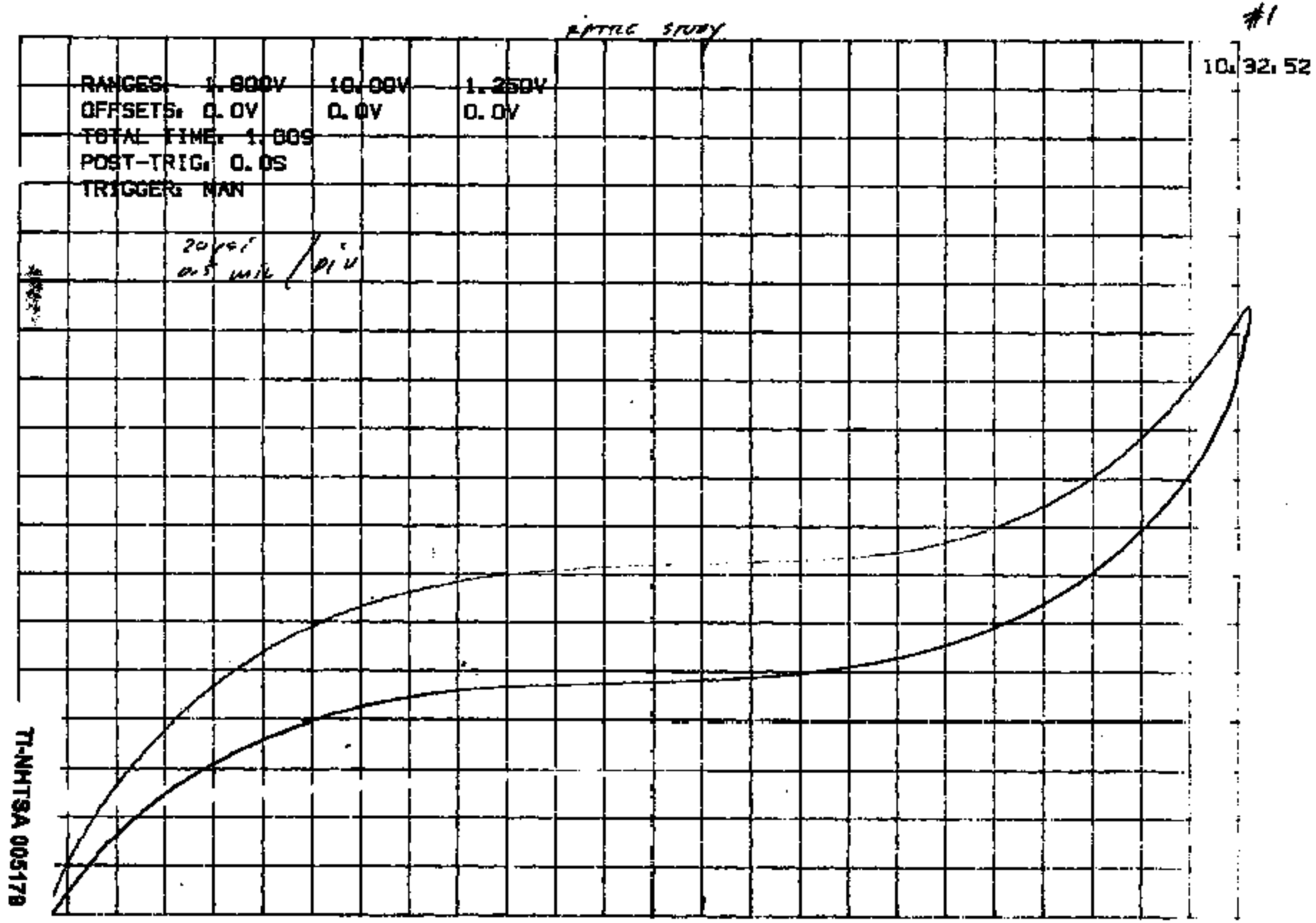


#2

BUFFALO STUDY

RANGES: 1.800V 10.00V 1.250V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 1.000
POST-TRIG: 0.0S
TRIGGER: MAN
TRIG TIME: 10:36:13

20 psi
0.5 mi/h / div


RIPPLE STUDY
#1
10: 32: 52
RANGES: 1.000V 10.00V 1.250V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 1.00S
POST-TRIG: 0.0S
TRIGGER: NAN
20 per
0.5 unit / div
TI-NHTSA 005178
#1

PROPOSED SPEC

TIM ISHIMAKI -
TOKICO
(313) 336-2110 FAX

(RESPONSIBLE FOR PART
TOKICO WILL ASSEMBLE
MIDDLE OF YEAR

COPY MICHIK FREIDA

Texas Instruments
Proposed Silent Switch Specification -REV B
77PSL3-1

The following modifications are suggested to the Ford ES spec to cover silent switches.

III TEST PROCEDURES AND REQUIREMENTS

N. SOUND LEVEL

1. Test Requirements

The test shall only be conducted if specified on the switch drawing.

a. Check switch sound level at room temperature (16°C- 35°C) using DOT 3 brake fluid.

b. Mount the switch in the test port of a pulse tester. A high Frequency (>10 Khz) reference transducer must be located within 3cm of the sensor. The reference transducer must be able to resolve to 0.01 psi. The passage between the switch & transducer must be a straight line. The passage must have a minimum diameter of .300".

c. Bleed the system to remove air from the lines by pressurizing the fluid or pulling a vacuum.

d. Apply a single pulse from 0 to 3,448 KPa +/-345 KPa (500 psi +/-50 psi) at a ramp rate of 700 KPa to 2,500 KPa/sec (101 psi - 362 psi/sec).

e. Monitor the electrical switch point during pressure ramp up using a 1kohm load resistor and 5-12vdc supply.

2. Acceptance Requirements

a. During the pressure ramp the pressure at the ref transducer must not have a negative spike of more than -10.34 Kpa (-1.5psi).

A negative spike is defined by the distance from the first inflection point in the pressure ramp to the bottom of the first following valley. The Spike (if any) can be found within approximately 200ms of the electrical switch signal.

DRS92-33/7-24-92
Rev-B, Lower sound limit added.

Proposed Validation Requirements.

N. Sound level
Production Validation, 12 parts, all must pass
IP-1, 6/mo, all must pass
IP-2, 12/6mo, all must pass

The flow chart would be modified to show that 12 parts would be sound tested prior to being used for vibration (I), vacuum(K), temp cycle (L) and Impulse (E). Three each would be tested prior to the tests. It would then go through the test with the remaining units. After I,K,L, & E are complete the same pieces would be checked for sound again.

DRS92-33/7-24-92
Rev-B, Lower sound limit added.

HOW TO MEASURE A TEXAS INSTRUMENTS, INC. PRESSURE SWITCH SOUND PULSE.
77PSL3-1 CRUISE CONTROL SWITCH

1) View the trace at full scale on the oscilloscope (no expansion).

2) You will see two lines.
A sloped line which is the pressure at the switch (solid line).
This line may be straight and smooth or it may have a ripple. The ripple is the sound pulse

A horizontal and vertical line, (dashed).
This line measures the voltage across the switch. When the switch opens the line jumps vertically from the bottom of the page to the top of the page.

3) With the trace still on the scope zoom into the ripple in the curve.

4) Move the curser to the visual peak prior to the first valley. For switches with no ripple estimate the point of major slope change to a nearly level line.

5) Reset the voltage to zero at that level.

6) Move the curser to the bottom of the first valley and read the voltage.
If the switch is quite use 6A instead.
6A) Move the curser to the next major slope change, usually at the end of a short flat section. This is a visual estimate and as such is subject to interpretation.

7) Multiply the voltage by 50psi/volt (ref transducer scale factor) to obtain the magnitude of the ripple in psi.

HOW TO MEASURE A TEXAS INSTRUMENTS, INC. PRESSURE SWITCH SOUND PULSE.
FOR 77PSL3-1 CRUISE CONTROL SWITCH

The same technique works on a plotted curve.

A) zoom into the ripple.

B) Plot the curve. Figure 1.

The scales for these lines are indicated in the boxes on the left. The right side of the box is drawn with the same line type as the actual curve (solid, dashed,etc)

V/D = Volts per division
Vy = voltage at tick mark next to Vy on left side of page

There are 2cm per division on the y axis

T/D = Time per division
TL = time at left edge of page

There are 2.5 cm per division on the x axis

C) Using a ruler measure the distance from peak to valley in centimeters.

D) Multiply that figure by the v/d value to obtain the height in volts.

E) Multiply by 50psi/volt to get the pressure reading.

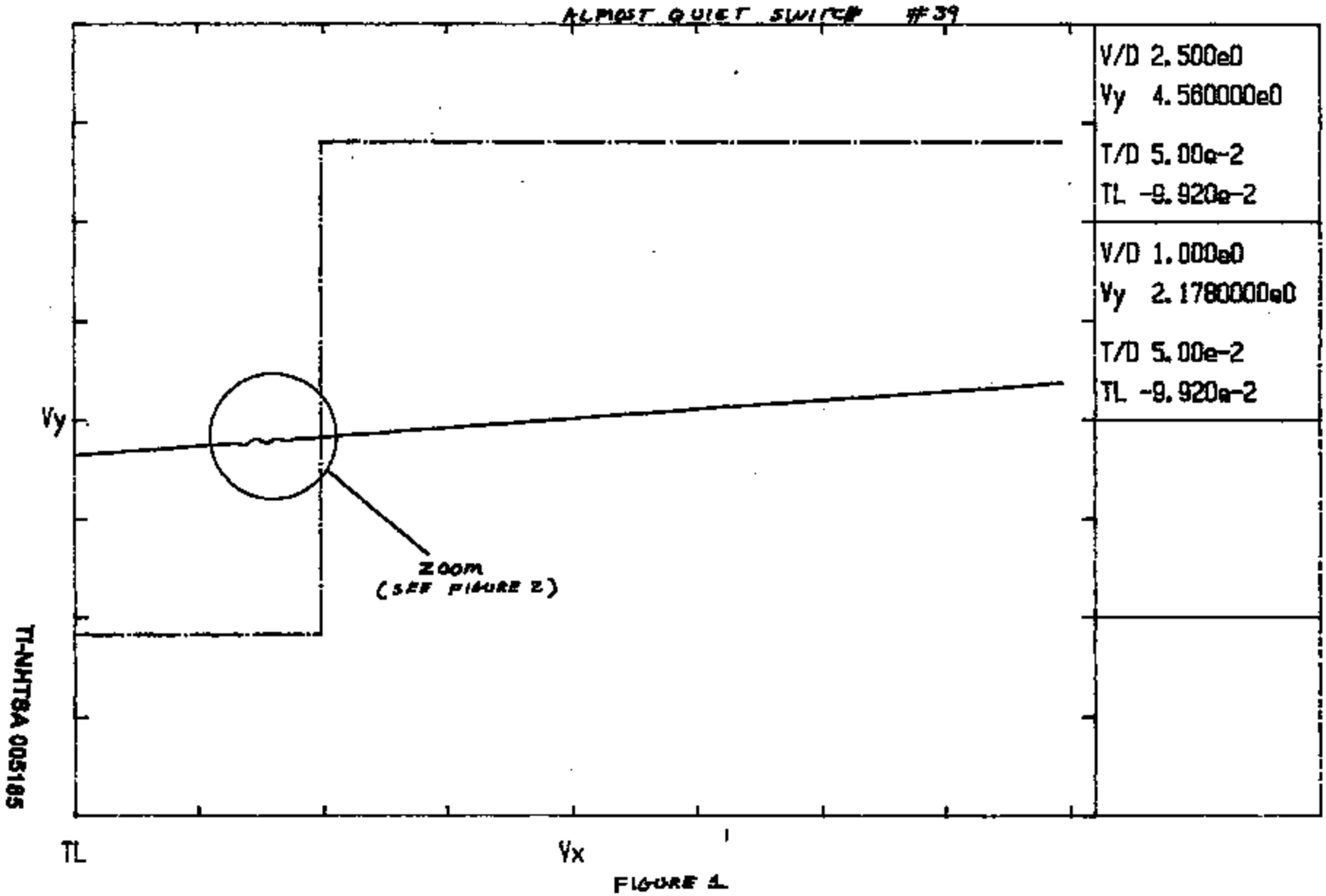

ALMOST QUIET SWITCH #39
V/D 2.500e0
Vy 4.560000e0
T/D 5.00e-2
TL -9.920e-2
V/D 1.000e0
Vy 2.178000e0
T/D 5.00e-2
TL -9.920e-2
Vy
ZOOM
(SEE FIGURE 2)
TL
Vx
TI-NHT8A 005185

FIGURE 1

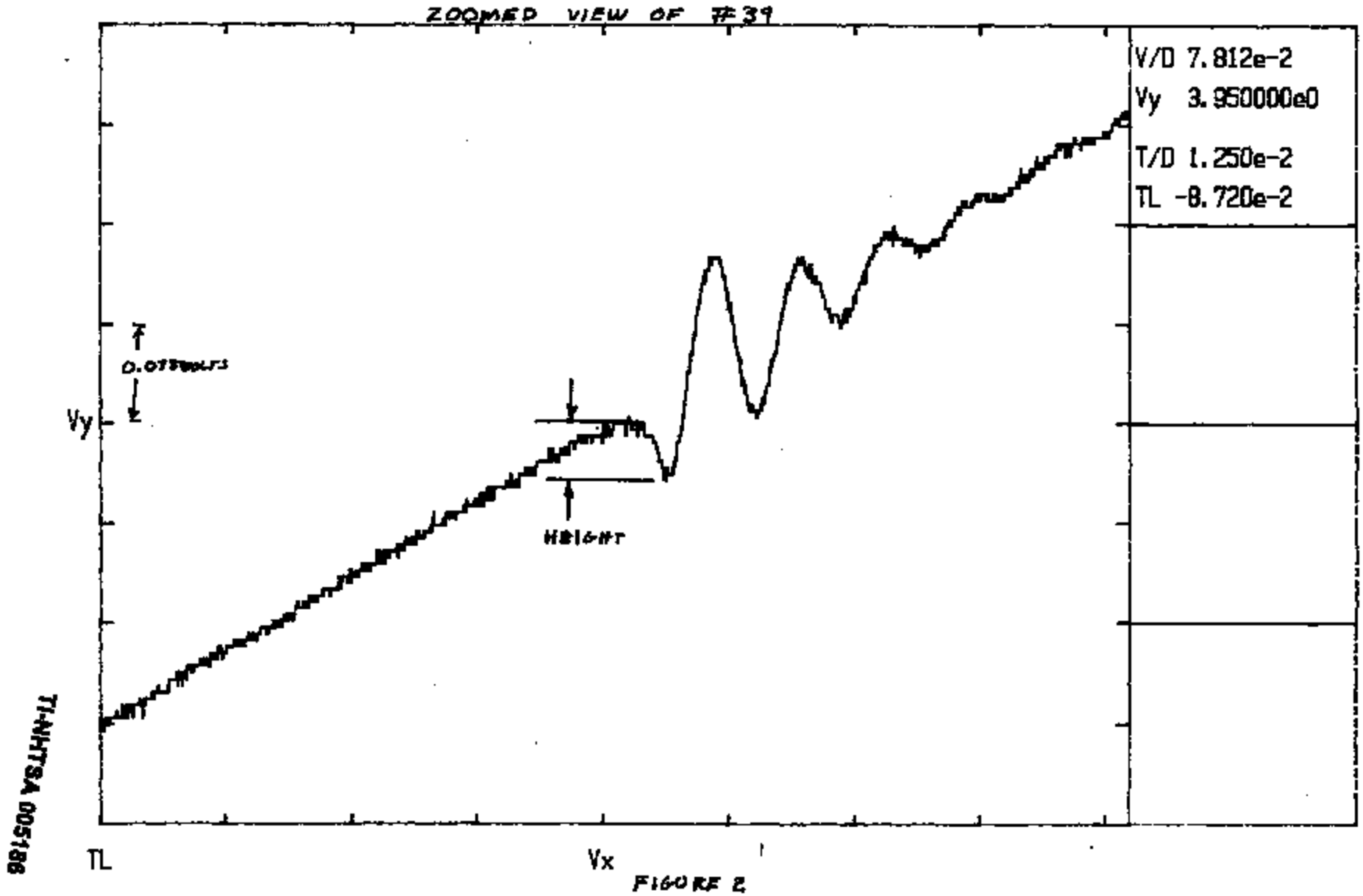

ZOOMED VIEW OF #39
V/D 7.812e-2
Vy 3.950000e0
T/D 1.250e-2
TL -8.720e-2
Vy
HEIGHT
TL
Vx
TI-NHTSA 005186

FIGURE 2

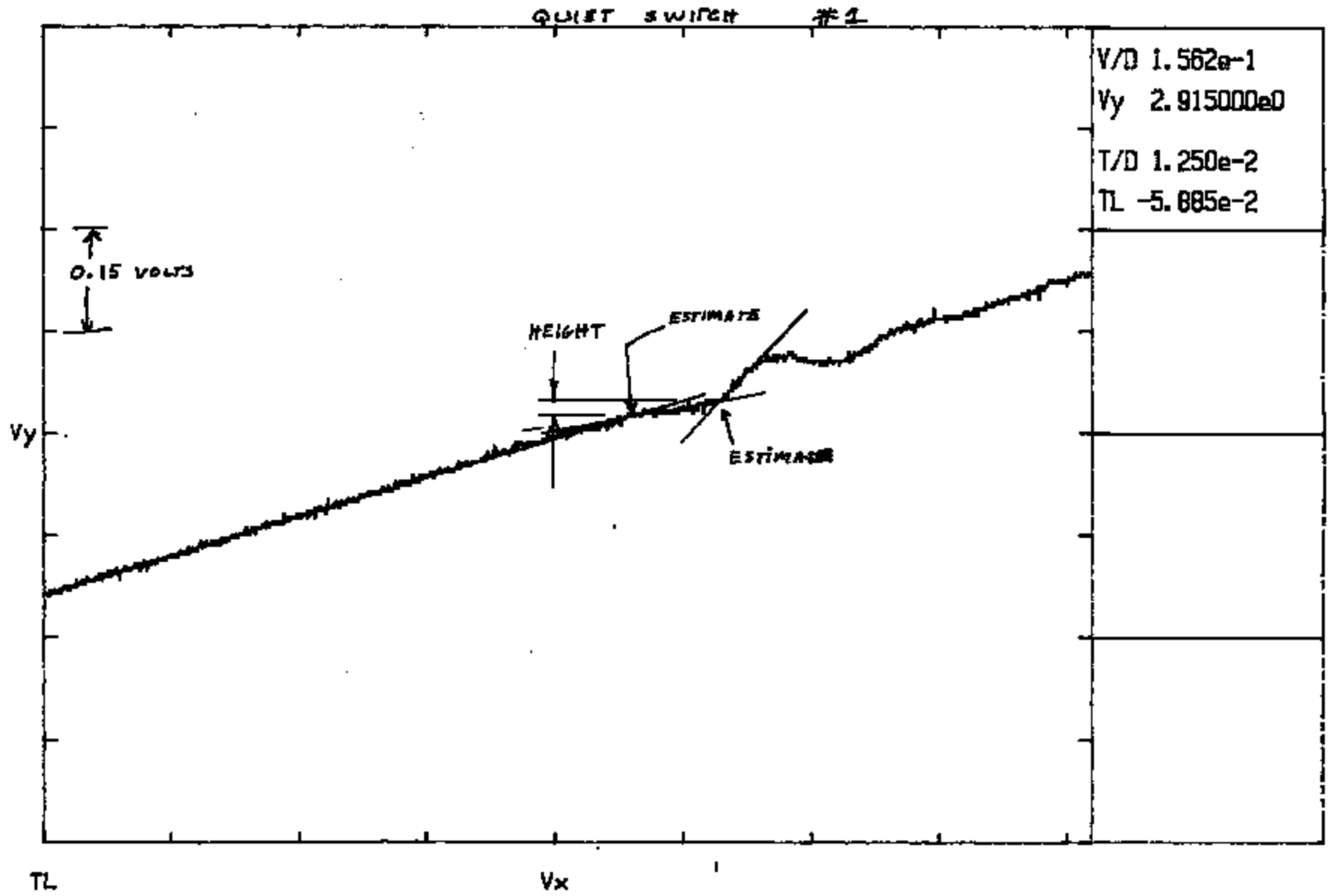


FIGURE 3

TO: DAVE CZARN   7-29-92
MATT SELLERS

FR: DALE SOGGE

SJ: CAP TEST OF PINNING

WE NEED TO ABANDON TRYING TO MEASURE THE 77PSL3-1 PACKARD CAPACITIVELY FOR THE FOLLOWING REASONS

1) THE TOTAL RANGE WE ARE TRYING TO MEASURE IS 0.07 pF (FROM 4 MIL TO 9.5 MIL) ON A BASE OF 1.8 pF.
THE APT LINE IS ONLY ABLE TO MEASURE ±.5 pF AND THEY HAVE TAKEN GREAT PAINS AND USED EXPENSIVE EQUIPMENT TO REACH THIS LEVEL

2) IF WE WANTED TO CUT OFF AT 9.5 MILS ± 0.5 MILS WE MUST BE ABLE TO RESOLVE TO ~~[illegible]~~ .004 pF

3) THE PROD TESTER COULD ONLY HOLD THE COOPSI TO ~~[illegible]~~ ± 5-10 PSI. ±10 PSI PRODUCES A VARIATION OF .008 pF WHICH IS LARGER THAN 2 ABOVE. 0.008 pF = 0.5 MILS

4) A TEST OF 40 RANDOM SWITCHES FROM THE PRODUCTION LINE NO LONGER MATCHED THE ORIGINAL CORRELATION. THE OLD CORRELATION SUGGESTED PACKARD WAS 9–10 MILS. THE PARTS WERE DISASSEMBLED AND MEASURED AND PACKARD WAS RIGHT AT 6.5-7 MILS. IN ADDITION THERE WAS A POOR CORRELATION (r = 0.2) BETWEEN THE MEASUREMENT AND THE CAPACITANCE VALUE.

5) THE ABILITY TO MAKE A CONNECTION TO THE SWITCH SEVERAL THOUSAND TIMES A DAY WHILE MAINTAINING THE QUALITY OF THE CONNECTION NEEDED TO MEASURE LOW pF VALUES IS PROBABLY IMPOSSIBLE.

WE MUST FIND ANOTHER METHOD TO CHECK DEVICES. THIS BECOMES MORE IMPORTANT BECAUSE OF OUR ACCURACY OF A 2.5 mil & 10.6 mil packed within the 40 piece Random sample. these would not be caught by HYPOT.

AT THIS POINT I have no alternative suggestion

REGARDS

DALE

MSG 050 134 PCME MDES-2 MFPC CPPC ZARN

TO:	BILL SWEET	PCME
	DAVE CZARN	ZARN
	STEVE OFFILER	SBO1
	DALE SOGGE	FFUN
	CLAIRE BALTHASAR	PCME
FR:	MATT SELLERS	MJS2

SJ: 77PSL3-1 CALIBRATION SHIFT STUDY

ATTACHED ARE TEST RESULTS FROM A STUDY TO DETERMINE THE CAUSE OF CALIBRATION SHIFTING THE LINE HAS BEEN EXPERIENCING ON THE NEW 77PSL3-1 QUIET SWITCH.

IN ALL, 15 TEST LOTS WERE SET UP; EACH WERE MADE FROM THE SAME COMPONENT LOTS. MANUFACTURING VARIABLES ARE OUTLINED ON THE ATTACHED SHEETS.

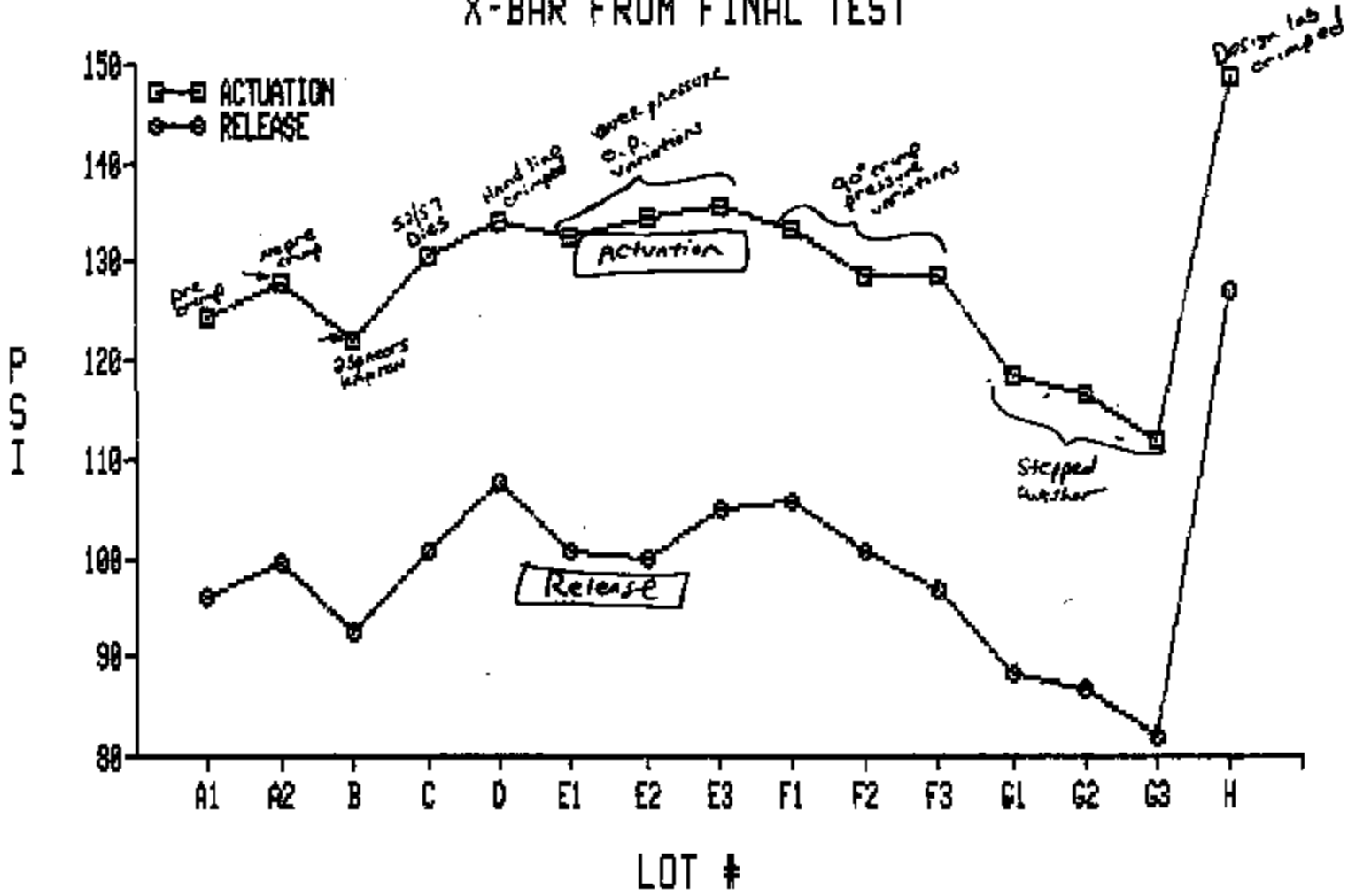
WE HAD EXPECTED THAT AN INCREASE IN DISC PRE-DEFLECTION WOULD POTENTIALLY INCREASE ACTUATION AND RELEASE VALUES. ACTUALLY WE SAW THE OPPOSITE. LOTS 'B' AND 'G' REPRESENT TWO ATTEMPTS TO INCREASE DISC PRE-DEFLECTION. 'B' HAD 2 SPACERS WHILE 'G1', 'G2', AND 'G3' HAD THE STEPPED DOWN WASHERS AT INCREASING LEVELS. IN ALL CASES ACTUATION AND RELEASE VALUES DROPPED FOR LOTS 'B' AND 'G'. DOES THE PROBLEM LIE IN PLACING EXCESSIVE PRE-DEFLECTION ON THE DISC? IF SO THERE SEEMS TO BE A VERY NARROW WINDOW BETWEEN LOOSE (RATTLING DISC) AND EXCESSIVE PRE-DEFLECTION. THE DESIGN LAB CRIMPED PARTS AS EXPECTED WERE SUBSTANTIALLY HIGHER IN ACTUATION AND RELEASE VALUES.

PLEASE REVIEW AND ADD YOUR COMMENTS.

REGARDS . . . MATT
X1245

77PS CRIMP MATRIX STUDY

X-BAR FROM FINAL TEST



crimp matrix Study

TYSL3-1 MAY 1992

ESIGN OF EXPERIMENTS
-EAR

	SENSOR MEASUREMENTS							FINISHED DEVICE		
EST LOT	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIF
A1	0.2782	0.2829	0.0047	1.1585	1.1624	0.0039	0.0469	124.4	95.8	28.6
A2	0.2789	0.2847	0.0058	1.1610	1.1644	0.0034	0.0471	127.7	99.5	29.7
B	0.2810	0.2849	0.0039	1.1592	1.1614	0.0022	0.0472	121.9	92.6	29.4
C	0.2775	0.2814	0.0039	1.1602	1.1651	0.0049	0.0474	130.4	100.5	29.9
D	0.2816	0.2851	0.0035	1.1590	1.1628	0.0038	0.0473	133.9	107.8	26.1
E1	0.2812	0.2857	0.0045	1.1572	1.1615	0.0043	0.0476	132.4	100.6	31.7
E2	0.2785	0.2840	0.0055	1.1585	1.1628	0.0043	0.0473	134.3	99.7	34.6
E3	0.2795	0.2862	0.0067	1.1597	1.1615	0.0028	0.0474	135.5	104.8	30.7
F1	0.2808	0.2858	0.0050	1.1610	1.6300	0.0020	0.0474	133.2	105.5	27.7
F2	0.2798	0.2843	0.0045	1.1612	1.1642	0.0030	0.0472	128.6	100.5	28.1
F3	0.2790	0.2845	0.0055	1.1610	1.1645	0.0035	0.0475	128.8	96.8	32.1
G1	0.2790	0.2835	0.0045	1.1607	1.1722	0.0115	0.0472	118.5	88.2	30.2
G2	0.2750	0.2797	0.0047	1.1612	1.1675	0.0063	0.0473	116.7	86.8	29.9
G3	0.2760	0.2815	0.0055	1.1617	1.1722	0.0105	0.0477	112.0	82.0	30.0
H	0.2866	0.2891	0.0026	1.1598	1.1653	0.0055	0.0472	148.9	127.0	21.9
OBL BAR	0.2795	0.2842	0.0047	1.1599	1.1959	0.0048	0.0473			

A_1 AMI w/pre-crimp

A_2 AMI No/pre-crimp

B Two Spacers

ESIGN OF EXPERIMENTS

DEV #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
A1	0.2785	0.2820	0.0035	1.1560	1.1600	0.0040	0.0468	121.5	93.5	27.9	
2	0.2765	0.2805	0.0040	1.1600	1.1620	0.0020	0.0469	132.1	100.1	31.9	
3	0.2805	0.2850	0.0045	1.1565	1.1650	0.0085	0.0470	121.5	96.1	25.3	
4	0.2750	0.2805	0.0055	1.1560	1.1565	0.0005	0.0467				DUMMY
5	0.2805	0.2865	0.0060	1.1640	1.1685	0.0045	0.0471	121.9	94.4	27.5	
6								120.5	93.4	27.0	
7								130.2	95.7	34.5	
8								122.7	93.7	29.0	
9								130.5	85.0	45.5	DFHI
10											ZPLF
11								128.4	107.1	21.9	
12								119.2	92.4	26.8	
13								117.2	94.4	22.8	
14								128.6	102.0	26.6	
15								119.9	86.9	33.0	
16								125.9	82.0	43.8	
17								122.3	101.2	21.1	
18								127.5	94.2	33.4	
19								124.4	101.8	22.6	
20								131.4	107.7	23.7	
21								124.2	98.2	26.0	
22								119.9	98.2	21.8	
23								126.2	93.1	33.1	
24								119.9	96.4	23.5	
-BAR	0.2782	0.2829	0.0047	1.1585	1.1624	0.0039	0.0469	124.4	95.8	28.6	
IGMA	0.0022	0.0024	0.0009	0.0091	0.0041	0.0027	0.0001	4.3332	6.1439	6.3578	
A25	0.2750	0.2840	0.0090	1.1615	1.1670	0.0055	0.0474	127.3	100.0	27.3	
26	0.2800	0.2850	0.0050	1.1625	1.1650	0.0025	0.0472	129.1	100.3	28.8	
27	0.2810	0.2835	0.0025	1.1620	1.1645	0.0025	0.0471	126.2	99.2	27.0	
28	0.2765	0.2850	0.0085	1.1590	1.1600	0.0010	0.0470	133.3	87.9	45.5	DFHI
29	0.2800	0.2860	0.0060	1.1600	1.1655	0.0055	0.0469	137.6	111.4	26.2	
30								125.3	92.6	32.6	
31								125.2	103.1	22.1	
32								130.1	93.6	36.6	
33								126.6	104.4	22.1	
34								130.1	100.2	29.8	
35								130.7	99.7	31.0	
36								124.4	106.1	18.3	
37								128.9	100.1	28.8	
38								131.7	106.0	25.7	
39								124.6	129.7		DFLO(5.1)
40								127.5	99.7	27.8	
41								119.3	95.7	29.6	
42								132.8	80.0	52.8	DFHI-CA
43								131.9	94.7	37.2	
44								129.4	104.3	25.1	
45								119.1	93.7	25.3	
46								125.5	95.3	30.2	
47								126.9	96.3	30.6	
48								122.4	92.8	29.7	
-BAR	0.2789	0.2847	0.0058	1.1610	1.1644	0.0034	0.0471	127.7	99.5	29.7	
IGMA	0.0021	0.0009	0.0021	0.0013	0.0024	0.0018	0.0002	4.2068	8.9964	7.3578	

Lot A1
- AMI pre-crimp
- AMI Low pin probe

Lot A2
- AMI crimped
(no pre-crimp)
(no low pin probe)

LV #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
B1	0.2780	0.2820	0.0040	1.5950	1.1620	0.0025	0.0474	114.1	92.6	21.5	
2	0.2805	0.2850	0.0045	1.1595	1.1600	0.0005	0.0471	124.2	86.3	37.9	
3	0.2820	0.2845	0.0025	1.1585	1.1600	0.0015	0.0473	115.0	88.4	26.6	
4	0.2820	0.2875	0.0055	1.1585	1.1605	0.0020	0.0471	115.0	92.9	22.1	
5	0.2825	0.2855	0.0030	1.1600	1.1645	0.0045	0.0469	127.9	102.5	25.5	
6								125.9	97.4	28.5	
7								127.9	86.1	41.9	
8								124.4	87.5	36.9	
9								122.4	94.2	28.2	
10								116.5	99.2	17.2	
11								129.6	103.1	26.5	
12								119.0	93.2	25.8	
13								118.6	94.9	23.7	
14								122.5	94.9	27.6	
15								124.7	95.3	29.4	
16								124.0	101.4	22.6	
17								128.3	98.6	29.7	
18								125.4	78.8	46.6	DFHI-CR
19								112.0	89.4	22.5	
20								124.0	94.9	29.1	
21								116.7	85.4	31.4	
22								124.2	94.8	29.4	
23								127.6	81.0	46.5	DFHI
24								115.1	89.9	25.2	
-BAR	0.2342	0.2374	0.0039	1.0386	0.9678	0.0022	0.0472	121.9	92.6	29.3	
IGMA	0.1047	0.1062	0.0011	0.4910	0.4328	0.0013	0.0002	5.1756	6.2559	7.4587	

LOT B
- LOT A, with 2 spacers
- AMI crimped

DEV #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
C1	0.2775	0.2790	0.0015	1.1620	1.1675	0.0055	0.0471	141.6	94.6	47.0	DFHI
2	0.2785	0.2825	0.0040	1.1605	1.1660	0.0055	0.0476	133.8	102.3	31.5	
3	0.2775	0.2800	0.0025	1.1600	1.1650	0.0050	0.0474	135.1	105.4	29.7	
4	0.2775	0.2835	0.0060	1.1590	1.1655	0.0065	0.0471	132.5	103.9	28.6	
5	0.2765	0.2820	0.0055	1.1595	1.1615	0.0020	0.0479	115.1	89.0	26.1	
6								132.7	100.8	31.9	
7								127.2	100.8	26.4	
8								134.2	97.7	36.5	
9								125.0	97.3	27.7	
10								128.5	99.2	29.3	
11								131.2	85.1	46.1	DFHI
12								140.3	110.1	30.2	
13								128.7	102.7	26.0	
14								141.4	110.4	31.0	
15								130.1	104.4	25.7	
16								126.7	100.7	26.0	
17								130.3	106.9	23.4	
18								126.9	92.7	34.2	
19								126.0	96.1	29.9	
20								124.6	106.9	17.7	
21								133.9	96.6	37.3	
22								123.8	104.8	19.0	
23								128.1	104.3	23.8	
24								132.5	100.1	32.4	
-BAR	0.2775	0.2814	0.0039	1.1602	1.1651	0.0049	0.0474	130.4	100.5	29.9	
IGMA	0.0006	0.0017	0.0017	0.0010	0.0020	0.0015	0.0003	5.8716	6.0678	6.8147	

Lot C
- Lot A2
- AMI crimped with 52/57PS dies vs. 77PS dies.

DEV #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
D1	0.2820	0.2875	0.0055	1.1590	1.1630	0.0040	0.0473	162.7	141.2	21.5	ACHI-CA
2	0.2810	0.2825	0.0015	1.1590	1.1620	0.0030	0.0478	125.1	97.0	28.1	
3	0.2805	0.2845	0.0040	1.1580	1.1635	0.0055	0.0470	136.0	116.5	19.5	
4	0.2840	0.2885	0.0045	1.1590	1.1635	0.0045	0.0476	135.5	110.1	25.4	
5	0.2805	0.2825	0.0020	1.1600	1.1620	0.0020	0.0470	139.3	106.9	32.4	
6								133.5	105.2	28.3	
7								131.6	109.6	22.0	
8								128.2	74.7	53.5	DFHI
9								129.9	109.3	20.6	
10								147.2	124.1	23.1	
11											ACLO=0
12								142.0	118.1	23.9	
13								119.7	98.3	21.4	
14								134.9	107.7	27.2	
15								134.2	106.6	27.6	
16								133.5	109.9	23.6	
17								134.0	110.5	23.5	
18								120.4	94.0	26.4	
19								134.0	102.0	32.0	
20								133.2	110.5	22.7	
21								130.8	108.6	22.2	
22								126.0	105.8	20.2	
23								134.4	106.3	28.1	
24								133.2	105.8	27.4	
BAR	0.2816	0.2851	0.0035	1.1590	1.1628	0.0038	0.0473	133.9	107.8	26.1	
SMA	0.0013	0.0025	0.0015	0.0006	0.0007	0.0012	0.0003	8.5918	11.7	6.8083	

Lot D

- Lot A;
- Hand line crimped with TRPS dies.

DEV #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
E1	0.2785	0.2845	0.0060	1.1580	1.1625	0.0045	0.0472	135.9	102.2	33.7	
2	0.2840	0.2875	0.0035	1.1570	1.1600	0.0030	0.0476	130.7	102.4	28.3	
3	0.2810	0.2850	0.0040	1.1565	1.1620	0.0055	0.0481	119.3	99.6	19.7	
4								127.1	104.6	22.5	
5								136.2	98.1	38.1	
6								134.4	103.8	30.6	
7								133.4	101.3	32.1	
8								131.2	103.0	28.2	
9								127.5	89.8	37.7	
10								136.6	101.6	35.0	
11								143.0	105.8	37.2	
12								133.2	95.5	97.7	
-BAR	0.2812	0.2857	0.0045	1.1572	1.1615	0.0043	0.0476	132.4	100.6	31.7	
IGMA	0.0022	0.0013	0.0011	0.0006	0.0011	0.0010	0.0004	5.7035	4.2447	5.8588	
E13	0.2790	0.2805	0.0015	1.1575	1.1600	0.0025	0.0477	134.5	96.8	37.7	
14	0.2760	0.2875	0.0115	1.1575	1.1625	0.0050	0.0471	134.5	99.3	35.2	
15	0.2805	0.2840	0.0035	1.1605	1.1660	0.0055	0.0471	135.1	101.5	33.6	
16								130.6	101.5	29.1	
17								139.7	107.9	31.8	
18								133.4	102.2	31.2	
19								132.1	107.6	24.5	
20								140.5	101.7	38.8	
21								139.0	100.9	38.1	
22								129.4	96.2	33.2	
23								142.4	100.9	41.5	
24								120.3	80.3	40.0	
#R	0.2785	0.2840	0.0055	1.1585	1.1628	0.0043	0.0473	134.3	99.7	34.6	
IGMA	0.0019	0.0029	0.0043	0.0014	0.0025	0.0013	0.0003	5.7400	6.7480	4.7542	
E25	0.2795	0.2840	0.0045	1.1590	1.1625	0.0035	0.0477	122.9	97.8	25.1	
26	0.2790	0.2875	0.0085	1.1575	1.1610	0.0035	0.0472	137.8	109.8	28.0	
27	0.2800	0.2870	0.0070	1.1595	1.1610	0.0015	0.0473	139.8	107.1	31.7	
28								135.8	107.1	28.7	
29								138.5	109.4	29.1	CR
30								137.3	103.9	33.4	
31								123.7	94.9	28.8	
32								142.3	106.1	36.2	
33								138.1	100.4	37.7	
34								130.7	99.4	31.3	
35								140.7	109.0	31.7	
36								139.1	112.4	26.7	
-BAR	0.2795	0.2862	0.0067	1.1587	1.1615	0.0028	0.0474	135.5	104.8	30.7	
IGMA	0.0004	0.0015	0.0016	0.0008	0.0007	0.0009	0.0002	6.0728	5.2453	3.5791	

1/ Lot E1
- Lot A, 950 psi o-pressure

2/ Lot E2
- Lot A, 1200 psi o-pressure

3/ Lot E3
- Lot A, 1400 psi o-pressure

#	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
F1	0.2600	0.2850	0.0050	1.1620	1.1645	0.0025	0.0470	132.5	101.0	31.5	
2	0.2815	0.2855	0.0040	1.1620	1.1645	0.0025	0.0476				CONT
3	0.2810	0.2870	0.0060	1.1590	1.1600	0.0010	0.0476	126.9	99.0	27.9	
4								137.5	110.6	26.9	
5								136.1	112.3	23.8	
6								127.9	102.6	25.3	
7								139.5	108.4	31.1	
8								133.1	105.8	27.3	
9								130.1	100.5	29.6	
10								138.8	102.3	36.5	
11								133.3	109.4	23.9	
12								129.4	108.6	20.8	
BAR	0.2808	0.2858	0.0050	1.1610	1.1630	0.0020	0.0474	133.2	105.5	27.7	
GMA	0.0006	0.0008	0.0008	0.0014	0.0021	0.0007	0.0003	4.1592	4.9872	4.1660	
F13	0.2800	0.2860	0.0060	1.1580	1.1620	0.0040	0.0472	128.5	95.4	33.1	
14	0.2795	0.2840	0.0045	1.1625	1.1655	0.0030	0.0472	127.7	99.6	28.1	
15	0.2800	0.2830	0.0030	1.1630	1.1650	0.0020	0.0472	129.7	107.4	22.3	
16								137.4	105.2	32.2	
17								128.3	103.4	24.9	
18								133.5	110.2	23.3	
19								121.1	95.3	25.8	
20								117.0	95.7	21.3	
21								126.4	92.8	33.6	
22								130.1	95.9	34.2	
23								130.8	102.3	28.5	
24								132.1	102.8	29.3	
R	0.2798	0.2843	0.0045	1.1612	1.1642	0.0030	0.0472	128.6	100.5	28.1	
A	0.0002	0.0012	0.0012	0.0022	0.0015	0.0009	0.0000	5.1521	5.3079	4.3712	
F25	0.2790	0.2840	0.0050	1.1605	1.1620	0.0015	0.0474	125.2	95.8	29.4	
26	0.2820	0.2855	0.0035	1.1605	1.1660	0.0055	0.0478	133.5	100.9	32.6	
27	0.2760	0.2840	0.0080	1.1620	1.1655	0.0035	0.0474	133.8	96.3	37.5	
28								131.1	99.8	31.3	
29								126.8	100.1	26.7	
30								125.3	95.6	29.7	
31								135.4	99.7	35.7	
32								124.7	93.3	31.4	
33								125.0	91.8	33.2	
34								134.8	108.4	26.4	
35								130.0	89.8	40.2	
36								120.3	89.8	30.5	
BAR	0.2790	0.2845	0.0055	1.1610	1.1645	0.0035	0.0475	128.8	96.8	32.1	
GMA	0.0024	0.0007	0.0019	0.0007	0.0018	0.0016	0.0002	4.7089	5.1446	3.9534	

Lot F1 – Lot A2 – 55psi 90° crimp

Lot F2 – Lot A2 – 60 psi 90° crimp

Lot F3 – Lot A2 – 65 psi 90° crimp

V #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
G1	0.2795	0.2830	0.0035	1.1610	1.1730	0.0120	0.0472	112.2	85.6	26.6	
2	0.2805	0.2840	0.0035	1.1610	1.1750	0.0140	0.0471	130.0	96.8	33.2	
3	0.2770	0.2835	0.0065	1.1600	1.1685	0.0085	0.0473	120.5	82.1	38.4	
4								112.2	91.8	20.4	
5								124.6	90.8	33.8	
6								121.5	84.2	37.3	
7								118.7	90.6	28.1	
8								114.9	85.3	29.6	
9								115.2	90.5	24.7	
10								120.6	82.2	38.4	
11								118.8	91.0	27.8	
12								112.3	87.9	24.4	
-BAR	0.2790	0.2835	0.0045	1.1607	1.1722	0.0115	0.0472	118.5	88.2	30.2	
IGMA	0.0015	0.0004	0.0014	0.0005	0.0027	0.0023	0.0001	5.2333	4.2527	5.7028	
G13	0.2760	0.2810	0.0050	1.1600	1.1655	0.0055	0.0472	112.0	86.9	25.1	
14	0.2740	0.2765	0.0025	1.1615	1.1690	0.0075	0.0473	109.1	82.5	26.6	ACLO
15	0.2750	0.2815	0.0065	1.1620	1.1680	0.0060	0.0473	115.9	85.5	30.4	
16								113.0	82.1	30.9	
17								107.4	82.1	25.3	ACLO
18								120.7	89.3	31.4	
19								120.7	86.2	34.5	
20								118.8	76.7	42.1	
21								120.5	89.4	31.1	
22								115.4	88.6	26.8	
23								129.0	100.6	28.4	
24								117.4	91.3	26.1	
BAR	0.2750	0.2797	0.0047	1.1612	1.1675	0.0063	0.0473	116.7	86.8	29.9	
MA	0.0008	0.0022	0.0016	0.0008	0.0015	0.0009	0.0000	5.6640	5.7276	4.6218	
G25	0.2785	0.2820	0.0035	1.1595	1.1730	0.0135	0.0473	114.7	87.4	27.3	
26	0.2730	0.2800	0.0070	1.1635	1.1710	0.0075	0.0483	111.7	87.5	24.2	
27	0.2765	0.2825	0.0060	1.1620	1.1725	0.0105	0.0476	107.5	74.8	32.7	ACLO
28								107.5	75.3	32.2	ACLO
29								113.6	83.4	30.2	
30								122.2	86.2	36.0	
31								122.9	91.4	31.5	
32								118.1	81.1	37.0	
33								99.7	75.8	23.9	ACLO
34								104.7	77.0	27.7	ACLO
35								111.3	84.2	27.1	
36								109.9	79.4	30.5	ACLO
-BAR	0.2760	0.2815	0.0055	1.1617	1.1722	0.0105	0.0477	112.0	82.0	30.0	
IGMA	0.0023	0.0011	0.0015	0.0016	0.0008	0.0024	0.0004	6.5827	5.3224	3.9948	

Lot G1
- Lot A2
- Step washer

Lot G2
- lot A2
- Step washer

Lot G3
- lot A3
- Step washer

/ #	CRMP LOW	CRMP HIGH	RANGE	DIAM LOW	DIAM HIGH	RANGE	SENSOR	ACT	REL	DIFF	
Hi	0.2870	0.2895	0.0025	1.1590	1.1665	0.0075	0.0472	148.1	126.2	21.9	
2	0.2875	0.2890	0.0015	1.1610	1.1650	0.0040	0.0472	142.4	123.1	19.3	
3	0.2900	0.2925	0.0025	1.1620	1.1675	0.0055	0.0475	148.5	126.2	22.3	
4	0.2860	0.2885	0.0025	1.1630	1.1660	0.0030	0.0472	156.4	134.5	21.9	ACHI
5	0.2860	0.2885	0.0025	1.1615	1.1630	0.0015	0.0471	153.7	133.0	20.7	ACHI
6	0.2895	0.2910	0.0015	1.1575	1.1625	0.0050	0.0472	149.1	127.9	21.2	
7	0.2855	0.2895	0.0040	1.1560	1.1620	0.0060	0.0472	136.7	119.7	17.0	
8	0.2850	0.2870	0.0020	1.1600	1.1670	0.0070	0.0473	148.6	124.7	23.9	
9	0.2880	0.2865	0.0035	1.1570	1.1635	0.0065	0.0472	152.7	128.5	24.2	ACHI
10	0.2865	0.2895	0.0030	1.1610	1.1675	0.0065	0.0471	153.7	134.8	18.9	ACHI
11								146.8	128.0	18.8	
12								152.4	128.3	24.1	ACHI
13								143.7	123.4	20.3	
14								134.1	110.2	23.9	
15								148.0	127.1	20.9	
16								150.9	129.1	21.8	ACHI
17								154.1	132.5	21.6	ACHI
18								150.0	130.6	19.4	ACHI
19								148.3	127.2	21.1	
20								149.2	125.9	23.3	
21								150.3	126.6	23.7	ACHI
22								153.1	129.3	23.8	ACHI
23								152.5	133.8	18.7	ACHI
24								151.2	129.3	21.9	ACHI
:EAR	0.2866	0.2891	0.0026	1.1598	1.1653	0.0055	0.0472	148.9	127.0	21.9	
:GMA	0.0020	0.0017	0.0008	0.0022	0.0020	0.0020	0.0001	5.1993	5.7551	1.7697	

X/

LOT H
- LOT A2
- Design lab crimped

6/30/92

TO: Matt Sellers
Dave Czarn
Steve Offiler
Dick Gariepy

FR: Dale Sogge

sj: Quiet switch preload

I have completed the preliminary capacitance vs preload study. As you may recall we proposed that capacitance could be used to check each device from possible mis-pining prior to shipping. It was felt that it would be a more useful test than Hypot. Hypot only checks for long pinned devices where as capacitance checks for both long and short pins.

There is an excellent correlation between capacitance and preload as shown in the attached figure (r=.95). The correlation includes two sets of readings taken one day apart, so repeatability seems to have little effect.

Twenty devices from production were measured to get a feel for our production capability. These are shown on the attached graph. Unfortunately we are not capable to the limits of 3.5 and 9.5. Cpk is 0.67. The data also shows that we are not centered at the 6.5 mil target.

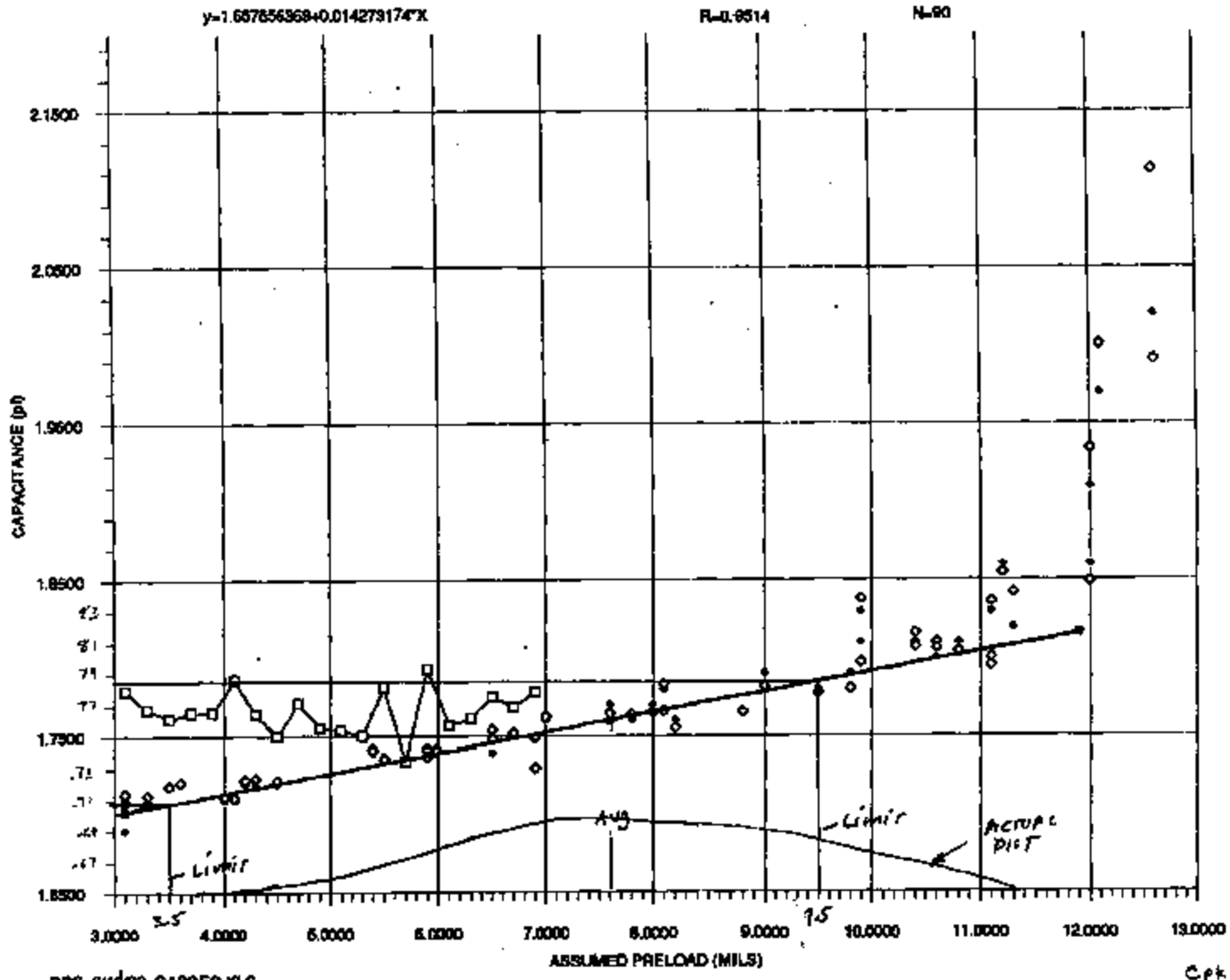
In spite of this lack of capability I strongly recommend that we add a capacitance test to the final tester. If we don't have it in place then we can't figure out what we have to do to improve. Matt has agreed to coordinate mechanization to get this built.

I also strongly suggest that we add this on a sample basis immediately to set if some bad parts are getting out the door. No one currently has this as an action item.

We temporarily installed the cap tester inside the final tester and found that we got identical readings to those taken in the lab. This means that we don't have to worry about electrical noise if cabled properly.

Regards,
Dale

CAPACITANCE VS PRELOAD 77PSL3-1



avg=1.7857pF (7.57 mils)

stndp=0.0136 (.955)

SE = 0.10 (7.63 mils)

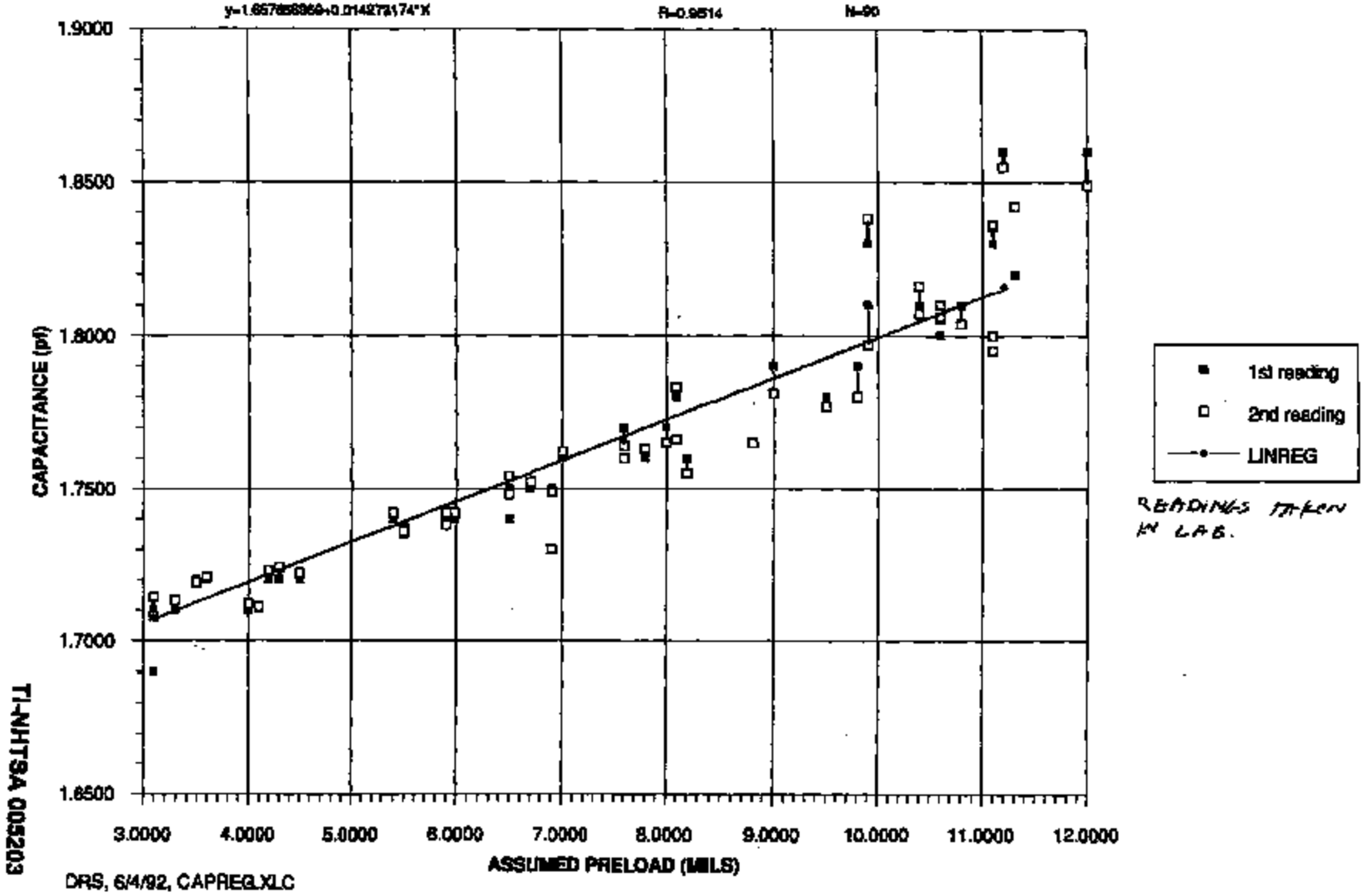
LS = .082 (5.72 mils)

Cpk = $\frac{\text{Actual Limit} - \bar{x}}{3\sigma}$

9.5 - 7.57 = 0.67

TI-NHTSA 005202

CAPACITANCE VS PRELOAD 77PSL3-1



77PSL3-1 MAY 28, 1992

DEVICES FOR CAPACITANCE TEST BY DES.ENG.

DEVICE #	PIN	SENSOR	BASE	PRELOAD	Capaticance (pF) 1st read	2nd read	3 reading	average	PREDICTED y=1.65755639+0.014273174*x
3-1	0.1400	0.0443	0.0926	3.1000	1.6900	1.7080		1.6990	1.7018
3-2	0.1396	0.0441	0.0920	3.5000	1.7200	1.7190		1.7195	1.7075
3-3	0.1397	0.0450	0.0914	3.3000	1.7100	1.7130		1.7115	
3-4	0.1400	0.0443	0.0926	3.1000	1.7100	1.7140		1.7120	
3-5	0.1400	0.0447	0.0917	3.6000	1.7200	1.7210		1.7205	
4-1	0.1401	0.0441	0.0917	4.3000	1.7200	1.7240		1.7220	
4-2	0.1401	0.0442	0.0914	4.5000	1.7200	1.7220		1.7210	
4-3	0.1398	0.0443	0.0915	4.0000	1.7100	1.7120		1.7110	
4-4	0.1399	0.0442	0.0916	4.1000	1.7100	1.7110		1.7105	
4-5	0.1400	0.0442	0.0916	4.2000	1.7200	1.7230		1.7215	
5-1	0.1402	0.0445	0.0902	5.5000	1.7350	1.7370		1.7360	
5-2	0.1399	0.0444	0.0900	5.5000	1.7350	1.7360		1.7355	
5-3	0.1401	0.0446	0.0896	5.9000	1.7400	1.7420		1.7410	
5-4	0.1400	0.0443	0.0903	5.4000	1.7400	1.7420		1.7410	
5-5	0.1403	0.0443	0.0901	5.9000	1.7400	1.7380		1.7390	
6-1	0.1412	0.0444	0.0908	5.9800	1.7400	1.7420		1.7410	
6-2	0.1417	0.0440	0.0912	6.5000	1.7400	1.7480		1.7440	
6-3	0.1419	0.0443	0.0907	6.9000	1.7300	1.7300		1.7300	
6-4	0.1417	0.0448	0.0902	6.7000	1.7500	1.7520		1.7510	
6-5	0.1410	0.0443	0.0902	6.5000	1.7500	1.7540		1.7520	
7-1	0.1418	0.0447	0.0902	6.9000	1.7500	1.7490		1.7495	
7-2	0.1418	0.0448	0.0900	7.0000	1.7600	1.7620		1.7610	
7-3	0.1419	0.0445	0.0898	7.6000	1.7600	1.7600		1.7600	
7-4	0.1420	0.0444	0.0900	7.6000	1.7700	1.7640		1.7670	
7-5	0.1417	0.0442	0.0897	7.8000	1.7600	1.7630		1.7615	
8-1	0.1418	0.0445	0.0885	8.8000	1.7650	1.7650		1.7650	
8-2	0.1420	0.0447	0.0892	8.1000	1.7800	1.7830		1.7815	
8-3	0.1418	0.0446	0.0892	8.0000	1.7700	1.7650		1.7675	
8-4	0.1420	0.0443	0.0895	8.2000	1.7600	1.7550		1.7575	
8-5	0.1419	0.0443	0.0895	8.1000	1.7800	1.7660		1.7730	
9-1	0.1417	0.0445	0.0882	9.0000	1.7900	1.7810		1.7855	
9-2	0.1422	0.0445	0.0878	9.9000	1.8300	1.8380		1.8340	
9-3	0.1420	0.0445	0.0877	9.8000	1.7900	1.7800		1.7850	
9-4	0.1416	0.0445	0.0872	9.9000	1.8100	1.7970		1.8035	
9-5	0.1420	0.0447	0.0878	9.5000	1.7800	1.7770		1.7785	
10-1	0.1418	0.0446	0.0866	10.6000	1.8000	1.8100		1.8050	
10-2	0.1420	0.0444	0.0870	10.6000	1.8050	1.8060		1.8055	
10-3	0.1415	0.0446	0.0865	10.4000	1.8100	1.8070		1.8085	
10-4	0.1420	0.0444	0.0872	10.4000	1.8100	1.8160		1.8130	
10-5	0.1421	0.0445	0.0868	10.8000	1.8100	1.8040		1.8070	
11-1	0.1422	0.0444	0.0865	11.3000	1.8200	1.8420		1.8310	
11-2	0.1421	0.0445	0.0865	11.1000	1.8300	1.8360		1.8330	
11-3	0.1423	0.0444	0.0868	11.1000	1.8000	1.7950		1.7975	

77PSL3-1		MAY 28, 1992							
DEVICES FOR CAPACITANCE TEST BY DES.ENG.									
						Capaticance (pF)			
DEVICE #	PIN	SENSOR	BASE	PRELOAD	1st read	2nd read	3 reading	average	PREDICTED
									y=1.65755639+0.014273174*x
11-4	0.1421	0.0443	0.0866	11.2000	1.8600	1.8550		1.8575	
11-5	0.1416	0.0445	0.0860	11.1000	1.8000	1.8000		1.8000	1.8160
12-1	0.1431	0.0449	0.0861	12.1000	1.9700	2.0010		1.9855	
12-2	0.1432	0.0442	0.0864	12.6000	2.0200	1.9910		2.0055	
12-3	0.1420	0.0444	0.0856	12.0000	1.9100	1.9340		1.9220	
12-4	0.1430	0.0446	0.0858	12.6000	#N/A	2.1120		#N/A	
12-5	0.1420	0.0445	0.0855	12.0000	1.8600	1.8490		1.8545	
					y=1.65755639+0.014273174*x				
					r=0.951				
					n=45				

To Capture

2

3

4

5

6

7

8

9

10

Act= 116
REQ= 93

Act= 114
REQ= 91 9

Act= 115.5
REQ= 89

Act= 110.8
REQ= 79.

Act= 124.2
REQ= 90+

dimmed

PRODUCTION PARTS - SHIFT FROM ROOM TO 150°C TO CHECK ON PERMANENT EFFECTS OF MISSING PRELOAD. THE DATA SHOWS A DROP BUT NOT ENOUGH TO EXPLAIN AN OPEN BELOW TOP::: THE DROP COULD BE ONLY TEMP SHIFT, ONLY PRELOAD SHIFT OR BOTH. SHIFT INDICATES POSITIVE PRELOAD IS AT LEAST 2.25 mil WHICH IS 4.85 FROM THE RANGE OF 6.5. POSSIBLY DISC PRELOAD SHIFT IS -.0048-.006 & TEMP SHIFT CAN ATTACH .002. NEED TO CONFIRM ACTUAL PRELOAD SO SPRING POINT IS KNOWN. (TRY CAPACITANCE TEST, CAP TEST SHOWS PRELOAD AT C = 8.7

'7P6L3-1 MAY 29,1992

'ROVIDE DES. ENG. WITH FINISHED DEVICES BUILT FROM SENSORS WHICH RATTLE
(SENSOR READINGS OVER .050)

EVICES #1-4 FROM LOT 5-20
EVICES #5-12 FROM LOT 5-22
NITIAL BASE CALIBRATION FOR BOTH LOTS .0678

DEVICE #	PIN	BASE before	BASE after	base delta	SENSOR before	SENSOR after	sensor delta	PRELOAD before	PRELOAD after	ACT before	ACT after	REL before	REL after	DIFF before	Measured capacitance(pF)	preload predicted by capacitance
1	0.1420	0.0682	0.0687	-0.0005	0.0510	0.0468	0.0042	0.0028	0.0065	131.0	139.0	88.5	90.0	38.9	1.7580	7.34
2	0.1421	0.0684	0.0678	0.0006	0.0510	0.0463	0.0047	0.0027	0.0080	131.0	141.0	95.6	102.0	35.4	1.7890	9.48
3	0.1420	0.0680	0.0672	0.0008	0.0508	0.0473	0.0035	0.0032	0.0075	124.8	141.0	98.4	93.0	26.4	1.799	10.17
4	0.1419	0.0688	0.0688	0.0000	0.0512	0.0466	0.0046	0.0018	0.0064	121.1	120.0	89.4	102.0	31.7	1.749	6.72
5	0.1419	0.0678	0.0682	-0.0004	0.0506	0.0497	0.0009	0.0035	0.0040	130.1	137.0	85.4	107.0	44.7	1.768	8.03
6	0.1420	0.0680	0.0685	-0.0005	0.0511	0.0463	0.0048	0.0029	0.0072	123.9	135.0	96.2	108.0	27.7	1.76	7.48
7	0.1416	0.0681	0.0678	0.0003	0.0507	0.0467	0.0040	0.0028	0.0071	123.4	136.0	91.9	94.0	31.5	1.764	7.90
8	0.1420	0.0686	0.0674	0.0012	0.0505	0.0464	0.0041	0.0029	0.0082	126.1	136.0	99.3	99.0	26.9	1.775	8.52
9	0.1418	0.0681	0.0681	0.0000	0.0507	0.0467	0.0040	0.0030	0.0070	123.1	150.5	96.2	85.0	26.9	1.76	7.48
10	0.1418	0.0685	0.0687	-0.0002	0.0508	0.0459	0.0049	0.0025	0.0072	127.4	146.0	96.6	98.0	31.8	1.769	8.10
11	0.1421	0.0682	0.0685	-0.0003	0.0511	0.0468	0.0042	0.0028	0.0067	126.2	136.0	95.4	96.0	30.8	1.76	7.48
12	0.1420	0.0683	0.0684	-0.0001	0.0517	0.0507	0.0010	0.0020	0.0029	126.2	194.0	80.0	88.0	46.0	1.756	7.21

TEST No 285-15-93

77ps disc heights at cup bump location

Passenger car discs measured at .470 bump diameter

Truck discs measured at .570 bump diameter

Measurement tool duplicated the cup bump shape, ie a ring on a dial indicator.

All Dimension in 10ths of mils

Loud Passenger Car					Quite Passenger car				
Serial #	lot #	Center height		Height at .470	Serial Num	lot #	Center Height		Height at .470
1	1.3	279		215	21	1	271		198
2	1.3	278		213	22	1	270		200
3	1.3	280		208	23	1	269		202
4	1.3	280		203	24	1	267		196
5	1.3	280		211	25	1	269		196
6	12.5	279		202	26	5	273		198
7	12.5	283		207	27	5	271		196
8	12.5	282		209	28	5	274		202
9	12.5	281		214	29	5	272		196
10	12.5	285		217	30	5	271		196
11	2.17	286		211	31	5.1	272		196
12	2.17	286		209	32	5.1	271		197
13	2.17	287		208	33	5.1	272		198
14	2.17	288		211	34	5.1	272		196
15	2.17	287		202	35	5.1	271		202
16	2.23	287		213	36	4	269		194
17	2.23	287		209	37	4	269		195
18	2.23	290		217	38	4	269		201
19	2.23	291		213	39	4	269		197
20	2.23	290		212	40	4	269		194
	Loud Pass Car	*Height at center*	*Loud Pass Car*	*Height at bump*		*Quiet Car*	*Center Height*		*Height at bump*
	Mean	284.4	Mean	210.2		Mean	270.3	Mean	196.15
	Standard Error	0.944234893	Standard Error	0.985687043		Standard Error	0.47072179	Standard Error	0.534499732
	Median	285.5	Median	211		Median	271	Median	196
	Mode	287	Mode	213		Mode	269	Mode	196
	Standard Deviation	4.222745426	Standard Deviation	4.408126467		Standard Deviation	2.105131575	Standard Deviation	2.390221307
	Variance	17.83157895	Variance	19.43157895		Variance	4.431578947	Variance	5.713157895
	Kurtosis	-1.480129074	Kurtosis	-0.267755947		Kurtosis	0.674576114	Kurtosis	-0.32140673
	Skewness	-0.065950139	Skewness	-0.455397573		Skewness	-0.669470793	Skewness	0.060317928
	Range	13	Range	15		Range	9	Range	8
	Minimum	278	Minimum	202		Minimum	265	Minimum	194
	Maximum	291	Maximum	217		Maximum	274	Maximum	202
	Sum	5688	Sum	4204		Sum	5406	Sum	3923
	Count	20	Count	20		Count	20	Count	20

Noisy truck data					
Series #	lot #	Center height		Height at .570	
41	2.39	291		165	
42	2.39	291		161	
43	2.39	292		162	
44	2.39	299		176	
45	2.39	291		176	
46	4.1	297		165	
47	4.1	297		162	
48	4.1	297		165	
49	4.1	294		162	
50	4.1	302		182	
51	6.1	291		165	
52	6.1	290		177	
53	6.1	291		180	
54	6.1	293		179	
55	6.1	299		179	
56	2.44	293		163	
57	2.44	289		183	
58	2.44	291		165	
59	2.44	291		177	
60	2.44	291		177	
	Loud Truck	*Center Height*		*Beep Height*	
	Mean	292.55	Mean	161	
	Standard Error	0.748665178	Standard Error	0.732665097	
	Median	291	Median	162	
	Mode	291	Mode	165	
	Standard Deviation	3.3476194	Standard Deviation	3.276712088	
	Variance	11.20769474	Variance	10.73864211	
	Kurtosis	2.116161031	Kurtosis	-1.388572269	
	Skewness	1.437448609	Skewness	-0.229388943	
	Range	14	Range	9	
	Minimum	288	Minimum	178	
	Maximum	302	Maximum	185	
	Sum	5851	Sum	3620	
	Count	20	Count	20	

5/4/92

[redacted]

cc Dave Czaja Dave Vaccaro
Matt Sullivan Kathy Brown

Ted Ballard

Shot Cruise Control Disc

Date: Based on the disc let on Evaluated Saturday - (Lot U)

Lot U

	Disc Before HT	Previous Test Disc After HT
Act	20.6	24.25
Rel	9.75	18.75
Diff.	10.85	

We Pull off 38,000 Discs

Lot Data For 19 Lots including Lot U, Shows:

Act. X Double Bar	20.65#	Range x Bars#	* Single Lot
Sigma x Bars	.41	19.4*/ 21.1	
Diff. X Double Bar	10.0#	8.8*- 10.9	
Sigma x Bars	.59		
Rel X Double Bar	10.68#	9.75/ 11.3	
Sigma x Bar	.51		

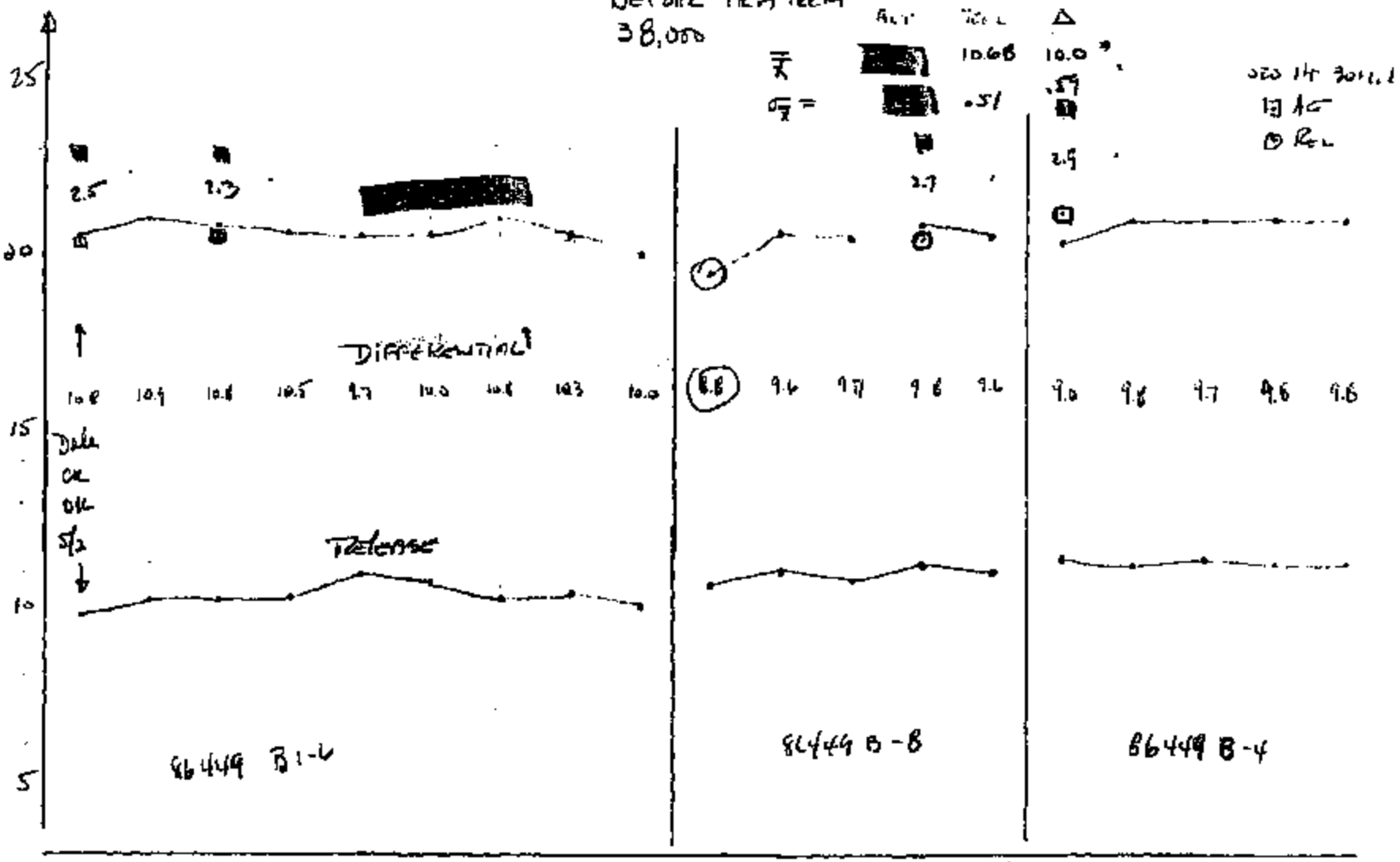
Discs were Made From 3 Coil Segments (14) on 5/4 and (5) on 5/4

FORD Clutch Cam Disc

Cast # 86449 S/L - S/N

BEFORE Heat Treat

38,000



TI-NHTSA 005211

CRUISE CONTROL
QUIET DISC

DALE SAGE

PROCESS

PREBLANK FORM HEAT TREAT 301 GSR SS .0122 x BTP
.2% Ys 200/230 Kpsi

FORM PROCEDURE

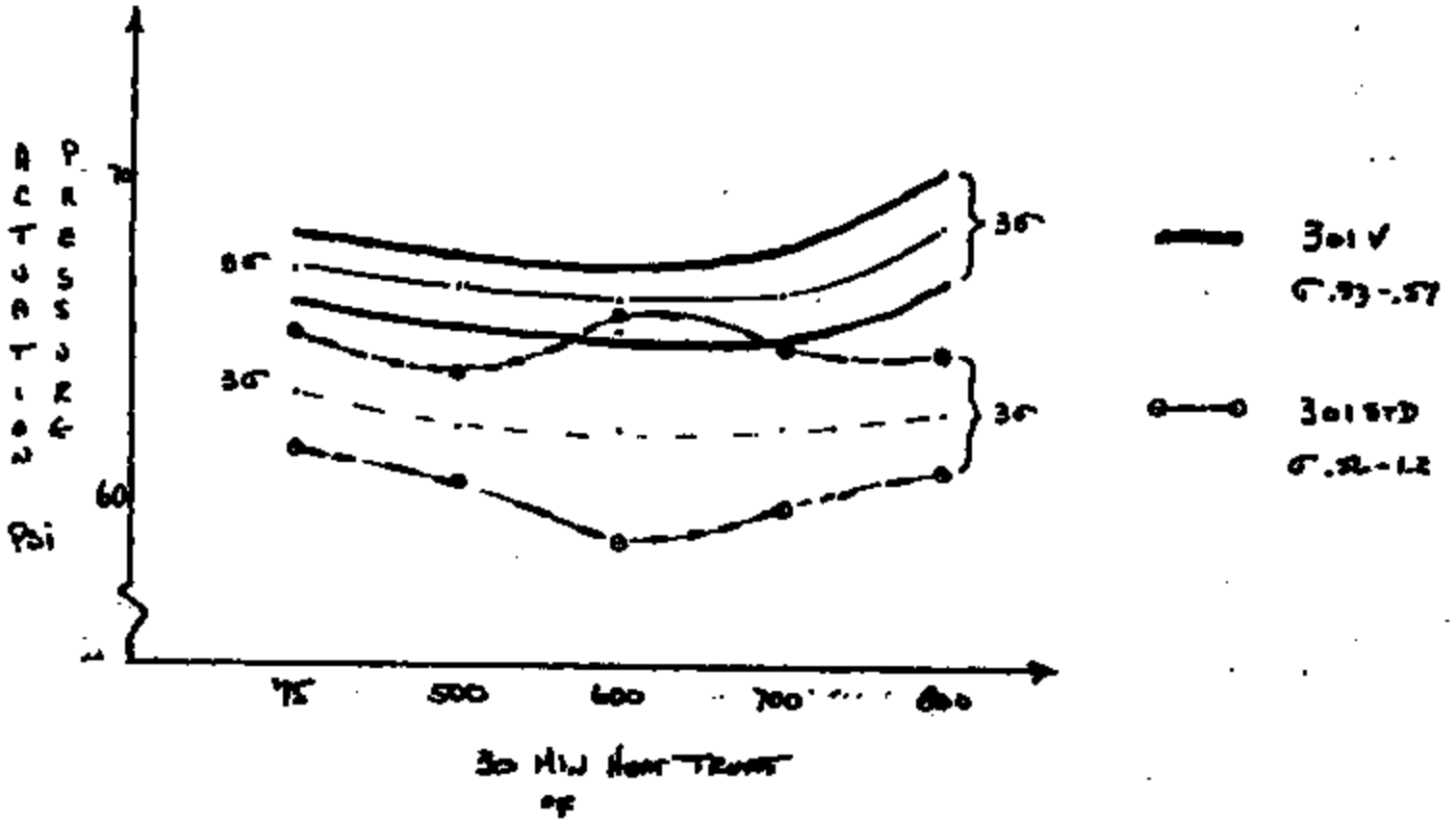
- ESTABLISH MATERIAL CHARACTERISTICS
  - SHIFT WITH HEAT TREAT
  - 1ST to 4TH cycle STABILITY (.9 to 1.2° @ 500° HT)
- SET UP
  - DETERMINE BEFORE HEAT TREAT 1∼ A/R
    - 3° OR LESS DIFFERENTIAL AT 520° HT
    - ACTUATION TO RESULT IN ≅ 24° APEX 4∼ WITH 600° HT.
- RECORD ACTUATION/RELEASE $\bar{X}$ AND SIGMA DATA FROM 10 PIECE RANDOM SAMPLE B HT. ADJUST MACHINE ITEMS AS NEEDED →
- ADJUST B HT SPEC BASED ON MPS FEED BACK FROM PILOT / PRODUCTION LOT PERFORMANCE
- CHECK FINISH H.T. DISC (600°) FOR NO SNAP NOISE

RS 5/13/92

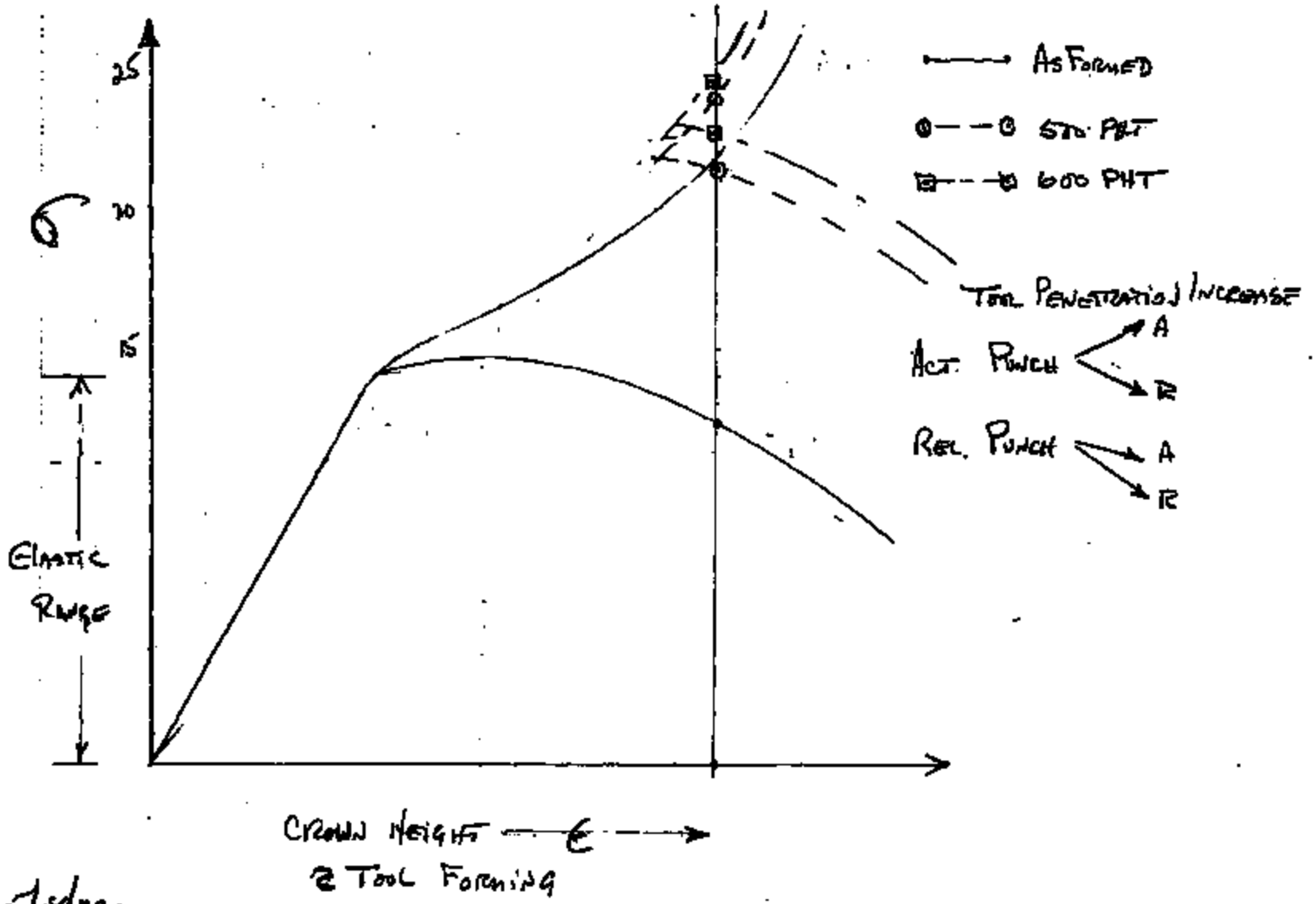
TI-NHTSA 005212

Pressure Switch Discs

366056-1 Actuation Pressure
Curves Vs New Metallic Inclusion Level



CRUISE CON. & DISC



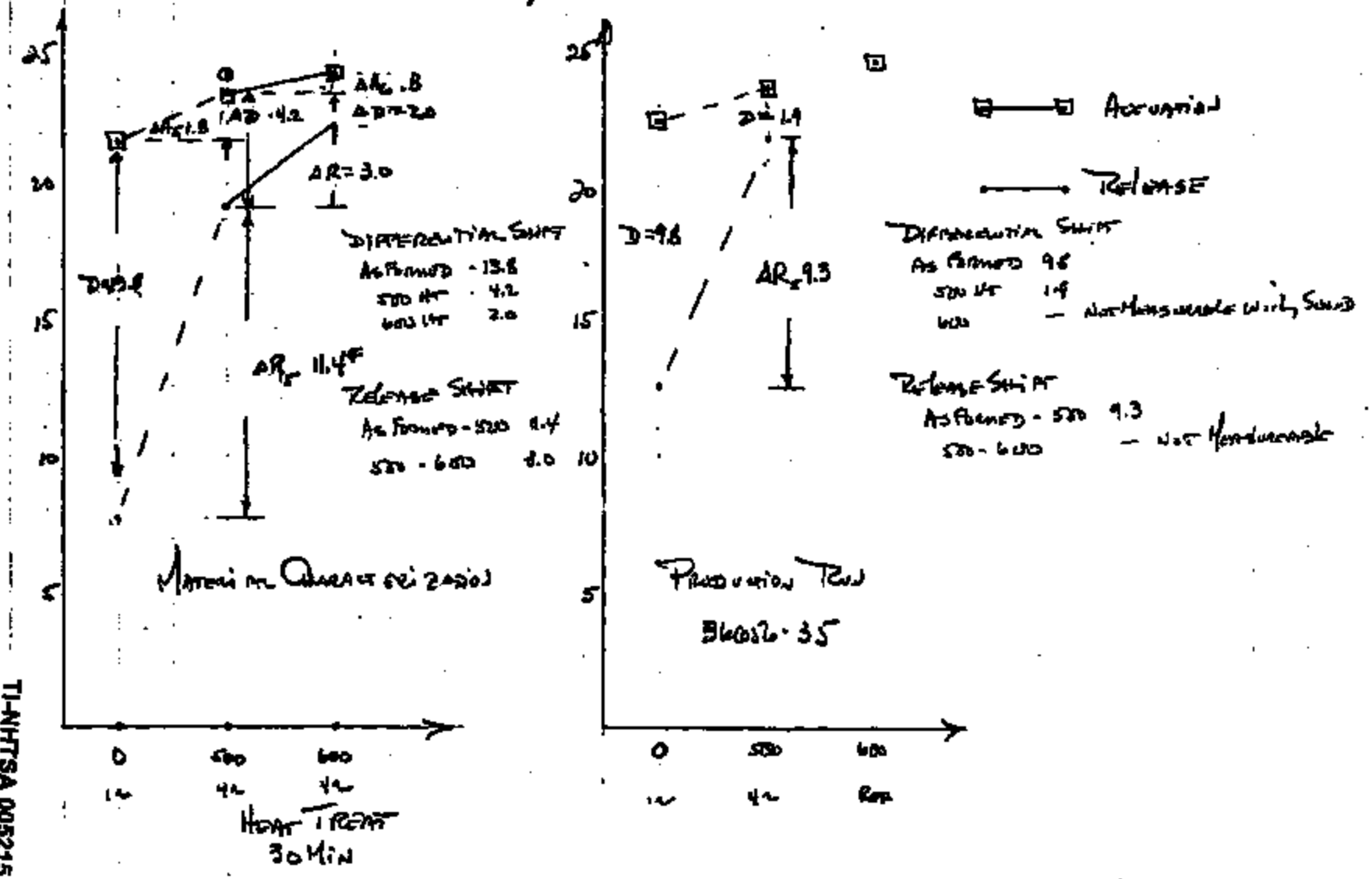
TI-NHTSA 006214

5/18/92

Cruise Control

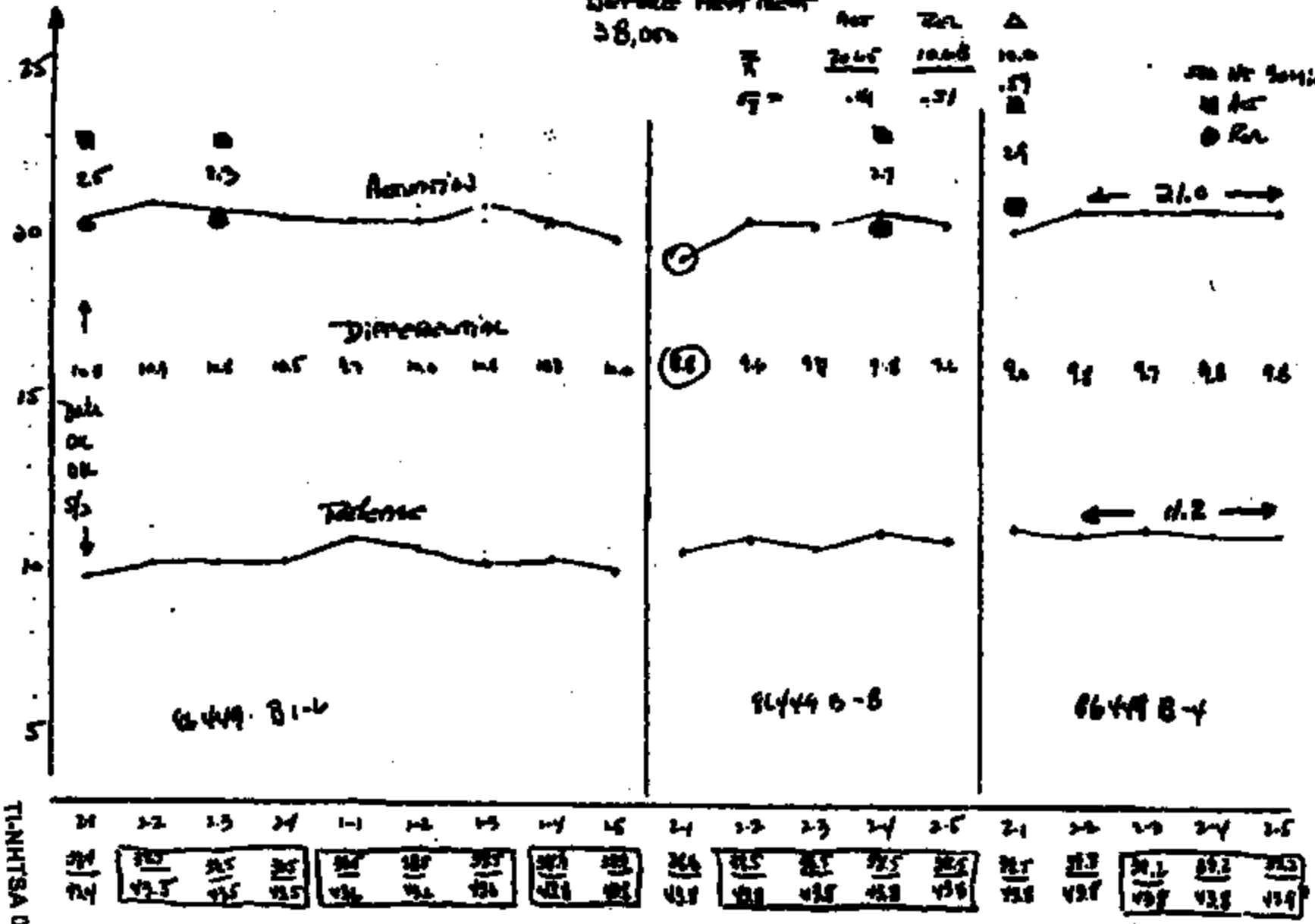
Outer Disc

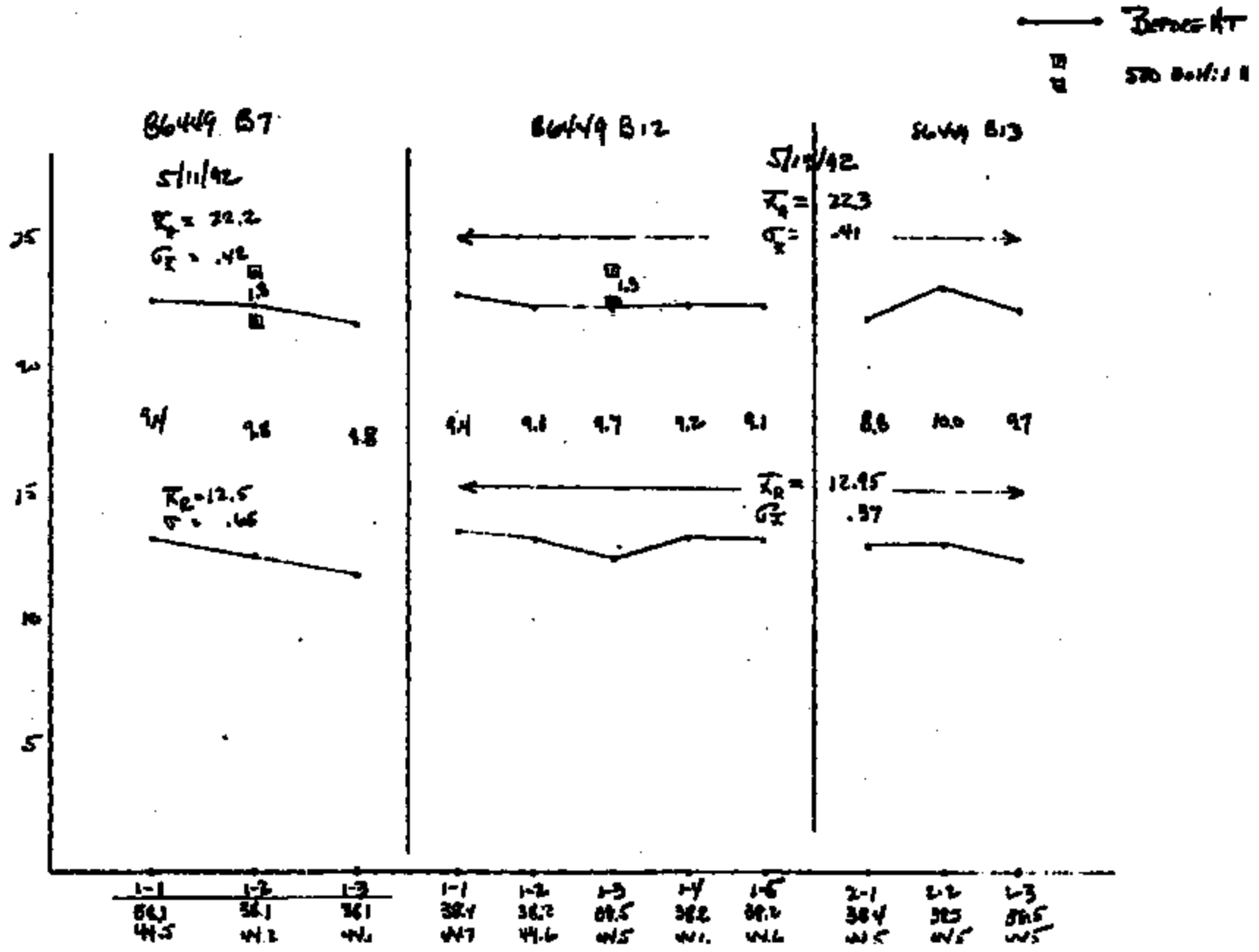
IMPACT / Post Heat Treat



TI-NHTSA 005215

5/13/92





TLNHTSA 005217

CRUISE CON -

30 LOTS 60K DISCS

BIT PRESSURE:

DATE	5/2	5/4	5/11	5/13
#LOTS 2(1600)	14	5	3	8
ACT $\bar{X}$	20.5	20.9	22.2	22.3
σ	.40	.31	.42	.41
REG $\bar{X}$	10.5	11.2	12.5	13.0
σ	.46	.11	.45	.57
Δ A/R	10.0	9.7	9.7	9.3
50° Δ	2.3/2.7	2.9	1.8	1.3

msg 50 101 zarn mjs2 rwg3 ab01 rca2 etb

TO: Dave Czarn
Matt Sellers
Dick Gariepy
Steve Offilier
Rusty Struble
Ted Ballard

FR: Dale Sogge

sj: High diff 77ps13-1

This memo serves as notice that the differential spec can be increased from 45psi to 50psi immediately. Testing has shown that these parts are as quiet as lower differential devices.

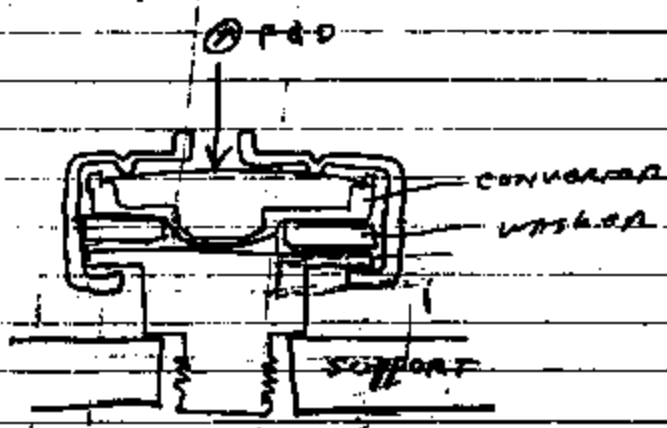
Also please note that due to a mix up in drafting the quiet truck discs will not be called -37. -37 has been reserved for stan homol. The truck disc will be given a number when we can actually put a spec together in about two weeks. In the meantime we should call the disc -sp.

DRAWINGS AVAILABLE UPON REQUEST

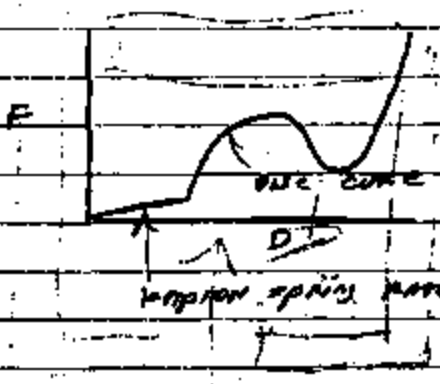
TO: pete simpson 6-3-92

FR: dale soggie

I need your assistance investigating a mfg problem could you please run force deflection curves on four sensor assemblies as shown;

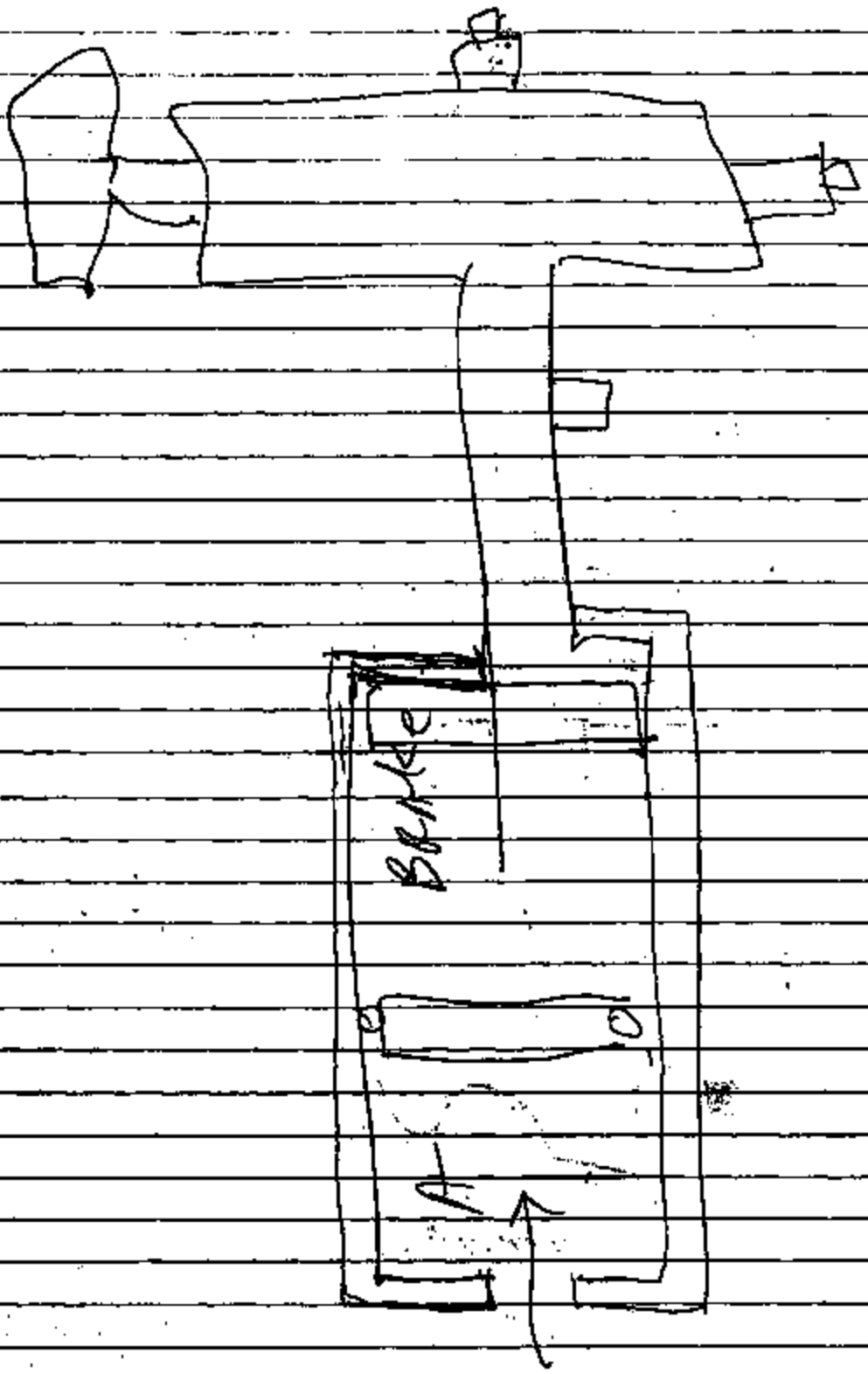


the disk is currently being held upwards by the hydraulic cylinder. I would expect the curve to look something like this.

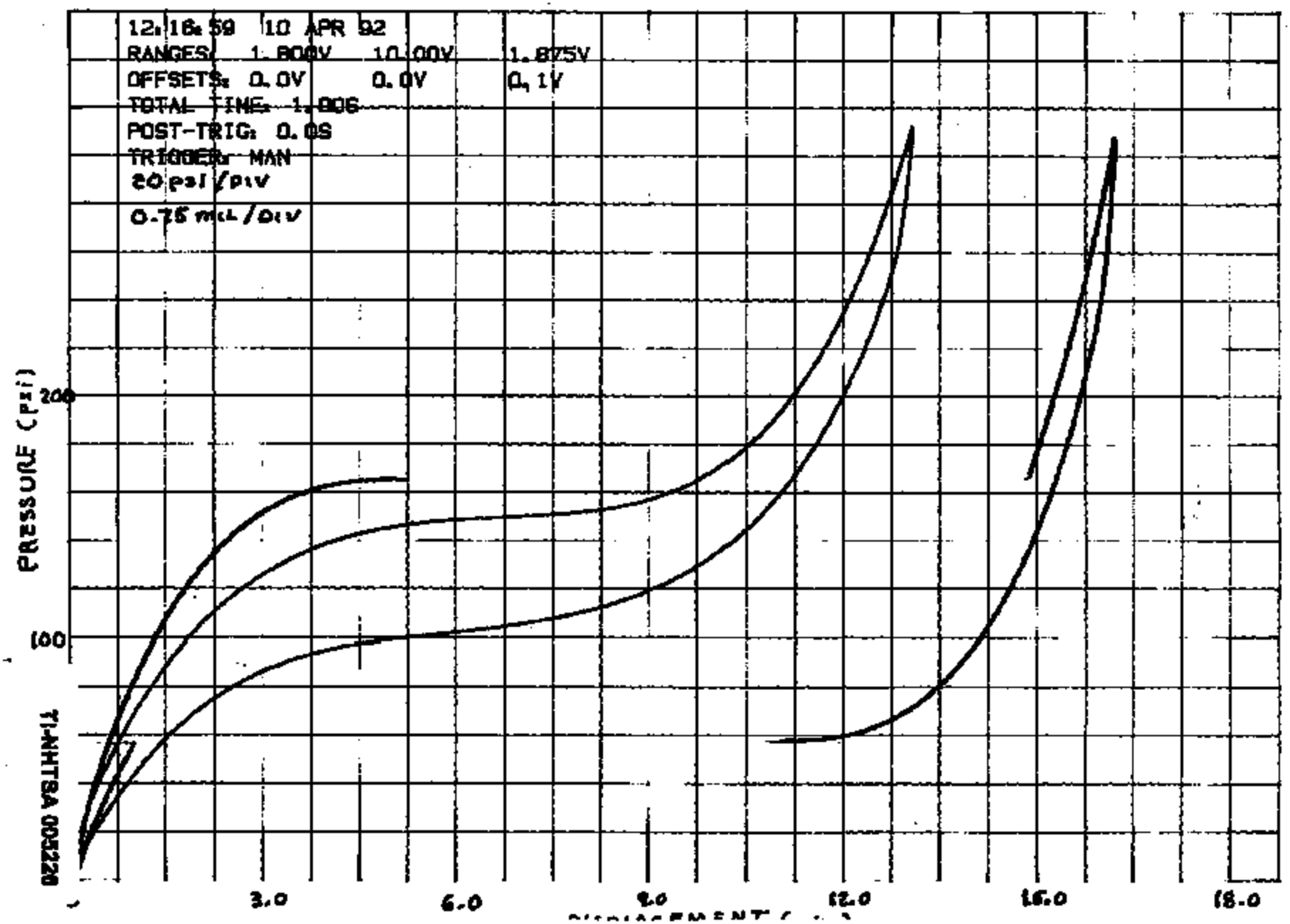


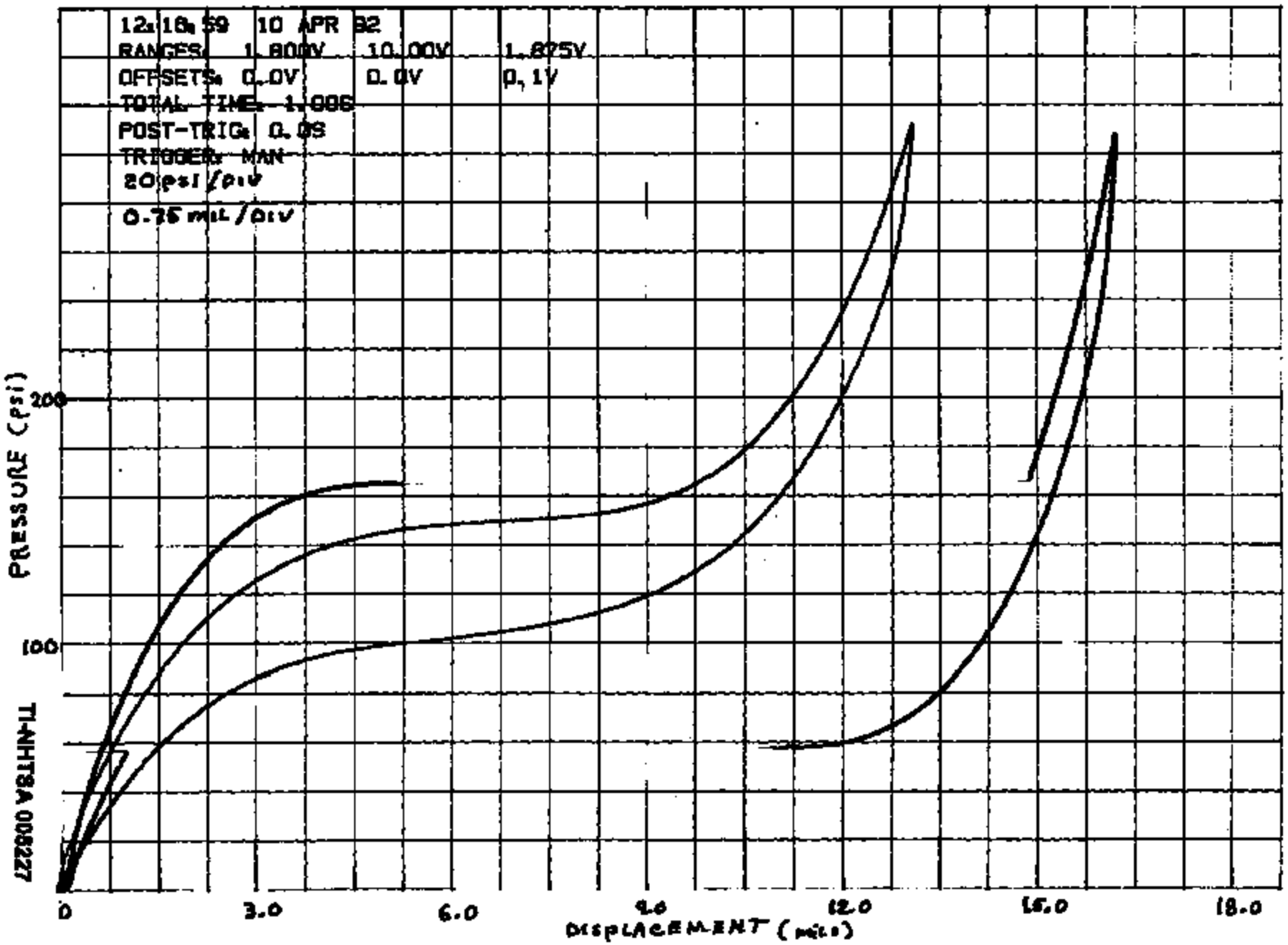
I am interested in what force is required to seat the convertor brace down onto the washer. I don't need the whole disc curve, I would appreciate it if you could complete the measurements by mon 6/8. thanks

DALE


BRAKE

DRAWINGS AVAILABLE UPON REQUEST


12:16:59 10 APR 92
RANGES: 1.800V 10.00V 1.875V
OFFSETS: 0.0V 0.0V 0.1V
TOTAL TIME: 1.00S
POST-TRIG: 0.0S
TRIGGER: MAN
20 psi/DIV
0.75 mL/DIV
PRESSURE (PSI)
200
100
3.0
6.0
9.0
12.0
15.0
18.0
TI-NHTSA 005228


12: 18: 59 10 APR 82
RANGES: 1.800V 10.00V 1.875V
OFFSETS: 0.0V 0.0V 0.1V
TOTAL TIME: 1.006
POST-TRIG: 0.0S
TRIGGER: MAN
20 psi/div
0.75 mil/div
PRESSURE (psi)
200
100
0
3.0
6.0
9.0
12.0
15.0
18.0
DISPLACEMENT (mils)
THANTRA 006227

-MSG M#= 00034824 FR=B512 TO=FFUN SENT=06/05/92 02:26 PM
R#=067 ST=C DIV=0050 CC=00101 BY=B512 AT=06/05/92 02:23 PM

To: MATT SELLERS MJ82

Copy: SOGGE FFUN

From: GEORGE HOLMAN B512

Subj: 27713

MATT,

THIS IS THE QUOTE WE TALKED ABOUT FROM VALENTINE.

PLEASE REVIEW AND LET ME KNOW WHAT ACTIONS YOU WOULD LIKE ME TO TAKE.

THANKS

GEORGE

-******* ORIGINAL MSG # 00024355 RECEIVED ON 06/05 AT 10:21 FOLLOWS *******-
Date: 06-05-92
To: George H.
From: Chuck Valentine
Subj: 27713 Cup

George,

At the request of Matt Sellers and Dale Sagge, we have come up with the costs associated with running a limited quantity of the 27713 Cup with modifications to the .090-.092 dimension. They have requested that this dimension be adjusted to be run at .086 to .088.

The cost to make these changes to the tooling, including setup time, changeover time from the 27288, and tool adjustments, will be $ 2,900.00.

Please remember that this part is run from the tool for part number 27288-1, and that a considerable amount of time is needed to change from one part to the other. When requesting a sample run, consideration has to be made for the status of the 27288 order, and that the time to adjust the tool and run a small qty could take as much as a week once the tool is in the press.

If the samples are found to be acceptable, we would need to quote permanent tooling changes, as other components in the tooling would need to be updated.

Regards,
Chuck Valentine

3. George, I was not sure of the spelling of your last name. Please Advise. Thanks

TO: Dave Czarn
Matt Sellers

drs92-47

FR: Dale Sogge

SJ: Target Preload

Attached is a report describing how the target preload was determined for quiet car and truck.

In reviewing my information I found that I had made a mistake and used +/-2.0mils for the manufacturing pinning capability rather than +/-2.5mils. Corrected analysis is shown on the attached curves.

QUIET CAR: Calculated Target preload = 7.0
Preload tolerance = less than zero

Discussion: Pinning at 7.00 will produce devices that fall slightly below 90psi at 150C. This does not account for the spread in the high temp base shift either. It assumes all bases shift exactly three mils. Since the actual operating temp is 125C, and pressure shift vs pin length at temp studies shown no pressure drop until less than 2 mils preload at 125C. Therefore, pinning at 7.0 should be ok.

QUIET TRUCK: Calculated Target preload = 10.6.
Preload tolerance = less than zero

Discussion: Pinning at 10.6 will produce devices that fall slightly below 90psi at 180C and exceed 300psi at -40C. This does not account for the spread in the base temp shift.

Pressure shift vs pin length at various temps shows that the pressure starts to drop at pin lengths somewhere between 4 and 6 mils. Six mils is less than the low spec limit of 8.1 so no pressure shift should occur.

To be on the safe side we need to see if the spec limits can be increased to 190-310psi. Or at least see if the customer can tolerate this range.

For rework purposes we can use the following tolerances:

CAR	7.0	-0.0	+0.5
Truck	10.6	-0.0	+0.5

This is based on the engineering judgement that very few parts will fallout at 300psi and these few can be tolerated.

The line needs to be informed of these new limits, assuming Czarn concurs.

Note: This analysis assumes that the static measurments indicate where the priload really is. Crimping can increase or decrease the preload depending on how tight it is. The LVDT work should be continued to find where the preload is really at on an assembled device.

Regards
Dale

ESTABLISHMENT OF QUIET SWITCH
AND QUIET TRUCK PARAMETERS
BASED ON NOMINAL DIMENSIONS

The quiet passenger car parameters for manufacturing were established as follows:

1. Measure disc diff in test fixture using 2° disc seat. (Dale's special version.)

2. Assemble a range of discs into sensor assemblies.

3. Test sound pulse to find a maximum disc differential that will have a pulse of less than -1.5 psi.

4. Build six sensor assemblies with discs from lots meeting requirement #2.

5. Plot sensor curve using an LVDT tracking the top of the disc. Plot all six curves on top of each other to get a visual indication of dispersion.

6. Draw a line horizontally across the page at 90 psi and 200 psi.

   90 psi is the lowest the act can go and still be acceptable to the customer.

   200 psi is the highest the act can go and still be acceptable to the customer.

   Prior to development the Ford spec was:
   Act 125± 35 psig
   Rel 20 psig min

   The customer felt it was okay to increase the upper limit on act. It was opened at 200 psi based on our combined experiences.

7. Draw a vertical line at the point 90 psi intersects the lowest act value curve.

8. Measure from this point over 5.5 mils and mark the spot
   (3.0 mils for 25°-150°C terminal movement)
   (2.5 mils for manufacturing capability consisting of
   ± 0.5 on pin and sensor, ± 2.0 on base calibration

9. From where the highest act value curve crosses 200 psi measure left 4.5 mils, 2 mils for cold temp shift and 2.5 mils for pin/base manufacturing capability. Mark this point.

10. Draw a line halfway between step 7 & 8. This is the target preload with Step 7 & 8 defining the tolerance on the target.

11. If the tolerance range is negative (overlap) pick the mid point and then calculate the actual worst case act pressures.

12. Decide if the tolerance is okay or if the target valve should be shifted one way or another to avoid failures. For example, shift the preload 0.5 mils higher (to the right) to reduce the risk of high temperature open circuits.

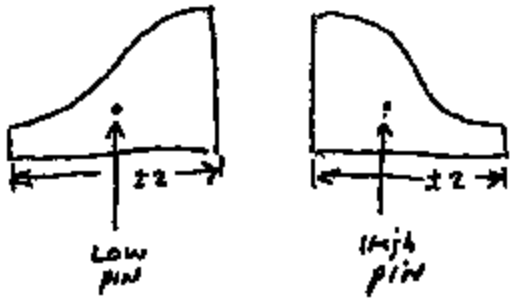
Shifting to slightly higher preloads + 0.5/+1.0 seems desirable at this time because a device that opens at high temperature is immediately recognizable by the customer as a failure.

For quiet truck the same steps except this device is know to operate at 182°C.
The customer has melted connectors.

Use 200 psi min act
300 psi max act
40 psi min release

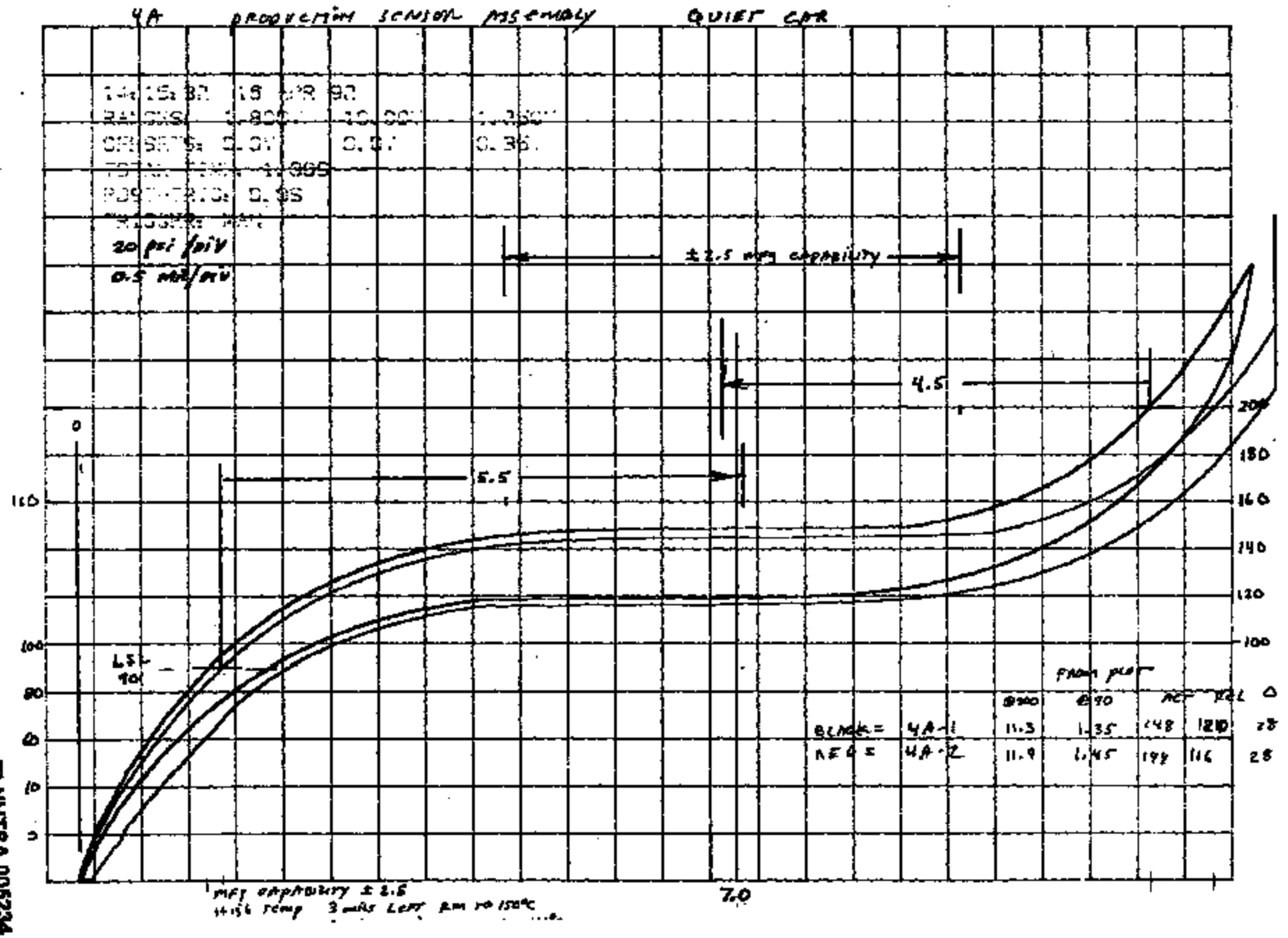
5 mil high temp movement 25°-182°C
plus 2.5 mil manufacturing cap (test 302-15)

NOTES: 1. Bases are calibrated, resulting in a truncated spread of ± 4 mils, normally distributed. The lot is split in half at the mean. The low half of the lot is used with a pin 1 mil less than calculated based on the mean of the entire base population. The upper half of the lot is pinned with a pin 1.0 mil longer than nominal. Pin and sensor capability is ± 0.5 mils.



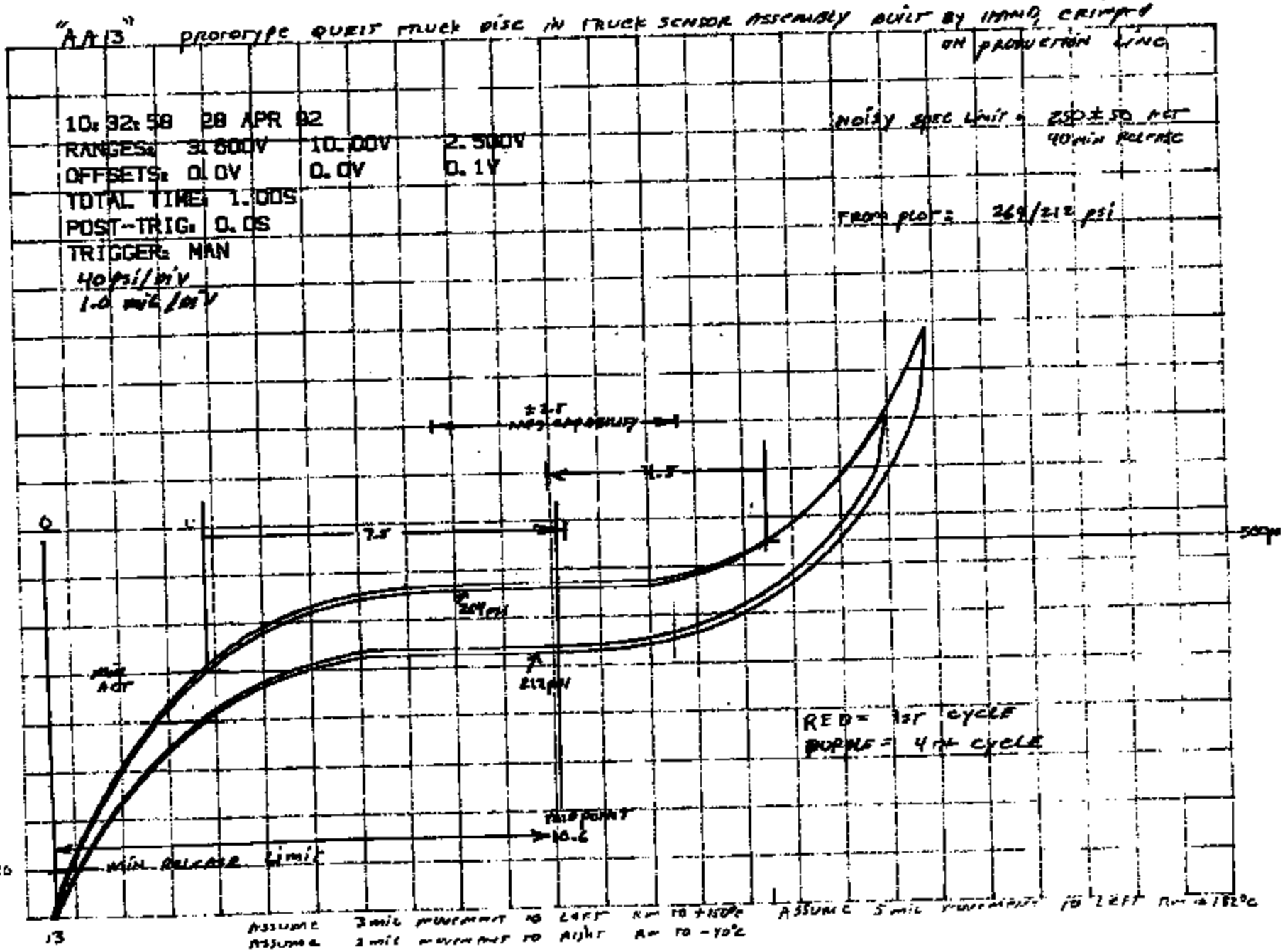
NOTES: 2. The temperature shift is taken at 150°C even though the max temp required is 125°C. This gives an extra cushion. Temp shift taken from test 302-15-24.

8-11-92



TI-NHTSA 005234

DRS 4-29-92



TI-NHTSA 005235

drs92-42, 7-31-92

TO: Dave Czarn
Matt Sellers
Steve Offiler
Clair Balthazar

FR: Dale Sogge

sj: 77ps preload

I have found some interesting results during my investigation of the missing preload associated with rattling quiet device.

Measured 20 discs for height at the bump diameter (.470 for car and .570 for truck) and got the following:

Loud car	avg	=	0.0210"	sigma =	0.00044"
Quiet car	avg	=	0.0198"	sigma =	0.00024"
Loud truck	avg	=	0.0185"	sigma =	0.0033"
Quiet truck	avg	=	0.0185"	sigma =	0.00017"

All except the quiet truck were from 5 or more lots. Quiet truck was one lot only.

Using the appropriate cup the calculated preloads are (see attached sheets):

Loud car	-.0070"
Quiet car	-.0065"
Loud truck	-.0073"
Quiet truck	-.0069"

Since there is minimal variation in the missing preload it suggest we should change the cup for all of these products and maybe the rest of the 77ps's as well.

My target of 4.5 mills was based on cross sections and pressure deflection curves. after testing I think we should go to 5.0 mils. This will leave approx 2mils for washer bending.

QUESTION? Why haven't other products shown up as rattlers?

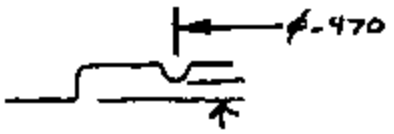
What do we need to do for evaluation if we want to change all of them?

Regards,
Dale

DATE 5091C 7-31-92

CAR

DATA FROM supplier capability study



cup 27713

$\bar{x}$ = .0909
σ = .00016

$\sigma = \sqrt{.0606^2 + .0^2}$
= .00030

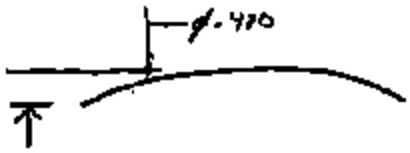
$\bar{x}$ = 0.1648
σ = 0.00009

$\bar{x}$ = .1042
σ = .00029

GAP = .0909 - .0606 = .0303

NOISY DISC

DATA FROM MEASUREMENT WITH AIR GAGE



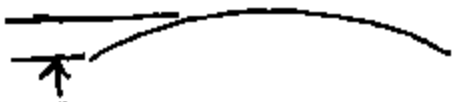
$\bar{x}$ = .0210"
σ = 0.00044"

DRAWN = 0.0274
σ = 0.0004

WAP RAN = .002

NOISY CAR PRELOAD .002 + .0210 + .0303 = +.0053

QUIET DISC



$\bar{x}$ = 0.0198
σ = 0.00024

DRAWN = 0.0270
σ = 0.0004

QUIET CAR PRELOAD .002 + .0198 + .0303 = +.0085

DELTA BETWEEN PRELOAD NOISY − QUIET 0.0015"

DRAFT 7-31-92

TRUCK

assumed cup capability is identical to 27713 with bump at different diameter

cup $\bar{x}$ = .0880
σ = .00016

CONVERTOR IS THE SAME = .0606

GAP = .0880 - .0606 = .0274

Noisy truck disc
AT BUMP $\bar{x}$ = .0181
σ = .00033

AT CENTER $\bar{x}$ = .0292
σ = .00034

Noisy truck preload = .0181 - .0274 = -.0093

QUIET TRUCK DISC
AT BUMP $\bar{x}$ = 0.0185
σ = 0.0023

AT CENTER $\bar{x}$ = .0277
σ = .00017

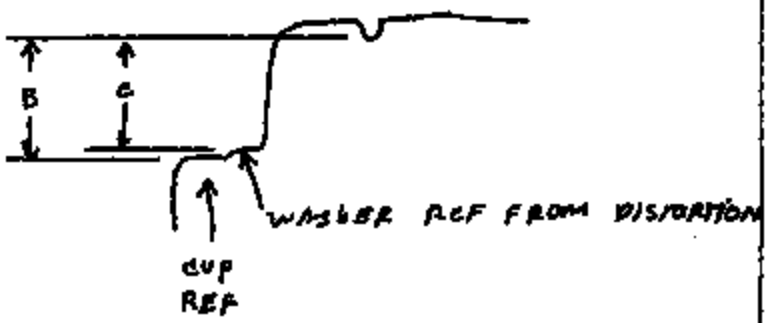
QUIET TRUCK PRELOAD $\pm .001$ of .85 - .0274 = -0.0069

CRIMP REDUCTION OF GAP FOR DISC

TWO CROSS SECTIONS WERE MEASURED ON TOOL MAKERS MICROSCOPE

THE FOLLOWING MEASUREMENTS WERE RECORDED

PRINT VAL B = .090/.092



	#1 4mil increased ramp height			#11 standard 27713 height
A	0.011"			0.0098"
B	0.0921	+.004 =	0.0961	0.0957
C	0.0911	+.004 =	0.0951	0.0920
D	0.0830	+.004 =	0.0870	0.0874
E	0.0209			0.0179

#11 PRODUCES VARIED ANSWERS ON THE DIMENSIONAL CHANGE DEPENDING ON HOW IT'S CALCULATED

FROM DIRECT WASHER MEASUREMENT	= 9.8 mils
DIFF BETWEEN PRINT NOM & B	= 4.7 mils
DIFF BETWEEN PRINT NOM & C	= 1.0 mils
DIFF BETWEEN PRINT NOM & D	= 3.6 mils

C IS A VERY DIFFICULT MEASUREMENT TO LOCATE, SO IGNORE IT.

FOR NOW USE 4.0 mils AS A ROUGH ASSUMPTION

FOR CAPABILITY ANALYSIS USE 3.5 - 9.8 mils

AN EARLIER STUDY OF CRIMP EFFECTS ON RETENTION VALUES CONDUCTED BY MFG ENGR PRODUCED THE FOLLOWING RESULTS

PART	BASE	WASHER TO BUMP ('D')
P-10	90° LAB CRIMP	0.0880
L-10	90° PROD CRIMP	0.0886
L-14	45° LAB	0.0892
P-11	45° PROD	0.0852
1A	Ami- noisy, std process	0.0876
1B	Ami- noisy, std process	0.0894

THESE NUMBERS ARE IN LINE WITH THE MEASUREMENT ON PART #11 DESCRIBED ABOVE.

TAKING THESE SIX READING PLUS #11 GIVES $\bar{X} = 0.0883$

$\sigma_{N-1} = 0.000763$

$n = 7$

THE CRIMP SHIFT IS

SUP AVG =	0.0909
− MEASURED AVG =	0.0883
	0.0026

CONCLUSION: FOR CAPABILITY ANALYSIS USE

$\bar{X} = .0026$

$\sigma = .00076$

TO: Dave Czarn
Matt Sellers
Steve Offilier
Bill Sweet

dra92-46

CC: Tom Charboneau

FR: Dale Sogge

s]: 77ps3-1 preload capability: VSA

In the process of correcting the preload for the quiet disc I wanted to understand the tolerance range we could hold on preload. The results show that the design was not even capable as toleranced on the prints.

I MADE THE ASSUMPTION THAT WE ARE TARGETING PRELOAD TO ZERO +/- .002"

PRINT CAPABILITY
Disc preload is defined by the print dimension shown in figure 1, assuming no crimp shifts. If the print tolerances represent three sigma limits, which they must by contract, then the stack capability can be calculated by root sum square method (assuming all parts have a normal distribution). Since there is no tolerance on the disc height, actual measurements are used.

Disc	.0198 +/-.0007
Kapton	.0020 +/- .0003
Convertor bump to convertor diaphragm surface (CONVTOP)	.1650 +/-.003
Convertor diaphragm surface to washer surface (CONVMID)	.1040 +/-.003
Cup washer surface to bump (CUPBUMP)	.0910 +/-.001

SQRT (.0007^2+.0003^2+.003^2+.003^2+.001^2) = +/-.0044

THIS IS A RANGE OF 8.8 MILS, FAR IN EXCESS OF THE TARGET!! CLEARLY NOT A CAPABLE DESIGN.

In addition there is a crimp shift effect. By measuring 7 cross sections I found the shift is an average of .0026 +/-0.0023". Adding this to the above tolerances gives:

SQRT (.0007^2 + .0003^2 + .003^2 + .003^2 + .001^2 + .0023^2) = +/-.0050

These two calculations show that based on prints the design does not work since the preload spread leaves no room for our production pinning tolerance.

ACTUAL CAPABILITY

As a check on the real capability; actual data from the suppliers on the critical dimensions was used in a Variational Simulation Analysis (VSA). VSA was chosen because root sum square is an inaccurate estimate; because it assumes that all tolerances are normally distributed and that they are all perfectly centered about the mean. VSA gives a more accurate picture by accounting for the low probability of all tolerances being at the worst case simultaneously and accounting for non-normal distributions (cup is non-normal). If you have more than two assemblies it is highly unlikely that they will all be at worst case at the same time, so VSA provides a greater tolerance zone.

Variational Simulation analysis (VSA) of the design without the crimp shift effect shows that the mean preload is -.0085" with a three sigma spread of 0.014" (figure2). The disc contributes 97% of the variation (figure 3).

VSA of the design with the crimp shift effect gives a mean= -.0058 and three sigma range = .0054" (figure 4). The crimp is now the key contributor (figure 5 & 6).

VSA with shear bumps added to the convertor to increase preload by 4.5 mils gives a mean of -.0014" and 3-sigma range of .0054". (figures 7-9).

VSA with the cup bumped up higher gives the same mean and spread as changing the convertor. You would expect the range to decrease because the cup has a smaller sigma, but the cup skewness causes the results to be the same.

The analysis also reveals that we can be 95% confident that somewhere between 22.1 and 28.6 % of the product will be out of spec and our CPK will be only 0.2263.

This high percentage out of spec raises the question; "Is plus/minus .002 really required." I believe the answer is yes, because our prod pinning tolerance plus temp shift puts the preload at 150C at 1.5 mils or less. Therefore we can't give up more than two mils of the disc throw.

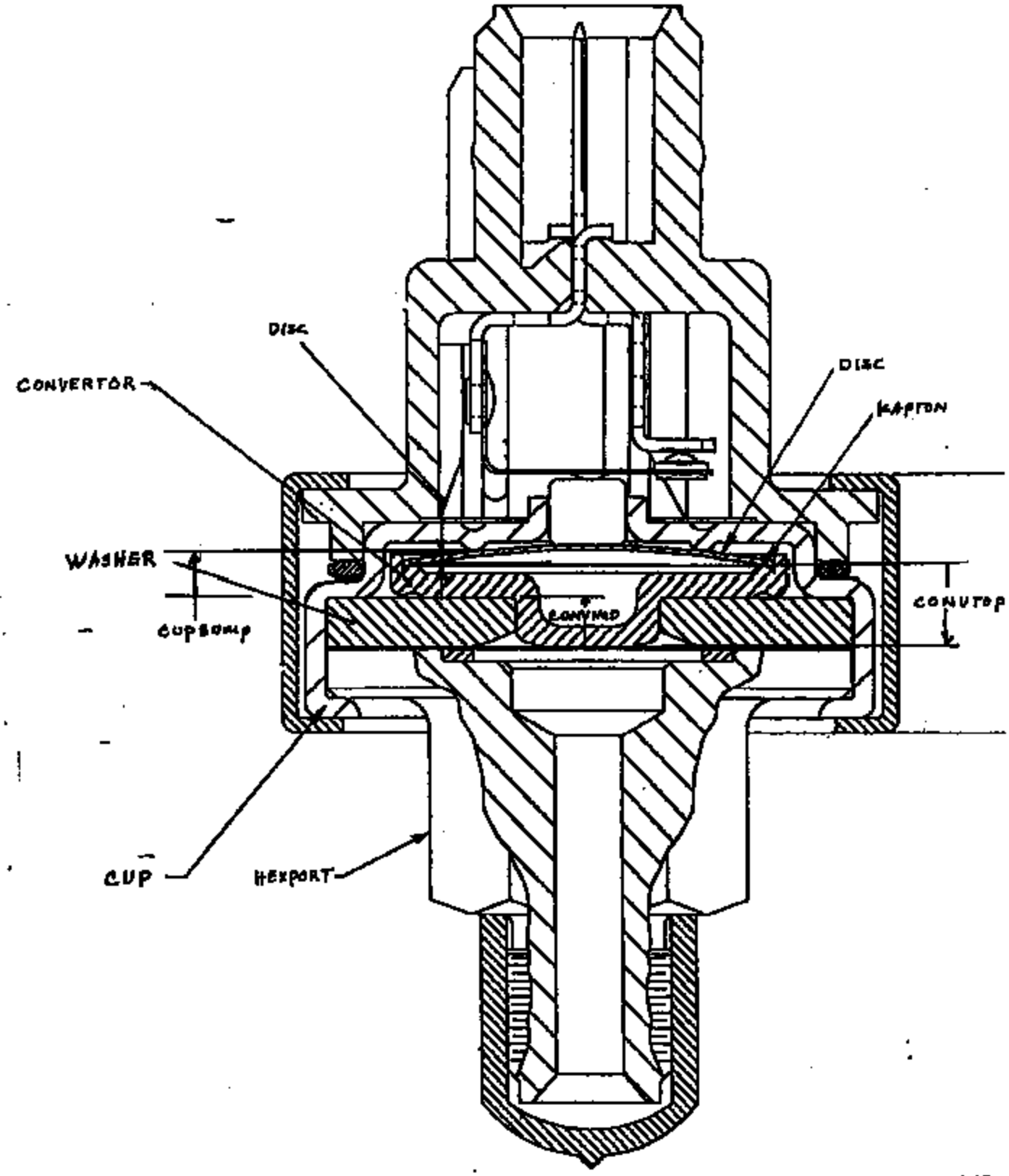
I have purposely not centered the preload because I believe the crimp shift effect can be larger than my limited sample revealed and I believe that we can tolerate some that are two mils loose (The Kapton will probably take up the two mil difference).

CONCLUSION
We are missing 5.8mils of preload. There is a large spread in ability to hit the target preload. Because of the spread and other factors the new target should be -1.4mils. This can be achieved by modifying the cup, convertor, washer or however else MFG Engr decides.

We are not capable and have a long way to go to be plus minus six sigma capability, as our new corporate philosophy directs.

VSA performed at an earlier stage in the project would have focused us on the magnitude of the problem much sooner and possible redirected our solution.

Dale



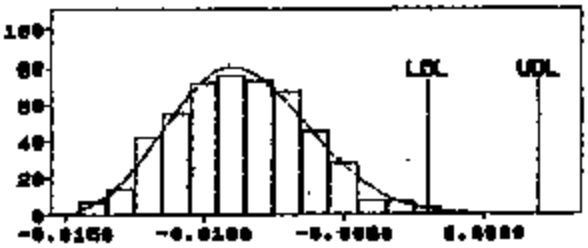
LABELS USED

FIGURE 1

Session: 2D-[redacted]

PRELOADS / GAP BETWEEN DISC AND BUMP ON TTPSL3-1 [redacted] samples

Nominal :	-0.[redacted]
Mean :	-0.[redacted]
Standard Deviation :	0.0084
Lower Design Limit :	-0.[redacted]
Upper Design Limit :	0.[redacted]
Cp :	0.2077
Cpk :	N/A
Distribution :	Pearson-Beta



	Actual	Est		Actual	Est*
% < Low Limit	00.0000	00.0103	Low	-0.0140	-0.0145
% > High Limit	0.0000	0.0000	High	-0.[redacted]	-0.[redacted]
% Out of Spec	00.2000	00.0103	Range	0.0145	0.0105

95% C.I. for % Out of Spec : 00.0446 to 00.0054 * Est Range : 00.7300

NO CRIMP SHIFT

FIGURE 2

Session: SD-[illegible]

PRELOAD2 / GAP BETWEEN DI90 AND BUMP ON TYPEL3-1

Nominal at Median : -0.0005
HLM Variance : 0.48438E-05

High-Low-Median Study

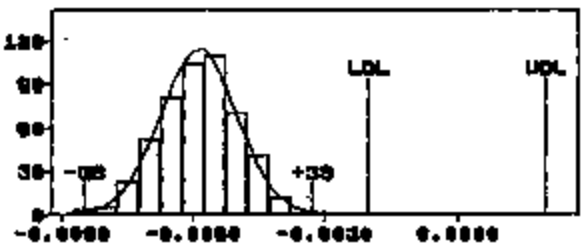
Tolerance		Effect
DI801	LINEAR Pearson XYURKPLN at 0.0000	97.25%
CONUMI01	LINEAR Normal 0.000000 XYURKPLN at 100.0000	1.00%
		99.12%
3 additional contributor(s) <1.0% each		0.88%

FIGURE 3

Document: SD-SP8067-100018

PRELOAD1 / OISO PRELOAD WITH CRIMP SHIFT AVG=.0038 STD=.0007 868 samples

Nominal :	-0.0050
Mean :	-0.0058
Standard Deviation :	0.0060
Lower Design Limit :	-0.0020
Upper Design Limit :	0.0020
Cp :	0.7677
Cpk :	N/A
Distribution :	Tested Normal



	Actual	Est		Actual	Est*
% < Low Limit	100.0000	99.9295	Low	-0.0060	-0.0095
% > High Limit	0.0000	0.0004	High	-0.0030	-0.0033
% Out of Spec	100.0000	99.9295	Range	0.0054	0.0062

95% C.I. for % Out of Spec : 100.0000 to 100.0000 * Est Range : 99.7304

WITH CRIMP SHIFT

FIGURE 4

Session: SD-020827-135500

PRELOAD1 / DISC PRELOAD WITH CRIMP SHIFT AVG=.0020 STD=.0007

Nominal at Median : -0.0050
RSS Variance : 4.7511E-06

High-Low-Median Study

Tolerance			Effect
CRIMP	LINEAR	Normal 0.002000 XYWRKPLN at 0.0000	75.01%
CONVRIG	LINEAR	Normal 0.000670 XYWRKPLN at 180.0000	11.26%
DISC	LINEAR	Pearson XYWRKPLN at 0.0000	6.27%
CUFBUMP	LINEAR	Pearson XYWRKPLN at 180.0000	3.31%
KAPTON	LINEAR	Normal 0.000300 XYWRKPLN at 0.0000	1.33%
CONUTOP	LINEAR	Normal 0.000270 XYWRKPLN at 0.0000	1.00%
			100.00%

WITH CRIMP SHIFT

FIGURE 5

Session: 2D-020697-135609

Tolerance Summary

Name	Distrib	Nominal	Tolerance	Sig	Source
CONVEXD	Normal	0.1042	0.0002	3	Manf
CONVEXD1	Normal	0.1042	0.0002	3	Manf
CONVTOP	Normal	0.1040	0.0002	3	Manf
CONVTOP1	Normal	0.1040	0.0002	3	Manf
CRIMP	Normal	0.0020	0.0002	3	Manf
CUPBUMP	Pearson	0.0010	NA	NA	Manf
CUPBUMP1	Pearson	0.0010	NA	NA	Manf
DISC	Pearson	0.0100	NA	NA	Manf
DISC1	Pearson	0.0100	NA	NA	Manf
KAPTON	Normal	0.0020	0.0003	3	Dsgn
KAPTON1	Normal	0.0020	0.0003	3	Dsgn

DISC $\bar{X}$ = .0198 σ = .00239 skew = .06 kurt = -.32

cupbump $\bar{X}$ = .0010127 σ = .00015 skew = -1.71 kurt = 12.38

without #'s used for Figure 2 & 3, no crimp

with #'s used for Figure 4 & 5, with crimp

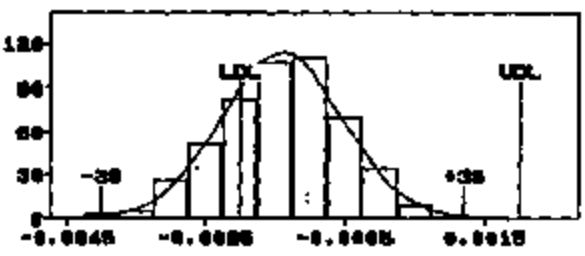
with crimp shift

FIGURE 6

DISC PRELOAD WITH CONVERTOR HEIGHT INCREASED BY
4.5MILS ASSUMINGTOLERANCE REMAINS SAME AS CONVMID
Session: SD-GS0907-164716

PRELOADS / DISC PRELOAD WITH CRIMP SHIFT AVG=.0025 STD=.0007 999 samples

Nominal :	-0.0014
Mean :	-0.0014
Standard Deviation :	0.0009
Lower Design Limit :	-0.0030
Upper Design Limit :	0.0020
Cp :	0.7870
Cpk :	0.2003
Distribution :	Tested Normal



	Actual	Est		Actual	Est*
% < Low Limit	25.4000	24.0031	Low	-0.0041	-0.0045
% > High Limit	0.0000	0.0000	High	0.0013	0.0012
% Out of Spec	25.4000	24.0031	Range	0.0054	0.0058

95% C.I. for % Out of Spec : 22.1373 to 26.0027 * Est Range : 80.7288

with shear bumps 4.5 mils high

FIGURE 7

DISC PRELOAD WITH CONVERTOR HEIGHT INCREASED BY
4.5MILS ASSUMING TOLERANCE REMAINS SAME AS CONAMID
Session: SO-960907-184715

PRELOAD1 / DISC PRELOAD WITH ORZMF SHIFT AVG=.0000 STD=.0007

Nominal at Median : -0.0014
MLM Variance : 0.7811E-06

High-Low-Median Study

Tolerance			Effect
ORZMF	LINEAR Normal 0.000000 XYWRKPLN at 0.0000		78.91%
CONAMID	LINEAR Normal 0.000070 XYWRKPLN at 166.0000		11.06%
DISC	LINEAR Pearson XYWRKPLN at 0.0000		6.27%
CUPBUMP	LINEAR Pearson XYWRKPLN at 180.0000		3.21%
KAPTON	LINEAR Normal 0.000200 XYWRKPLN at 0.0000		1.32%
CONUTOP	LINEAR Normal 0.000070 XYWRKPLN at 0.0000		1.06%
			100.00%

with shear bumps
FIGURE 8

DISC PRELOAD WITH CONVERTOR HEIGHT INCREASED BY
4.5MILS ASSUMINGTOLERANCE REMAINS SAME AS CONUMID
Session: SD-020807-154716

Tolerance Summary

Name	Distrib	Nominal	Tolerance	Sig	Source
CONUMID	Normal	0.0057	0.0008	3	Manf
CONUMID1	Normal	0.1848	0.0009	2	Manf
CONUTOP	Normal	0.1848	0.0003	3	Manf
CONUTOP1	Normal	0.1848	0.0003	3	Manf
CRIMP	Normal	0.0028	0.0031	3	Manf
CUPBUMP	Pearson	0.0010	NA	NA	Manf
CUPBUMP1	Pearson	0.0010	NA	NA	Manf
DISC	Pearson	0.0100	NA	NA	Manf
DISC1	Pearson	0.0100	NA	NA	Manf
KAPTON	Normal	0.0020	0.0003	3	Dsgn
KAPTON1	Normal	0.0020	0.0003	3	Dsgn

Reflect reduced value from shear bumps.

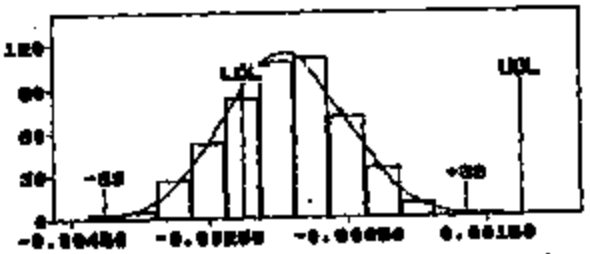
with shear bumps

FIGURE 9

DISC PRELOAD WITH CUP WEIGHT INCREASED BY 4.5 MILS
ASSUMING TOLERANCE REMAINS SAME AS CUPSUMP
Session: SD-920810-113742

PRELOAD3 / DISC PRELOAD WITH CRIMP SHIFT AVG=.0025 STD=.0007 599 samples

Nominal :	-0.00138
Mean :	-0.00141
Standard Deviation :	0.00067
Lower Design Limit :	-0.00300
Upper Design Limit :	0.00300
Cp :	0.78783
Cpk :	0.75527
Distribution :	Tested Normal



	Actual	Est		Actual	Est*
% < Low Limit	25.40000	24.00313	Low	-0.00415	-0.00402
% > High Limit	0.00000	0.00000	High	0.00127	0.00119
% Out of Spec	25.40000	24.00313	Range	0.00542	0.00521

95% C.I. for % Out of Spec : 22.19725 to 26.00875 * Est Range : 29.7369

DISC PRELOAD WITH CUP HEIGHT INCREASED BY 4.5 MILS
ASSUMING TOLERANCE REMAINS SAME AS CUPBUMP
Session: SD-980818-113742

PRELOAD3 / DISC PRELOAD WITH CRIMP SHIFT AVG=.0025 STD=.0007

Nominal at Median : -0.00130
MLM Variance : 0.7511E-05

High-Low-Median Study

Tolerance		Effect
CRIMP	LINEAR Normal 0.002000 XYWRKPLN at 0.0000	78.81%
CONUMID	LINEAR Normal 0.000670 XYWRKPLN at 100.0000	11.20%
DISC	LINEAR Pearson XYWRKPLN at 0.0000	8.87%
CUPBUMP	LINEAR Pearson XYWRKPLN at 100.0000	0.21%
KAPTON	LINEAR Normal 0.000200 XYWRKPLN at 0.0000	1.35%
CONUTOP	LINEAR Normal 0.000270 XYWRKPLN at 0.0000	1.66%
		100.00%

DIBO PRELOAD WITH CUP HEIGHT INCREASED BY 4.5 MILS
ASSUMING TOLERANCE REMAINS SAME AS CUPBUMP
Session: RD-SESS19-113742

Tolerance Summary

Name	Distrib	Nominal	Tolerance	Sig	Source
CONVHID	Normal	0.1842	0.0000	3	Manf
CONVHID1	Normal	0.1842	0.0000	3	Manf
CONVTOP	Normal	0.1840	0.0003	3	Manf
CONVTOP1	Normal	0.1840	0.0003	3	Manf
CRIMP	Normal	0.0628	0.0003	3	Manf
CUPBUMP	Pearson	0.0064	NA	NA	Manf
CUPBUMP1	Pearson	0.0060	NA	NA	Manf
DIBO	Pearson	0.0198	NA	NA	Manf
DIBO1	Pearson	0.0190	NA	NA	Manf
KAPTON	Normal	0.0026	0.0003	3	Dsgn
KAPTON1	Normal	0.0026	0.0003	3	Dsgn

TEST No 269-15-80									
Typical diam heights at sup bump locations									
Passenger car diams measured at .470 bump diameter									
Truck diams measured at .670 bump diameter									
Measurement tool duplicated the sup bump shape, in a ring on a dial indicator .									
All Dimensions in 1000s of mil Peak heights not necessarily at center									
Used Passenger Car					Quiet Passenger car				
Serial #	Lot #	Center height		Height at .470	Serial #	Lot #	Center Height		Height at .
1	1.1	278		215	21	1	272		198
2	1.1	279		213	22	1	270		200
3	1.1	280		208	23	1	269		202
4	1.1	280		203	24	1	267		196
5	1.1	280		211	25	1	269		196
6	13.1	279		202	26	6	273		196
7	13.1	283		207	27	6	271		198
8	13.1	283		209	28	6	274		203
9	13.1	281		214	29	6	272		199
10	13.1	280		217	30	6	271		198
11	2.17	280		211	31	5.1	272		198
12	2.17	286		209	32	5.1	272		197
13	2.17	287		208	33	5.1	272		196
14	2.17	288		211	34	5.1	272		196
15	2.17	287		202	35	5.1	271		202
16	2.23	287		213	36	4	269		194
17	2.23	287		208	37	4	269		195
18	2.23	290		217	38	4	269		201
19	2.23	291		213	39	4	265		197
20	2.23	290		212	40	4	269		194
	Used Pass Car	ht at center	Used Pass Car	ight at bump		Quiet Car	nter Height		Height at bump
	Mean	284.6	Mean	210.2		Mean	270.3	Mean	196.15
	Standard Error	0.944334983	Standard Error	0.989687043		Standard Error	0.47072173	Standard Error	0.5144697322
	Median	289.5	Median	211		Median	271	Median	198
	Mode	287	Mode	213		Mode	269	Mode	196
	Standard Deviation	4.222743439	Standard Deviati	4.426132467		Standard Deviati	2.1051231575	Standard Deviati	2.3008219077
	Variance	17.831577895	Variance	19.431577895		Variance	4.4311578947	Variance	5.7193578895
	Kurtosis	-1.6861295	Kurtosis	-0.257758868		Kurtosis	0.8744078114	Kurtosis	-0.3214687136
	Skewness	-0.0438801	Skewness	-0.45882787		Skewness	-0.66447079	Skewness	0.9603178216
	Range	13	Range	18		Range	9	Range	8
	Minimum	278	Minimum	202		Minimum	265	Minimum	194
	Maximum	291	Maximum	217		Maximum	274	Maximum	202
	Sum	5686	Sum	4204		Sum	5406	Sum	3923
	Count	20	Count	20		Count	20	Count	20

TEST By 2013-12-09

77pc disc heights at cup bump location

Measurement was discs measured at: .470 bump diameter

Truck discs measured at .570 bump diameter

Measurement tool duplicated the cup bump shape, in a ring on a dial indicator .

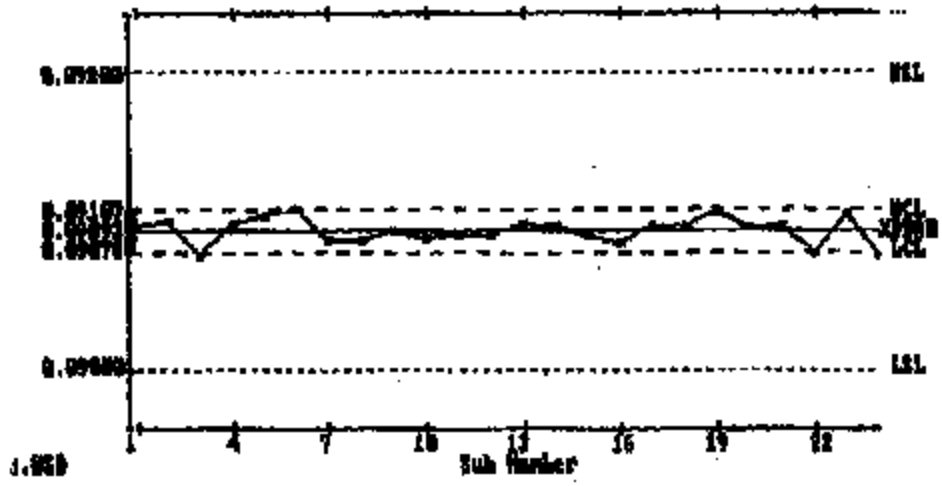
All Dimension in 10ths of mil Peak height not necessarily at center

Noisy truck disc					Quiet truck disc				
Serial #	Lot #	peak height		Height at .570	Serial #	Lot #	peak height		Height at .
41	2.38	291		158	1	AA	274		180
42	2.38	291		161	2		280		168
43	2.38	292		162	3		279		192
44	2.38	291		176	4		278		172
45	2.38	291		176	5		278		172
46	4.1	297		186	6		275		169
47	4.1	297		182	7		277		190
48	4.1	297		186	8		277		187
49	4.1	296		182	9		278		184
50	4.1	302		182	10		278		184
51	6.1	291		168	11		276		162
52	6.1	290		177	12		278		184
53	6.1	291		188	13		279		203
54	6.1	295		179	14		275		213
55	6.1	300		179	15		278		203
56	2.44	292		183	16		277		202
57	2.44	289		183	17		279		205
58	2.44	291		186	18		279		216
59	2.44	291		177	19		278		224
60	2.44	291		177	20		278		220
	Lost truck	peak height		Bump Height		Quiet truck	peak height		Bump Height
	Mean	292.50	Mean	181		Mean	277.15	Mean	185.2
	Standard Error	0.748588174	Standard Error	0.732585097		Standard Error	0.281818913	Standard Error	5.197388939
	Median	291	Median	182		Median	278	Median	182
	Mode	291	Mode	182		Mode	278	Mode	172
	Standard Deviation	3.3478194	Standard Deviati	3.277712088		Standard Deviati	1.7854424464	Standard Deviati	23.2893814
	Variance	11.20788474	Variance	10.73884711		Variance	3.0815728947	Variance	542.7473684
	Kurtosis	2.1181813131	Kurtosis	-1.20887227		Kurtosis	-0.74328806	Kurtosis	-1.44784888
	Skewness	1.4974488688	Skewness	-0.22931454		Skewness	-0.51277128	Skewness	0.178206884
	Range	14	Range	9		Range	6	Range	70
	Minimum	288	Minimum	176		Minimum	274	Minimum	154
	Maximum	302	Maximum	186		Maximum	280	Maximum	224
	Sum	5851	Sum	3620		Sum	5543	Sum	3704
	Count	20	Count	20		Count	20	Count	20

File Name	27713-1PCI	Nominal Dim	0.0910	Maximum Subs	50
Description	WELD/-B-	+ Tolerance	0.0010	Subs in File	24
Samples per Sub	5	- Tolerance	0.0010	Subs Free	26
Limits thru Sub	30	Units	IN	Limit Type	Sliding
Company:	TEXAS INSTRUMENTS	Part:		CUP	

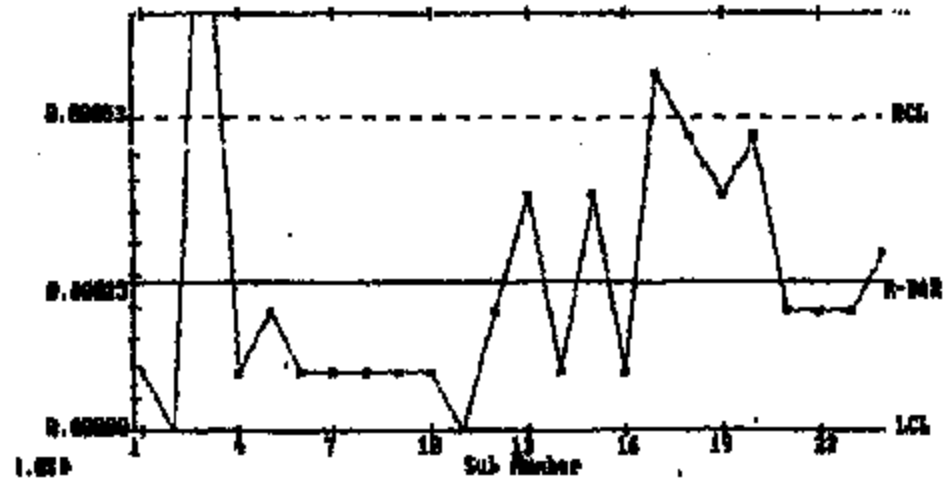
File 27713-1PCI Feature 1 WELD/-B- 07/01/92
X - B A R C O N T R O L C H A R T Subs 1 - 24

Control Mean 0.09093 Lower Limit 0.09078 Upper Limit 0.09107



File 27713-1PCI Feature 1 WELD/-B- 07/01/92
R A N G E C O N T R O L C H A R T Subs 1 - 24

Control Mean 0.00025 Lower Limit 0.00000 Upper Limit 0.00053



TI-NHTSA 005257

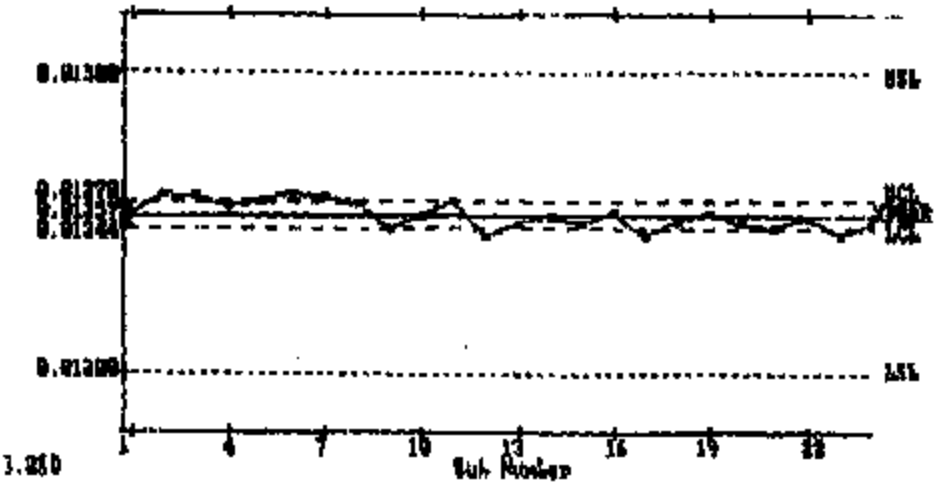
File 27713-1PCI Feature 1 WELD/-B- 07/01/92
Process Capability Standard deviation Subs 1 - 24

Cp	2.130	Cpk	1.993	Z(upper)	6.92	Z(lower)	5.98	% Spec Used	46.50
Estimated percent undersize			0.00			Estimated percent oversize			0.00
Skewness			-1.716			Kurtosis			12.385
Mean -3 Sigma		0.09046		Mean	0.090927		Mean +3 Sigma		0.09139
Mean -4 Sigma		0.09031		Sigma	0.000155		Mean +4 Sigma		0.09155
Min		0.0900		Range	0.0013		Max		0.0913

File Name	27713-1PCI	Nominal Dim	0.0135	Maximum Subs	50
Description	WELD HT	+ Tolerance	0.0015	Subs in File	24
Samples per Sub	5	- Tolerance	0.0015	Subs Free	26
Subs thru Sub	50	Units	IN	Limit Type	Sliding
Company	TEXAS INSTRUMENTS	Part		CUP	

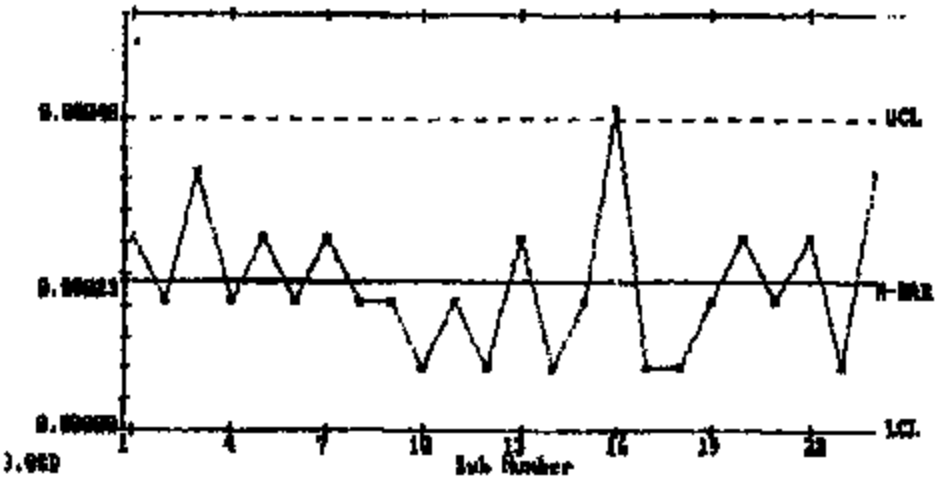
File 27713-1PCI Feature 2 WELD HT
X B A R C O N T R O L C H A R T
07/01/92
Subs 1 - 24

Control Mean 0.01357 Lower Limit 0.01344 Upper Limit 0.01370



File 27713-1PCI Feature 2 WELD HT
R A N G E C O N T R O L C H A R T
07/01/92
Subs 1 - 24

Control Mean 0.00023 Lower Limit 0.00000 Upper Limit 0.00048



TI-NHTSA 005258

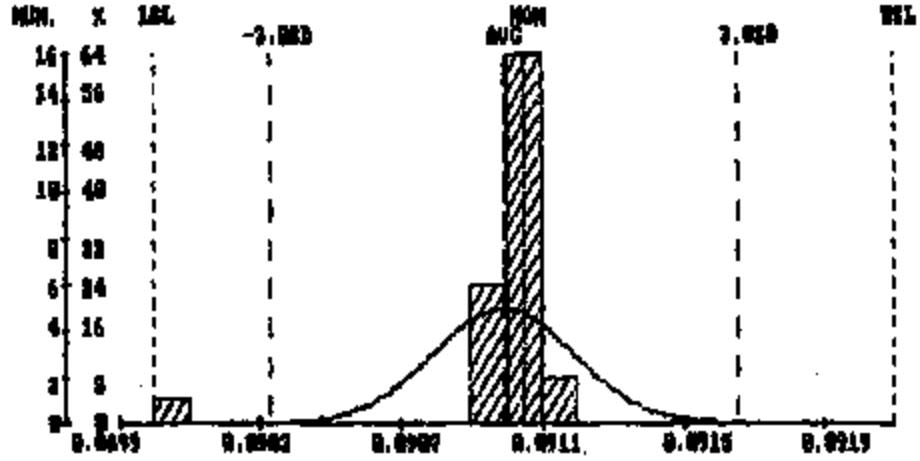
File 27713-1PCI Feature 2 WELD HT
Process Capability Standard deviation
07/01/92
Subs 1 - 24

3.064	Cpk	2.920	Z(upper)	8.76	Z(lower)	9.63	X Spec Used 32.63
Estimated percent undersize		0.00			Estimated percent oversize		0.00
Skewness		0.135			Kurtosis		2.324
Mean +3 Sigma	0.01308	Mean	0.013571		Mean +3 Sigma		0.01406
Mean -4 Sigma	0.01292	Sigma	0.000163		Mean +4 Sigma		0.01422
Min	0.0133	Range	0.0007		Max		0.0140

File Name	27713-1MCI2	Nominal Dim	0.0910	Maximum Subs	50
Description	WELD/-B-	+ Tolerance	0.0010	Subs in File	5
Samples per Sub	5	- Tolerance	0.0010	Subs Free	45
Limits thru Sub	30	Units	IN	Limit Type	Sliding
Company:	TEXAS INSTRUMENTS	Part:		CUP	

File 27713-1MCI2 Feature 1 WELD/-B- 07/01/92
HISTOGRAM 3.0BD Subs 1 - 5

Cell Width 0.000100 Mean 0.0909 Standard Deviation 0.00020



Cell Statistics

Cell No.	Value	Number of Observations	% Relative Frequency
2	0.0900	1	4.00
11	0.0909	6	24.00
12	0.0910	16	64.00
13	0.0911	2	8.00

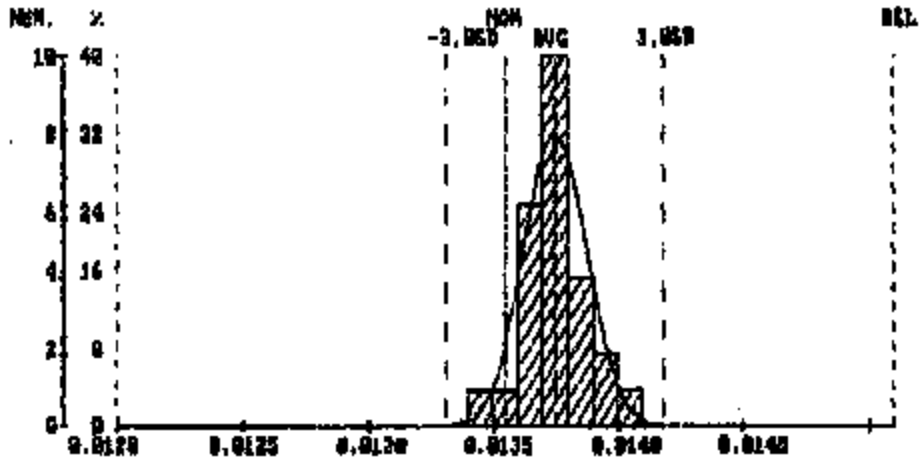
File 27713-1MCI2 Feature 1 WELD/-B- 07/01/92
Process Capability Standard deviation Subs 1 - 5

Cp	1.632	Cpk 1.540	Z(upper) 5.17	Z(lower) 4.62	% Spec Used 61.29
Estimated percent undersize		0.00	Estimated percent oversize		0.00
Skewness		-4.147	Kurtosis		19.024
Mean -3 Sigma	0.09033	Mean	0.090944	Mean +3 Sigma	0.09156
Mean -4 Sigma	0.09013	Sigma	0.000204	Mean +4 Sigma	0.09176
Min	0.0900	Range	0.0011	Max	0.0911

Part Name	27713-1MC12	Nominal Dim	0.0135	Maximum Subs	50
Description	WELD HT	+ Tolerance	0.0015	Subs in File	5
Samples per Sub	5	- Tolerance	0.0015	Subs Free	45
Control Limit Sub	30	Units	IN	Limit Type	Running
Company:	TEXAS INSTRUMENTS	Part:		CUP	

File 27713-1MC12 Feature 2 WELD HT 07/01/92
H I S T O G R A M 3.08b Subs 1 - 5

Cell Width: 0.000100 Mean 0.0137 Standard Deviation 0.00013



Statistics

Cell No.	Value	Number of Observations	% Relative Frequency
13	0.0134	1	4.00
16	0.0135	1	4.00
17	0.0136	6	24.00
19	0.0137	10	40.00
19	0.0138	4	16.00
20	0.0139	2	8.00
21	0.0140	1	4.00

File 27713-1MC12 Feature 2 WELD HT 07/01/92
Process Capability Standard deviation Subs 1 - 5

Cp 3.875	Cpk 3.357	Z(upper) 10.07	Z(lower) 13.17	% Spec Used	25.82
Estimated percent undersize	0.00		Estimated percent oversize		0.00
Skewness	0.119		Kurtosis		3.436
Mean -3 Sigma	0.01331	Mean	0.013700	Mean +3 Sigma	0.01409
Mean -4 Sigma	0.01318	Sigma	0.000129	Mean +4 Sigma	0.01422
Min	0.0134	Range	0.0006	Max	0.0140

Test 297-18-10							
Investigation of Assessment product to adjust for spot dies on TTpe13-1							
Unloaded							
Part No.	Act:		DSE		Disc Height		Depth to Di
1	21.8		19.5		18.1		485
2	21.8		19.3		18		488
3	22		19.2		18		485
4	21.9		18.1		18		488
5	22.8		19.6		18		505
6	24.1		20		18.1		482
7	23.5		20		18		484
8	23.5		19.6		18.2		481
9	23.4		20		17.8		492
10	22.2		19		17.8		481
Column 1		Column 1			#N/A	Column 1	
					#N/A		
Mean	22.29	Mean	19.56		#N/A	Mean	487.8
Standard Error	0.182848	Standard Error	0.11972		#N/A	Standard Error	2.407264831
Median	22.35	Median	19.55		#N/A	Median	485
Mode	#N/A	Mode	20		#N/A	Mode	488
Standard Deviati	0.578216	Standard Deviati	0.37863		#N/A	Standard Deviati	7.612454626
Variance	0.334333	Variance	0.14339		#N/A	Variance	57.96185556
Kurtosis	-0.16488	Kurtosis	-1.1882		#N/A	Kurtosis	1.919536213
Skewness	-0.43739	Skewness	-0.0408		#N/A	Skewness	1.492152135
Range	1.9	Range	1		#N/A	Range	24
Minimum	21.2	Minimum	19		#N/A	Minimum	481
Maximum	24.1	Maximum	20		#N/A	Maximum	505
Sum	222.9	Sum	195.6		#N/A	Sum	4878
Count	10	Count	10		#N/A	Count	10

					[illegible]		
					[illegible]		
					[illegible]		
no praised					[illegible]		
11	22.6		19		17.8		463
12	23.4		18.2		18		469
13	25.5		22.2		19.6		463
14	24.4		20.6		19.2		458
15	23.3		19		17.8		469
16	23.2		19.8		18		454
17	25.6		22.1		19.8		456
18	23.3		19.7		18		468
19	24.2		19.7		18		467
20	24.3		20		18.1		459
Column 1		Column 1		Column 1		Column 1	
Mean	24.16	Mean	20.11	Mean	18.075	Mean	458
Standard Error	0.439538	Standard Error	0.38019	Standard Error	[illegible]	Standard Error	0.802772972
Median	23.8	Median	19.7	Median	18	Median	458
Mode	23.3	Mode	19	Mode	18	Mode	469
Standard Deviati	1.970949	Standard Deviati	1.70227	Standard Deviati	0.348843514	Standard Deviati	3.590891035
Variance	3.878896	Variance	3.44944	Variance	0.041973489	Variance	5.444444444
Kurtosis	0.106851	Kurtosis	0.11709	Kurtosis	2.484701482	Kurtosis	-0.80134873
Skewness	1.078343	Skewness	1.17059	Skewness	1.772831794	Skewness	-0.10197463
Range	6	Range	5.3	Range	1	Range	9
Minimum	21.6	Minimum	19	Minimum	17.8	Minimum	454
Maximum	25.6	Maximum	22.3	Maximum	18.8	Maximum	463
Sum	241.6	Sum	201.1	Sum	361.5	Sum	4589
Count	10	Count	10	Count	20	Count	10

K. F. BASSLER COMPANY, INC.
PRECISION TOOLING & METAL STAMPINGS
45 John Willem St. • Attleboro, MA 02703 • (508) 222-1061 • Fax: (508) 226-1606
EST. 1946

DAK,
- AS You requested.
- No data yet From Valentine on 27713
matt

June 16, 1992

Mr. Matt Sellers, MS 12-37
Texas Instruments, Inc.
34 Forest Street
Attleboro MA 02703

Matt:

Last Thursday we received your request from George Lavoie to provide you with data on part 27389-2 for some design engineering studies.

Enclosed are a 25 piece capability study with average and sigma calculated for .101 - .107 and .162 - .168, and a process capability study consisting of 5 piece sub-groups over an extended period of time on the same dimensions.

If you have any questions or need any additional information, please feel free to call.

Cordially,

John P. Masse
Quality Control Manager

Enclosures

$\bar{x}$ = .10414 σ = .00029 n = 25

= .16483 - .10414 = .06067

$\bar{x}$ = 0.16483
σ = 0.00009
n = 25

analyst: JOHN P. MASSE date: 06-12-92 time: 10:35

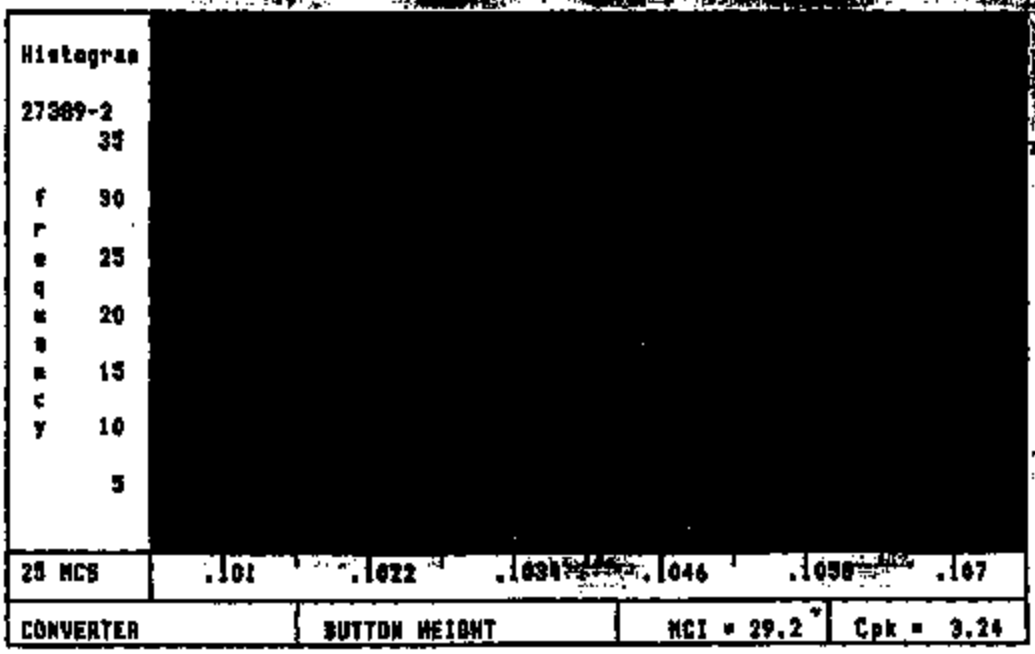
part number: 27389-2 description: CONVERTER
customer: T.I.A. product code: G
dim descr: BUTTON HEIGHT process: 25 PCS
specification limits: lsl .1010 usl .1070

$\bar{x}$ = 0.10416 sample size = 25
σ = 0.00029
minimum = 0.10380
maximum = 0.10490 range = 0.00110

PCI = 29.2% Cpk = 3.24
estimated percent out of spec = 0.00
OHL = 0.00
ULL = 0.00

notes:
25 PCS. MEASURED ON A TENTHS DIAL INDICATOR GAUGE.

F12 quit



[redacted]

1	.1040	21	.1039	41		61		81	
2	.1040	22	.1042	42		62		82	
3	.1041	23	.1045	43		63		83	
4	.1043	24	.1039	44		64		84	
5	.1042	25	.1040	45		65		85	
6	.1041	26		46		66		86	
7	.1045	27		47		67		87	
8	.1045	28		48		68		88	
9	.1040	29		49		69		89	
10	.1042	30		50		70		90	
11	.1040	31		51		71		91	
12	.1049	32		52		72		92	
13	.1041	33		53		73		93	
14	.1040	34		54		74		94	
15	.1041	35		55		75		95	
16	.1049	36		56		76		96	
17	.1040	37		57		77		97	
18	.1039	38		58		78		98	
19	.1039	39		59		79		99	
20	.1038	40		60		80		100	

F5 erase F6 calculate F12 quit

PART NAME (PRODUCT)	OPERATION (PROCESS)	SPECIFICATION LIMITS
CONVERTER	Progressive #1	.1101 - .107

OPERATOR	MACHINE	GAUGE	UNIT OF MEASURE	ZERO EQUALS
	60 Ton L+J	Dial Indicator	Inches	-0-

DATE	06-11-92																6-12-92						
TIME	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:15	1:45	2:15	2:45	3:15	3:45	4:15	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00
SAMPLE MEASUREMENTS 1	.1037	.1034	.1049	.1037	.1041	.1040	.1035	.1034	.1035	.1049	.1048	.1037	.1040	.1035	.1037	.1038	.1038	.1040	.1037	.1035	.1033	.1055			
2	.1043	.1036	.1037	.1035	.1043	.1036	.1039	.1036	.1036	.1037	.1036	.1035	.1037	.1034	.1034	.1034	.1034	.1040	.1040	.1035	.1032	.1035			
3	.1041	.1036	.1037	.1039	.1037	.1036	.1036	.1037	.1036	.1035	.1040	.1036	.1035	.1033	.1033	.1033	.1039	.1035	.1040	.1036	.1034	.1036			
4	.1039	.1036	.1041	.1039	.1040	.1037	.1036	.1039	.1037	.1038	.1035	.1036	.1034	.1037	.1035	.1040	.1040	.1040	.1036	.1036	.1034	.1033			
5	.1042	.1034	.1033	.1034	.1034	.1033	.1036	.1037	.1036	.1039	.1040	.1035	.1035	.1035	.1035	.1035	.1041	.1035	.1039	.1034	.1036	.1032			
SUM	.5202	.5177	.5198	.5194	.5214	.5182	.5182	.5183	.5185	.5197	.5199	.5179	.5181	.5174	.5174	.5180	.5192	.5190	.5192	.5176	.5169	.5171			
AVERAGE, $\bar{X}$	.1040	.1035	.1040	.1039	.1043	.1036	.1036	.1037	.1037	.1039	.1040	.1036	.1036	.1035	.1035	.1036	.1038	.1038	.1038	.1035	.1034	.1034			
RANGE, R	.0006	.0002	.0012	.0005	.0006	.0004	.0003	.0003	.0002	.0002	.0005	.0002	.0006	.0003	.0002	.0005	.0003	.0005	.0003	.0002	.0002	.0004			

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

AVERAGES $\bar{X}$

UCL $\bar{X}$ = .1056

$\bar{\bar{X}}$ = .1037

LCL $\bar{X}$ = .1023

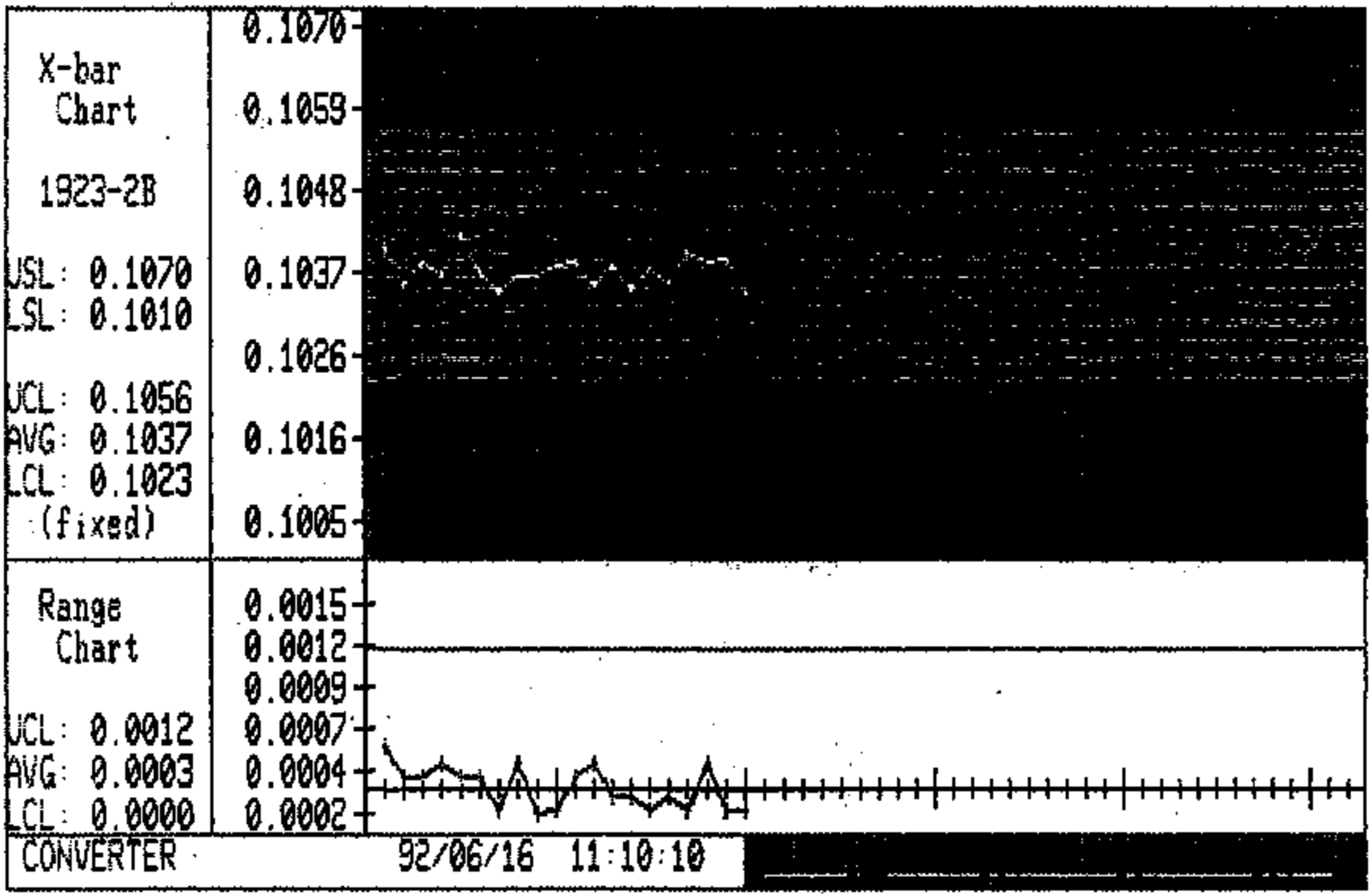
RANGES R

UCL R = .0012

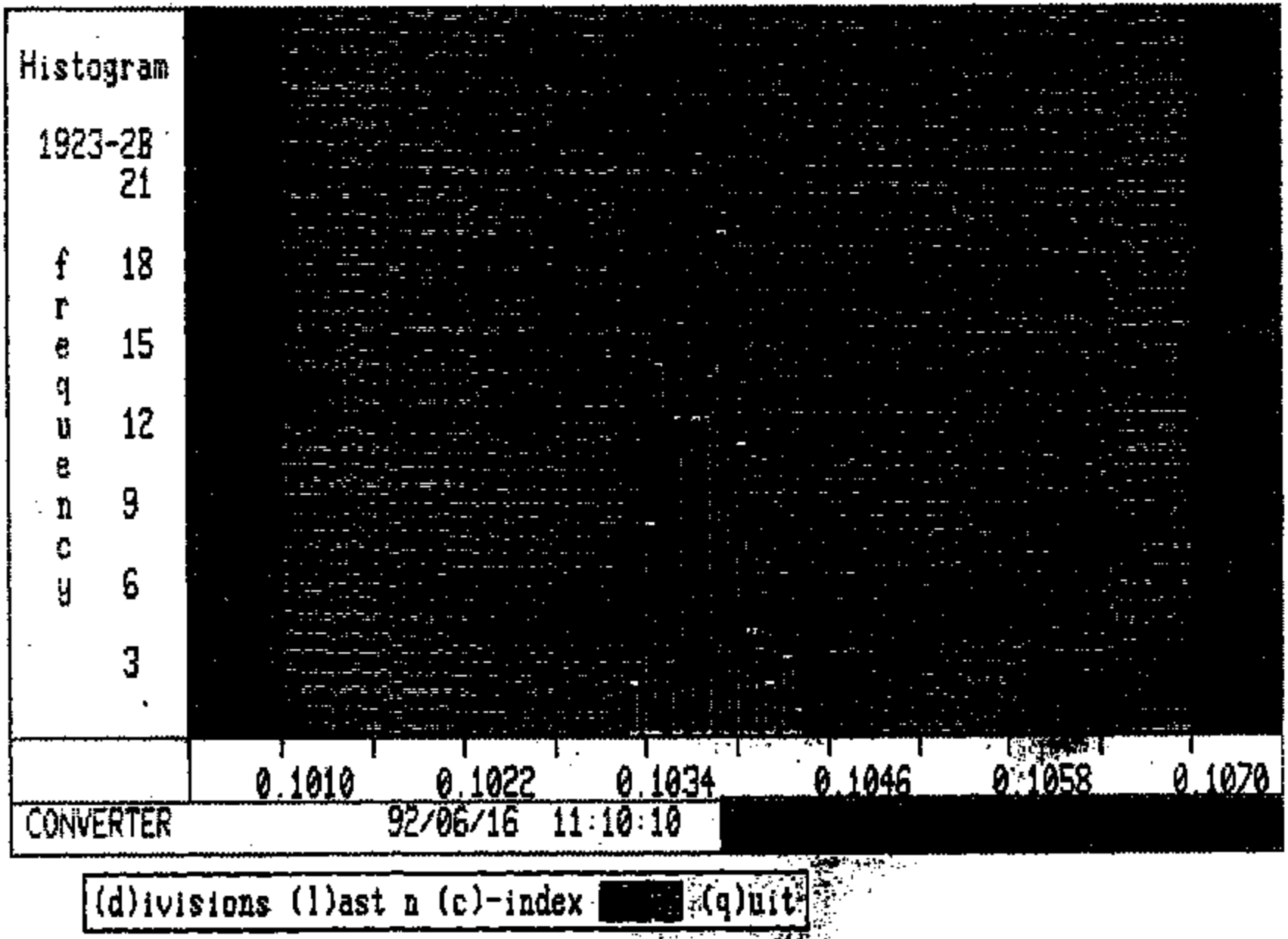
$\bar{R}$ = .0005

LCL R =

TI-NHTSA 005268



f12



f12

DRAWINGS AVAILABLE UPON REQUEST

analyst: JOHN P. NASSE date: 06-12-92 time: 10:01

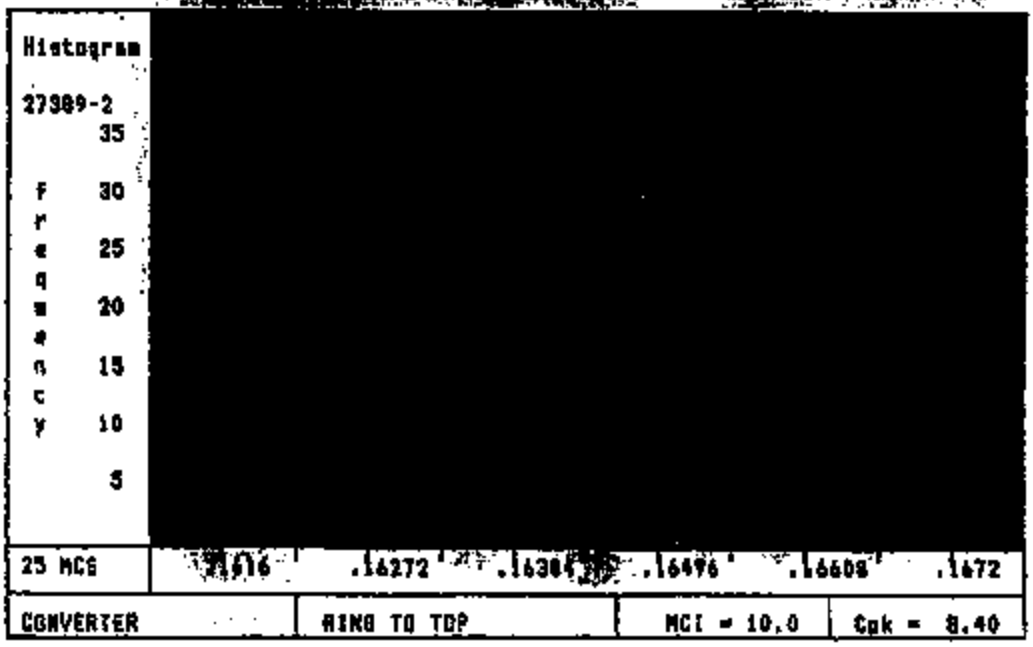
part number: 27389-2 description: CONVERTER
customer: T.I.A. product code: 0
dim descr: RING TO TOP process: 25 MCS
specification limits: lsl .1616 usl .1672

$\bar{X}$ = 0.16483 sample size = 25
σ = 0.00009
minimum = 0.16460
maximum = 0.16500 range = 0.00040

MCI = 10.0% Cpk = 8.40
estimated percent out of spec = 0.00
OHL = 0.00
ULL = 0.00

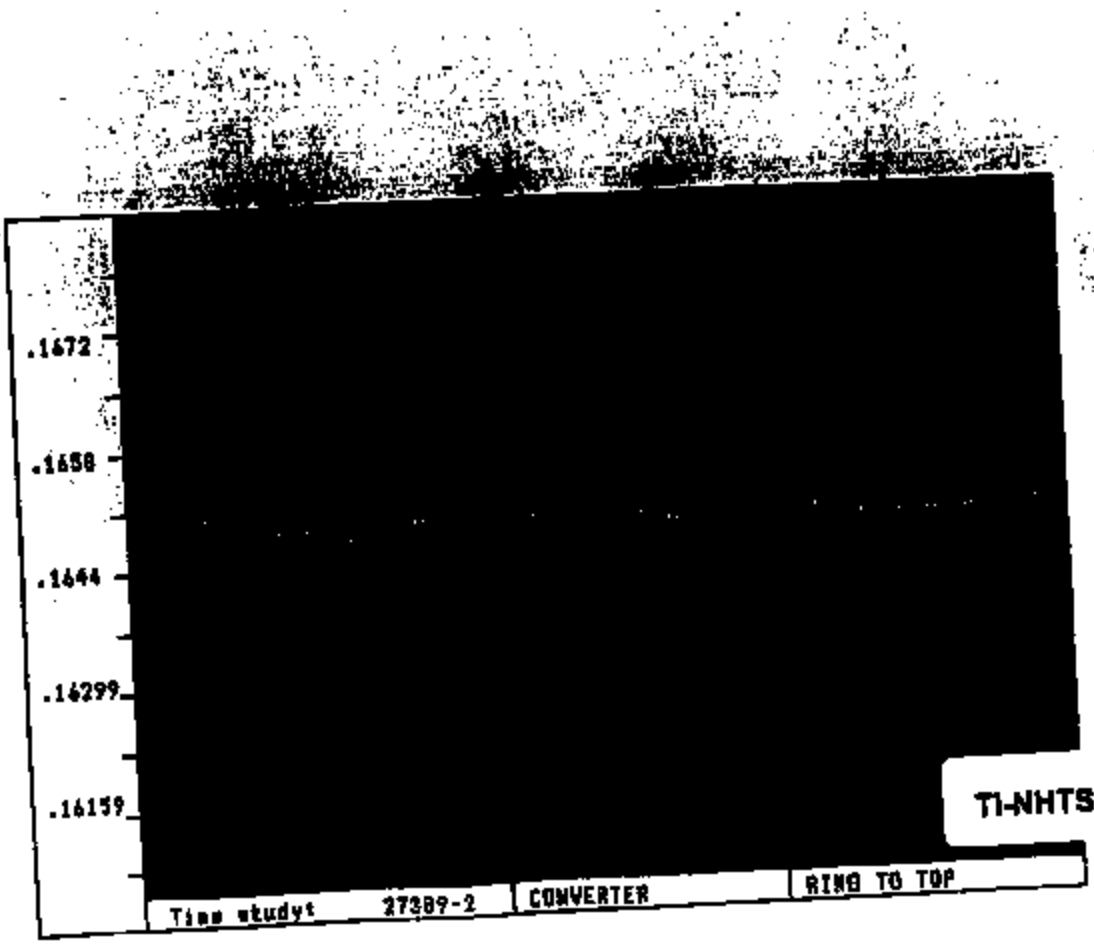
notes:
25 PCS. MEASURED TO A PREPLATE SPEC. USING A TENTHS DIAL INDICATOR.

F12 quit



1	.1646	21	.1648	41		61		81	
2	.1650	22	.1648	42		62		82	
3	.1650	23	.1648	43		63		83	
4	.1648	24	.1649	44		64		84	
5	.1648	25	.1649	45		65		85	
6	.1647	26		46		66		86	
7	.1648	27		47		67		87	
8	.1649	28		48		68		88	
9	.1649	29		49		69		89	
10	.1647	30		50		70		90	
11	.1649	31		51		71		91	
12	.1649	32		52		72		92	
13	.1647	33		53		73		93	
14	.1649	34		54		74		94	
15	.1648	35		55		75		95	
16	.1648	36		56		76		96	
17	.1648	37		57		77		97	
18	.1649	38		58		78		98	
19	.1649	39		59		79		99	
20	.1648	40		60		80		100	

F2 graue F4 calculate F12 quit



PART NAME (PRODUCT)	OPERATION (PROCESS)	SPECIFICATION LIMITS
CONVERTER	PROGRESSIVE #1	.16K – .16T4 (PRE BAR)

OPERATOR	MACHINE	UNIT OF MEASURE	ZERO EQUALS
	60 TON [illegible]	Inches	-0-

DATE	06-[illegible]-12	06-12-12
TIME	8:00 8:30 9:00 9:30 10:00 10:30 11:00 11:30 12:00 12:30 1:15 1:45 2:15 2:45 3:15 3:45 9:00 9:30 10:00 10:30 11:00
SAMPLE MEASUREMENTS 1	.1646 .1647 .1650 .1647 .1649 .1651 .1643 .1647 .1647 .1644 .1645 .1644 .1643 .1645 .1644 .1645 .1647
2	.1647 .1647 .1651 .1647 .1649 .1646 .1647 .1645 .1645 .1647 .1647 .1644 .1645 .1644 .1645 .1647
3	.1648 .1648 .1650 .1649 .1649 .1647 .1645 .1647 .1645 .1643 .1645 .1644 .1645 .1644 .1645 .1647
4	.1650 .1647 .1651 .1647 .1647 .1645 .1647 .1645 .1645 .1647 .1647 .1644 .1645 .1644 .1645 .1647
5	.1647 .1647 .1650 .1650 .1650 .1651 .1647 .1645 .1645 .1647 .1647 .1644 .1645 .1644 .1645 .1647
SUMMARY	[illegible]
AVERAGE, $\bar{X}$	.1648 .1647 .1650 .1648 .1648 .1648 .1645 .1646 .1645 .1645 .1646 .1644 .1645 .1644 .1645 .1647
RANGE, R	.0001 .0001 .0002 .0002 .0002 .0005 .0004 .0002 .0002 .0004 .0002 .0001 .0002 .0002 .0002 .0001 .0001

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

AVERAGES $\bar{X}$

UCL $\bar{X}$ = .1660

$\bar{\bar{X}}$ = .1645

LCL $\bar{X}$ = .1629

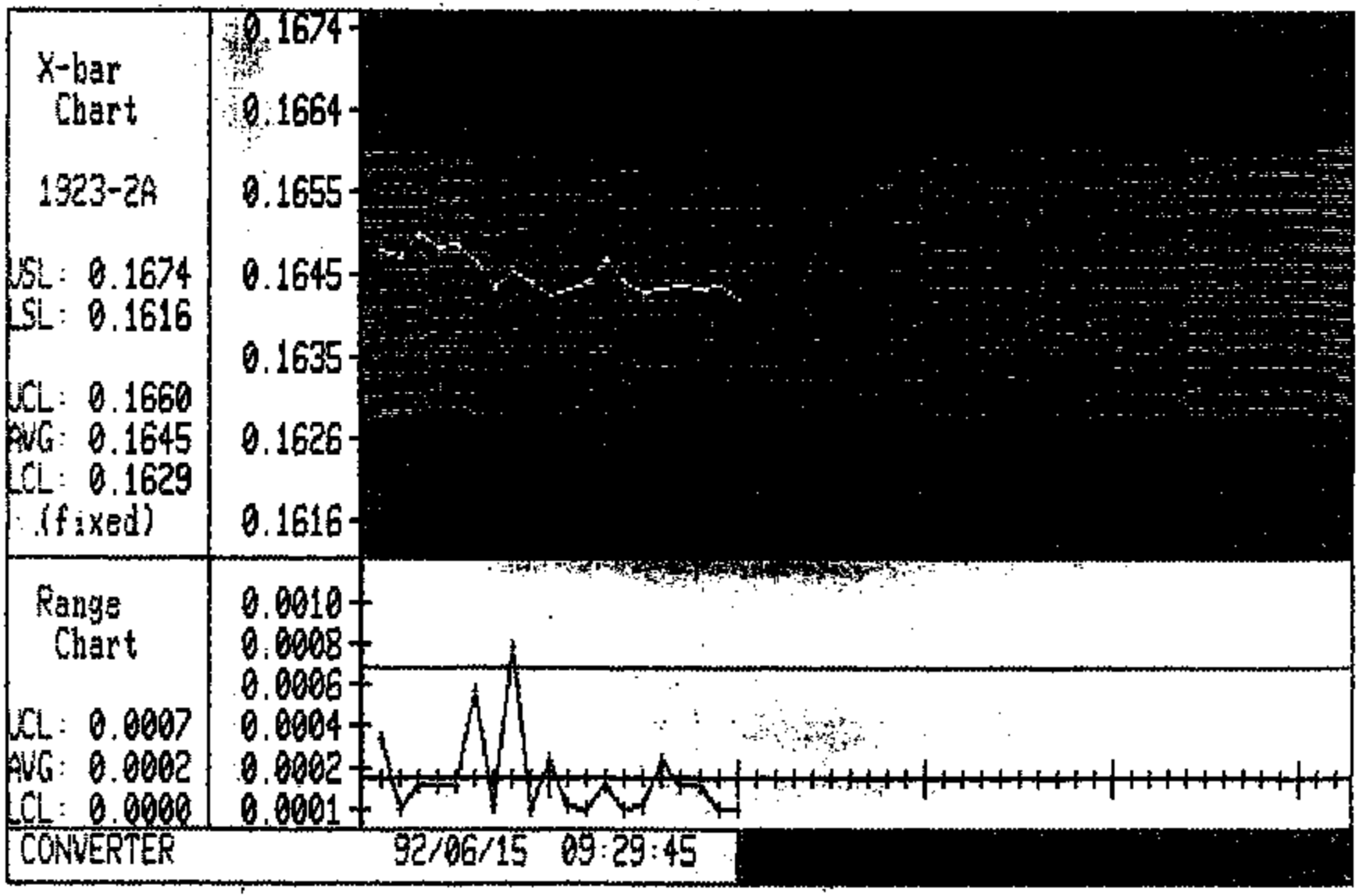
RANGES R

UCL R = .0007

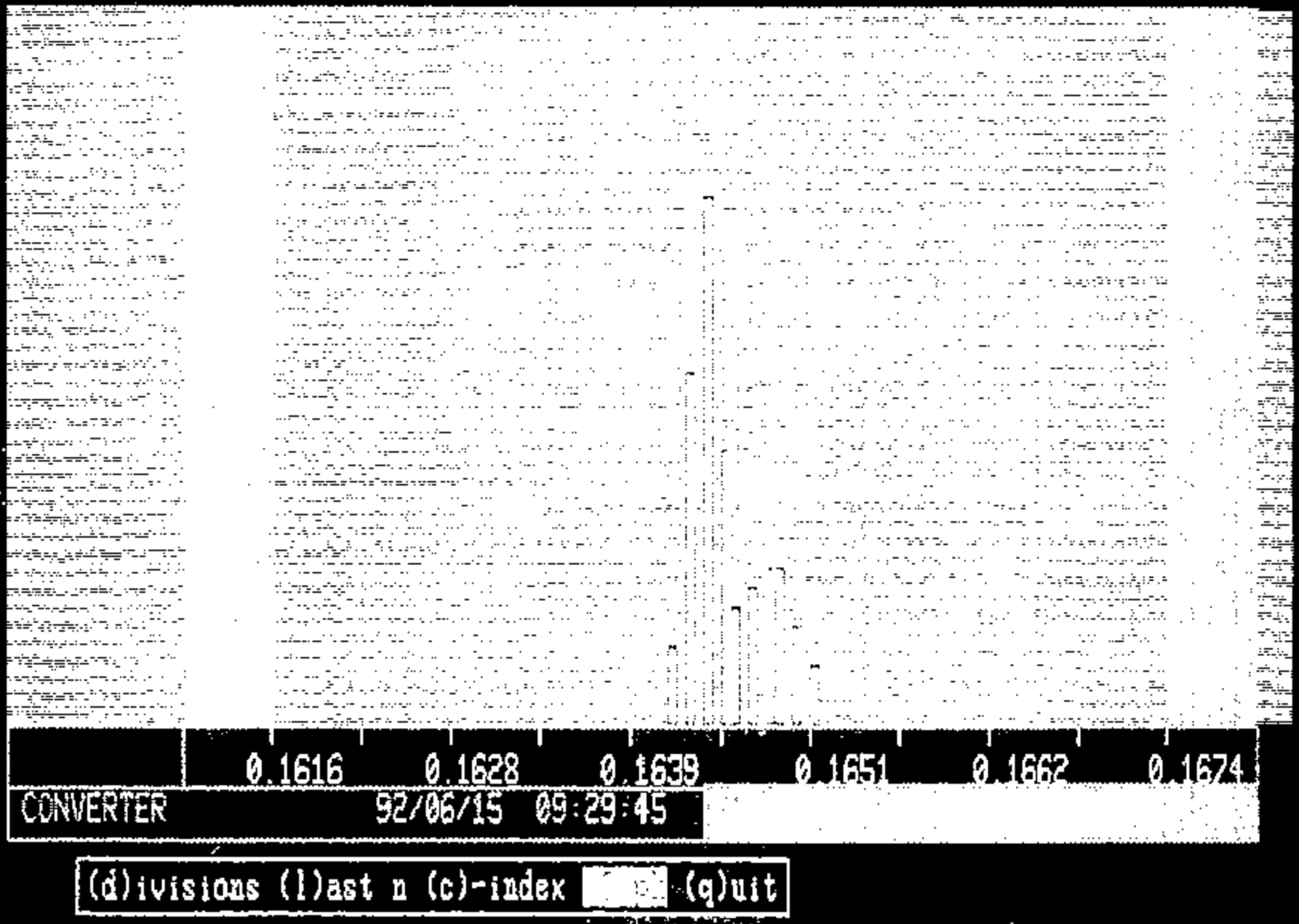
$\bar{R}$ = .0002

LCL R = .0000

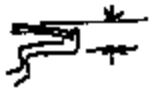
TI-NHTSA 005272



f12



Bump dia .9656



	Bump to Washer	pre crown	Nominal gap	Add .003 for Kapton below die / Conversion to Wire Conveyor Bump	
10 mil pad P-10	.0870	.0199	.0	.0618	DIC 12-2
(L-10) 10 mil pad P-30	.0886	.0177	.0067	.0612	
30 mil pad L-14	.0892	.0213	.005	.0606	
10 mil pad P-11	.0872	.0193	.0045	.0614	
noisy Ami 2A	.0876	.020	.0047	.0612	
noisy Ami 2B	.0874	.0191	.0045	.0622	

DIC Lot 2A	to center	to .96 dia
	.027"	.0190
	.0255	.0195
	.02965"	.0200

Measured on cross sections

Does not reflect drop when pressure applied to dies.

77PS CUP DEC.10,1992
27713

"A" DIMENSION

SAMPLE	713-1	713-2	DELTA	288-1
1	0.0900	0.0867	0.0033	0.0870
2	0.0898	0.0865	0.0033	0.0879
3	0.0901	0.0871	0.0029	0.0873
4	0.0900	0.0866	0.0034	0.0873
5	0.0890	0.0865	0.0025	0.0872
6	0.0900	0.08625	0.0038	0.0871
7	0.0903	0.08685	0.0034	0.0874
8	0.0901	0.0864	0.0037	0.0876
9	0.0903	0.08665	0.0037	0.0874
10	0.0902	0.08615	0.0040	0.0874
MEAN	0.0900	0.0866	0.0034	0.0873
SIGMA	0.00035	0.00026	0.00041	0.00024

OLD CUPS

CUPS WITH DECREASED Height TO COMPENSATE FOR QUIFF DISC

USING NEW CUPS IS GIVING SLIGHT INCREASE AMOUNTS OF PRELOAD ON DISC. CHARACTERISTIC CURVE HAS ALSO CHANGED CAUSING VALVES TO OPEN AT HIGH PSIG.

SEEMS THAT ~~INCREASED~~ VARIABILITY IN SENSOR DIMENSION MAY HAVE BEEN HIDDEN BY THE LOOSE CUP.

VALENTINE TOOL & STAMPING, INC. INSPECTION REPORT

INSTRUMENTS INC	Date 2/28/81
PART : 22713-1	Lot Size 55
CUP REV.A	Sample Size 5
P.O :	Mat. Lot Number 9027
FJO : 18461	Prod.Lot Number
Tool Samples	Insp. By

Code	CHARACTERISTIC	Use	1	2	3	4	5
1	.038/.041		.040	.0398	.0398	.040	.040
2	1.065 /1.067 #		1.068	1.0675	1.068	1.068	1.068
3	.835 /.839 #		.838	.837	.8375	.836	.837
	.318 /.320		.315	.3152	.316	.317	.3157
5	.012 /.015		.0132	.0133	.0137	.014	.0134
6	.890 /.892		.891	.8908	.8908	.8909	.8912
7	Note 2 .050 Ref		.056	.060	.058	.0594	.060
8	.003 /.007 R.		.006	TYP	—	—	—
9	.010 Max R. (x2)		.004	TYP	—	—	—
10	.005 Max R.		.0035	TYP	—	—	—
11	.910 Max #		.9015	.902	.9025	.9025	.902
12	.795 W Min Flat		.823	.8252	.8233	.8203	.827
13	.156 /.161 # thru .050 Min		.159	.159	.159	.159	.159
14	.466 /.472 #		.468	.4668	.4687	.468	.4668
15	Flat .003 TIR		.007	.0015	.0013	.002	.0012
16	.005 Max R		.005	TYP	—	—	—
	.028 /.032 R		.030	"	—	—	—
18	// within .0015 TIR		.0003	.0002	.0003	.0003	.0003
19	Flat within .0015		.0003	.0003	.0002	.0003	.0002

VALENTINE TOOL & STAMPING, INC. INSPECTION REPORT

"IAS INSTRUMENTS INC	Date	11/19/92	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
PART : Z7213-2	Lot Size	10								
CUP REV.C	Sample Size	10								
P.O.: 505138012	Mat. Lot Number	9970								
FAI : 19285	Prod.Lot Number	1								
	Insp. By									

ode	CHARACTERISTIC	Use								
1	.838 -.841	.839								
2	Ø 1.865 -1.869 -A-	1.4685								
3	0.835 -.839	.9385								
	TP .005 A	.0026								
5	.318 -.328	.316 .319								
6	.012 -.015	.013 .022								
7	DIM "A"	.0846 .0878								
8	PARALLEL .005 B	.003								
9	.058 REF	.059 .060								
10	R .015 MAX	.012								
11	FLAT .003	.001								
12	Ø .468 -.472	.471								
13	TP .005 A	.0036								
14	MIN FLAT Ø .795	.821								
15	Ø .918 MAX	.9086								
16	NO BURR ALLOWED	✓								
	R .005 MAX	.005								
18	R .015 MAX	.012								
19	MM	✓								

ENGINE NOISES

I AM NOT TOTALLY CONVINCED THAT THE DISC ITSELF IS THE SOURCE OF THE NOISE. IT SEEMS THAT THERE ARE SEVERAL POSSIBLE SOURCES THAT WE HAVEN'T FINISHED CHECKING OUT YET.

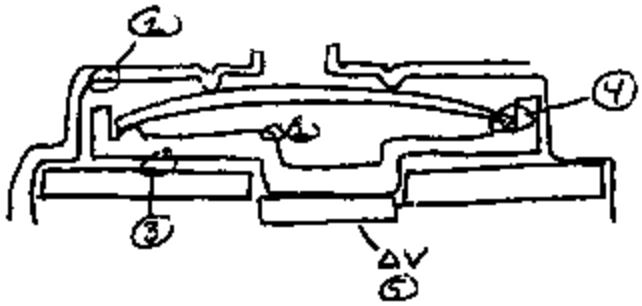
1) IMPACT OF THE DISC TO THE CONVERTOR ON ACTUATION. THE IMPACT IS THEN TRANSMITTED THRU THE CONVERTOR TO THE FLUID. (THE DISC ISN'T TOUCHING ANYTHING ELSE AT THIS POINT). THERE ARE WEAR MARKS IN THIS AREA ON PARTS THAT HAVE COMPLETED LIFE TEST. ON PAPER THE DISC DOES NOT HIT BUT IN REALITY THE DISC OVER TRAVELS BEFORE REACHING THE FINAL RESTING POSITION.

2) CONVERTOR IMPACTS THE CUP ON ACTUATION. THE ENERGY IS TRANSMITTED THROUGH THE CUP TO THE WASHER. THE WASHER VIBRATES AXIALLY SENDING THE SOUND DOWN THE HYDRAULIC FLUID. THERE ARE WEAR MARKS ON LIFE TEST PARTS. UNKNOWN IF FROM HOT OR OVERPRESSURE. PROBABLY BOTH

3) ON RELEASE THE CONVERTOR IMPACTS THE WASHER

4) THE DISC TRANSMITS ITS ENERGY TO IT'S LUGS WHEN IT SNAPS, THE ENERGY THEN TRANSMITS THROUGH THE CONVERTOR THIS FLO BEST WITH THE LOW DIFFERENTIAL DISC IMPROVEMENT ALTHOUGH A LOW DIFFERENTIAL DISC WOULD ALSO HELP 1, 2, 3 BECAUSE OF LOWER CROWN HEIGHT & LOWER KINETIC ENERGY.

5) THE SUDDEN MOVEMENT OF THE CONVERTOR CAUSES THE FLUID TO VERY RAPIDLY FLOW INTO THE INCREASED VOLUME. IF THE FLOW RATE IS HIGH ENOUGH IT CAN GENERATE SOUND EVEN IF THE VOLUME IS SMALL. SINCE THE CONVERTOR PROBABLY MOVES .014" IN SEVERAL MILLISECONDS THIS SEEMS LIKELY. IN THIS CASE THE SNUBBER WOULD HAVE SOME EFFECT BECAUSE OF REDUCED FLOW RATE.



Acoustics

There is two methods that sound can couple to the master cylinder. The first is through the metal to metal coupling from the disc all the way to the master cylinder. The second is through the fluid itself. Your test with the rubber hose would seem to indicate that it is through the fluid & not the metal. This fits with acoustic theory because the resistance of metal to sound is greater than the resistance of fluid. So even if a metal couple exists the sound will tend to travel through the fluid. Acoustic resistance to sound is a complex impedance just like electronic impedance.

steel	=	39×10^6 kg/m²s (MKS rayl)
engine oil	=	1.45×10^6 rayls
rubber	≈	$.06 \times 10^6$
air	=	428×10^0

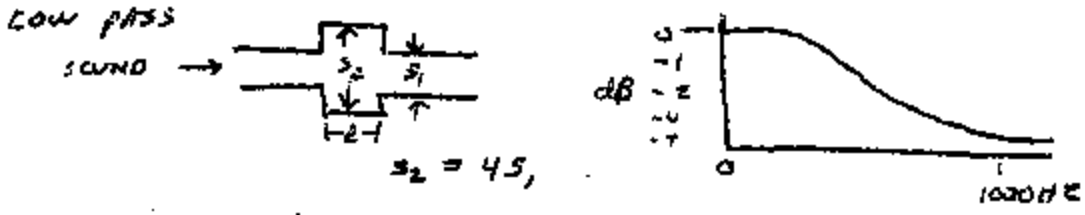
Resistance of steel is 30 times that of oil

impedance $Z = \pm \rho_0 c$ for a plane wave

ρ_0 = equilibrium density
c = wave (sound) velocity

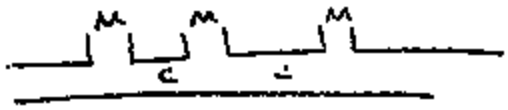
plane (rather than spherical) are commonly produced by a piston vibrating at one end of a fluid filled tube. This make the analysis easier.

If the sound is really traveling through the fluid then it is possible to build a sound filter if we know the frequencies to be filtered. A simple low pass filter can be built by changing the diameter of the pipe



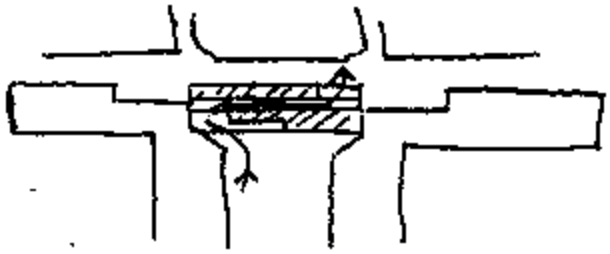
This is the theory behind mufflers & gun silencers

HIGH PASS



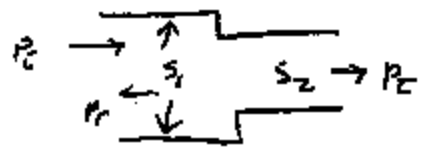
C = Acoustic compliance (capacitor)
M = Acoustic Inertance (inductor)

Using these ideas we maybe able to build a simple filter into the pipe



We have most of width & length to play with. several plastic pipes may do the trick. I built one that like move. it had no effect but it may not be tuned to the right frequency. That is why the spectrum analysis could be important. I am sure GM has an Acoustic expert who could help us with the filter design

RUBBER (ORFIÉE)



IF WAVELENGTH IS LARGE COMPARED TO DIAMETER OF TUBE THEN THE SOUND POWER TRANSMISSION COEFFICIENT IS

$$\alpha_t = \frac{4 S_1 S_2}{(S_1 + S_2)^2}$$

SOME ADDITIONAL THOUGHTS

YOUR COMMENT ABOUT FEELING THE SOUND IN THE PEDAL IS INTERESTING. DO YOU ACTUALLY FEEL A MOTION. IF SO THEN IT'S PROBABLY DUE TO THE SUDDEN INCREASE IN THE FLUID VOLUME WHICH WOULD POINT TO FS AS THE PROBLEM.

WE MAYBE ABLE TO SEPERATE MECHANICAL COUPLING FROM FLUID COUPLING BY PUTTING AN ACCELEROMETER ON THE SWITCH OR MASTER CYLINDER AND COMPARING TO THE MICROPHONE PICK UP. IF THESE DISC DIRECTLY COUPLES TO THE FLUID THERE SHOULD BE VERY LITTLE VIBRATION. IF THE DISC IMPACTS SOME PART THE ACCELEROMETER SHOULD SEE IT. I TRIED DETECTING THE SNAP ON THE MR COMBINATION STAND WITH A ±2g ACCELEROMETER MOUNTED ON TOP OF THE DRIVE RING. I DID NOT DETECT ANYTHING. PROBABLY BECAUSE THE ACCELEROMETER ONLY MEASURES TO 1 kHz. WE NEED TO TRY A PIEZOELECTRIC TYPE THAT CAN MEASURE TO 20 OR 100kHz.

USING RIGID BRAKE LINE BETWEEN ME AND SWITCH YOU MAYBE ABLE TO BUILD AN ACOUSTIC FILTER BY TWISTING IT INTO A COMPLEX SHAPE SUCH AS A Z. THIS IS A HIT OR MISS PROPOSITION.

The spectrum analyzer used for testing should be able to measure to 25khz or better. You can't use a scope. It's too slow. Humans can hear from 20 to 15,000 Hz

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