EA02-025

TEXAS INSTRUMENTS, INC.'S 9/10/03 ATTACHMENT

REQUEST NO. 7

BOX 8

PART A-U

PART B

PRESSURE SWITCH DATA Form 21605 TEST NO. 332-15-66

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PS		Steve Offiley	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey DiDomenico	920925		

PROJECT TITLE: Speed Control Deactivate PS

CUSTOMER:

PURPOSE OF TEST: Evaluation of Rubber Diaphragms / Round Kapton

PROCEDURE:

Color Code: Black – control

Blue – Rubber Diaphragm

Red – Round Kapton

L – .004" offset

H – .009" offset

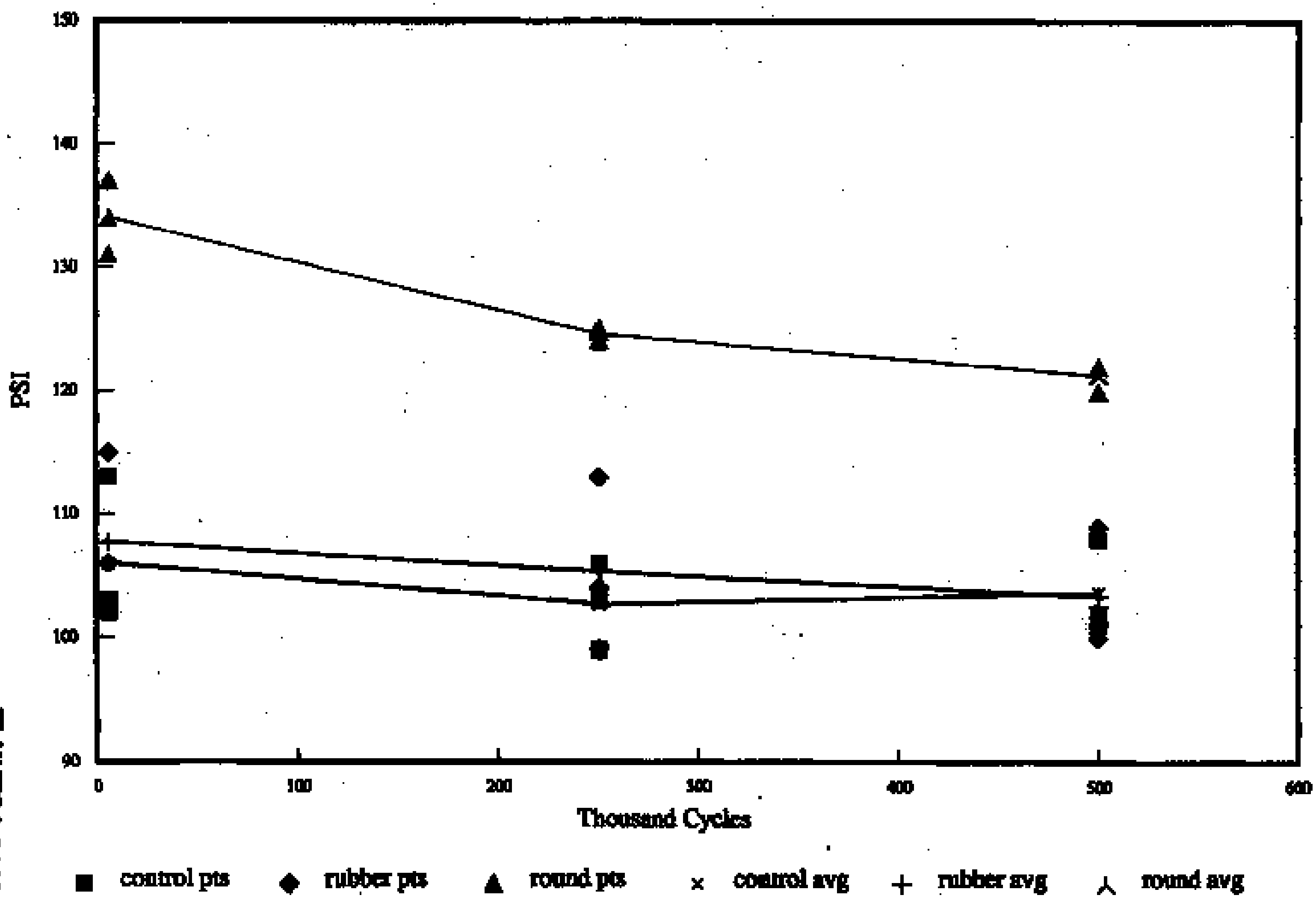
All devices subjected to .0006 PSIA vacuum for 60 sec.

Device #	Test	Seal	Offset	Init Act	Init Rel	Post Vacuum Act	Post Vacuum Rel	Final Act	Final Rel	Remarks			Δ	
322-15-01	Thermal	Acetal	.004"	126	103	118	107	119	93	T-56 [illegible]	111°C;		-9	-14
-02	Cycle			127	99	129	100	112	91	T-56 [illegible]	145°C;		-16	-9
-03				125	97	125	98	97	74	T-56 [illegible]	141°C;		-28	-24
												X̄	-18	-16
322-15-04			.009"	156	143	160	143	133	110				-27	-33
-05				210	203	234	205	161	136				-73	-69
-06				177	150	179	152	127	102				-52	-59
												X̄	-51	-52
322-15-07		Rubber	.004"	142	105	146	104	123	102	T-56 [illegible]	144°C;		-13	-2
-08		diaphragm		135	105	137	108	112	87	T-56 [illegible]	143°C;		-25	-19
-09				139	103	135	104	124	96	T-56 [illegible]	137°C;		-11	-8
												X̄	-16	-10
322-15-10			.009"	175	158	176	155	136	110				-40	-45
-11				180	156	186	162	143	115				-43	-47
-12				184	163	186	161	138	109				-46	-52
												X̄	-44	-48
322-15-13		Round	.004"	153	135	158	136	125	100				-33	-36
-14		Kapton		162	129	163	130	126	104				-37	-26
-15				154	129	157	129	—	—	Leak: 31 [illegible] Samples				
												X̄	-25	-31
322-15-16			.009"	293	260	306	274	191	151				-105	-123
-17				211	184	217	189	150	129				-67	-60
-18				266	234	278	240	179	124				-99	-108
												X̄	-87	-93

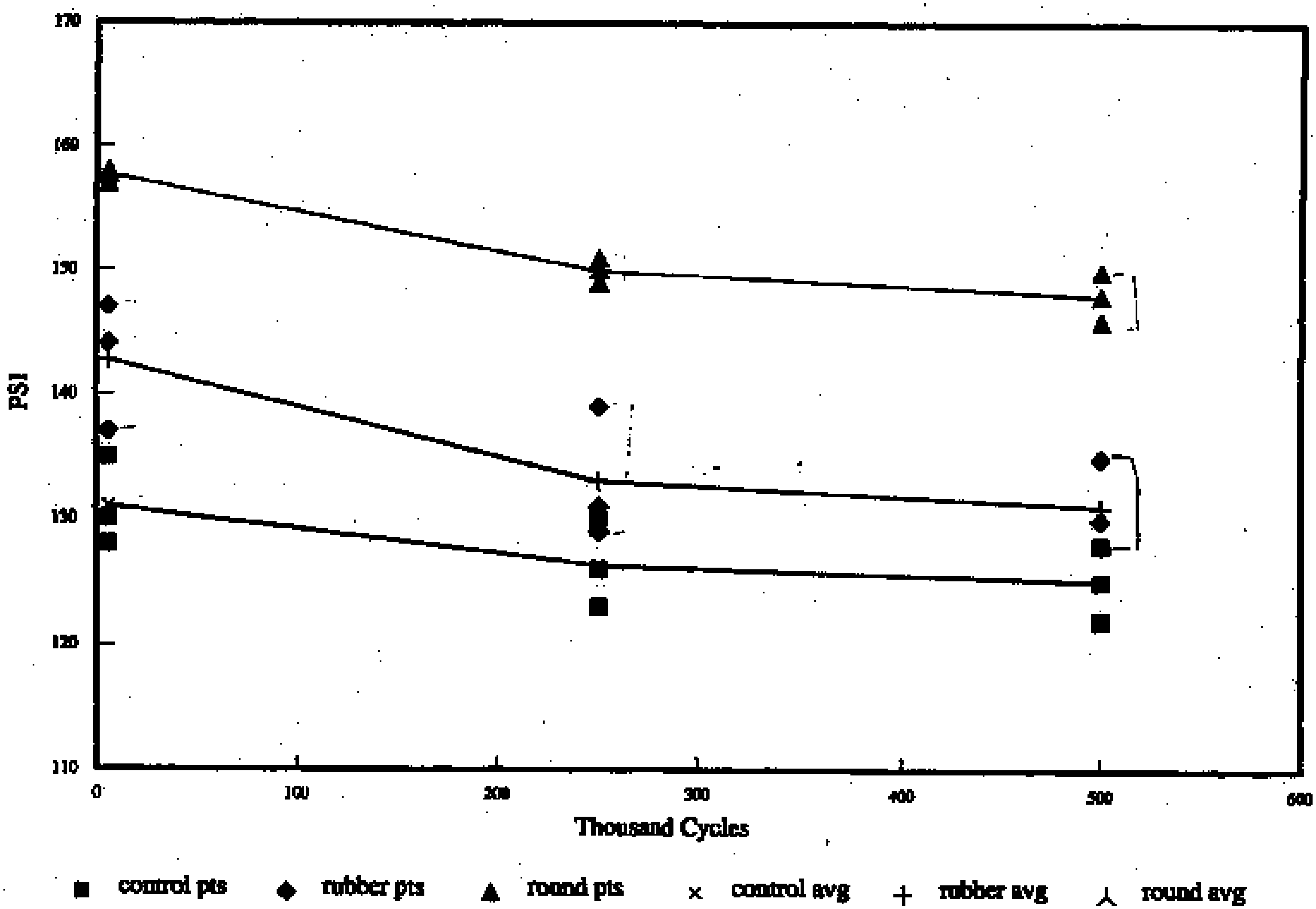
TI-NHTSA 011263

(OVER)

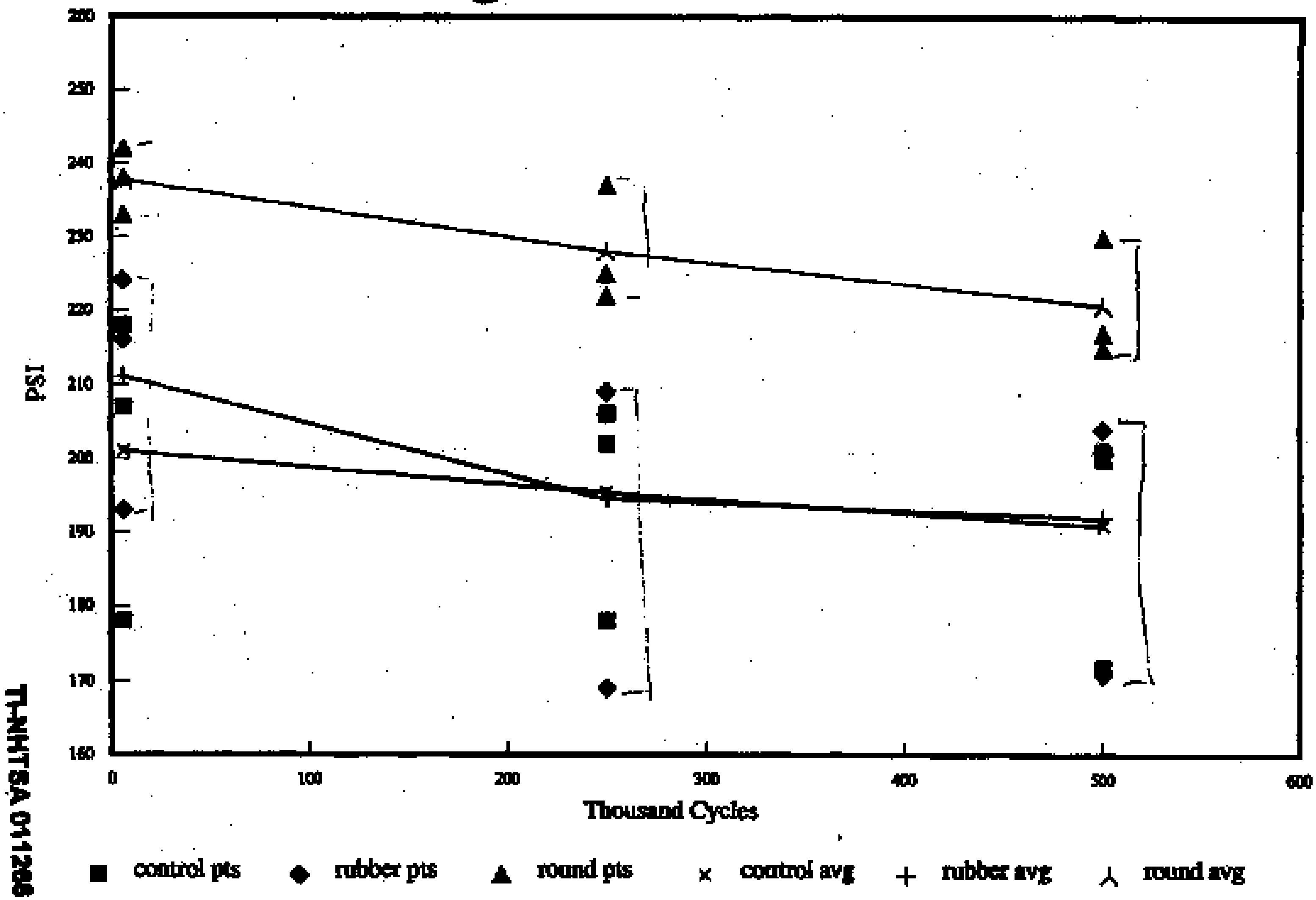
Low Pin Release



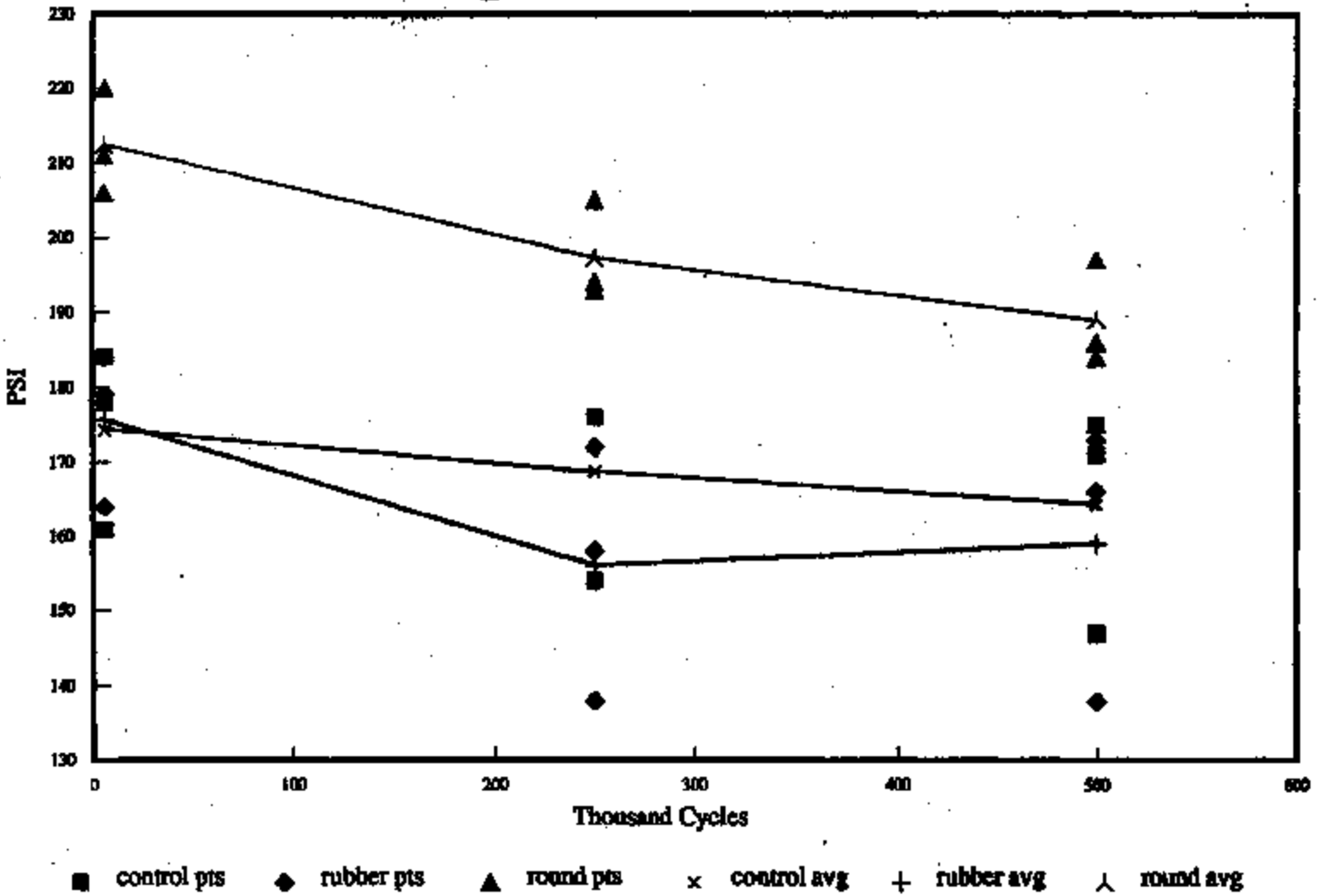
Low Pin Actuation



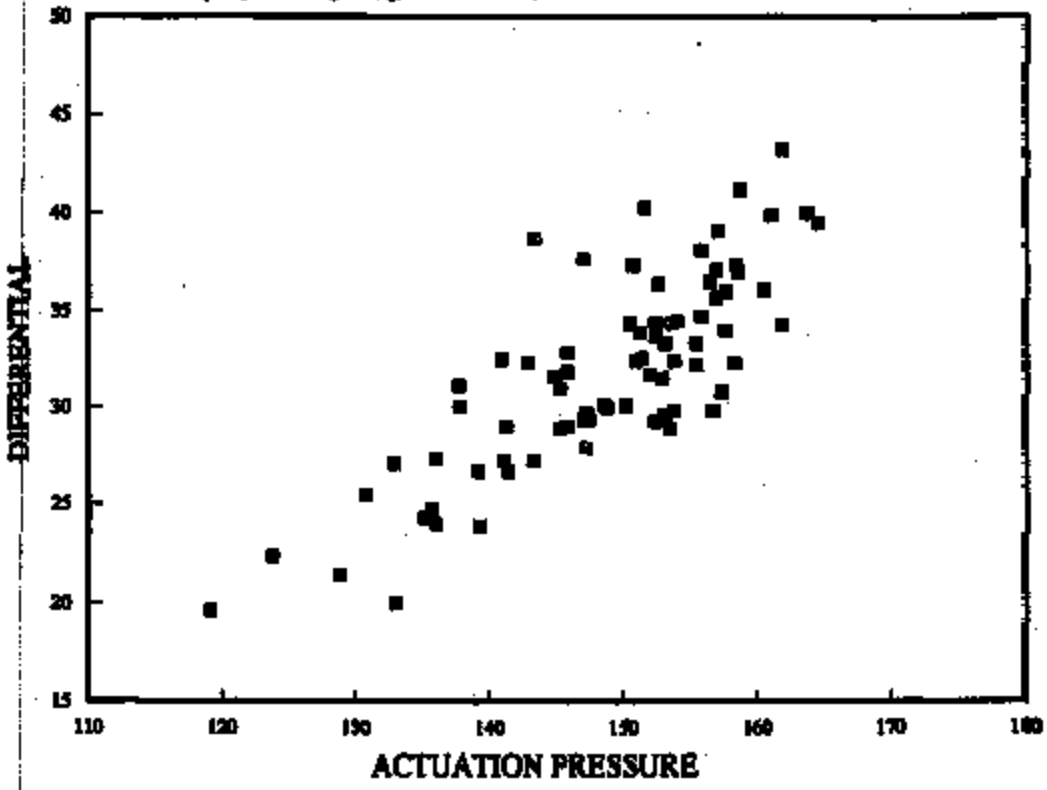
High Pin Actuation



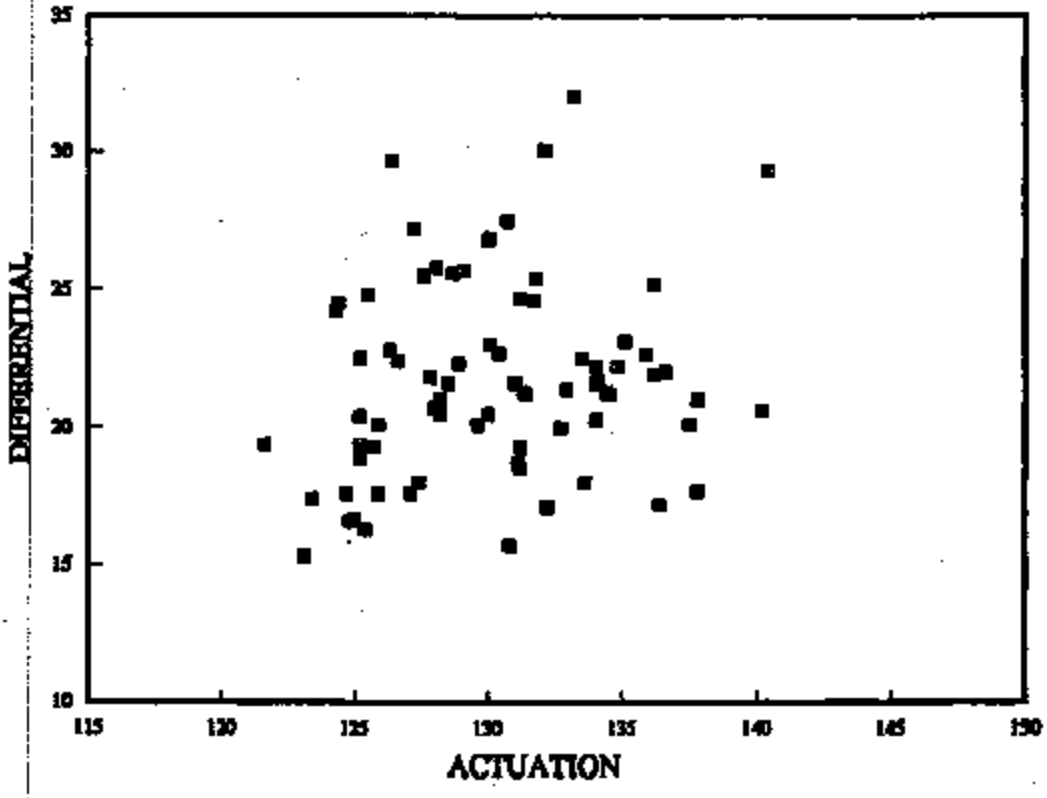
High Pin Release



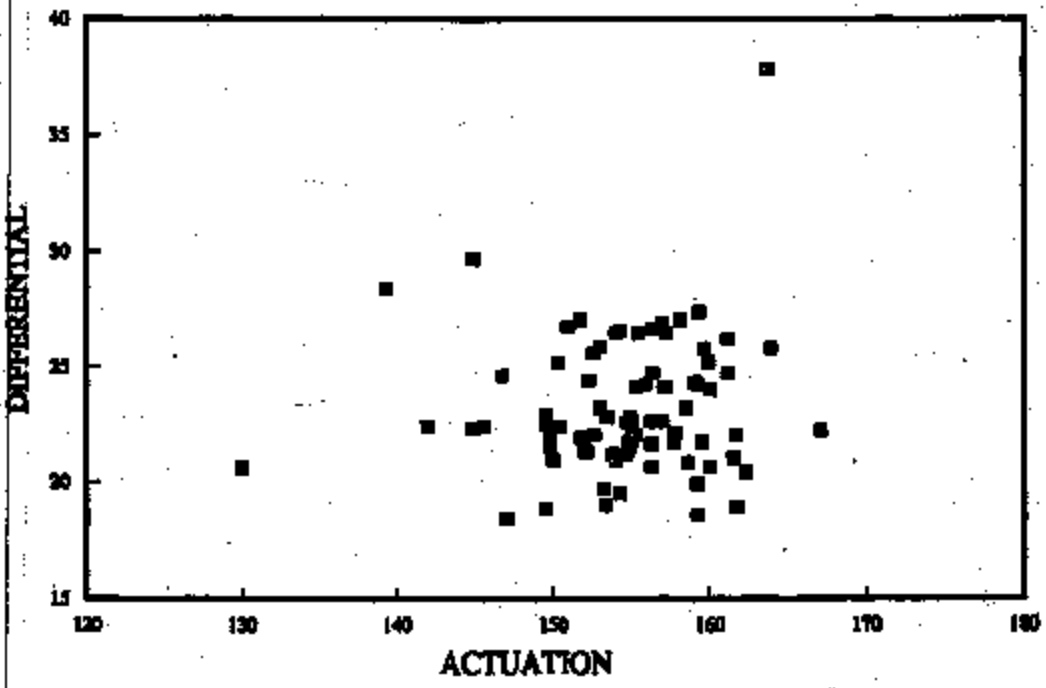
RUBBER DIA.


DIAMETRAL
50
45
40
35
30
25
20
15
110
120
130
140
150
160
170
180
ACTUATION PRESSURE

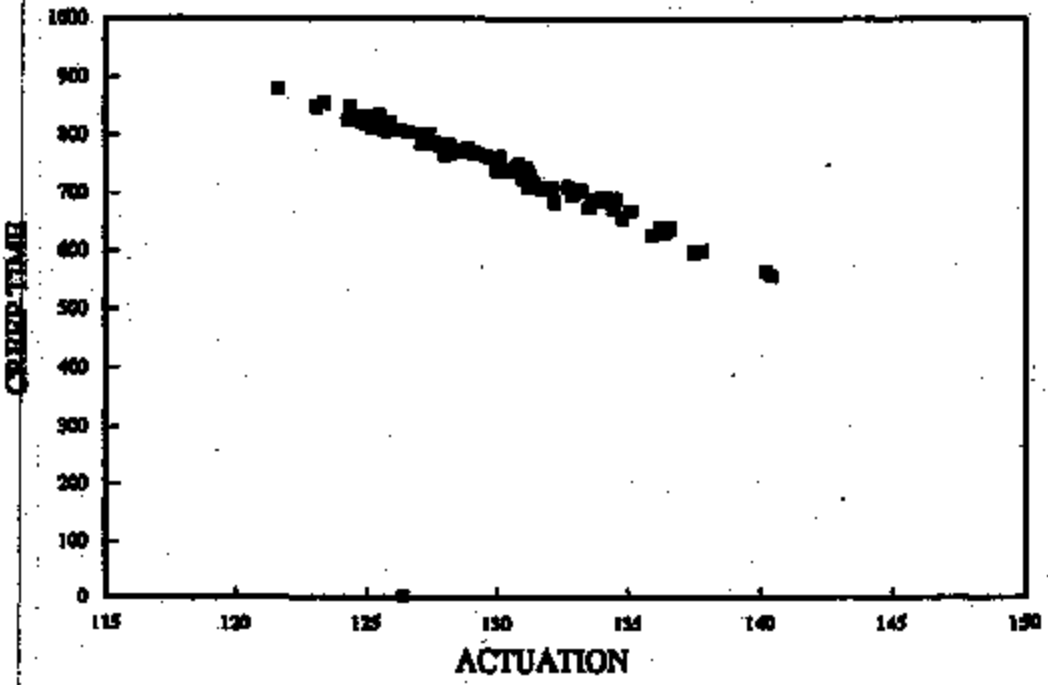
CONTROL LOT



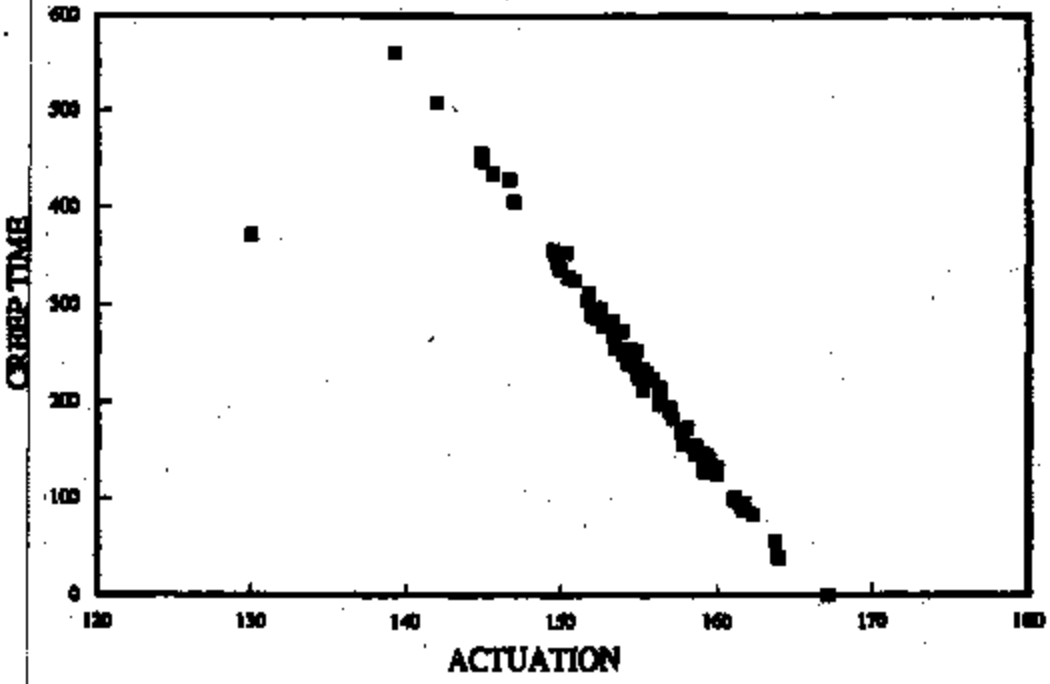
ROUND KAPTON



CONTROL LOT


CRUISE TIME
1000
900
800
700
600
500
400
300
200
100
0
115
120
125
130
135
140
145
150
ACTUATION

ROUND KAPTON



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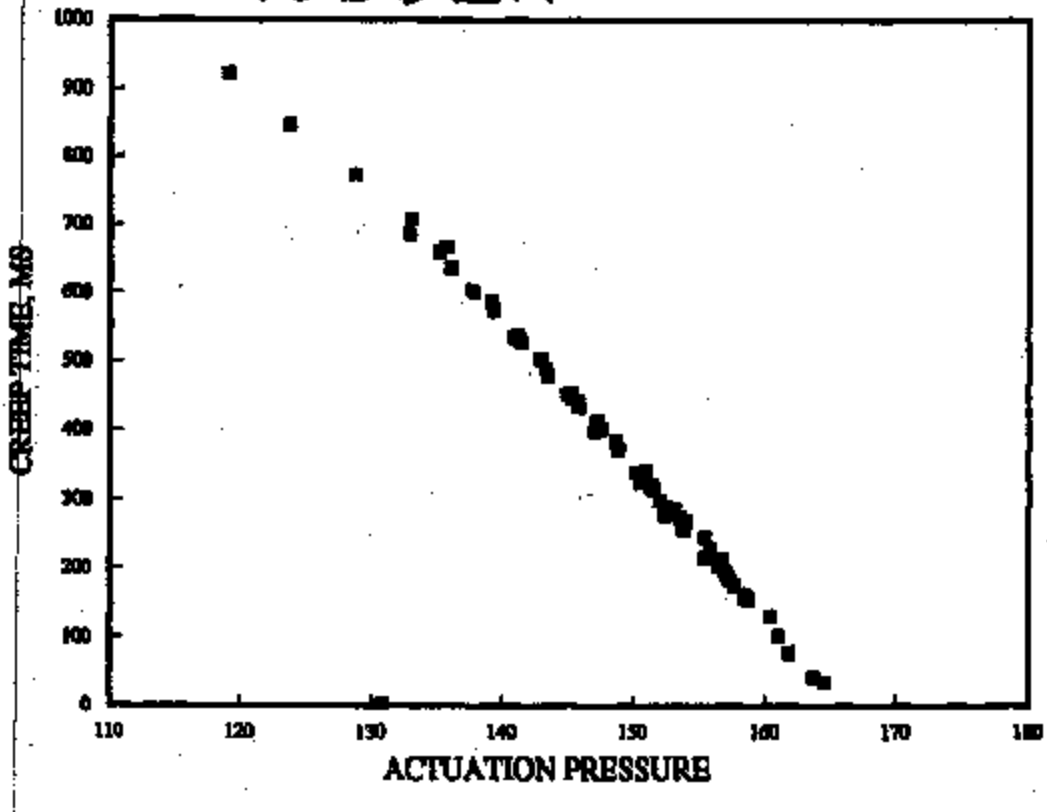

CREEP TIME, MS
1000
900
800
700
600
500
400
300
200
100
0
110
120
130
140
150
160
170
180
ACTUATION PRESSURE

GROUP: RUBBER DIAPHRAGM

(SORT BY ACT)

DEVICE	ACT	REL	DIF	ACTCR	RELCR	COMMEN
66	119.1	99.5	19.6	922.3	3847.8	
67	123.8	101.4	22.4	847.5	3897.3	
32	128.8	107.4	21.4	773.8	4023.0	
31	130.8	105.3	25.5	2.0	3971.3	ACCR
37	132.9	105.8	27.1	687.0	3981.3	
35	133.0	113.0	20.0	709.3	4160.3	
33	135.2	110.9	24.3	660.5	4103.5	
11	135.7	111.0	24.7	668.3	4082.5	
73	136.0	108.7	27.3	638.0	4053.3	
53	136.0	112.0	24.0	635.3	4155.0	
56	137.7	106.6	31.1	604.5	4027.3	
57	137.8	107.8	30.0	602.0	4036.8	
36	139.2	112.5	26.7	587.0	4150.5	
38	139.3	115.4	23.9	575.0	4227.5	
21	140.9	108.4	32.5	535.8	4056.3	
13	141.1	113.9	27.2	538.5	4185.5	
22	141.3	112.3	29.0	532.3	4147.5	
6	141.4	114.7	26.7	528.0	4174.3	
62	142.9	110.6	32.3	504.3	4115.8	
60	143.3	116.1	27.2	490.3	4226.5	
27	143.4	104.7	38.7	479.0	3957.8	
75	144.9	113.3	31.6	452.5	4178.5	
8	145.3	114.3	31.0	447.5	4170.8	
5	145.3	116.4	28.9	453.5	4216.0	
17	145.8	113.0	32.8	441.8	4164.0	
16	145.8	116.8	29.0	433.3	4245.0	
15	145.8	114.0	31.8	435.0	4188.0	
47	147.0	109.3	37.7	398.5	4091.0	
64	147.1	117.7	29.4	407.8	4276.5	
1	147.2	119.3	27.9	414.5	4262.5	
54	147.3	117.6	29.7	402.8	4273.5	
18	147.5	118.1	29.4	402.0	4283.8	
51	148.6	118.4	30.2	383.5	4291.0	
2	148.8	118.8	30.0	373.3	4254.0	
63	150.2	120.1	30.1	339.3	4324.5	ACHI
58	150.5	116.1	34.4	325.0	4226.8	ACHI
55	150.7	113.3	37.4	326.0	4179.5	ACHI
10	150.9	118.5	32.4	343.0	4265.3	ACHI
42	151.3	117.4	33.9	318.0	4254.0	ACHI
4	151.4	118.8	32.6	319.8	4261.0	ACHI
19	151.6	111.3	40.3	314.5	4131.0	ACHI
76	152.0	120.3	31.7	298.5	4327.0	ACHI
23	152.4	123.1	29.3	286.5	4389.0	ACHI
29	152.4	118.7	33.7	290.3	4287.8	ACHI
28	152.4	118.0	34.4	278.3	4262.0	ACHI
39	152.6	116.2	36.4	282.0	4241.0	ACHI
41	152.9	121.4	31.5	282.5	4349.5	ACHI
49	153.1	119.8	33.3	285.0	4316.8	ACHI
61	153.1	123.5	29.6	284.3	4409.5	ACHI
26	153.5	124.6	28.9	273.3	4407.3	ACHI
20	153.6	119.2	34.4	266.8	4303.5	ACHI
74	153.8	124.0	29.8	256.3	4406.8	ACHI

	43	153.8	121.4	32.4	260.5	4348.8	ACHI
	9	154.0	119.5	34.5	268.5	4295.3	ACHI
	25	155.4	123.2	32.2	215.8	4379.8	ACHI
	12	155.4	122.1	33.3	244.8	4337.3	ACHI
	40	155.8	117.7	38.1	228.3	4264.0	ACHI
	48	155.8	121.1	34.7	223.0	4346.5	ACHI
	30	156.4	119.9	36.5	203.0	4306.0	ACHI
	68	156.7	126.9	29.8	213.0	4479.8	ACHI
	65	156.9	121.2	35.7	196.8	4356.5	ACCR
	52	156.9	119.8	37.1	196.8	4311.3	ACCR
	44	157.1	118.0	39.1	187.3	4279.3	ACCR
	7	157.3	126.5	30.8	183.0	4426.8	ACCR
	14	157.6	123.6	34.0	174.3	4388.8	ACCR
	34	157.6	121.6	36.0	175.3	4348.3	ACCR
	24	158.3	126.0	32.3	161.0	4448.0	ACCR
	72	158.4	121.0	37.4	155.0	4345.0	ACCR
	3	158.5	121.5	37.0	157.5	4316.0	ACCR
	59	158.7	117.5	41.2	153.8	4256.5	ACCR
	50	160.4	124.3	36.1	130.8	4407.0	ACCR
	46	161.0	121.1	39.9	102.8	4341.0	ACCR
	70	161.8	118.6	43.2	79.3	4301.3	ACCR
	69	161.8	127.5	34.3	77.0	4471.8	ACCR
	71	163.7	123.7	40.0	41.3	4399.0	ACCR
	45	164.5	125.0	39.5	34.3	4427.5	ACCR
AVG		148.7	116.8	31.8	355.1	4242.1	
STD		9.4	6.1	5.0	199.9	136.8	

GROUP: FULL ROUND KAPTON

(SORT BY ACT)

DEVICE	ACT	REL	DIF	ACTCR	RELCR	COMMEN
80	130.0	109.4	20.6	372.0	869.5	
78	139.3	110.9	28.4	561.3	4126.8	
49	142.0	119.6	22.4	508.3	4302.0	
58	144.9	115.2	29.7	457.8	4224.3	
45	144.9	122.6	22.3	448.3	4363.0	
73	145.6	123.2	22.4	435.5	4369.8	
10	146.7	122.1	24.6	428.8	4357.0	
25	147.0	128.6	18.4	405.5	4467.3	
23	149.5	130.7	18.8	356.5	4526.0	
61	149.6	127.1	22.5	355.0	4433.8	
14	149.6	126.7	22.9	353.3	4450.0	
35	149.8	128.3	21.5	349.8	4446.8	
36	149.8	127.7	22.1	342.8	4476.8	
44	150.0	129.1	20.9	336.3	4498.0	
42	150.3	125.1	25.2	354.3	4419.3	ACHI
15	150.5	128.1	22.4	328.0	4473.3	ACHI
3	150.9	124.1	26.8	325.5	4395.5	ACHI
12	151.7	124.6	27.1	305.3	4403.5	ACHI
41	151.8	129.9	21.9	311.8	4506.3	ACHI
7	152.0	130.7	21.3	289.0	4538.8	ACHI
5	152.0	130.4	21.6	290.0	4529.8	ACHI
62	152.2	130.9	21.3	288.0	4519.0	ACHI
56	152.3	127.9	24.4	296.3	4494.8	ACHI
2	152.6	127.0	25.6	294.5	4458.8	ACHI
4	152.7	130.7	22.0	279.0	4533.0	ACHI
70	153.0	129.8	23.2	280.0	4520.0	ACHI
68	153.0	127.1	25.9	281.5	4461.8	ACHI
16	153.3	133.6	19.7	283.0	4588.0	ACHI
29	153.4	134.4	19.0	266.3	4612.5	ACHI
51	153.5	130.7	22.8	256.0	4536.8	ACHI
18	153.8	132.6	21.2	272.3	4565.8	ACHI
79	154.0	133.1	20.9	249.5	4593.3	ACHI
71	154.0	127.5	26.5	273.8	4471.3	ACHI
27	154.3	127.7	26.6	253.8	4441.0	ACHI
59	154.3	134.8	19.5	239.8	4630.5	ACHI
17	154.7	132.1	22.6	249.3	4560.3	ACHI
69	154.7	133.5	21.2	237.0	4599.5	ACHI
40	154.8	133.1	21.7	253.3	4574.3	ACHI
60	154.9	133.4	21.5	228.5	4569.5	ACHI
32	154.9	132.1	22.8	228.8	4527.8	ACHI
26	155.0	133.2	21.8	225.0	4548.0	ACHI
30	155.1	132.7	22.4	230.3	4589.3	ACHI
6	155.1	132.5	22.6	227.3	4570.0	ACHI
37	155.3	133.3	22.0	212.3	4585.8	ACHI
22	155.3	131.2	24.1	233.5	4533.8	ACHI
19	155.5	129.0	26.5	229.8	4491.5	ACHI
74	155.9	131.7	24.2	222.3	4535.5	ACHI
52	156.3	134.7	21.6	211.3	4612.3	ACHI
67	156.3	133.7	22.6	209.0	4603.3	ACHI
33	156.3	135.7	20.6	198.8	4607.8	ACCR
8	156.4	129.7	26.7	213.8	4501.5	ACHI
50	156.4	131.7	24.7	200.8	4559.5	ACHI

64	157.0	130.1	26.9	193.8	4531.8	ACCR
20	157.0	134.4	22.6	191.0	4598.0	ACCR
31	157.1	133.0	24.1	188.5	4595.5	ACCR
21	157.2	130.7	26.5	182.3	4528.5	ACCR
48	157.7	136.0	21.7	169.3	4636.0	ACCR
34	157.8	135.7	22.1	156.0	4609.5	ACCR
9	158.1	131.0	27.1	172.5	4532.8	ACCR
76	158.5	135.3	23.2	153.8	4637.8	ACCR
72	158.6	137.8	20.8	154.8	3393.3	ACCR
75	158.6	137.8	20.8	145.3	4724.8	ACCR
55	159.0	134.7	24.3	147.5	4615.5	ACCR
28	159.2	139.3	19.9	125.8	4700.3	ACCR
63	159.2	140.6	18.6	136.8	4693.3	ACCR
39	159.2	135.0	24.2	135.8	4612.5	ACCR
53	159.3	131.9	27.4	144.3	4559.3	ACCR
1	159.5	137.8	21.7	139.3	4660.8	ACCR
47	159.6	133.8	25.8	125.3	4584.3	ACCR
54	159.9	134.7	25.2	129.5	4620.3	ACCR
38	160.0	136.0	24.0	124.0	4641.0	ACCR
57	160.0	139.4	20.6	132.5	4717.0	ACCR
13	161.1	136.4	24.7	100.0	4640.3	ACCR
46	161.1	134.9	26.2	99.0	4609.8	ACCR
24	161.5	140.5	21.0	91.5	0.3	ACCR
11	161.7	139.7	22.0	95.3	4699.3	ACCR
77	161.7	142.8	18.9	87.3	4835.8	ACCR
43	162.3	141.9	20.4	83.3	4805.0	ACCR
81	163.7	125.9	37.8	54.5	1220.3	ACCR
65	163.9	138.1	25.8	37.5	4683.8	ACCR
66	167.1	144.9	22.2	0.0	4836.3	CONT
	154.6	131.4	23.2	237.5	4391.3	
	5.7	6.2	3.0	108.4	751.3	

GROUICONTROL
(SORT BY REL, #26 AND #10 REMOVED FROM STATS)

DEVICE	ACT	REL	DIF	ACTCR	RELCR	COMMEN
26	126.4	96.7	29.7	2.0	3775.5	ACCR
2	124.4	99.9	24.5	850.0	3839.8	
62	127.2	100.0	27.2	803.8	3877.3	
19	124.3	100.1	24.2	828.0	3874.8	
47	125.5	100.7	24.8	834.5	3854.0	
24	133.2	101.1	32.1	707.0	3874.0	
43	132.1	102.0	30.1	709.8	3897.0	
36	127.6	102.1	25.5	787.3	3898.3	
63	121.6	102.2	19.4	881.5	3922.8	
33	128.1	102.3	25.8	785.0	3916.3	
21	125.2	102.7	22.5	833.3	3906.5	
40	128.7	103.1	25.6	773.8	3930.0	
70	130.7	103.2	27.5	745.0	3939.5	
1	130.1	103.2	26.9	764.8	3924.8	
11	130.0	103.2	26.8	761.3	3889.8	
61	129.1	103.4	25.7	771.3	3967.3	
49	126.3	103.5	22.8	810.0	3938.8	
30	126.6	104.2	22.4	807.8	3950.3	
65	125.2	104.8	20.4	815.0	3973.3	
13	125.9	105.8	20.1	816.0	4011.0	
66	125.2	105.8	19.4	812.3	3993.0	
29	123.4	106.0	17.4	857.3	3989.5	
31	127.8	106.0	21.8	785.8	3987.8	
34	125.2	106.3	18.9	827.0	3998.5	
57	125.7	106.4	19.3	808.0	4016.0	
59	131.8	106.4	25.4	712.0	4014.0	
44	131.2	106.5	24.7	733.3	4012.0	
23	128.9	106.6	22.3	779.3	4008.3	
5	128.5	106.9	21.6	772.8	4034.3	
67	131.7	107.1	24.6	709.5	4036.8	
27	130.1	107.1	23.0	762.8	4026.0	
38	124.7	107.1	17.6	832.3	4025.8	
64	128.2	107.2	21.0	782.5	4058.8	
42	128.0	107.3	20.7	766.5	4033.8	
45	128.2	107.7	20.5	782.3	4044.8	
7	130.4	107.7	22.7	740.3	4049.8	
69	123.1	107.8	15.3	850.3	4043.8	
72	124.8	108.2	16.6	826.0	4065.5	
16	125.9	108.3	17.6	824.0	4070.3	
52	125.0	108.3	16.7	820.5	4057.3	
71	125.4	109.1	16.3	821.0	4089.3	
56	127.4	109.4	18.0	803.0	4089.0	
51	131.0	109.4	21.6	726.0	4080.5	
41	127.1	109.5	17.6	786.5	4088.8	
4	129.6	109.5	20.1	766.3	4077.3	
17	130.0	109.5	20.5	740.5	4104.0	
14	131.3	110.0	21.3	730.0	4110.3	
18	131.4	110.2	21.2	717.8	4124.3	
37	136.2	111.0	25.2	640.8	4112.3	
20	133.5	111.0	22.5	677.0	4148.0	
55	140.4	111.1	29.3	557.8	4128.3	
6	132.9	111.5	21.4	697.3	4148.0	

	54	134.0	111.8	22.2	693.5	4143.0	
	76	131.2	111.9	19.3	711.3	4146.5	
	22	135.1	112.0	23.1	670.5	4150.5	
	12	131.1	112.4	18.7	744.3	4106.5	
	39	134.0	112.4	21.6	688.8	4133.8	
	9	134.1	112.4	21.7	687.8	4105.0	
	50	134.8	112.6	22.2	657.8	4154.8	
	32	132.7	112.7	20.0	711.3	4149.5	
	3	131.2	112.7	18.5	739.0	4142.0	
	46	134.4	113.1	21.3	673.3	4175.5	
	74	135.9	113.3	22.6	626.8	4179.0	
	28	134.5	113.3	21.2	691.0	4181.3	
	53	134.0	113.7	20.3	687.3	4187.3	
	68	136.2	114.3	21.9	629.5	4202.8	
	15	136.6	114.6	22.0	638.8	4212.5	
	35	130.8	115.1	15.7	751.8	4194.3	
	73	132.2	115.1	17.1	685.5	4211.3	
	48	133.6	115.6	18.0	688.0	4228.8	
	58	137.8	116.8	21.0	600.0	4253.8	
	75	137.5	117.4	20.1	598.5	4267.8	
	8	136.4	119.2	17.2	631.8	4314.5	
	25	140.2	119.6	20.6	564.5	4330.8	
	60	137.8	120.1	17.7	600.8	4325.3	
	10	167.4	149.9	17.5	0.0	24.3	CONT
avg		130.3	108.7	21.6	742.0	4064.2	
std		4.3	4.9	3.4	74.6	117.1	

GROUCONTROL
(SORT BY ACT, REMOVE #10 FROM STATS)

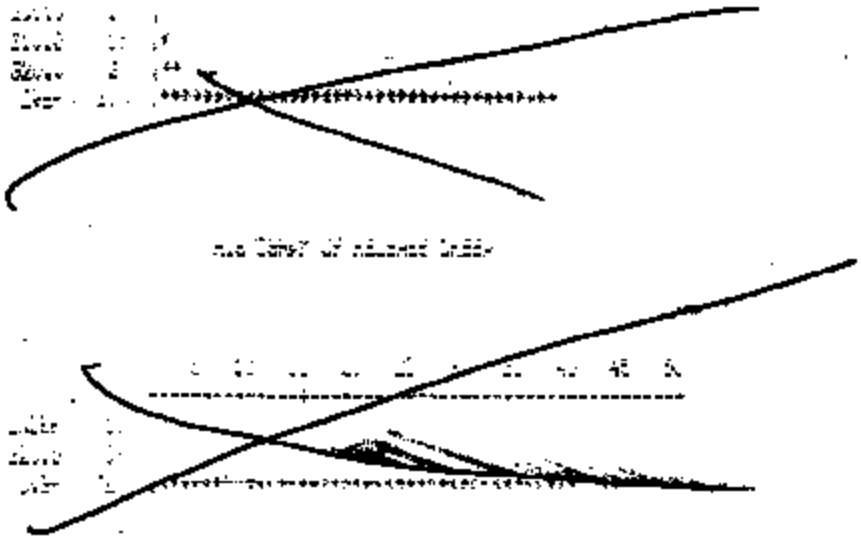
DEVICE	ACT	REL	DIF	ACTCR	RELCR	COMMEN
63	121.6	102.2	19.4	881.5	3922.8	
69	123.1	107.8	15.3	850.3	4043.8	
29	123.4	106.0	17.4	857.3	3989.5	
19	124.3	100.1	24.2	828.0	3874.8	
2	124.4	99.9	24.5	850.0	3839.8	
38	124.7	107.1	17.6	832.3	4025.8	
72	124.8	108.2	16.6	826.0	4065.5	
52	125.0	108.3	16.7	820.5	4057.3	
21	125.2	102.7	22.5	833.3	3906.5	
34	125.2	106.3	18.9	827.0	3998.5	
66	125.2	105.8	19.4	812.3	3993.0	
65	125.2	104.8	20.4	815.0	3973.3	
71	125.4	109.1	16.3	821.0	4089.3	
47	125.5	100.7	24.8	834.5	3854.0	
57	125.7	106.4	19.3	808.0	4016.0	
13	125.9	105.8	20.1	816.0	4011.0	
16	125.9	108.3	17.6	824.0	4070.3	
49	126.3	103.5	22.8	810.0	3938.8	
26	126.4	96.7	29.7	2.0	3775.5	ACCR
30	126.6	104.2	22.4	807.8	3950.3	
41	127.1	109.5	17.6	786.5	4088.8	
62	127.2	100.0	27.2	803.8	3877.3	
56	127.4	109.4	18.0	803.0	4089.0	
36	127.6	102.1	25.5	787.3	3898.3	
31	127.8	106.0	21.8	785.8	3987.8	
42	128.0	107.3	20.7	766.5	4033.8	
33	128.1	102.3	25.8	785.0	3916.3	
64	128.2	107.2	21.0	782.5	4058.8	
45	128.2	107.7	20.5	782.3	4044.8	
5	128.5	106.9	21.6	772.8	4034.3	
40	128.7	103.1	25.6	773.8	3930.0	
23	128.9	106.6	22.3	779.3	4008.3	
61	129.1	103.4	25.7	771.3	3967.3	
4	129.6	109.5	20.1	766.3	4077.3	
17	130.0	109.5	20.5	740.5	4104.0	
11	130.0	103.2	26.8	761.3	3889.8	
1	130.1	103.2	26.9	764.8	3924.8	
27	130.1	107.1	23.0	762.8	4026.0	
7	130.4	107.7	22.7	740.3	4049.8	
70	130.7	103.2	27.5	745.0	3939.5	
35	130.8	115.1	15.7	751.8	4194.3	
51	131.0	109.4	21.6	726.0	4080.5	
12	131.1	112.4	18.7	744.3	4106.5	
76	131.2	111.9	19.3	711.3	4146.5	
44	131.2	106.5	24.7	733.3	4012.0	
3	131.2	112.7	18.5	739.0	4142.0	
14	131.3	110.0	21.3	730.0	4110.3	
18	131.4	110.2	21.2	717.8	4124.3	
67	131.7	107.1	24.6	709.5	4036.8	
59	131.8	106.4	25.4	712.0	4014.0	
43	132.1	102.0	30.1	709.8	3897.0	
73	132.2	115.1	17.1	685.5	4211.3	

	32	132.7	112.7	20.0	711.3	4149.5	
	6	132.9	111.5	21.4	697.3	4148.0	
	24	133.2	101.1	32.1	707.0	3874.0	
	20	133.5	111.0	22.5	677.0	4148.0	
	48	133.6	115.6	18.0	688.0	4228.8	
	39	134.0	112.4	21.6	686.8	4133.8	
	53	134.0	113.7	20.3	687.3	4187.3	
	54	134.0	111.8	22.2	693.5	4143.0	
	9	134.1	112.4	21.7	687.8	4105.0	
	46	134.4	113.1	21.3	673.3	4175.5	
	28	134.5	113.3	21.2	691.0	4181.3	
	50	134.8	112.6	22.2	657.8	4154.8	
	22	135.1	112.0	23.1	670.5	4150.5	
	74	135.9	113.3	22.6	626.8	4179.0	
	37	136.2	111.0	25.2	640.8	4112.3	
	68	136.2	114.3	21.9	629.5	4202.8	
	8	136.4	119.2	17.2	631.8	4314.5	
	15	136.6	114.6	22.0	638.8	4212.5	
	75	137.5	117.4	20.1	598.5	4267.8	
	60	137.8	120.1	17.7	600.8	4325.3	
	58	137.8	116.8	21.0	600.0	4253.8	
	25	140.2	119.6	20.6	564.5	4330.8	
	55	140.4	111.1	29.3	557.8	4128.3	
	10	167.4	149.9	17.5	0.0	24.3	CONT
avg		130.2	108.5	21.7	732.1	4060.3	
std		4.3	5.1	3.5	112.7	121.0	

GROUP: CONTROL

DEVICE	ACT	REL	DIF	ACTCR	RELCR
1	130.1	103.2	26.9	764.8	3924.8
2	124.4	99.9	24.5	950.0	3839.8
3	131.2	112.7	18.5	739.0	4142.0
4	129.6	109.5	20.1	766.3	4077.3
5	128.5	106.9	21.6	772.8	4034.3
6	132.9	111.5	21.4	697.3	4148.0
7	130.4	107.7	22.7	740.3	4049.8
8	136.4	119.2	17.2	631.8	4314.5
9	134.1	112.4	21.7	687.8	4105.0
10	167.4	149.9	17.5	0.0	24.3
11	130.0	103.2	26.8	761.3	3889.8
12	131.1	112.4	18.7	744.3	4106.5
13	125.9	105.8	20.1	816.0	4011.0
14	131.3	110.0	21.3	730.0	4110.3
15	136.6	114.6	22.0	638.8	4212.5
16	125.9	108.3	17.6	824.0	4070.3
17	130.0	109.5	20.5	740.5	4104.0
18	131.4	110.2	21.2	717.8	4124.3
19	124.3	100.1	24.2	928.0	3874.8
20	139.5	111.0	22.5	677.0	4148.0
21	125.2	102.7	22.5	933.3	3906.5
22	135.1	112.0	23.1	670.5	4150.5
23	128.9	106.6	22.3	779.3	4008.3
24	133.2	101.1	32.1	707.0	3874.0
25	140.2	119.6	20.6	564.5	4330.8
26	126.4	96.7	29.7	2.0	3775.5
27	130.1	107.1	23.0	762.8	4026.0
28	134.5	113.3	21.2	691.0	4181.3
29	123.4	106.0	17.4	957.3	3969.5
30	126.6	104.2	22.4	807.8	3950.3
31	127.8	106.0	21.8	785.8	3987.8
32	132.7	112.7	20.0	711.3	4149.5
33	128.1	102.3	25.8	785.0	3916.3
34	125.2	106.3	18.9	827.0	3998.5
35	130.8	115.1	15.7	751.8	4194.3
36	127.6	102.1	25.5	787.3	3898.3
37	136.2	111.0	25.2	640.8	4112.3
38	124.7	107.1	17.6	832.3	4025.8
39	134.0	112.4	21.6	688.8	4133.8
40	128.7	103.1	25.6	779.8	3930.0
41	127.1	109.5	17.6	786.5	4088.8
42	128.0	107.3	20.7	766.5	4033.8
43	132.1	102.0	30.1	709.8	3897.0
44	131.2	106.5	24.7	733.3	4012.0
45	128.2	107.7	20.5	782.3	4044.8
46	134.4	113.1	21.3	673.3	4175.5
47	125.5	100.7	24.8	834.5	3854.0
48	139.6	115.6	18.0	666.0	4228.8
49	126.3	103.5	22.8	810.0	3938.8
50	134.8	112.6	22.2	657.8	4154.8
51	131.0	109.4	21.6	726.0	4080.5
52	125.0	108.3	16.7	820.5	4057.3

53	134.0	113.7	20.3	687.3	4187.3
54	134.0	111.8	22.2	693.5	4149.0
55	140.4	111.1	29.3	557.8	4126.3
56	127.4	109.4	18.0	803.0	4089.0
57	125.7	106.4	19.3	808.0	4016.0
58	137.8	116.8	21.0	600.0	4253.8
59	131.8	106.4	25.4	712.0	4014.0
60	137.8	120.1	17.7	600.8	4325.3
61	129.1	103.4	25.7	771.3	3967.3
62	127.2	100.0	27.2	803.8	3877.3
63	121.6	102.2	19.4	881.5	3922.8
64	128.2	107.2	21.0	782.5	4058.8
65	125.2	104.8	20.4	815.0	3973.3
66	125.2	105.8	19.4	812.3	3993.0
67	131.7	107.1	24.6	709.5	4036.8
68	136.2	114.3	21.9	629.5	4202.8
69	123.1	107.8	15.3	850.3	4043.8
70	130.7	103.2	27.5	745.0	3939.5
71	125.4	109.1	16.3	821.0	4089.3
72	124.8	108.2	16.6	826.0	4065.5
73	132.2	115.1	17.1	695.5	4211.3
74	135.9	113.3	22.6	626.8	4179.0
75	137.5	117.4	20.1	598.5	4267.8
76	131.2	111.9	19.3	711.9	4146.5
77					
78					
79					
80					
81					



Control Group

[illegible]

[illegible] MARG=42.7; LEAK RATE= 0.6
[illegible] 112.4; [illegible] ACTD= 667.6ms; RELDK= 4105.0

[illegible]

[illegible]

[illegible] MARG=42.7; LEAK RATE= 0.6
[illegible] 746.3ms; [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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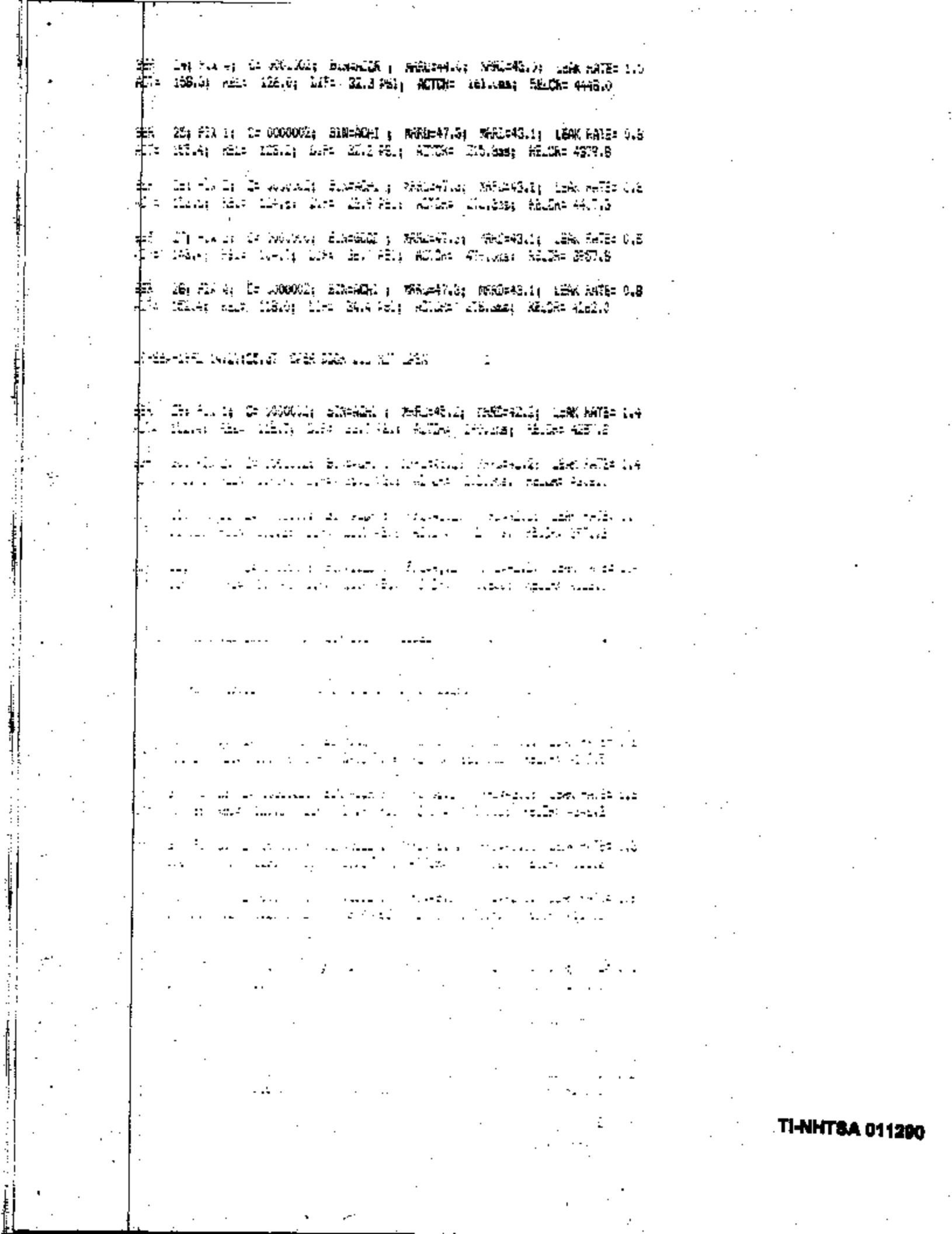
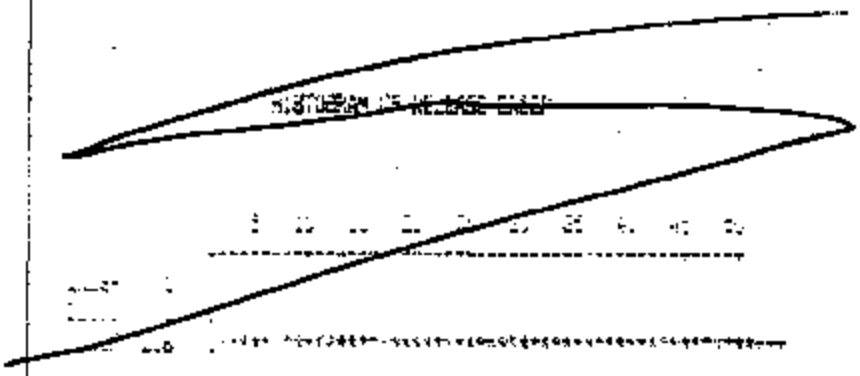
Rubber Diaphragms



GROUP: RUBBER DIAPHRAGM

DEVICE	ACT	REL	DIF	ACTCR	RELCR
1	147.2	119.3	27.9	414.5	4262.5
2	148.8	118.8	30.0	373.3	4254.0
3	158.5	121.5	37.0	157.5	4316.0
4	151.4	118.8	32.6	319.8	4261.0
5	145.3	116.4	28.9	459.5	4216.0
6	141.4	114.7	26.7	528.0	4174.3
7	157.3	126.5	30.8	183.0	4426.8
8	145.3	114.3	31.0	447.5	4170.8
9	154.0	119.5	34.5	268.5	4295.3
10	150.9	118.5	32.4	343.0	4265.3
11	135.7	111.0	24.7	668.3	4082.5
12	155.4	122.1	33.3	244.8	4337.3
13	141.1	113.9	27.2	538.5	4185.5
14	157.6	123.6	34.0	174.3	4388.8
15	145.8	114.0	31.8	435.0	4188.0
16	145.8	116.8	29.0	433.3	4245.0
17	145.8	113.0	32.8	441.8	4164.0
18	147.5	118.1	29.4	402.0	4283.8
19	151.6	111.3	40.3	314.5	4131.0
20	153.6	119.2	34.4	266.8	4303.5
21	140.9	106.4	32.5	535.8	4056.3
22	141.3	112.3	29.0	532.3	4147.5
23	152.4	123.1	29.3	286.5	4389.0
24	158.3	126.0	32.3	161.0	4448.0
25	155.4	123.2	32.2	215.8	4379.8
26	153.5	124.6	28.9	273.3	4407.3
27	143.4	104.7	38.7	479.0	3957.8
28	152.4	118.0	34.4	278.3	4262.0
29	152.4	118.7	33.7	290.3	4287.8
30	156.4	119.9	36.5	203.0	4306.0
31	130.8	105.3	25.5	2.0	3971.3
32	128.8	107.4	21.4	773.8	4023.0
33	135.2	110.9	24.3	660.5	4103.5
34	157.6	121.6	36.0	175.3	4348.3
35	133.0	113.0	20.0	709.3	4160.3
36	139.2	112.5	26.7	587.0	4150.5
37	132.9	105.8	27.1	687.0	3981.3
38	139.3	115.4	23.9	575.0	4227.5
39	152.6	116.2	36.4	282.0	4241.0
40	155.8	117.7	38.1	226.3	4264.0
41	152.9	121.4	31.5	282.5	4349.5
42	151.3	117.4	33.9	318.0	4254.0
43	153.8	121.4	32.4	260.5	4348.8
44	157.1	118.0	39.1	187.3	4279.3
45	164.5	125.0	39.5	34.3	4427.5
46	161.0	121.1	39.9	102.8	4341.0
47	147.0	109.3	37.7	398.5	4091.0
48	155.8	121.1	34.7	223.0	4346.5
49	153.1	119.8	33.3	285.0	4316.8
50	160.4	124.3	36.1	130.8	4407.0
51	148.6	118.4	30.2	383.5	4291.0
52	156.9	119.8	37.1	196.8	4311.3

53	136.0	112.0	24.0	635.3	4155.0
54	147.3	117.6	29.7	402.8	4273.5
55	150.7	113.3	37.4	326.0	4179.5
56	137.7	106.6	31.1	604.5	4027.3
57	137.8	107.8	30.0	602.0	4036.8
58	150.5	116.1	34.4	325.0	4226.8
59	158.7	117.5	41.2	153.8	4256.5
60	143.3	116.1	27.2	490.3	4226.5
61	153.1	123.5	29.6	284.3	4409.5
62	142.9	110.6	32.3	504.3	4115.8
63	150.2	120.1	30.1	339.3	4324.5
64	147.1	117.7	29.4	407.8	4276.5
65	156.9	121.2	35.7	196.8	4356.5
66	119.1	99.5	19.6	922.3	3847.8
67	123.8	101.4	22.4	847.5	3897.3
68	156.7	126.9	29.8	213.0	4479.8
69	161.8	127.5	34.3	77.0	4471.8
70	161.8	118.6	43.2	79.3	4301.3
71	163.7	123.7	40.0	41.3	4399.0
72	158.4	121.0	37.4	155.0	4345.0
73	136.0	108.7	27.3	638.0	4053.3
74	153.8	124.0	29.8	256.3	4404.8
75	144.9	113.3	31.6	452.5	4178.5
76	152.0	120.3	31.7	299.5	4327.0
77					



Round Kapton

[illegible] 9 / [illegible] LEAK RATE= [illegible]
[illegible] 95.0ms; [illegible]

[illegible]-1992 [illegible]:24.51 OPEN DOOR DID NOT CLOSE 1

[illegible] DID NOT CLOSE

[illegible]

[illegible] 12 / [illegible] LEAK RATE= 1.2
[illegible]

[illegible] 13 / [illegible] 1.2
[illegible]

[illegible] 14 / [illegible] LEAK RATE= 1.2
[illegible]

[illegible] 15 / [illegible] 1.2
[illegible]

[illegible]

16 / [illegible]

17 / [illegible]

18 / [illegible]

19 / [illegible]

[illegible]

20 / [illegible]

21 / [illegible]

22 /

23 /

24 /

TI-NHTSA 011294

TI-NHTSA 011295

[illegible]

[illegible]-1992 [illegible] OPEN DOOR DID NOT CLOSE 1

[illegible] FIX 1; [illegible] MARD=47.0; MARD=42.8; LEAK RATE= 0.6
[illegible] ACTUAL= [illegible]; RELCAL= 4031.8

[illegible] MARD=47.0; MARD=42.8; LEAK RATE= 0.6
[illegible]

[illegible] MARD=47.0; MARD=42.8; LEAK RATE= 0.6
[illegible] 4636.3

[illegible] FIX [illegible] MARD=47.0; MARD=42.8; LEAK RATE= 0.6
[illegible]

[illegible]-1992 [illegible] OPEN DOOR DID NOT CLOSE [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TI-NHTSA 011297

[illegible] OPEN DOOR DID NOT CLOSE

SER[illegible]; FIX 1; ID= 0000000; SIN=GOOD ; MARL=4[illegible]; MARD=42.7; LEAK RATE= 0.6
[illegible] 109.4; DIF= 20.6 PSI; ACTCR= 372.0ms; RELCR= 869.5

[illegible] FIX 2; [illegible] MARD=42.7; LEAK RATE= 0.6
[illegible] 37.9 PSI; ACTCR= [illegible] RELCR= [illegible]

~~[illegible] 42.7; LEAK RATE= [illegible]~~

~~[illegible] FIX 4; [illegible] 42.7; LEAK RATE= [illegible]~~

[illegible] OPEN DOOR DID NOT CLOSE 1

[illegible] RAND KAYTON

[illegible]

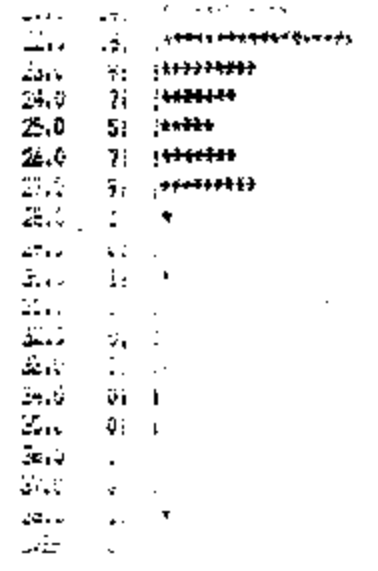
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.00	[illegible]
DIFFERENTIAL	[illegible]	[illegible]	[illegible]

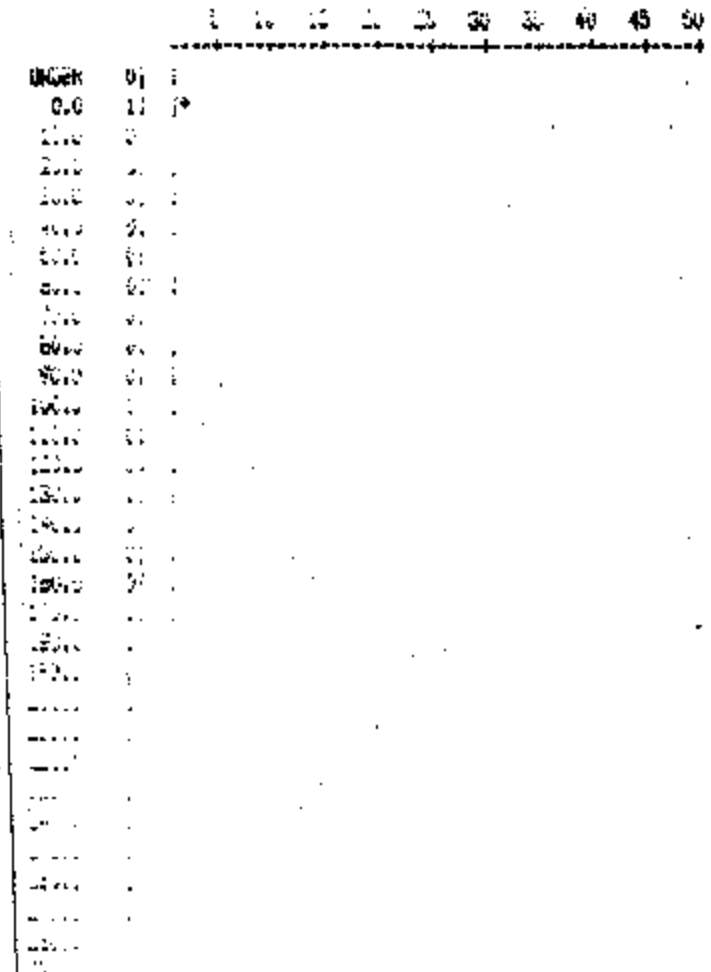
[illegible] PRESSURE

5 [illegible] [illegible] [illegible] [illegible] [illegible] 35 [illegible] 45 50

[illegible]

TI-NHTSA 011299





TI-NHTSA 011301

GROUP: FULL ROUND KAPTON

DEVICE	ACT	REL	DIF	ACTCR	RELCR
1	159.5	137.8	21.7	139.3	4660.8
2	152.6	127.0	25.6	294.5	4458.8
3	150.9	124.1	26.8	325.5	4395.5
4	152.7	130.7	22.0	279.0	4533.0
5	152.0	130.4	21.6	290.0	4529.8
6	155.1	132.5	22.6	227.3	4570.0
7	152.0	130.7	21.3	289.0	4538.8
8	156.4	129.7	26.7	213.8	4501.5
9	158.1	131.0	27.1	172.5	4532.8
10	146.7	122.1	24.6	428.8	4357.0
11	161.7	139.7	22.0	95.3	4699.3
12	151.7	124.6	27.1	305.3	4403.5
13	161.1	136.4	24.7	100.0	4640.3
14	149.6	126.7	22.9	353.3	4450.0
15	150.5	128.1	22.4	328.0	4473.3
16	153.3	133.6	19.7	283.0	4588.0
17	154.7	132.1	22.6	249.3	4560.3
18	153.8	132.6	21.2	272.3	4565.8
19	155.5	129.0	26.5	229.8	4491.5
20	157.0	134.4	22.6	191.0	4598.0
21	157.2	130.7	26.5	182.3	4528.5
22	155.3	131.2	24.1	233.5	4533.8
23	149.5	130.7	18.8	356.5	4526.0
24	161.5	140.5	21.0	91.5	0.3
25	147.0	128.6	18.4	405.5	4467.3
26	155.0	133.2	21.8	225.0	4548.0
27	154.3	127.7	26.6	253.8	4441.0
28	159.2	139.3	19.9	125.8	4700.3
29	153.4	134.4	19.0	266.3	4612.5
30	155.1	132.7	22.4	230.3	4589.3
31	157.1	133.0	24.1	188.5	4595.5
32	154.9	132.1	22.8	228.8	4527.8
33	156.3	135.7	20.6	198.8	4607.8
34	157.8	135.7	22.1	156.0	4609.5
35	149.8	128.3	21.5	349.8	4446.8
36	149.8	127.7	22.1	342.8	4476.8
37	155.3	133.3	22.0	212.3	4585.8
38	160.0	136.0	24.0	124.0	4641.0
39	159.2	135.0	24.2	135.8	4612.5
40	154.8	133.1	21.7	253.3	4574.3
41	151.8	129.9	21.9	311.8	4506.8
42	150.3	125.1	25.2	354.3	4419.3
43	162.3	141.9	20.4	83.3	4805.0
44	150.0	129.1	20.9	336.3	4498.0
45	144.9	122.6	22.3	448.3	4363.0
46	161.1	134.9	26.2	99.0	4609.8
47	159.6	133.8	25.8	125.3	4584.3
48	157.7	136.0	21.7	169.3	4636.0
49	142.0	119.6	22.4	508.3	4302.0
50	156.4	131.7	24.7	200.8	4559.5
51	153.5	130.7	22.8	256.0	4536.8
52	156.3	134.7	21.6	211.3	4612.3

53	159.3	131.9	27.4	144.3	4559.3
54	159.9	134.7	25.2	129.5	4620.3
55	159.0	134.7	24.3	147.5	4615.5
56	152.3	127.9	24.4	296.3	4494.8
57	160.0	139.4	20.6	132.5	4717.0
58	144.9	115.2	29.7	457.8	4224.3
59	154.3	134.8	19.5	239.8	4630.5
60	154.9	133.4	21.5	228.5	4569.5
61	149.6	127.1	22.5	355.0	4433.8
62	152.2	130.9	21.3	288.0	4519.0
63	159.2	140.6	18.6	136.8	4693.3
64	157.0	130.1	26.9	193.8	4531.8
65	163.9	138.1	25.8	37.5	4683.8
66	167.1	144.9	22.2	0.0	4836.3
67	156.3	133.7	22.6	209.0	4603.3
68	153.0	127.1	25.9	281.5	4461.8
69	154.7	133.5	21.2	237.0	4599.5
70	153.0	129.8	23.2	280.0	4520.0
71	154.0	127.5	26.5	273.8	4471.3
72	158.6	137.8	20.8	154.8	3393.3
73	145.6	123.2	22.4	435.5	4369.8
74	155.9	131.7	24.2	222.3	4535.5
75	158.6	137.8	20.8	145.3	4724.8
76	158.5	135.3	23.2	153.8	4637.8
77	161.7	142.8	18.9	87.3	4835.8
78	139.3	110.9	28.4	561.3	4126.8
79	154.0	133.1	20.9	249.5	4593.3
80	130.0	109.4	20.6	372.0	869.5
81	163.7	125.9	37.8	54.5	1220.3

- Add FCS
- Add Vac
- Leak @ 9, 1.1, 0.4 mm Hg
  PHOTO'S

- X-sect rubber dia

DIAPHRAGM REDESIGN TESTING

- Less Kapton (optimize) also gland shape

Results from initial testing of high-vacuum exposure combined with diaphragm life cycling have shown two candidates for improving the design of the diaphragm: the rubber diaphragm (plus 3 pc. standard square Kapton) and the full-round Kapton diaphragm (3 pc). This test compares various performance parameters of these two designs plus a control group.

Engineering tests include: thermal cycling, characterization at temp extremes, drift over life, and aging. Manufacturing tests include: statistical determination of act/rel average and standard deviation.

For engineering evaluations, build 1/2 at low preload extreme (4 mils) and the other 1/2 at high preload extreme (9 mils). To choose pin on each of these devices, measure sensor and base individually, but assume no variability in pin, and no crimp shift. For statistical evaluation, build all devices using normal production tooling and techniques, with the standard quiet pass-car preload value of 6.5 - 7.0 mils.

Perform a quick check on the eng. parts using the auto. pressure tester, to ensure functionality. Rebuild bad devices as necessary. All devices for eng. tests will ultimately be characterized using the normal manual lab technique. All devices for mfg. statistics should be checked on the auto pressure tester, collecting data for each device.

EXPERIMENT SPECIFICS:

Thermal Cycle

* 3 low pin/3 high pin per lot x 3 lots (=18)
* Preferred, Cycler B (auto temp ctrl); or CCPS cycler
* Pre-char act/rel
* Run cycler at approx. 0.1 Hz continuous
* Ramp from -40 C to +175 C, with soaks of 30-60 min (T-B-D, flexible) at each extreme
* Test completion point is T-B-D (based on failures ?)
* Final char act/rel, compare data for pre-post shifts, discrepancies related to preload, failures if any
* Disassemble, analyze (compr set, diaphragm condition)

SBO/920928/file DIAPHR.001

TI-NHTSA 011304

Calibration Shift at Temperature Extremes

* 3 low pin/3 high pin per lot x 3 lots (=18)
* Measure act/rel @ RT, -40 C, +175 C
* Run in any convenient oven - Delta (?)
* Compare data for shift magnitude relative to control lot, and discrepancies related to preload

Drift over life

* 3 low pin/3 high pin per lot x 3 lots (=18)
* Characterize act/rel
* Run in production cycler
* Run 1.5 lots (9) to 250K cycles, remove and char.
* Complete 500K cycles, char.
* Repeat on remaining 1.5 lots
* Draw graphs of act/rel vs. # cycles

High Temperature Aging

* 2 low pin/2 high pin per lot x 3 lots (=12)
* Run in Despatch oven
* Characterize act/rel
* Prefill devices, install on manifold and fill (optional, use fluid reservoir T-B-D, purposely entrap air, which will expand to pressurize devices slightly when heated)
* Soak at 150 C for as long as feasible
* Post-char, look for shifts
* Disassemble, examine diaphragm condition

Hatchet curves

Statistics

* Build remainder (approx. 75) from each lot, on 77 line, using all normal techniques
* Run each lot separately thru automatic pressure tester
* Collect data for each device individually
* Bad devices should be analyzed for failure mode; if not representative of production, toss data
* Calc. avg & std, histogram for each lot
* compare lots for avg (piloting concerns) and std (device variability)

SBO/920928/file DIAPHR.001

Clear at Temp of production-pinned Devices

Device #	Discharge	RT act	RT adj	-40°C act	-40°C adj	125°C act	125°C adj	Δ-40	Δ125
322-15-67	Control	139	93	136	112	98	66	+7	+19	-31	-27
-69		135	104	148	125	97	77	+9	+21	-38	-27
-69		131	99	141	117	54	49	+10	+18	-77	-68
-70	↓	125	105	133	106	47	35	+8	+1	-76	-70
							X	+9	+16	-68	-44
322-15-71	Silver	117	94	133	109	no cont		+16	+15	~~~	
-72		140	109	150	125	74	58	+10	+16	-66	-51
-73		142	109	153	122	98	73	+11	+13	-44	-36
-74	↓	140	109	162	128	77	58	+22	+19	-63	-51
							X	+16	+16	-46	-46
322-15-75	Red	154	129	165	138	100	85	+11	+9	-54	-44
-76		148	121	158	129	104	87	+8	+8	-44	-34
-77		150	125	162	141	116	96	+13	+16	-34	-29
-78	↓	149	124	138	142	109	93	+18	+18	-46	-31
							X	+15	+13	-63	-36

Device #	Test	Seal	offset	Init Act	Init Rel	Act	Rel	-40°C Act	-40°C Rel	+175°C Act	+175°C Rel	Δ -40°C		Δ +175°C	
322-15-19	cut shift at seal	Control	.107	145	115	146	138	156	125	111	82	+10	+7	-35	[illegible]
-20				128	108	126	107	137	106	78	72	+11	-1	-20	[illegible]
-21				131	103	133	105	145	122	85	67	+12	+17	-46	[illegible]
												+11	+8	-37	[illegible]
322-15-22			.109	156	127	153	125	193	125	116	92	+40	+40	-37	[illegible]
-23				153	134	155	136	202	183	112	87	+49	+49	-38	[illegible]
-24				179	149	178	176	227	202	118	87	+51	+56	-60	[illegible]
												+44	+40	-45	[illegible]
322-15-25		Rubber Diaphragm	.107	143	97	147	100	178	147	No Cont		+31	+49	N/A	[illegible]
-26				145	112	145	112	163	127	97	71	+18	+15	-48	[illegible]
-27				129	106	131	107	145	118	70	54	+14	+11	-61	[illegible]
												+21	+25	-55	[illegible]
322-15-28			.109	211	188	218	191	316	264	130	78	+98	+73	-88	[illegible]
-29				196	167	199	166	273	242	124	101	+74	+76	-75	[illegible]
-30				225	200	230	205	312	278	128	99	+82	+73	-102	[illegible]
												+84	+74	-88	[illegible]
322-15-31		Bread Rubber	.109	156	127	157	129	169	145	118	97	+12	+16	-39	[illegible]
-32				153	133	154	133	168	147	129	103	+15	+14	-24	[illegible]
-33				149	119	150	119	157	131	77	77	+8	+12	-61	[illegible]
												+12	+14	-38	[illegible]
322-15-34			.109	190	174	196	172	234	205	132	107	+38	+37	-64	[illegible]
-35				203	179	209	184	274	217	138	110	+65	+33	-71	[illegible]
				230	204	249	216	316	250	147	117	+72	+46	-101	[illegible]
								250 Kcyc		500 Kcyc		+46	+37	-79	[illegible]
				130	102	130	102	123	99	122	101				
				132	112	125	117	130	106	128	108				
				139	101	128	103	126	103	125	102				
				182	132	178	161	178	154	172	147				
				195	179	209	178	204	176	200	175				
				207	174	218	184	202	176	201	171				
				178	107	149	106	129	99	130	100				
				134	102	137	102	131	104	128	101				
				139	109	147	115	139	113	135	109				
				210	187	224	184	207	158						
				194	158	193	164	169	138						
				209	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
322-15-49		Bread Rubber													
-50															
-51															
322-15-52															
-53															
-54															

LOW-PIN UTT -40

ACT	REL
CTRL +11	CTRL +8
RND +12	RND +14
RUB +21	RUB +25

HIGH PIN UTS -40

ACT	REL
CTRL +46	CTRL +40
RND +65	RND +37
RUB +85	RUB +74

LOW-PIN UTS +175

ACT	REL
CTRL -37	CTRL -39
RND -38	RND -34
RUB -55	RUB -47

HIGH-PIN UTS +175

ACT	REL
CTRL -45	CTRL -49
RND -79	RND -79
RUB -85	RUB -88

TI-NHTSA 011307

Sensor Diameters

	Control	Rubber Diaphragm	Round Kapton
1	.0483	.0481	.0483
2	.0477	.0480	.0479
3	.0476	.0479	.0482
4	.0478	.0478	.0480
5	.0477	.0480	.0481
6	.0480	.0475	.0481
7	.0478	.0479	.0480
8	.0479	.0476	.0475
9	.0479	.0476	.0477
10	.0478	.0479	.0479
11	.0480	.0477	.0480
12	.0480	.0477	.0480
13	.0481	.0480	.0478
14	.0475	.0472	.0476
15	.0480	.0481	.0480
16	.0478	.0483	.0479
17	.0478	.0475	.0480
18	.0480	.0478	.0480
19	.0475	.0481	.0480
20	.0480	.0476	.0478
$\bar{x}$	.0478	.0478	.0477
σ	.00012	.00027	.00017

TARGET PRELOAD (GILBERT (AK)) 6.5 MILS

MFG ASSUMES ±2.5 MILS IS 3σ.

EXTREMES ARE 4 AND 9 MILS

TI-NHTSA 011308

T Sensor Dimension @ Temp.

Diaphragm	Device*	Room Temp.	125°C	Δ	$\bar{\Delta}$
Control	A	.0490	.0497	.0007	
	B	.0492	.0494	.0012	
	C	.0490	.0502	.0012	.00096
	D	.0490	.0499	.0009	
	E	.0495	.0504	.0009	
Rubber	A	.0498	.0512	.0014	
	B	.0503	.0515	.0012	
	C	.0502	.0517	.0015	.00142
	D	.0509	.0523	.0014	
	E	.0501	.0517	.0016	
Rigid	A	.0497	.0510	.0013	
	B	.0495	.0505	.0010	
	C	.0494	.0506	.0012	.00112
	D	.0493	.0503	.0010	
	E	.0490	.0501	.0011	

-MSG M#= 00219780 FR=SBO1 TO=SBO1 SENT=10/01/92 08:02 AM
S#=056 ST=C DIV=0050 CC=00101 BY=SBO1 AT=10/01/92 08:02 AM

TO:	Dave Czarn	ZARN	Dennis Natale	DJN1
	Jeff DiDomenico	DIDO	Danny O'Driscoll	DOD
	Charlie Douglas	CMP1	Matt Sellers	MJS2
	Andy McKenna	SPRT	Chris Wagner	CDW3

FR: Steve Offiler SBO1

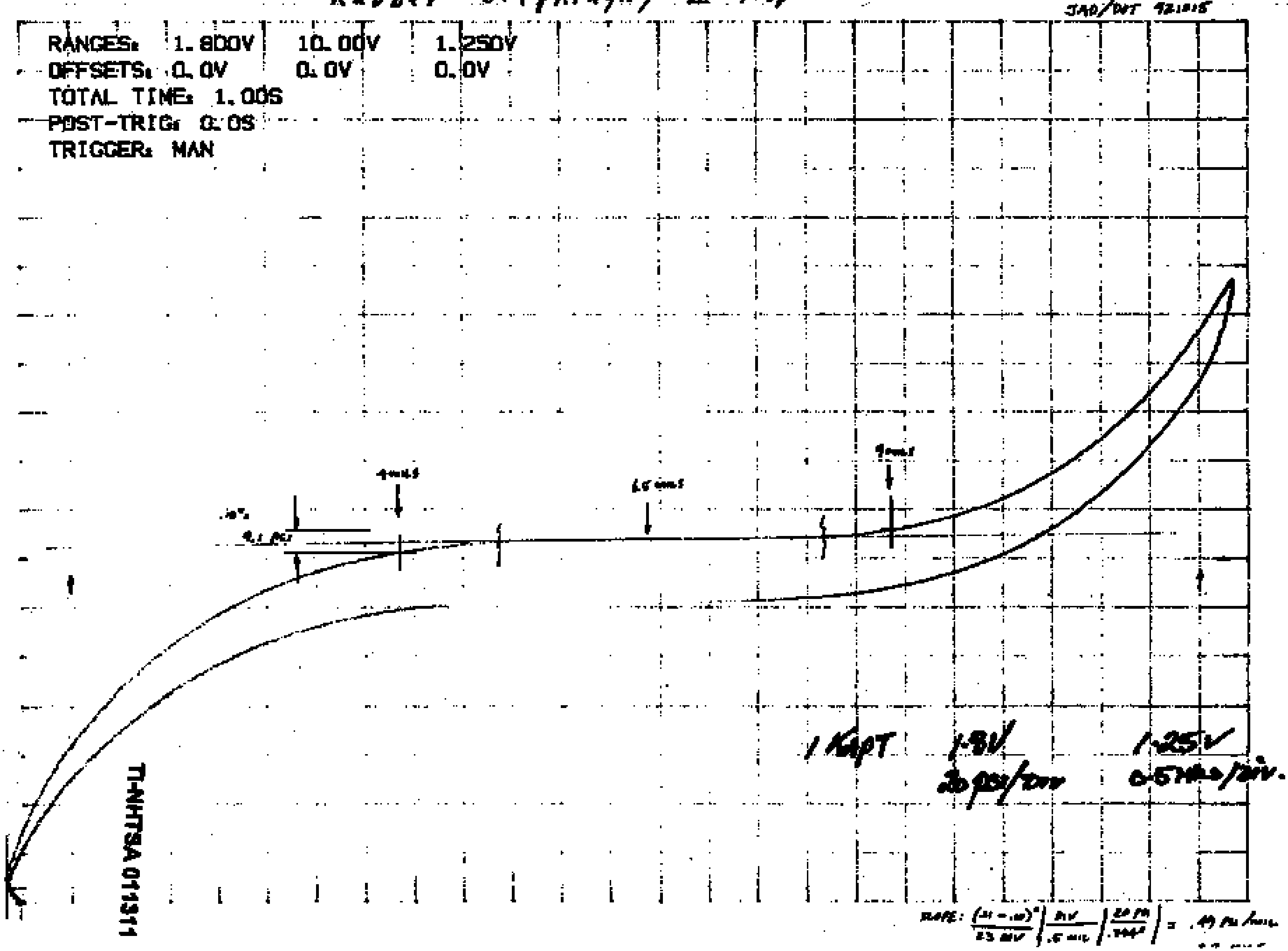
SJ: Vacuum/Diaphragm Life Test Update

At this point, ALL devices from every lot except rubber diaphragm have died. There have still been NO failures in the rubber diaphragms. The test is at about 2.6 million cycles, and will be aborted as soon as other planned testing is ready to commence. We will open one of the rubber dia. parts for internal inspection, hoping to learn something about the longevity of this design. The other 5 may be cycled to failure at a later date as time permits.

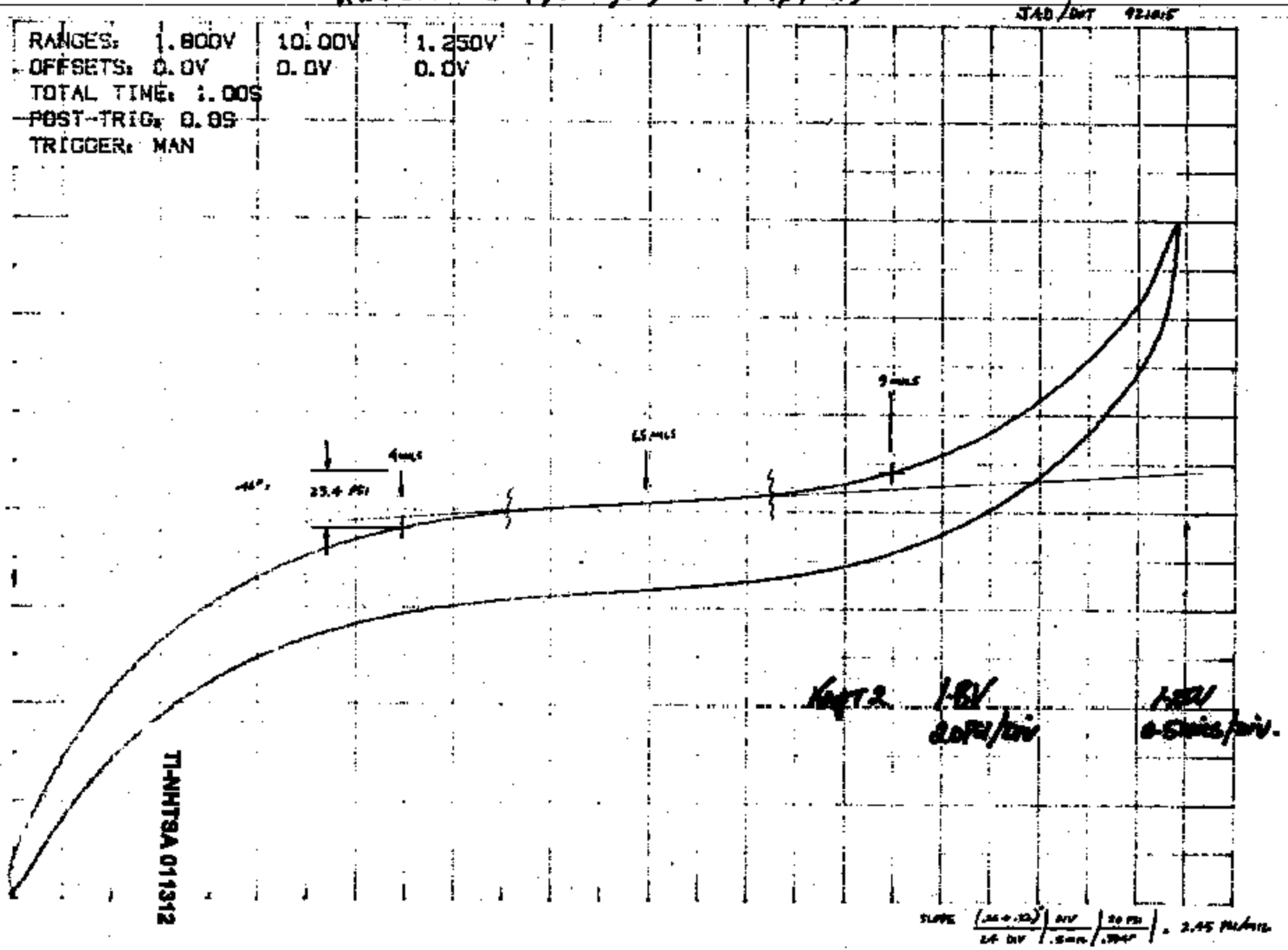
Dia Config	Vac	Beta	Theta
Rubber dia	yes	NO FAILURES thru 2.6MK	
Full-rnd	yes	10.8	2238
Std	no	14.0	1522
Std	yes	4.6	1596
rough flange	yes	6.5	1197
Tefzel	yes	5.5	1209

Regards, Steve O.

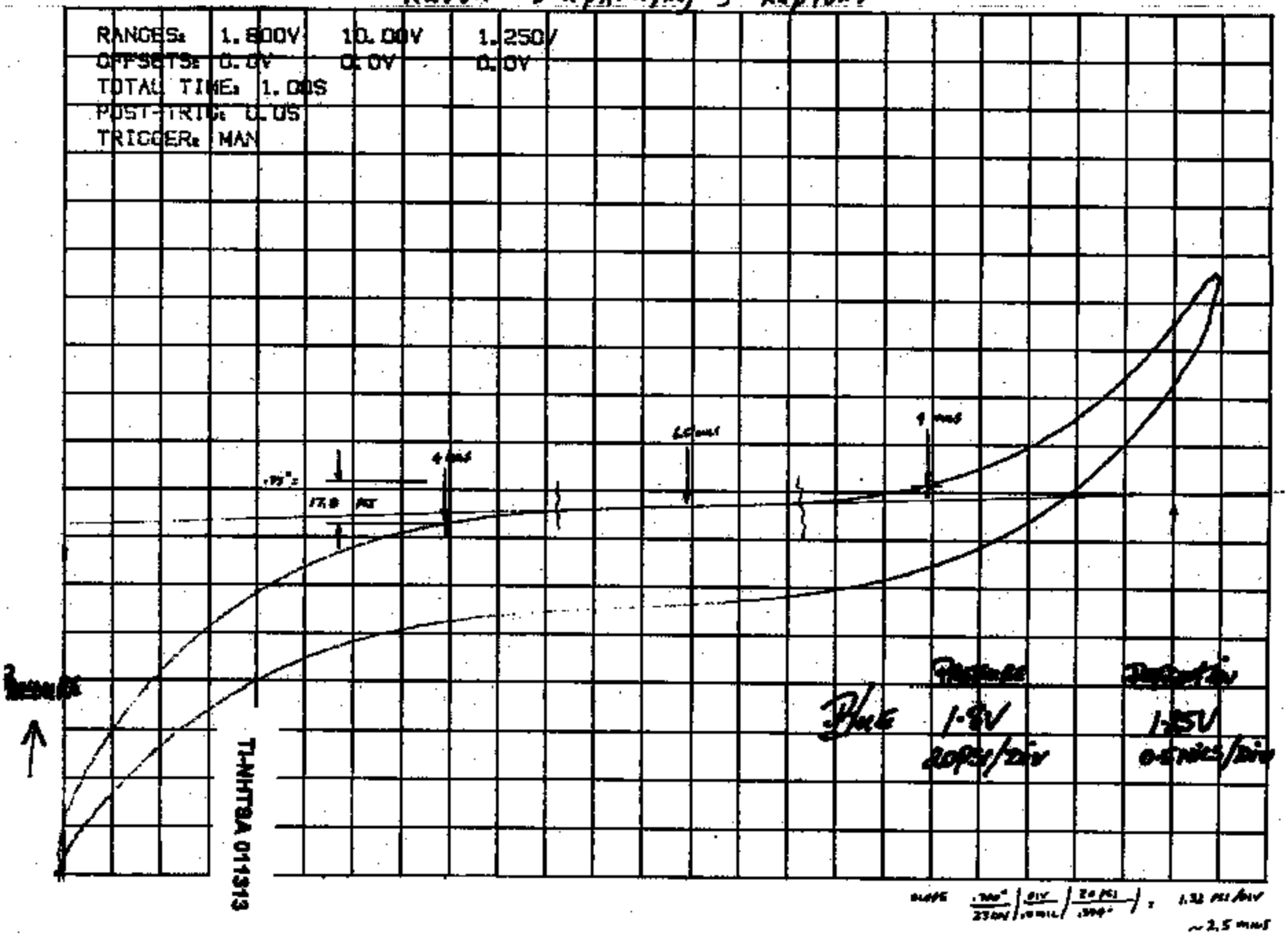
Rubber Diaphragm, 2 kapton



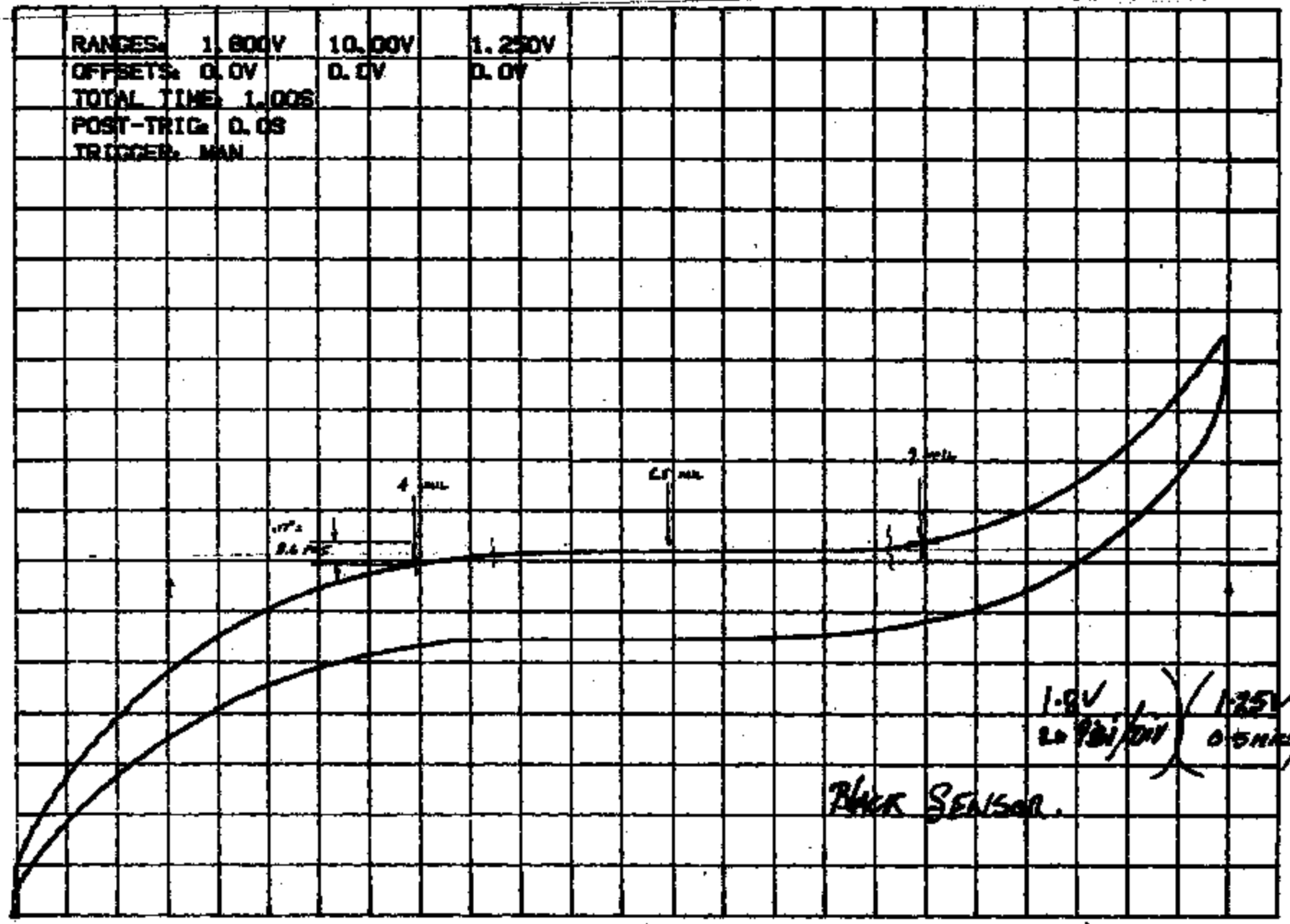
Rubber Diaphragm, 2 kaptons



Rubber Diaphragm, 3 Kaptons

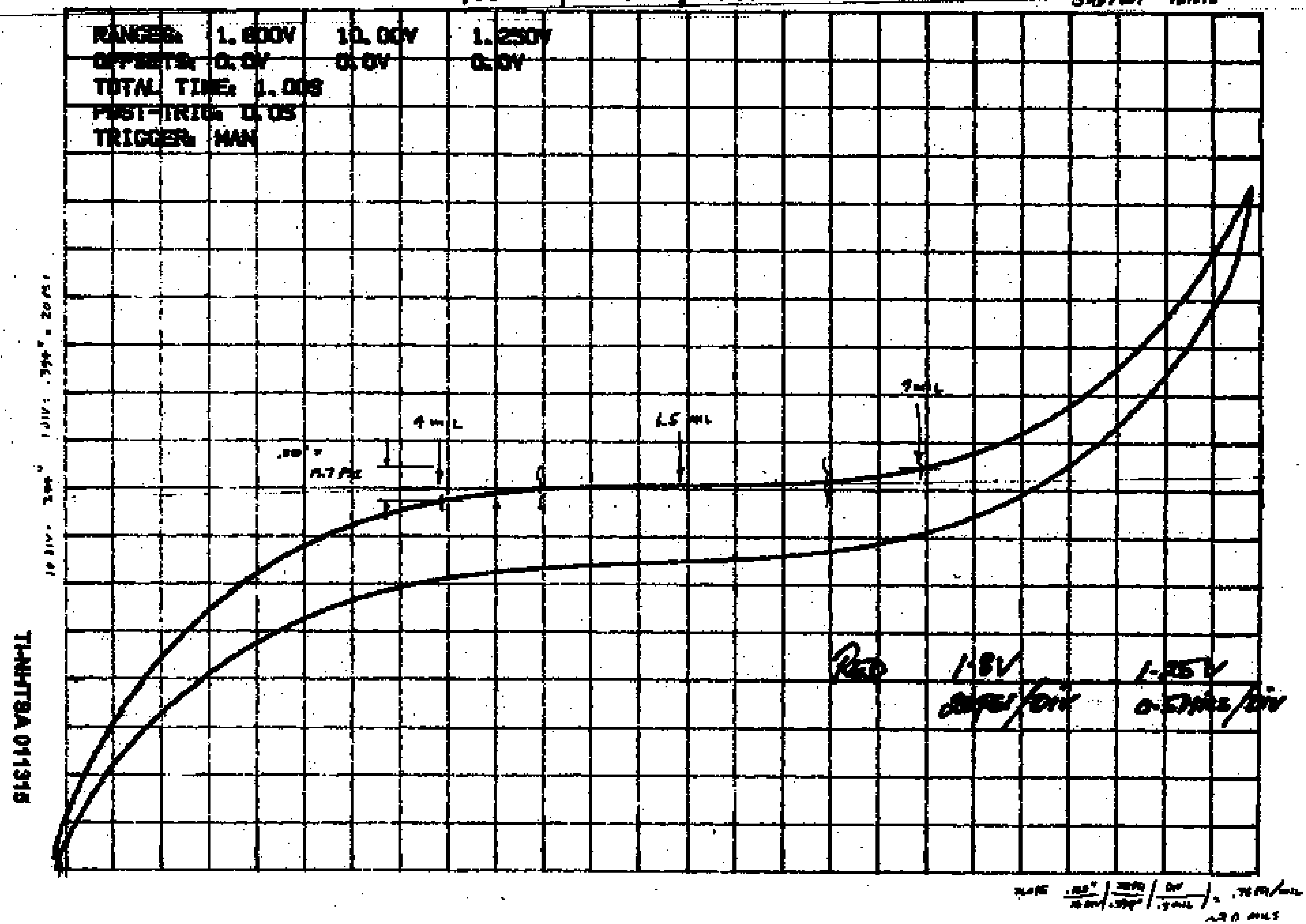


Control

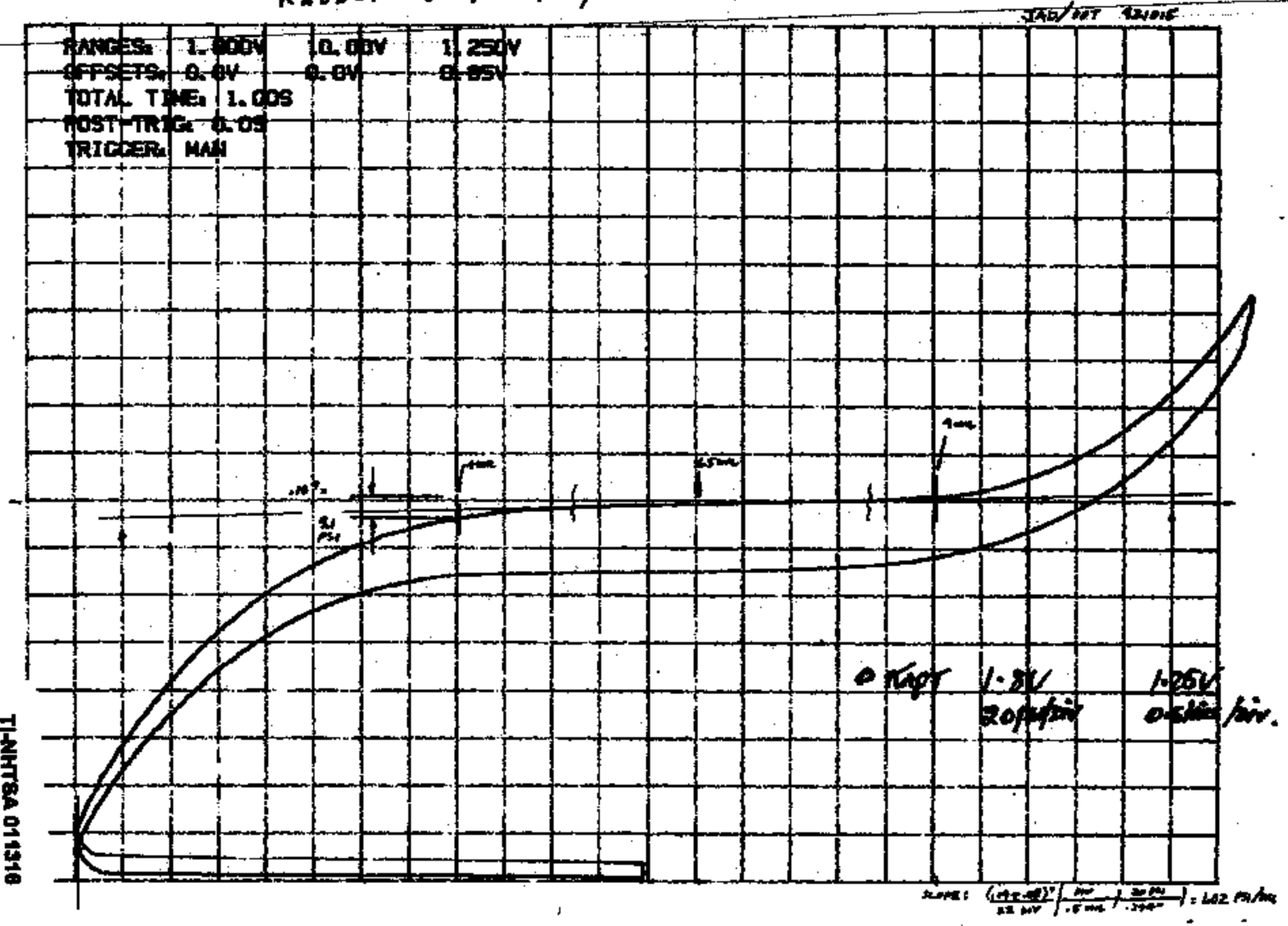


TI-NHTSA 011314

Round Kapton



Rubber Diaphragm, no Kapton



TI-NHTSA 014318

Rubber Diaphragm 10-6-92
Cost potential Calculations

Scenario #2 : - 100% 5205/5705/7703/8705 Conversion
- Possible Kapton Elim Shown as option
- Yield loss adders broken out
- Modif. to amt Ec-ants 14 ssq Shown
- Dia design per EX - - -

Material Changes :

Std gasket to dia 10.70

Elim 2 pcs kapton : (31.42)
(29.37 (K)) x1.07
or

Elim 1 pcs kapton (15.74)
(14.71 (K)) x1.07
or

Elim 3 pcs kapton (47.22)
(44.13 (K)) x1.07

Labor Changes :

N/c

Yield loss (Est.)

5% 60 ea. 4EK vol 30.00

10% " " 60.00

Tooling

Dia 2.0K
Amt 15.0K

TI-NHTSA 011317

Rubber Diaphragm — 10-6-92
Cost potential Calculations

Scenario #1:
- Only Ford Aust Connection (25K annual)
- Does not eliminate any Kapton
- Same Consequence with prelim testing
- manual sensor assy
- Rubber diaphragm design per EX3492-65 Rev 1 dated 7/30/92

Material Changes:

From std gasket to diaphragm — 10.70
$10 x 1.07 (Yield)

Labor Changes:

From AMI assy to manual assy
$10.81/hr — 87.13
160/hr → (18hrs x 4) 7.2 hrs/k
6.2 hrs x 10.81 x 1.3

Yield Loss @ (EIM):

10% yield loss over & above current levels
@ 60¢ each pc on 25k annual vol — 60.00

total Δ → (157.83)

5% — 30.00

total Δ → (127.83)

Tested: 3m, 3.0K

Rubber Diaphragm -- 10/6/92
Potential cost calculations Rev: A
What-if scenarios

Scenario # 2:

1.0 100% 52/57/77/87pa conversion.
2.0 Kapton elimination possible but not definate.
3.0 Actuation sigma performance may be degraded.
4.0 Modification to AMM2 for automatic assy possible.
5.0 Rubber diaphragm design per EX3423-85 rev. 1.

Potential material change calculations:	$/K
From standard gasket to rubber diaphragm :	+ 10.7
Eliminate 1 piece of kapton :	- 15.74
Eliminate 2 pieces of kapton :	- 31.48
Eliminate 3 pieces of kapton :	- 47.22

Potential labor change calculations:	
None anticipated	0

Potential function test yield loss change calculations:	
5% over and above current levels :	+ 30.00
10% over and above current levels :	+ 60.00

Possible tooling for scenario # 1:	K$
Rubber diaphragm :	2.00
AMM2 feed upgrades	15.00
Total tooling :	17.00

MJS Rubber.xls 10/6/92

Rubber Diaphragm — 10/6/92
Potential cost calculations Rev: A
What-if scenarios

Scenario # 1:

1.0 Only a Ford Australia requirement.
2.0 Kapton elimination possible but not definate.
3.0 Actuation sigma performance may be degraded.
4.0 Manual sensor belt used.
5.0 Rubber diaphragm design per EX3423-66 rev. 1.

Potential material change calculations: **$/K**

From standard gasket to rubber diaphragm : + 10.7

Potential labor change calculations:

From AMI to manual belt : + 67.13

Potential function test yield loss change calculations:

5% over and above current levels : + 30.00

10% over and above current levels : + 60.00

Possible tooling for scenario # 1:	**K$**
Rubber diaphragm :	2.00
Manual belt	2.00
Total tooling :	4.00

Rubber Diaphragm -- 10/8/02
Potential cost calculations Rev: A
What-if scenarios

Scenario # 1:

1.0 Only a Ford Australia requirement.
2.0 Kapton elimination possible but not definate.
3.0 Actuation sigma performance may be degraded.
4.0 Manual sensor belt used.
5.0 Rubber diaphragm design per EX3423-65 rev. 1.

MATT, IS THERE AN EVALUATION SCHEDULE?

Potential material change calculations:	**$/K**
From standard gasket to rubber diaphragm :	+ 10.7

Potential labor change calculations:	
From AMI to manual belt :	+ 57.13

Potential function test yield loss change calculations:

5% over and above current levels :	+ 30.00
10% over and above current levels :	+ 60.00

Possible tooling for scenario # 1:	**K$**
Rubber diaphragm :	2.00
Manual belt	2.00
Total tooling :	**4.00**

Round-Kapton Diaphragm 10/7/92
Potential cost calculations Rev: A
What-if scenarios

Scenario # 3:

1.0 100% 52/57/77/87pe conversion.
2.0 Actuation sigma performance may be degraded.
3.0 Sensors method not yet developed. distinguishing between none, one, two, and three pieces reliably is questionable and not tested.

Potential material change calculations: **$/K**

From 3-square to 3-round pieces of kapton : + 59.02

Potential labor change calculations:

None anticipated 0

Potential function test yield loss change calculations:

5% over and above current levels : + 30.00

10% over and above current levels : + 60.00

Possible tooling for scenario # 3: **K$**

Duplicate 0.00
AMM2 feed/check upgrades 25.00

Total tooling : 25.00

-MSG M#= 00400341 FR=SARN TO=SBO1 SENT=10/07/92 01:32 PM
R#=060 ST=C DIV=0050 CC=00101 BY=SARN AT=10/07/92 01:32 PM

OCTOBER 7, 1992
TO: DANNY O'DRISCOLL DOD
CC: GARY SNYDER GJS1
STEVE OFFILER SBO1
CHARLIE DOUGLAS CHP1
MATT SELLERS MJS2
FR: DAVE CHARN SARN

RE: CCPS FOR FORD AUSTRALIA

DANNY,
THE FOLLOWING SUMMARIZES MY THOUGHTS ON WHERE WE'VE BEEN AND WHERE WE'RE GOING ON THE AUSTRALIA PROGRAMS.

WHERE WE'VE BEEN

IN RESPONSE TO YOUR DISCOVERY IN JUNE '92 THAT THE FORD AUSTRALIA VACUUM SPEC MAY BE MORE STRINGENT THAN THE US ENGINEERING SPEC, WE PUT SOME LOW LEVEL EFFORT INTO SEEING IF IT WAS A CAUSE FOR CONCERN. OUR TESTING IN JUNE CONFIRMED OUR CONCERN DUE TO DIAPHRAGM DISPLACEMENT. IN JULY, FORD AUS WAS STILL NOT SURE THAT THE HIGHER VACUUM WAS NEEDED; IN EARLY AUGUST, HOWEVER, JOHN PECK VALIDATED THE NEED THROUGH ACTUAL MEASUREMENTS. AFTER THAT, WITH A PPH BUILD AND VALIDATION TESTING FORTHCOMING, WE TURNED UP THE EFFORT SIGNIFICANTLY ON OUR END, LOOKING AT POSSIBLE ALTERNATIVES.

OUR FIRST PASS DIAPHRAGM LIFE TESTING OF TODAY'S DESIGN VS. TWO ALTERNATIVES SHOWED ALL SWITCHES TO PASS THE R8 REQUIREMENT; HOWEVER, WE CONCLUDED THAT TODAY'S DESIGN WILL NOT CONSISTENTLY MEET LIFE REQUIREMENTS DUE TO DIAPHRAGM DISPLACEMENT. THE TWO ALTERNATIVES SHOW PROMISE, FROM A DIAPHRAGM LIFE STANDPOINT; HOWEVER, NO OTHER EFFECTS HAD YET BEEN CONSIDERED. THESE INCLUDE TEMPERATURE EFFECTS ON CALIBRATION, EFFECT ON DRIFT OVER LIFE, EFFECTS ON PRODUCTION EQUIPMENT & YIELDS, ETC. BASED ON DIAPHRAGM LIFE TESTING AND IMPACT ON TODAY'S MANUFACTURING EQUIPMENT, THE FULL ROLLER DIAPHRAGM HAS BECOME THE FAVORED APPROACH.

BOTH ALTERNATIVE DESIGNS HAVE A GOOD PROBABILITY OF PASSING THE R8, BUT BOTH HAVE ZERO FIELD HISTORY.

AN ENGINEERING TEAM (STEVE AND JEFF) HAS SPENT APPROXIMATELY 75% OF THEIR TIME FOR 6 TO 8 WEEKS (EST.) IN DEVELOPING THE ALTERNATIVES SO FAR.

WHERE WE'RE GOING

TI AND FORD NEED TO BOTH UNDERSTAND THAT THE UNIQUE VACUUM REQUIREMENT HAS TURNED THIS INTO A FULL SWITCH DEVELOPMENT EFFORT. WE'RE NO LONGER SELLING THEM THE U.S. DESIGN AROUND WHICH ALL OF OUR FIELD EXPERIENCE, EQUIPMENT DESIGN, ETC. IS BASED. TO REITERATE A POINT MADE EARLIER, WE WILL PROBABLY PASS THE R8 TESTING WITH

BOTH THE ALTERNATIVE DESIGNS; HOWEVER, WE HAVE NO FIELD EXPERIENCE WITH EITHER. MOVING FORWARD QUICKLY WITH A NEW DESIGN PUTS TI AT SIGNIFICANT RISK. STEVE OFFILER'S RISK ANALYSIS REPORT WILL PROVIDE MORE DETAIL.

A MUCH GREATER TI/FORD IS NEEDED TO MAKE THIS CHANGE SUCCESSFUL. VALIDATING TO THE ES AND RELEASING A NEW DESIGN IN NOVEMBER'92 SHOULD BE AVOIDED. THE DEVELOPMENT EFFORT, I BELIEVE, IS AN ADDITIONAL 4-5 MONTHS, PUSHING VALIDATION AND ISR TO MARCH/APRIL '93. AS DISCUSSED IT LOOKS TO ME LIKE AN APPROXIMATE 40K-50K DEVELOPMENT PROGRAM. WE WOULD HAVE NO REAL REASON TO UNDERTAKE THIS NEW IT NOT FOR FORD AUSTRALIA'S REQUIREMENT.

SCHEDULE AS I SEE IT

DIRECTION FROM FORD ADS AND POSSIBLE DEVELOPMENT FUNDING	OCT'92
>>>>IF FORD ASSUMES FULL RISK & DECLINES FURTHER DEVELOPMENT>>> TI VALID'N TESTING OF TODAY'S DESIGN BY NOV'92 END	
>>>>IF FORD AGREES TO DEVELOPMENT>>>>	
TI/FORD JOINT DEVELOPMENT; TESTING REQUIREMENTS T-2-D	OCT'92-MAR'93
TI VALIDATION TO ES	MAR'93-APR'93
ISR	"END/APR'93"
FORD JOB 1	JUNE'93

14 APR '93 HARD PRT PCB (SALABLE) FULLY ISR'ED

REGARDS,
DAVE
\2-tiass.wp1

- PCB PARTS & ISR ARRIVE AUST. 4/4/93
- SHIP (2 wks ?) 3/26/93
- COMPL W/H ISR 3/24
- BEGIN W/H FINISH DATA 3/19

(ASSUMES ISR REC'D W/ PCA'S; NOT REQ'D BEFOREHAND ?? FOR "AUTHORIZATION TO SHIP" ALA [illegible]

WHEN IS ISR DUE?
TO WHOM ?
WHAT CONSIST OF ?

-MSG Id= 00393685 FR=YPC1 TO=SBO1 SENT=10/07/92 10:57 AM
Rf=059 ST=C DIV=0050 CC=00101 BY=YPC1 AT=10/07/92 10:57 AM
TO: DANNY O'DRISCOLL DOD

CC: STEVE OFFILER SBO1
DAVE CZARN ZARN
MATT SELLERS MJS2

FR: CHARLIE DOUGLAS CMP1
RE: COSTS ASSOCIATED WITH CAPRI/FALCON DEVELOPMENT

DANNY, BASED ON WHAT WE KNOW TODAY, THE FOOLLOWING ARE THE COSTS WE WOULD LIKE YOU TO PRESENT TO FORD:

TOOLING:	AT OR BELOW $25K	(A)
DEVELOPMENT FUNDING:	$20K - $40K	(B)
PIECE COST ADDER:	$.10 - $.30	(C)

(A) BASED ON WHAT WE KNOW TODAY, OUR BEST ESTIMATE IS ACTUALLY $19K. WHEN WE BEGIN TO RUN ADDITIONAL TESTS, WE WILL GAIN A BETTER UNDERSTANDING IF ANY NEW PROCESS REQUIREMENTS ARE NEEDED (SUCH AS AN OVERPRESSURE TEST FOR INSTANCE). FORD WILL ONLY BE CHARGED FOR THE MONEY WE ACTUALLY SPEND ON TOOLING. WHAT THIS MEANS IS THAT IF YOU PREPARE FORD FOR $25K AND WE ONLY SPEND $19K, WE WILL ONLY INVOICE FORD FOR $19K.

(B) YOU ARE THE BEST JUDGE OF WHAT YOU FEEL WE CAN REASONABLY ASK FOR IN DEVELOPMENT FUNDING. I BELIEVE WE CAN MAKE A CASE FOR A MINIMUM OF $20K AND UP TO $40K. HOWEVER, AT THE SAME TIME, I DON'T WANT SOME PURCHASING AGENT AT FORD OF AUSTRALIA TO GO BALLISTIC AND HAVE IT GET BACK TO US HERE IN THE STATES. I KNOW YOU HAVE PUT IN A SIGNIFICANT LEVEL OF EFFORT IN DEALING WITH FORD ON THIS PROGRAM AND I DEFER TO YOUR JUDGEMENT AS TO EXACTLY WHAT LEVEL OF DEVELOPMENT FUNDING TO ASK FOR.

(C) AT THIS POINT, WE CANNOT GIVE A BETTER RANGE THAN $.10 - $.30. WHILE THE RUBBER DIAPHRAGM IMPACTS LIFE POSITIVELY, THE FIRST PASS TESTING INDICATES THERE WILL BE A NEGATIVE IMPACT TO OUR YIELDS AS A RESULT OF THE ACTUATION TOLERANCE OPENING. WE ARE HOPEFUL THAT BY ELIMINATING 1, 2, OR EVEN ALL 3 LAYERS OF KAPTON WE CAN REDUCE THE ACTUATION TOLERANCE (I EMPHASIZE THE WORD HOPEFUL, NOTHING IN OUR EXPERIENCE INDICATES REMOVING THE KAPTON WILL HAVE ANY IMPACT AT ALL ON ACTUATION TOLERANCE - THOUGH IT WILL CERTAINLY REDUCE MATERIAL COST IF IT CAN BE ACCOMPLISHED).

DANNY, I KNOW YOU ASKED HOW WE PRESENT THIS MAJOR SHIFT IN PHILOSOPHY TO FORD. PERSONALLY, I DON'T VIEW THIS AS THE 180 DEGREE SHIFT THAT YOU DO (THIS IS AN AREA WHERE DAVE, STEVE, AND I ALL HAVE VARYING OPINIONS - TO SOME EXTENT BASED ON THE LEVEL OF RISK TAKEN INHERENT IN EACH OF US). AS I SAID IN OUR PHONE DISCUSSION, WE DO FEEL PRETTY GOOD ABOUT THE RUBBER DIAPHRAGM BEING AN EFFECTIVE SOLUTION. IN TERMS OF LIFE TESTING, WE SHOULD FEEL GOOD. HOWEVER, EXPERIENCE HAS TAUGHT US (AND THE PSM IS A PERFECT EXAMPLE OF THIS), THAT WE NEED TO CONSIDER A LOT MORE THAN JUST LIFE CYCLE TESTING WHEN INTRODUCING ANY NEW PRODUCT - WHETHER IT IS A MODIFICATION OF AN EXISTING PRODUCT OR A PRODUCT DEVELOPED FROM SCRATCH.

ANOTHER EXAMPLE OF WHY WE NEED TO BE A LITTLE CONSERVATIVE IS THE QUIET SWITCH. IT IS TRUE THAT WE TOOK THIS FROM THEORY TO PRODUCTION IN 2 WEEKS. IT IS ALSO TRUE THAT BOTH FORD AND TI UNDERSTOOD AND ASSUMED PROBABLY MORE RISK THAN WE ARE LOOKING AT WITH THE RUBBER DIAPHRAGM. WHAT IT IS MOST UNFORTUNATELY TRUE IS THAT FROM A PROCESS STANDPOINT (BECAUSE OF THE TIMING), WE WERE FORCED TO MAKE ASSUMPTIONS THAT STILL HAVE NOT FULLY PANNED OUT. AS A RESULT, THE PROFITABILITY OF THE QUIET SWITCH IS NOT WHERE WE HAD HOPED OR

WOULD LIKE IT TO BE.

I GUESS ONE OF THE WAYS I WOULD CONSIDER IN PRESENTING OUR PHILOSOPHY CHANGE TO FORD IS TO DRAW UPON SPECIFIC EXPERIENCES. BASED ON THESE EXPERIENCES, WE PREFER TO TAKE THE CAUTIOUSLY OPTIMISTIC APPROACH RATHER THAN PROCEEDING AS THOUGH EVERYTHING IS ROSY.

REGARDS, CHARLIE

-MSG MS= 00041459 FR=YPC1 TO=SBO1 SENT=10/15/92 10:18 AM
RS=074 ST=C DIV=0050 CC=00101 BY=YPC1 AP=10/15/92 10:18 AM

TO: DANNY O'DRISCOLL DOD

CC: STEVE OFFILER SBO1
DAVE CHARN KARN
MATT SELLERS MJS2

FR: CHARLIE DOUGLAS CMP1
RE: CCPS AND THE VACUUM

DANNY, WE MET TODAY TO DISCUSS YOUR MSG TO US. FROM A TECHNICAL STANDPOINT, WE SHOULD BE ABLE TO RESPOND TO THE ISSUES WHICH YOU RAISED BY EARLY NEXT WEEK (THERE ARE SOME CURRENT TESTS WHICH WILL BE COMPLETE TOMORROW P.M. OUR TIME).

I THINK I CAN RESPOND NOW ON SOME OF THE COMMERCIAL ISSUES WHICH YOU BROUGHT OUT. WHILE WE PREFER NOT TO AMORTIZE, GIVEN THE $ FIGURES INVOLVED, I THINK IT IS AN OPTION IN THIS CASE. HOWEVER, I WOULD WANT TO CHANGE THE TERMS OF THE AMORTIZATION TO INCLUDE BOTH THE FALCON AND THE CAPRI (SINCE THE VACUUM ISSUE APPLIES TO BOTH PLATFORMS). I WOULD PROPOSE AMORTIZING OVER THE FIRST 50K COMBINED UNITS THAT WE SHIP.

WE HAVE SOME FEEL FOR THE COST ADDERS ASSOCIATED WITH THE RUBBER DIAPHRAGM AND THEY ARE AS FOLLOWS:

TOOLING:

DIE	$2K
AMI MED'S	$15K
TOTAL	$17K
DEVELOPMENT:	$40K

WE DO NOT HAVE A FEEL FOR ANY PIECE COST ADDERS ASSOCIATED WITH THE GENERAL PROCESS (I.E. IMPACT ON YIELD). WE WILL STILL HAVE MANY TESTS TO RUN BEFORE WE CAN DETERMINE THIS (PRESENTLY, WE KNOW THAT WHEN WE USE 3 PIECES OF KAPTON WITH THE RUBBER DIAPHRAGM, THERE IS A NEGATIVE IMPACT TO ACTUATION TOLERANCE WHICH IN TURN RESULTS IN A LOWER YIELD - BECAUSE OF THIS, WE RECOGNIZE A NEED TO RUN TESTS ELIMINATING 1 PIECE OF KAPTON AT A TIME).

IN REGARD TO THE ROUND KAPTON, THE ONE NEGATIVE WHICH WE SPELLED OUT BUT PROBABLY DID NOT EMPHASIZE ENOUGH IS THAT WE DO NOT KNOW HOW TO AUTOMATE THIS PROCESS. WE ALREADY HAVE A KAPTON FEED STATION AND WE WOULD CERTAINLY NOT WANT TO GO ACROSS THE BOARD WITH ROUND KAPTON. AS A RESULT, WE WOULD HAVE TO DEVELOP A SOME SORT OF QUICK CHANGE STATION FOR THE AMI.

AT THIS POINT, I THINK IT MIGHT BE A GOOD IDEA FOR US TO HAVE A CONFERENCE CALL TOMORROW NIGHT YOUR TIME AFTER YOU HAVE RECEIVED ADDITIONAL TECHNICAL INFORMATION FROM US.

I DO HAVE A FEW QUESTIONS FOR YOU:

WHEN YOU REFER TO THE LIFE OF THE CAPRI, IS THIS U.S. LIFE?, TOTAL LIFE?, OR IS U.S. LIFE AND TOTAL LIFE ONE AND THE SAME?

THERE IS STILL SOME CONFUSION ON OUR PART AS TO THE NEXT TIME WE NEED TO SUPPLY SAMPLES FOR THE CAPRI?

IN DAVE'S MOST RECENT MSG TO YOU (DATED 7/10), HE PRESENTED A TIMING CHART FOR PRODUCT INTRODUCTION/DEVELOPMENT. HAS FORD SEEN THIS AND DO WE HAVE THEIR BUY IN?

ONE ADDITIONAL POINT IN REGARD TO THE RUBBER DIAPHRAGM IS THAT THE MATERIAL IS EXACTLY THE SAME AS THE RUBBER GASKET AND THE SUPPLIER IS THE SAME. THEREFORE, AT LEAST FROM A CHEMICAL COMPATIBILITY (I HAVE TO CREDIT DAVE FOR THE SEMANTICS HERE) STANDPOINT, THERE SHOULD NOT BE AN ISSUE.

ALSO, I THINK YOU MAY BE GETTING HUNG UP A LITTLE BIT IN REGARD TO SEMANTICS IN TERMS OF DEVELOPMENT. IN TERMS OF TRUE DEVELOPMENT, THE PRODUCT IS PROBABLY 90% DEVELOPED. HOWEVER, THE ADDITIONAL 10% DEVELOPMENT REQUIRES A SIGNIFICANT LEVEL OF "TESTING". STEVE AND HIS TECHNICIAN JEFF ARE BASICALLY DEDICATING ALL THEIR PRESENT EFFORTS TO SETTING UP AND RUNNING VARIOUS TEST MATRICES. THIS HAS BEEN ONGOING FOR SOME TIME NOW AND WILL CONTINUE INTO THE FORESEEABLE FUTURE.

THE BOTTOM LINE IS THAT WE WILL SPEND MUCH MORE THAN $40K IN DEVELOPMENT OF A PRODUCT FOR FORD AUSTRALIA WHEN ALL IS SAID AND DONE. HOWEVER, WHEN VIEWING THIS BUSINESS FROM A GLOBAL PERSPECTIVE, WE RECOGNIZE A STRATEGIC IMPORTANCE. THIS IS WHY I THINK IT MAKES A LOT OF SENSE TO GET THE FALCON AND CAPRI TEAMS TO SHARE THE BURDEN (WHICH RESULTS IN A LESSENING IN THE INDIVIDUAL BURDEN - WHICH SEEMS TO BE A BIG DEAL TO FORD U.S. PLATFORMS ANYWAY).

ONE FINAL POINT. AT THIS POINT, I DO NOT WANT YOU TO PRESENT THE AMORTIZATION IN THIS MSG TO FORD. THIS IS STRICTLY INTERNAL BRAINSTORMING (I.E. THE HIGHIGS AT TI WHO HAVE TO APPROVE THIS ARE NOT IN TODAY). WE WILL DISUCSS FURTHER ON TUESDAY.

REGARDS, CHARLIE

-MSG Nº= 02437427 FR=DOD TO=SEC1 SENT=10/15/92 12:40 AM
RE=073 ST=C DIV=0050 CC=00101 RY=DOD AT=10/15/92 12:00 AM

To: CHARLIE DOUGLAS CHP1
DAVID CZARN CZARN

Copy: STEPHEN B. OFFILER SEC1
MATT SELLERS MJS2

From: DANNY O'DRISCOLL DOD

Subj: CCPS AND THE VACUUM

FORDS POSITION AT THIS STAGE IS THAT THEY REJECT OPTIONS 1 & 2 AS PREDICTED. THEY PREFER THE KAPTON OVER THE RUBBER BECAUSE WE HAVE EXPERIENCE WITH THE KAPTON MATERIAL OVER LIFE AND IN THE FIELD.

THE MAJOR PROBLEM FOR THE CAPRI TEAM IS THAT THE TOOLING HAS BEEN SIGNED OFF AND FOR THEM TO NOW GO BACK TO THE BEANS AND ASK FOR ANY MORE TOOLING WILL CREATE PROBLEMS. IN FACT A TOOLING COST OF $65K WILL PROBABLY JEOPARDISE THE CRUISE CONTROL PROJECT AND IT COULD GO BACK TO THE OLD MAZDA CRUISE CONTROL SYSTEM.
JOHN PECK INDICATED THAT THEY COULD PROBABLY GET $30K TOOLING MONEY BUT THAT WOULD BE ABOUT THE LIMIT. HE ALSO INDICATED THAT IT IS FAR EASIER FOR THEM TO SIGN OFF ON A PIECE PRICE INCREASE (AS IT DOESNT INVOLVE TOP LEVEL MANAGEMENT BEANS).

NOTE THAT JOHN ADVISED THAT THE LIFE OF THE CAPRI IS ONLY ABOUT 50K UNITS. THE REASON FOR THIS IS THAT FORD CAN NO LONGER SELF THE CAPRI TO THE US AFTER 1995 DUE TO THE EMISSION REGULATIONS.

FORD HAVE ASKED US FOR A DETAILED BREAKDOWN ON THE TOOLING AND DEVELOPMENT FOR THE BOTH THE KAPTON & RUBBER OPTIONS.
ARE YOU ABLE TO CALCULATE A PIECE PRICE ADDER THAT WILL INCLUDE THE ADDITION -AL MLO COST PLUS A COST THAT REPRESENTS THE AMORTISATION OF THE DEVELOPMENT COST (SAY BASED ON 40K UNITS) ?

FOR EXAMPLE:	KAPTON	RUBBER
ROUND PUNCH	$5K	
DIE		$10K
ANI MED'S	$5K	$5K
FIXTURING	$2K	$3K
TOT TOOLING	$12K	$18K
MLO COST/UNIT	$0.20	$0.30

eg. cont'd: NOW TOTAL DEVELOPMENT COST KAPTON = $20K
" " " " RUBBER = $30K

SAY BASED ON 40K UNITS THE PIECE PRICE ADDER IS :

KAPTON = $20K/40K =$0.5
RUBBER = $30K/40K =$0.75

THUS --> PIECE PRICE ADDER IS :

KAPTON = $0.2 + $0.5 =$0.7
RUBBER = $0.3 + $0.75 =$1.05

THIS IS SOME ACCOUNTING BUT I HOPE IT ILLUSTRATES MY POINT. MY APOLOGIES IF I AM TELLING YOU HOW TO SUCK EGGS!

NOTE: FORD TOLD ME THEY COULD POSSIBLY TOLERATE A PIECE PRICE ADDER OF UP TO $1.00 AUSTRALIAN DOLLARS. (ROE=0.72). 0.72 US$ = 1 Aus$ = $0.72 US DOLLARS — 1 US$ WILL BUY 1.39 Aus$

* I DO NOT THINK THAT I UNDERSTAND WHAT IS INVOLVED IN THE DEVELOPMENT PROCESS COULD YOU PLEASE EXPLAIN THE STEPS ??

CALL ME IF YOU HAVE A PROBLEM.

REGS, DANNY

-MSG M#= 2437427 FR=DC O=MJS2 SENT=10/15/92 12:40 AM
R#=100 ST=C DIV=00 (CC=00270 BY=DOD AT=10/15/92 12:00 AM

To: CHARLIE DOUGLAS CMP1
DAVID CZARN ZARN

Copy: STEPHEN B. OFFILER SBO1
MATT SELLERS MJS2

From: DANNY O'DRISCOLL. DOD

Subj: CCPS AND THE VACUUM

FORDS POSITION AT THIS STAGE IS THAT THEY REJECT OPTIONS 1 & 2 AS PREDICTED. THEY PREFER THE KAPTON OVER THE RUBBER BECAUSE WE HAVE EXPERIENCE WITH THE KAPTON MATERIAL OVER LIFE AND IN THE FIELD.

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JOHN PECK INDICATED THAT THEY COULD PROBABLY GET $30K TOOLING MONEY BUT THAT WOULD BE ABOUT THE LIMIT. HE ALSO INDICATED THAT IT IS FAR EASIER FOR THEM TO SIGN OFF ON A PIECE PRICE INCREASE (AS IT DOESNT INVOLVE TOP LEVEL MANAGEMENT BEANS).

NOTE THAT JOHN ADVSIED THAT THE LIFE OF THE CAPRI IS ONLY ABOUT 50K UNITS. THE REASON FOR THIS IS THAT FORD CAN NO LONGER SHIP THE CAPRI TO THE US AFTER 1995 DUE TO THE EMISSION REGULATIONS.

FORD HAVE ASKED US FOR A DETAILED BREAKDOWN ON THE TOOLING AND DEVELOPMENT FOR THE BOTH THE KAPTON & RUBBER OPTIONS.
ARE YOU ABLE TO CALCULATE A PIECE PRICE ADDER THAT WILL INCLUDE THE ADDITIONAL MLO COST PLUS A COST THAT REPRESENTS THE AMORTISATION OF THE DEVELOPMENT COST (SAY BASED ON 40K UNITS) ?

FOR EXAMPLE:	KAPTON	RUBBER
ROUND PUNCH	$5K	
DIE		$10K
ANI MOD'S	$5K	$5K
FIXTURING	$2K	$3K
TOT TOOLING	$12K	$18K
MLO COST/UNIT	$0.20	$0.30

eg. cont'd: NOW TOTAL DEVELOPMENT COST KAPTON = $20K.
" " " " " = $30K

SAY BASED ON 40K UNITS THE PIECE PRICE ADDER IS :

KAPTON = $20K/40K =$0.5
RUBBER = $30K/40K =$0.75

THUS --> PIECE PRICE ADDER IS :

KAPTON = $0.2 + $0.5 =$0.7
RUBBER = $0.3 + $0.75=$1.05

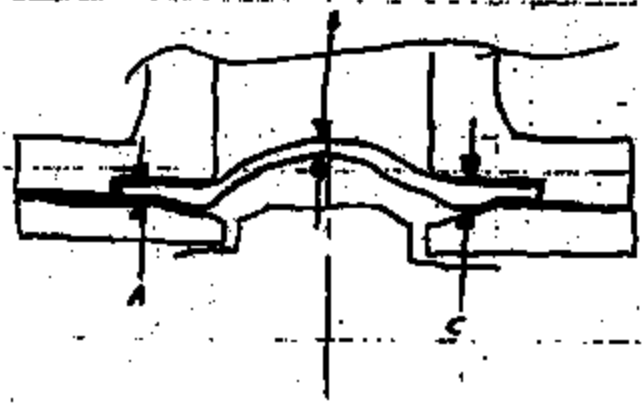
THIS IS BUSH ACCOUNTING BUT I HOPE IT ILLUSTRATES MY POINT. MY APOLOGIES IF I AM TELLING YOU HOW TO SUCK EGGS.

I DO NOT THINK THAT I UNDERSTAND WHAT IS INVOLVED IN THE DEVELOPMENT PROCESS
COULD YOU PLEASE EXPLAIN THE STEPS ??

CALL ME IF YOU HAVE A PROBLEM.

RODS, DANNY

PAGES IN 931016-1



	Large dome	Small dome
A	.0218, .0244	.0242, .0249
B	.0313	.0327
C	.0343, .0333	.0331, .0331

Small dome (1 PC KAPTON)

Large dome (2 PC KAPTON)

DOME HT. VS. ACT ON RUB DIA

JAD
92-1029

	Device #	Act	Rel	Δ	Dome 1	Dome 2		
	11	119.3	92.3	26.6	.077	.076	.0765	
LOWER	19	130.9	105.5	24.3	.067	.067	.0670	
5	51	134.9	105.4	26.5	.050	.051	.0505	X̄ .057
	9	135.7	116.6	23.1	.059	.058	.0585	σ .012
	29	136.0	113.8	22.2	.071	.070	.0705	
		[illegible]	[illegible]	[illegible]				
	5	147.9	116.5	31.2	.101	.100	.1005	
MEDIUM	22	150.1	113.5	37.6	.102	.102	.1020	
5	27	151.2	112.4	37.8	.108	.107	.1075	X̄ .105
	43	152.0	121.0	31	.115	.115	.1150	σ .007
	16	152.1	117.9	34.2	.099	.099	.0990	
		[illegible]	[illegible]	[illegible]				
	54	161.0	124.2	36.8	.105	.105	.105	
HIGHER	45	161.3	127.7	31.6	.106	.105	.1055	
5	57	166.4	117.6	48.8	.120	.121	.1205	X̄ .111
	58	161.0	122.2	34.8	.109	.109	.109	σ .007
	61	166.7	130.1	36.6	.116	.116	.116	
		[illegible]	[illegible]	[illegible]				

- LOWER ACTUATION DEVICES HAVE LOWER DOME HT
- MED & HIGH HAVE FAIRLY SIMILAR DOME HT
- MED & HIGH HAVE SIMILAR Δ

MSG M#= 00089451 FR=YPC1 TO=SBD1 SENT=10/16/92 02:39 PM
R#=077 ST=C DIV=0050 CC=00101 BY=YPC1 AT=10/16/92 02:39 PM
TO: DANNY O'DRISCOLL DOD

CC: DAVE CIARN ZARN
STEVE OFFILER SBD1

FR: CHARLIE DOUGLAS CMP1
RE: CCPS VACUUM

DANNY, BEING THAT IT IS NOW FRIDAY AFTERNOON, MY WISDOM METER HAS RUN OUT! HINDSIGHT BEING 20/20, I DON'T THINK ANY OF US FORESAW THE LEVEL OF DEVELOPMENT/TESTING THAT WOULD ACTUALLY BE REQUIRED TO MEET THE VACUUM REQUIREMENTS OF FORD. IN ADDITION, UNTIL PETER VISITED THE U.S., I DON'T THINK ANY OF THE FOLKS OVER HERE REALLY APPRECIATED JUST HOW CRITICAL IT WAS FOR THE FIRST PARTS THAT WE SHIP TO MEET ALL FORD REQUIREMENTS (I AM NOT SUGGESTING THAT OUR EFFORT WAS ANYTHING LESS THAN 100%, HOWEVER, I KNOW IN MY OWN MIND I FELT THAT SINCE WE WERE BEING ASKED ON SHORT NOTICE TO MEET A NEW/STRICT CUSTOMER REQUIREMENT, THERE WOULD BE SOME LEVEL OF FORGIVENESS IF WE HAD A FAILED DEVICE - RATHER THAN THE DEATH PENALTY).

FROM A COMMERCIAL STANDPOINT, I DON'T THINK THE PICTURE IS QUITE AS BLEAK AS YOU DO. THE TOTAL TOOLING AND DEVELOPMENT IS $25K RATHER THAN $60K. WE WOULD IDEALLY LIKE TO RECEIVE THE $17K UP FRONT, AND WE ARE WILLING TO AMORTIZE THE $40K OVER THE FIRST 50K UNITS SHIPPED (AGAIN, IDEALLY THIS WILL BE THE FIRST COMBINED 50K SHIPPED TO THE FALCON AND THE CAPRI). OUTSIDE OF TOOLING AND DEVELOPMENT, I DON'T BELIEVE THE PIECE COST ADDER WILL COME CLOSE TO $.50. BASED ON WHAT WE KNOW TODAY, IF THE RUBBER DIAPHRAGM PROVES OUT, THE PIECE COST ADDER WILL PROBABLY BE LESS THAN $.15. IN FACT, IT IS NOT INCONCEIVABLE (THOUGH UNLIKELY) THAT THE ADDER COULD ACTUALLY BE 0.

AMONG THE TESTS WE ARE PLANNING IS TO BUILD PARTS WITH RUBBER DIAPHRAGMS AND ELIMINATE 1 PIECE OF KAPTON AT A TIME. THE HOPE IS (AND I EMPHASIZE HOPE) THAT WE WILL GAIN BACK SOME OF THE ACTUATION TOLERANCE THAT WE LOST IN ADDING THE RUBBER DIAPHRAGM TO THE STANDARD DEVICE (AT THIS POINT, I THINK THE GENERAL FEELING IS THAT WE WILL BE ABLE TO ELIMINATE AT LEAST 1 AND PROBABLY 2 PIECES OF KAPTON - AGAIN, IMPACT ON PERFORMANCE TBD).

FROM A WISDOM STANDPOINT, I BELIEVE THE BEST WAY TO DEAL WITH FORD IS JUST TO LEVEL WITH THEM. THERE ARE CULTURAL PHILOSPHICAL DIFFERENCES BETWEEN FORD U.S. AND FORD AUSTRALIA. WE MADE A MAJOR ERROR IN NOT UNDERSTANDING THESE DIFFERENCES. IT HAS BEEN MY EXPERIENCE THAT WHEN YOU MAKE A MISTAKE YOU ADMIT AND TRY TO MOVE FORWARD (ADMITTEDLY, THIS IS EASY FOR ME TO SAY AS I DON'T HAVE TO TAKE IT TO FORD). FORD IS MOST LIKELY GOING TO BE UPSET NO MATTER WHAT YOU TELL THEM. AT LEAST IF YOU START FROM THE TACK THAT WE ARE AT SOME LEVEL OF FAULT, YOU WILL NOT RUN THE RISK OF HAVING THEM TWIST YOUR WORDS AND USE THEM AGAINST YOU.

I KNOW THE ABOVE PROBABLY IS NOT THE WISDOM YOU WERE LOOKING FOR. HOWEVER, WE CAN DISCUSS THIS FURTHER ON TUESDAY.

REGARDS, CHARLIE

-MSG NO= 02003608 FR=DOD TO=SB01 SENT=10/16/92 02:41 AM
N#=075 ST=C DIV=0050 CC=00101 BY=DOD AT=10/16/92 02:16 AM

To: CHARLIE DOUGLAS CWF1

Copy: STEPHEN B. OFFILER SB01
DAVID CHASE KANE
MATT SELLERS MJS2

From: DANNY O'DRISCOLL DOD

Subj: VACUUM

ANSWERS TO YR QU'S:

> US LIFE = TOTAL LIFE = 2.5YRS THAT IS FORD PLAN TO CEASE PRODUCTION AT THE END OF 1995.
> SAMPLE BUILDS ARE ON HOLD. ***** AT THIS STAGE I ESTIMATE THAT WE WILL NOW BE REQUIRED TO SHIP SAMPLES MID JAN 1993 **** I AM HAVING A MTG WITH FORD AND BCIA NEXT FRIDAY IN MELBOURNE AND I WILL FIND OUT MORE THEN.
> RE DAVE'S TIMING: FORD KNOW ABOUT IT BUT WE WILL DISCUSS IT NEXT FRI. I NEED A DETAILED PLAN FROM YOU EXPLAINING THE TESTING PLAN OVER AND ABOVE THE ES TESTING THAT WILL TAKE YOU FROM ES LEVEL CONFIDENCE TO A LEVEL OF CONFIDENCE THAT WILL ENABLE US TO SHIP PRODUCTION PARTS.

NOTE: FORD OPTED FOR THE KAPTON SOLUTION BECAUSE STEVES REPORT HIGHLIGHTED THE UNKNOWN FIELD EXPERIENCE AND MATERIAL VARIABILITY ASSOCIATED WITH THE RUBBER AS A RISK. IF YOU THINK THAT THE RUBBER IS THE BEST OPTION AND THE MATERIAL VARIABILITY IS QUANTIFIABLE THEN PLS PUT THIS OPTION FORWARD.

BASICALLY I THINK YOU NEED TO NOMINATE (IF YOU ARE ABLE TO AT THIS STAGE) THE PREFERRED OPTION - FROM A TOTAL COST (TO BOTH TI & FORD) AND RELIABILITY STANDPOINT.

CHARLIE, I MUST ADMIT THAT I AM A LITTLE RED FACED AT THE MOMENT. THE REASON IS THAT BASED ON THE PCD CONFIDENCE LEVEL I TOLD FORD APPROX 4 WKS AGO THAT WE DID NOT FORSEE MUCH IN THE WAY OF TOOLING AND DEVELOPMENT CHARGES AND THE WORST CASE WOULD BE A PRICE ADDER OF $0.50 AUD.
NOW I HAVE HAD TO TURN AROUND AND TELL THEM THEIR WILL BE A TOOLING & DEVELOPMENT CHARGE OF $[illegible],000 AND A PIECE PRICE ADDER OF $0.50.
THE PROBLEM LIES IN THE FACT THAT THEY QUESTION WHY WE DID NOT FORSEE THIS 4WKS AGO. THIS IS COMPOUNDED BY THE FACT THAT UP UNTIL 2WKS AGO WE INTENDED TO SUPPLY OTS LEVEL SAMPLES.
I HAVE TOLD FORD THAT THE REASON FOR TI'S POSITIONAL CHANGE IS THAT WE HAVE JUST COMPLETED TESTING AND THE TEST RESULTS INDICATED THAT MORE TESTING IS REQUIRED. I ALSO SAID THAT THIS WAS ALWAYS A POSSIBILITY BECAUSE OUR TIMING PLAN WAS BASED ON THE ASSUMPTION THAT THE PROTOTYPES WOULD PASS ALL OUR TESTING WITHOUT ANY HOBBLES AND THIS DID NOT OCCUR.

AUD$

CAN YOU ADD ANY WORDS OF WISDOM OR PARABLES TO HELP ME OUT??

RGDS, DANNY

-MSG N#= 2003609 FR=DOD TO=MJS2 SENT=10/16/92 02:41 AM
R#=103 ST=C DIV=0071 CC=00270 BY=DOQ AT=10/16/92 02:16 AM

To: CHARLIE DOUGLAS CMP1

Copy: STEPHEN B. OFFILER 8901
DAVID CZARN ZARN
MATT SELLERS MJS2

From: DANNY O'DRISCOLL . DOD

Subj: VACUUM

ANSWERS TO YR QU'S:
> US LIFE = TOTAL LIFE = 2.5YRS THAT IS FORD PLAN TO CEASE PRODUCTION AT THE END OF 1995.
> SAMPLE BUILDS ARE ON HOLD. ***** AT THIS STAGE I ESTIMATE THAT WE WILL NOW BE REQUIRED TO SHIP SAMPLES MID JAN 1993 **** I AM HAVING A MTG WITH FORD AND BCIA NEXT FRIDAY IN MELBOURNE AND I WILL FIND OUT MORE THEN.
> RE DAVE'S TIMING: FORD KNOW ABOUT IT BUT WE WILL DISCUSS IT NEXT FRI. I NEED A DETAILED PLAN FROM YOU EXPLAINING THE TESTING PLAN OVER AND ABOVE THE ES TESTING THAT WILL TAKE YOU FROM ES LEVEL CONFIDENCE TO A LEVEL OF CONFIDENCE THAT WILL ENABLE US TO SHIP PRODUCTION PARTS.

NOTE: FORD OPTED FOR THE KAPTON SOLUTION BECAUSE STEVES REPORT HIGHLIGHTED THE UNKOWN FIELD EXPERIENCE AND MATERIAL VARIABILITY ASSOCIATED WITH THE RUBBER AS A RISK. IF YOU THINK THAT THE RUBBER IS THE BEST OPTION AND THE MATERIAL VARIABILITY IS QUANTIFIABLE THEN PLS PUT THIS OPTION FORWARD.

BASICALLY I THINK YOU NEED TO NOMINATE (IF YOU ARE ABLE TO AT THIS STAGE) THE PREFFERED OPTION - FROM A TOTAL COST (TO BOTH TI & FORD) AND RELIABILITY STANDPOINT.

CHARLIE, I MUST ADMIT THAT I AM A LITTLE RED FACED AT THE MOMENT. THE REASON IS THAT BASED ON THE PCD CONFIDENCE LEVEL I TOLD FORD APPROX 4 WKS AGO THAT WE DID NOT FORSEE MUCH IN THE WAY OF TOOLING AND DEVELOPMENT CHARGES AND THE WORST CASE WOULD BE A PRICE ADDER OF $0.50 AUD.
NOW I HAVE HAD TO TURN AROUND AND TELL THEM THEIR WILL BE A TOOLING & DEVELOPMENT CHARGE OF $80K AUD AND A PIECE PRICE ADDER OF $0.50.
THE PROBLEM LIES IN THE FACT THAT THEY QUESTION WHY WE DID NOT FORSEE THIS 4WKS AGO. THIS IS COMPOUNDED BY THE FACT THAT UP UNTIL 2WKS AGO WE INTENDED TO SUPPLY OTS LEVEL SAMPLES.
I HAVE TOLD FORD THAT THE REASON FOR TI'S POSITIONAL CHANGE IS THAT WE HAVE JUST COMPLETED TESTING AND THE TEST RESULTS INDICATED THAT MORE TESTING IS REQUIRED. I ALSO SAID THAT THIS WAS ALWAYS A POSSIBILITY BECAUSE OUR TIMING PLAN WAS BASED ON THE ASSUMPTION THAT THE PROTOTYPES WOULD PASS ALL OUR TESTING WITHOUT ANY WORRIES AND THIS DID NOT OCCUR.

CAN YOU ADD ANY WORDS OF WISDOM OR PARABLES TO HELP ME OUT??

REGDS. DANNY

921016

MODIR-SHIF DIAL IND. w/ JD's T-PIN TIP DOME HT.

RND KAP (CARL)	0	0	0	ADJ. TO 3-PL 0
#31	.115	.114	.114	.114
#32	.077	.077	.076	.077
NO VAC A	.104	.103	.103	.103
NO VAC B	.063	.065	.064	.064
RUB 0	.072	.074	.071	.087
* → RUB 1	.030	.029	.027	.039
RUB 2	.078	.077	.076	.082
RUB 3	.094	.093	.093	.093

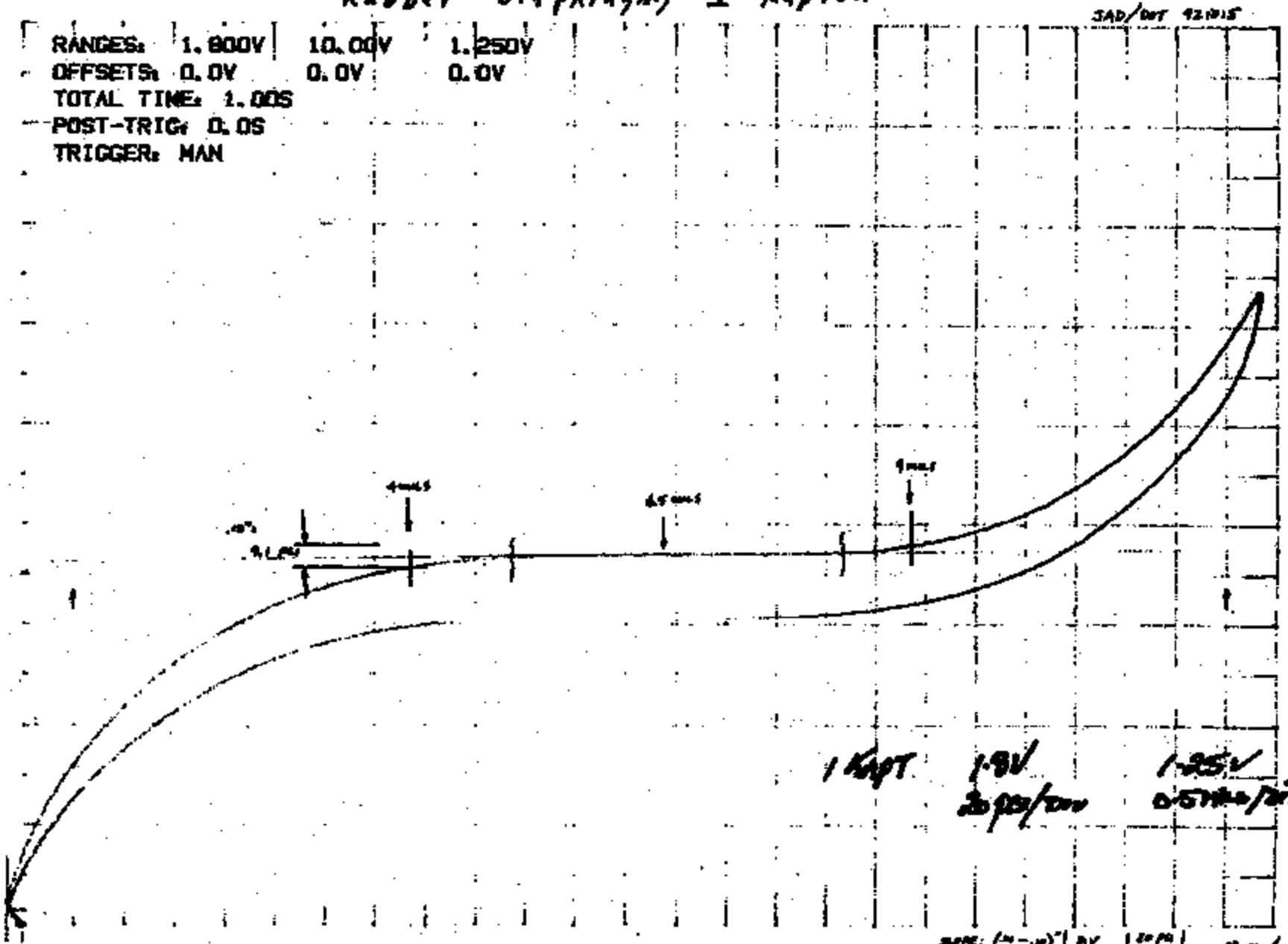
HATCHET CURVES

LOT	FLAT SLOPE	FLAT LENGTH	Δ 4.9 mil
CTRL	0.34 mi/mil	3.5 mil	8.6 mi
RND	0.76	3.0	13.7
RUB 0	1.02	3.1	9.1
* → RUB 1	0.49	3.3	9.1
RUB 2	2.45	2.7	23.4
RUB 3	1.52	2.5	17.8

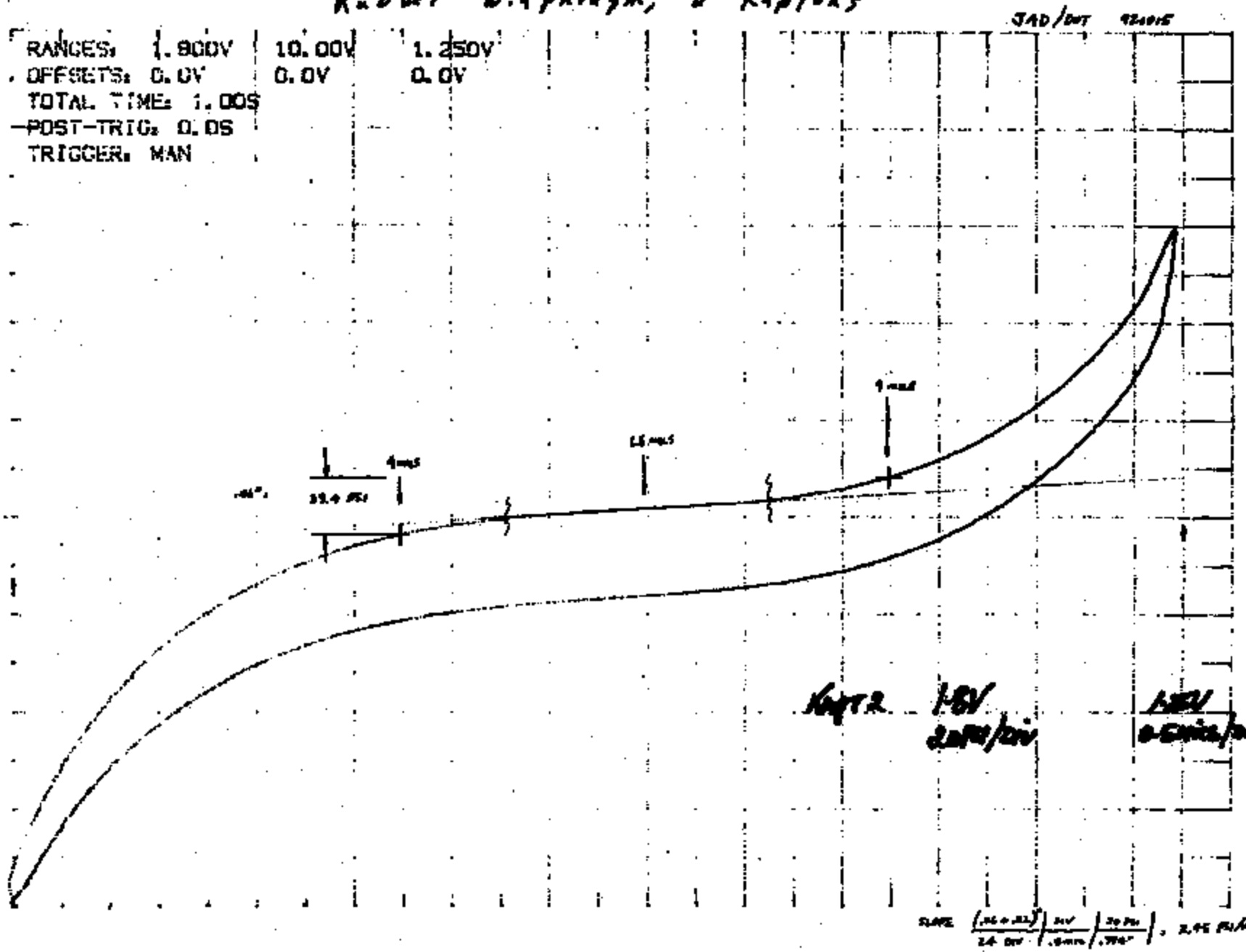
PARTS IN BAG 921016-1

* NOTE 'RUB 1' HAD SMALLEST DOME HT & BEST HATCHET CURVE

Rubber Diaphragm, 2 kapton

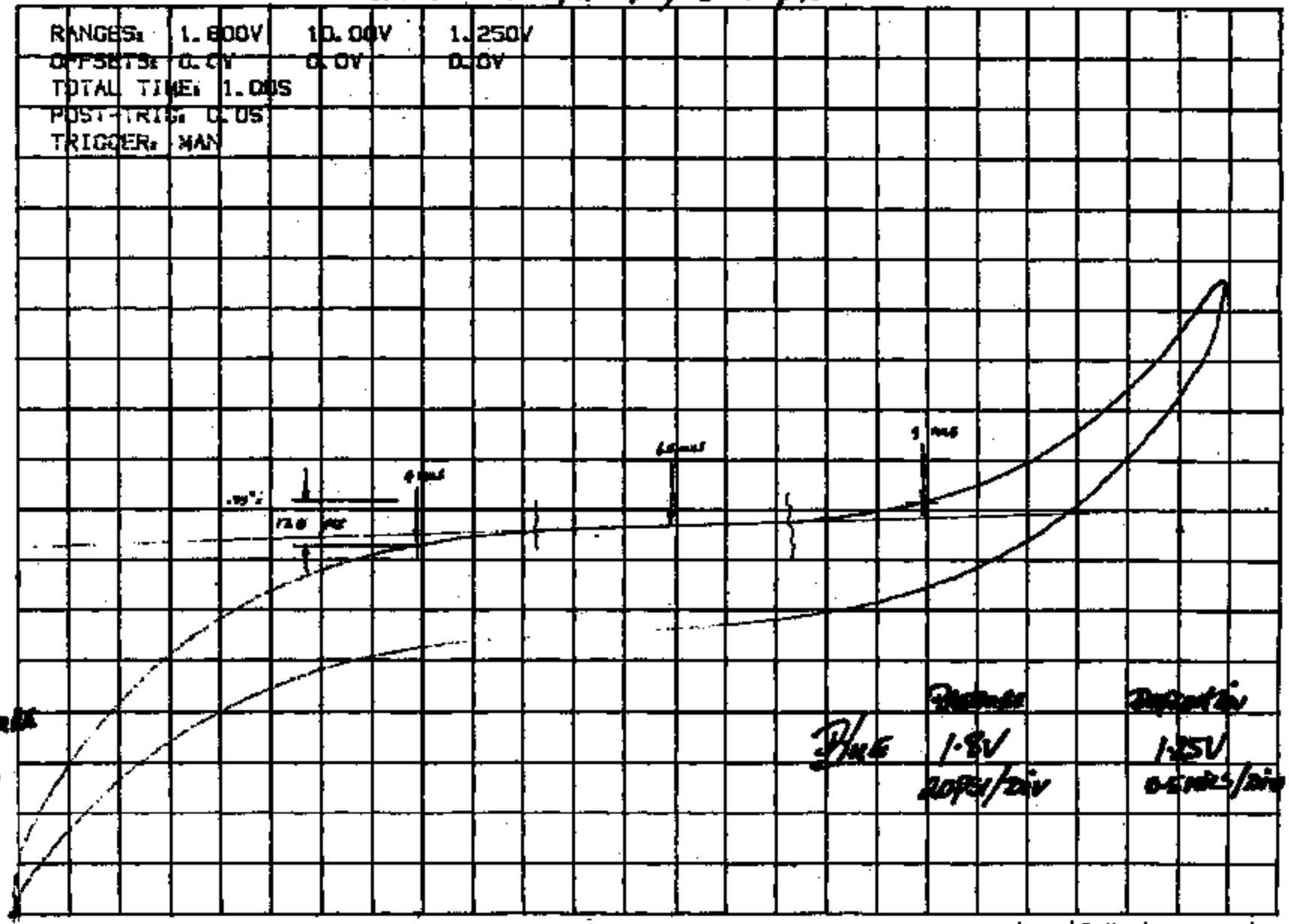


Rubber Diaphragm, 2 kaptons



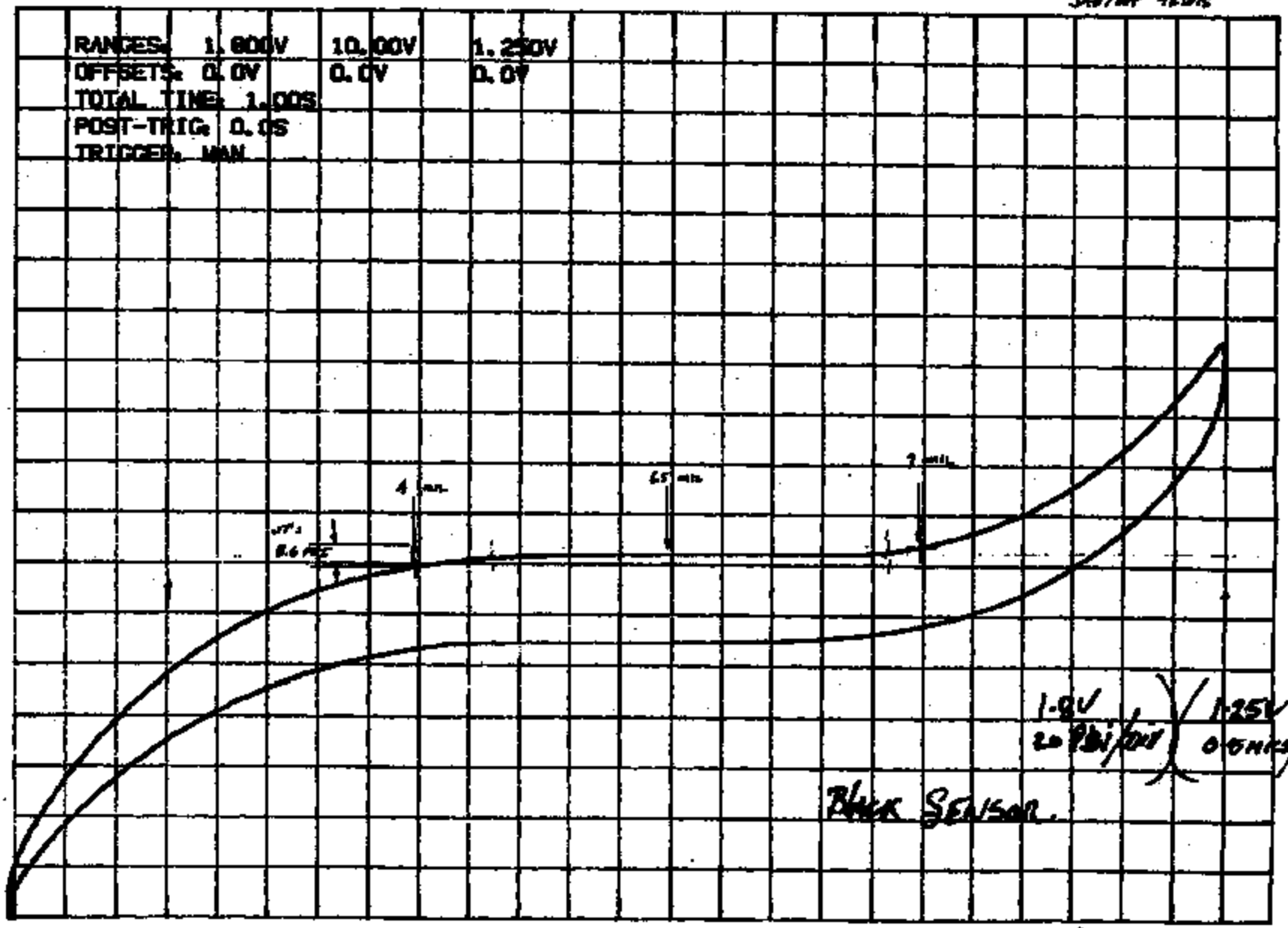
TI-NHTSA 011340

Rubber Diaphragm, 3 Kaptons



TI-NHTSA 011341

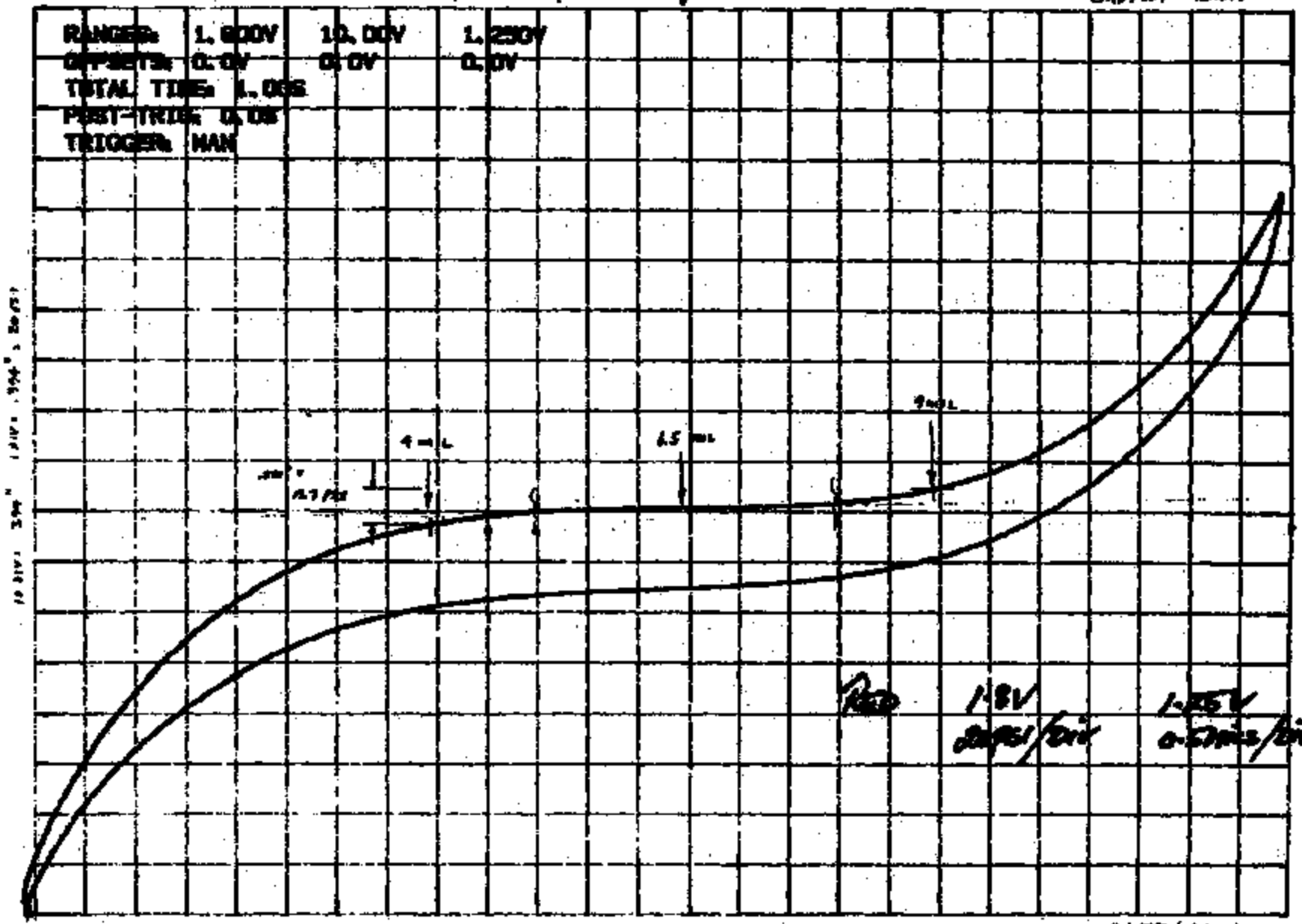
Control



TI-NHTBA 011342

Round Kapton

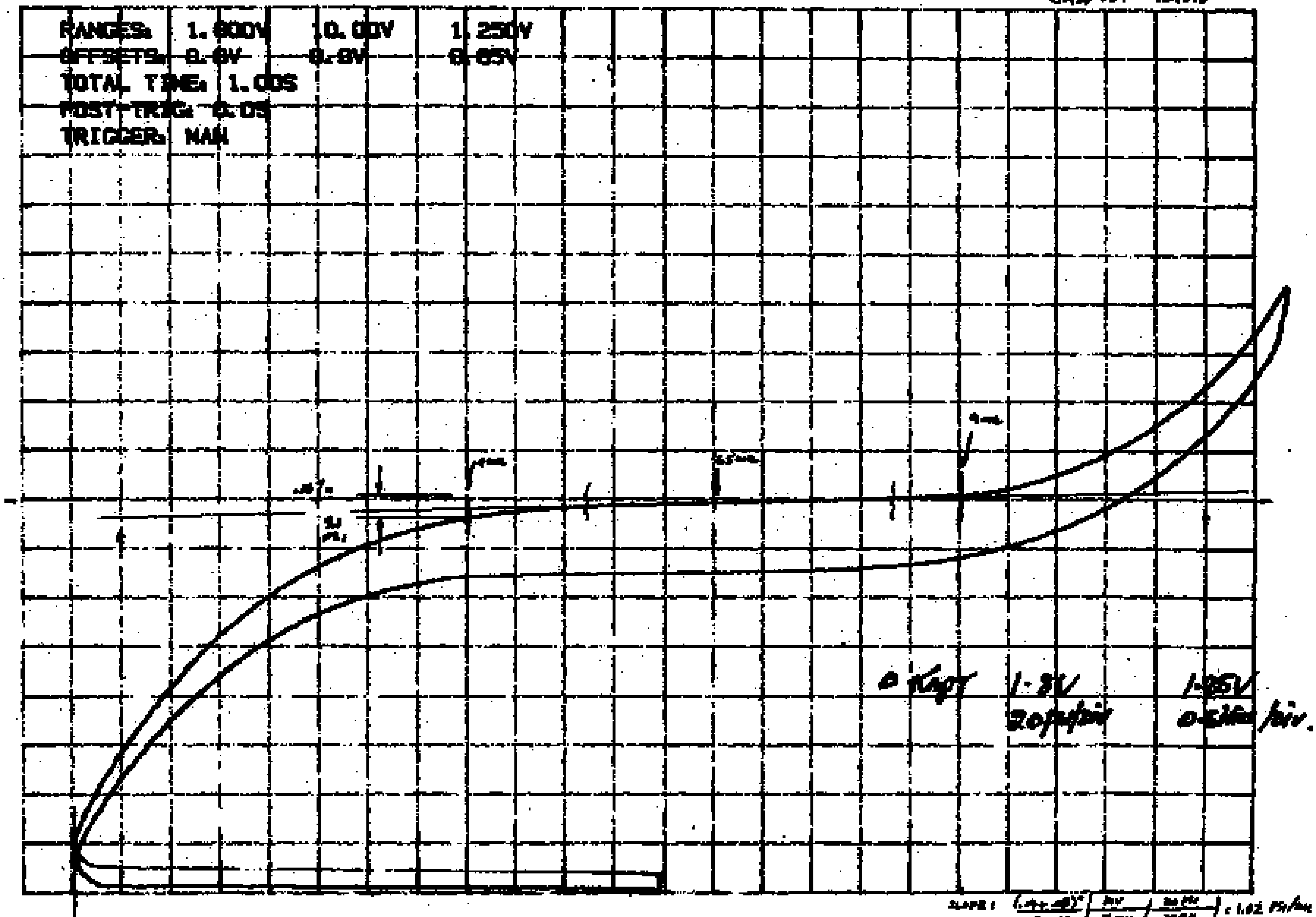
JAB/MT 92-1015



TLNHTSA 011343

Rubber Diaphragm, no Kapton

JAD/DOT 921015



Design Meeting: 10-19-92

Rubber Diaphragm 3 pcs. kapton
Round Kapton 2 pcs. kapton

Thermal Cycle -40°C + 175°C w/pressure cycles

Z-Characterization Down drift
Control } 4 mil's lost CNT @ elev. temp.
Rubber }
Round 2x down
- leaker @ end of test.
- why 2x shift need to look @ curves.

Note: * Round kapton did not shift thermally as did standard & rubber. why? less washer bending due to solid kapton stack.

* possibly re-do test without fully assembled devices. use sensor only and examine P-D curves.

Rubber

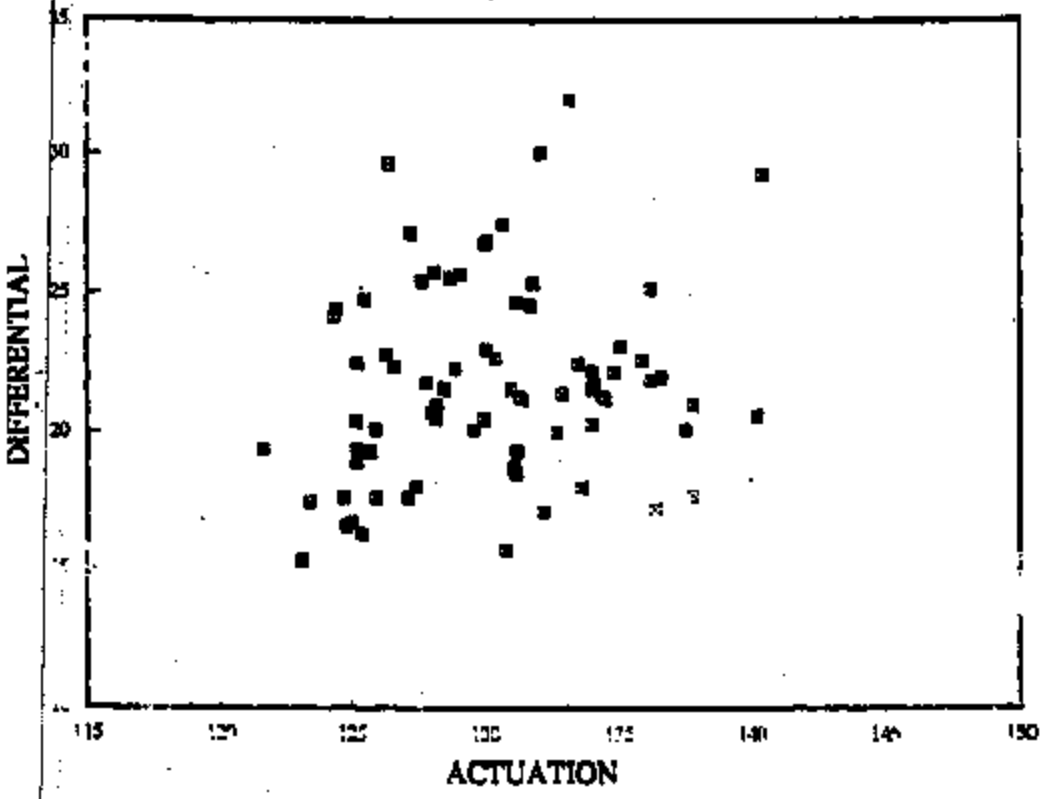
Note: * Dome height may have an affect on actuation. Possibly leading to higher sigmas.

* more work trying to correlate sigma w/ dome height.

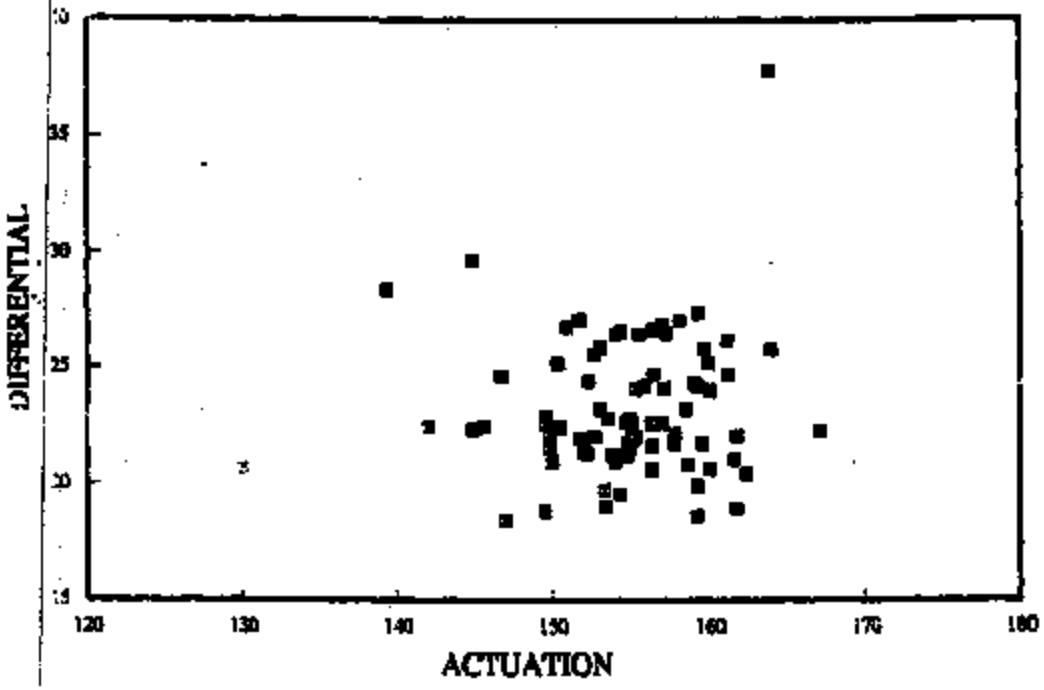
* more work understanding thermal shift issues.

TI-NHTSA 011345

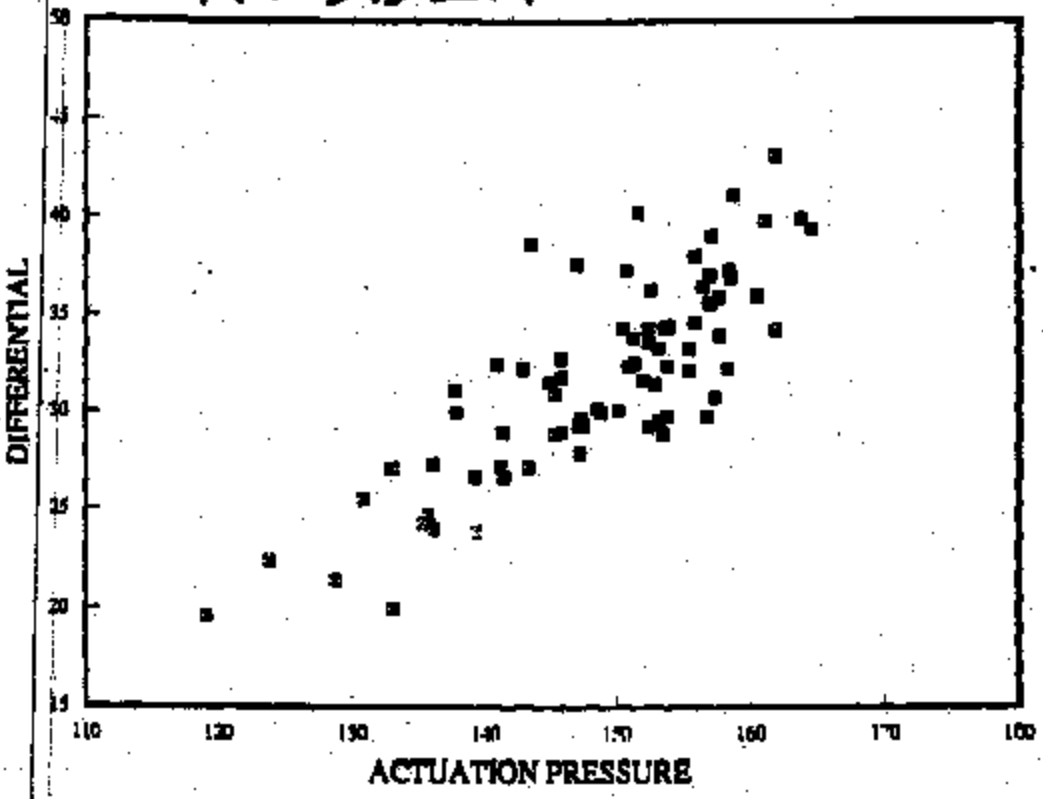
CONTROL LOT



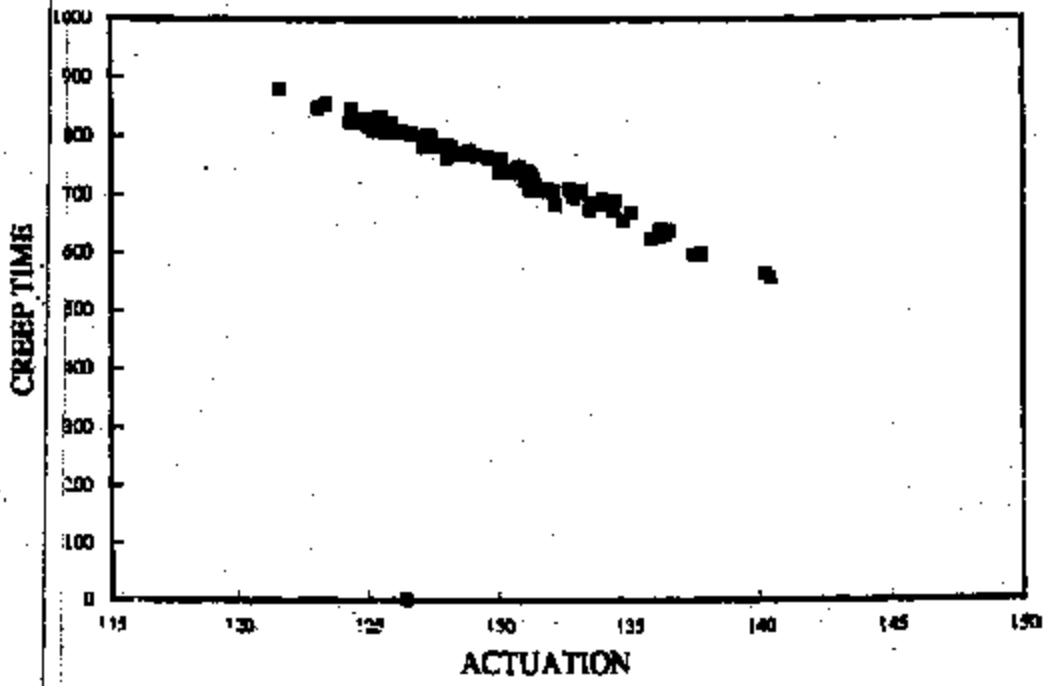
ROUND KAPTON



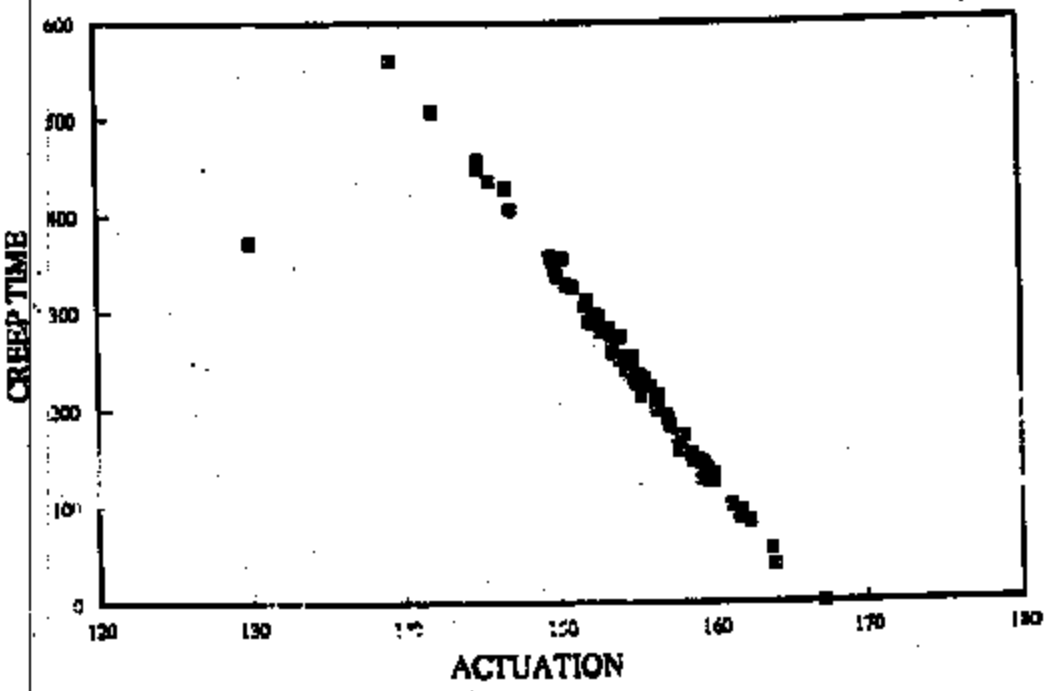
RUBBER DIA.



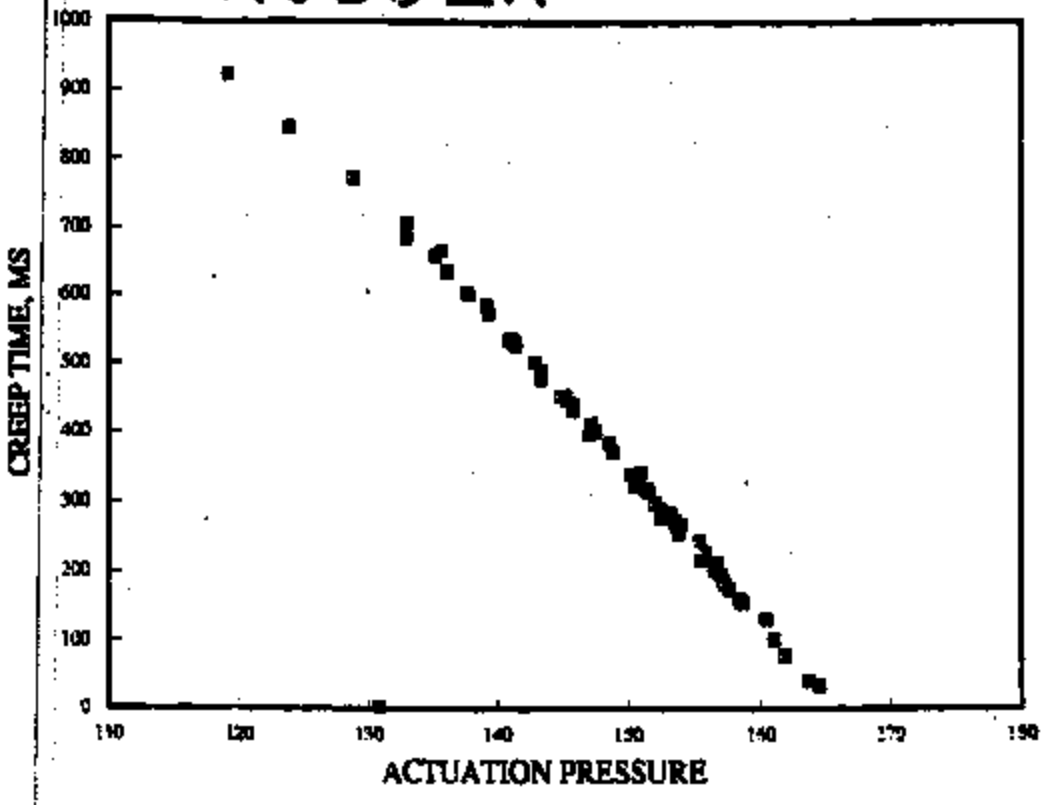
CONTROL LOT


CREEP TIME
1000
900
800
700
600
500
400
300
200
100
0
115
120
125
130
135
140
145
150
ACTUATION

ROUND KAPTON



RUBBER DIA.


CREEP TIME, MS
1000
900
800
700
600
500
400
300
200
100
0
110
120
130
140
150
160
170
180
ACTUATION PRESSURE

* Full round rubber vs. Control.
* Round kapton vs. Control.

9/22 Evaluation Plans

600 devices

200 Control
200 Rubber
200 round kapton } Build & Characterize.

1 → Thermal cycle
2 → Charact @ temp extremes. } by 9/23/92
3 → Drift Analysis. pred cycles

Results by 9/27/92

Next eval'ol

- long term affects on rubber. (Aging)
- FMEA prior D-P

-MSG MS= 00133649 FR=SBO1 TO=SBO1 SENT=10/19/92 01:30 PM
S#=069 ST=C DIV=0050 CC=00101 SY=SBO1 AT=10/19/92 01:38 PM

To:	Dave Czarn	KARN	Danny O'Driscoll	DOD
	Jeff DiDomenico	DIDO	Matt Sellers	MJS2
	Charlie Douglas	CMW1	Bill Sweet	WS4

Fr: Steve Offiler SBO1

Sj: Ford Australia Diaphragm Design

We are progressing with internal tests to try to characterize the various diaphragm options. Briefly, we have built test lots of about 100/each of the following three configurations: standard diaphragms (control lot); rubber diaphragms; and full-round Kapton. All sensors were assembled on the hand-line (production tooling, non-automated). The tests we've come up with are: thermal cycling
-40 to +175 C, combined with pressure cycling 0-1450 psi at 0.1 Hz; thermal characterization (actuation and release) at the same temperature extremes; drift in characteristics over life with data taken at 0, 250K, and 500K cycles; collection of act/rel data for statistical projections on manufacturing yields; and X-Y plots of pressure versus disc deflection.

Below is a brief summary of the results of these tests to-date in matrix format, INTERPRETED relative to a particular "issue" rather than presented raw. The results for the various options are ranked on a 0-10 scale, with "10" best.

[illegible]

Issue	Std	Full Rnd	Rubber
Vac/Dia. life	5	7	10
Char shift (-40C)	8	8	7
Char shift (+175C)	5	6	5
Drift over life	9	8	7
*Temp shift	7	9	7
Prod. variability	8	7	5
**Mfg-ability	8	5	9
Develop. effort	10	8	4

(* Temp shift: this is a well-known condition involving a loss of continuity at high temperature which is related to dimensional shifts. We saw this issue with every control and rubber dia. part but NONE of the full-round.)

(** Mfg-ability: this assumes no automation of the full-round Kapton design, and also assumes the rubber is slightly better than today's design because optimization of the design will indicate use of less Kapton.)

The above matrix shows how each issue fares independently; the performance of the test lots are ranked relative to each other and also roughly against a perceived ideal "10" in each category. However, the above neglects the relative importance of each issue. For example, it is likely that diaphragm life is a much more important concern than a shift in actuation pressure at -40 C. Therefore, the following matrix attempts to assign a weighting to each

of the categories.

Weight	Issue	Std	Full End	Rubber
(5)	Vac/Dia. life	25	35	50
(1)	Char shift (-40C)	8	8	7
(2)	Char shift (+175C)	10	12	10
(1)	Drift over life	9	8	7
(3)	*Temp shift	21	27	21
(3)	Prod. variability	24	21	15
(3)	**Mfg-ability	24	15	27
(2)	Develop. effort	20	16	8
	TOTALS----->	141	142	145

It's almost amazing to see that all three configurations are in basically a dead tie. If anyone sees the weighting system differently, or if I've forgotten any important categories of comparison, please contact me.

Regards, Steve O.

Rubber Diaphragm Fallout — 10-20-92
Potential Cost Impact

(1) Kapton Elimination: 1pc gone −15.74; 2pcs gone −31.48; 3pcs gone −47.22

(2) Rubber Diaphragm add:
Lathe cut $ 20.34
Rubber Dia $ 28.00
+7.14 ×1.07
$ 8.20
+ 8.20

(3) AMI Yield Improvement

(4) AMI Downtime Improvement
= R+M
= Manufacturing

-MSG M#= 223436 FR=SBOI TO=MJS2 SENT=10/21/92 07:00 PM
R#=117 ST=C DIV=0050 CC=00101 BY=SBOI-AT=10/21/92 07:00 PM

TO: Danny O'Driscoll DOD

CC: Dave Czarn ZARN
Charlie Douglas CMP1
[redacted] MJS2

FR: Steve Offiler SBOI

SJ: Timing for Rubber and Full-Round Options

Danny, per your request here is the APPROXIMATE timing to produce each of the options. I must stress that this is a first-pass; please treat it as such in discussions with the customer. This timing assumes we get underway pretty much immediately.

Timing to produce full-round Kapton:	WHEN
* production-intent samples (punch in model shop)	NOW
* design/build round Kapton punch tooling	08 Jan 93
* OTS samples (MRD)	29 Jan 93
* ISR (w/ similarity claims)	26 Feb 93

Timing to produce rubber diaphragm:	
* hand-build prototypes	NOW
* development and testing (tighten actuation sigma, optimize # Kapton layers)	12 Mar 93
* define/quantify rubber material variability	ongoing
* design AMI pick&place for rubber, presence sensor	12 Mar 93
* build " " " " " "	23 Apr 93
* offline debug	30 Apr 93
* AMI installation	07 May 93
* OTS samples (MRD)	28 May 93
* ISR (w/ similarity claims)	25 Jun 93

Regards, Steve O.

-MSG M#= 02060306 FR=DOD TO=SB01 SENT=10/23/92 02:25 AM
R#=090 ST=C DIV=0050 CC=00101 BY=DOD AT=10/23/92 12:48 AM

To: CHARLIE DOUGLAS CMD1

Copy: DAVID CRANN EARM
STEPHEN B: OFFILER SB01
PETER BURNER EAGT

From: DANNY O'DRISCOLL DOD

Subj: CCPS VACUUM

I HAD A MTG WITH BCIA & FORD TODAY TO DISCUSS THE CCPS OPTIONS RE THE VACUUM BASICALLY I PRESENTED THE FOLLOWING:

1> THE CURRENT LEVEL DESIGN IS CAPABLE OF PASSING THE 500K LIFE CYCLE TEST BUT THE WEIBULL ANALYSIS INDICATES THAT THE LIFE CYCLE RELIABILITY IS MARGINAL.
2> TI'S PREFERRED PATH TO MEET THE VACUUM REQUIREMENT IS THE FULL ROUND KAPTON DESIGN AND THE ISR COULD BE READY BY MAR 1993.
3> THE RUBBER SOLUTION OFFERS SUPERIOR RELIABILITY CHARACTERISTICS BUT IT REQUIRES A SUBSTANTIAL DEVELOPMENT EFFORT AND THE MRD DATE FOR ISR SUBMISSION WOULD BE AUGUST 1993. THE UPSIDE OF THIS SOLUTION IS THAT AFTER AN AMORTISATION PERIOD THE PIECE PRICE DROPS TO APPRX $0.15 EA.

THE DISCUSSION WENT AS FOLLOWS:

1> FORD & BCIA EXPLORED THE RISK OF USING THE CURRENT LEVEL DESIGN.
A) THE CHIEF ENG AT BCIA QUESTIONED THE ACTUAL VACUUM LEVELS DRAWN DOWN BY THE NAO EVACUATE AND FILL PROCESS. THE THRUST OF THIS WAS THAT ALL FORD & BCIA ENGINEERING FELT THAT IT WAS POSSIBLE THAT FORD NAO WERE SUBJECTING THE CURRENT LEVEL DESIGN TO A VACUUM LEVEL NEAR THE LEVEL OF FORD AUST. IF SO THEN IT MAY BE POSSIBLE TO COMMENCE PRODUCTION WITH THE CURRENT LEVEL DESIGN AND THEN CHANGE OVER TO THE KAPTON .
(NOTE: IF FORD NAO "DISCOVER" THAT THEY ARE APPLYING A VACUUM AS LOW AS .4 MBAR THEN FCD WILL BE FORCED TO FIND A LOW COST SOLUTION FOR FORD)

** B) FORD ASKED US TO NOMINATE THE FAILURE EFFECTS OF THE KAPTON DIAPHRAGM RUPTURING. **** PLS LET ME KNOW THIS ANSWER TODAY *****
PLS NOTE THAT WE ARE INTERESTED TO LEARN IF THE CCPS WILL ALLOW BRAKE FLUID TO LEAK OUT OF THE SWITCH -- OR -- WILL THE SWITCH CONTAIN THE FLUID SUCH THAT NO LEAKAGE OCCURS WHILST THE SYSTEM IS UNDER PRESSURE.
2> THE TIMING PLAN FOR DELIVERY OF THE ISIR IS END OF MARCH 1993. THIS IS A BRICK WALL AS FAR AS FORD ARE CONCERNED.

3> BASED ON THE TIMING PLAN AND THE LACK OF FIELD EXPERIENCE THE RUBBER DIAPHRAGM WAS RULED OUT BY BOTH BCIA & FORD.
(NOTE THE FORD GUYS WERE CAPRI PEOPLE THUS THEY WERE ONLY INTERESTED IN THE CAPRI. YOU MUST UNDERSTAND THAT THE CAPRI LIFE IS ONLY APPROX 45KU SO CONSEQUENTLY, THE OPTION OF REDUCING THE PRICE AFTER 100KU IS NOT AT ALL PERTINENT TO THE CAPRI TEAM.)
*** THE BCIA ENG WANTS TO KNOW THE MATERIAL DESIGNATION FOR THE RUBBER DIAPHRAGM ---- CAN YOU LET ME KNOW? ****

4> THE KAPTON WAS THE PREFERRED OPTION BECAUSE TI HAS EXPERIENCE WITH IT ON THE CURRENT LEVEL AND TI IS ABLE TO SUPPLY THE ISIR BY MAR 1993.
** PLS SUPPLY YOUR BEST & REALISTIC TIMING PLAN TO SUPPLY THE ISIR ***
****

5> FORD WANT US TO PROVIDE A DETAILED TOOLING QUOTE AND PRICE ADDER BY TUESDAY OUR TIME (!! YES TUESDAY - I FOUGHT LIKE A WILD DOG BUT FORD WERE ADAMANT THAT THEY NEED A TOOLING & PRICING ESTIMATE TO WITHIN +/- 10% BY TUESDAY. THEY NEED THIS INFO TO GET IT SIGNED OFF BY TOP MGT)
I WILL NOT BE AT HOME TONITE BUT PLS CALL ME SAY NINE (9E TIME) IF YOU NEED CLARIFICATION.

****

PLEASE CALCULATE THE PIECE PRICE ADDER TO REFLECT THE FOLLOWING:
- MATERIAL ADDER
- MANUAL ASSEMBLY (LABOUR & OH)
- DEVELOPMENT AMORTISATION

NOTE: I INADVERTENTLY TOLD FORD & NCIA THAT THE DEVELOPMENT COST ON THE KAPTON IS SMALL AND THAT WE ARE ABSORBING A LOT OF THE COST.
PLEASE TRY TO ARRANGE THE ADDER TO REFLECT A LOW DEVELOPMENT AMORTISATION COMPONENT.

WHAT I AM TRYING TO SAY HERE IS THAT I HAVE PREPARED FORD FOR THE $0.40 PRICE ADDER BUT I DO NOT WANT TO REDUCE THE PRICE AFTER A QUANTITY OF SUPPLY.

TO RECAP WHAT I NEED FROM YOU BY TUESDAY (!!!):
1> THE EFFECT OF KAPTON RUPTURE FROM THE PERSPECTIVE OF FLUID CONTAINMENT
2> THE RUBBER COMPOSITION
3> DETAILED BREAKDOWN OF TOOLING COST AND PIECE PRICE ADDER FOR THE KAPTON
4> DETAILED TIMING PLAN FOR THE SUPPLY OF THE 16XX & SAMPLES BEFORE MARCH END 1993.

REGS,DANNY

-MSG MS= 00269886 FR=SBC1 TO=SBC1 SENT=10/23/92 08:21 AM
SS=075 ST=C DIV=0050 CC=00101 RY=SBC1 RT=10/23/92 08:21 AM

TO: Danny O'Driscoll DOD

CC: Dave Czarn XARN
Jeff DiDomenico DIDO
Charlie Douglas CMP1

FR: Steve Offiler SBC1

SJ: CCPS - Yr MSG 2080305

1) Rupture of the diaphragm results in fluid leak. However, the failure mode, as observed during many many diaphragm life tests, is not catastrophic. That is, the leak begins small, and even with the full MS-specified pressure of 1450 psi (10,000 kPa) behind it, I've rarely seen the fluid leak proceed at anything greater than a drip. To the end customer, a leaking switch should result in a puddle of fluid on the garage floor and/or a dashboard warning lamp (w/ fluid level sensor in M/C reservoir) before complete Loss of braking ability occurs. Running at 1450 psi at 2 cycles per second at 135 C fluid temp, it takes several hundred cycles from the onset of rupture to the point where the device no longer withstands pressure.

2) The present incarnation of the rubber diaphragm is made of the exact same material, by the same supplier, using the same techniques, as the fully ISR'ed rubber gasket which is used in all brake pressure switch applications. This is an Ethylene Propylene Di Methyl ("EPDM") rubber, which is extruded and sliced, not molded. The supplier is J-S-L, a division of Parker Seals. Parker is a major supplier of O-rings and all types of seals in the USA.

3) Detailed commercial info - Charlie will respond.

4) Detailed timing plan - Look for this in a separate MSG.

Also, Danny, I too have wondered what NAO (or is that NAAO, North American Automotive Operations ...) uses for a vacuum level. I guess we're hesitant to bring this topic to them, from concern that they'll over-react and send us scurrying into an "emergency" situation that isn't. We've been selling brake switches to them since 1987 with the 57PSP3-x series, and we know of no problems in the field. Also, the present Engineering Specification does not call out a vacuum exposure prior to other tests; rather vacuum is just a small test unto itself. This issue may expand into a re-write of the ES! Regards, Steve O.

MSG #= 029690 FR=SBO1 TO=MJS2 SENT=10/26/92 12:54 PM
R#=123 ST=C DIV=0050 CC=00101 BY=SBO1 AT=10/26/92 12:54 PM

			Resp. code
To:	Danny O'Driscoll	DOD	(DO'D)
	Jeff DiDomenico	DIDO	(JD)
	Mat[redacted]	MJS2	(MS)
	Jim Watt	JW04	(JW)
CC:	Peter Burnar	SAGT	
	Dave Czarn	ZARN	
	Charlie Douglas	CMP1	
	Mike Downey	MIKD	
	Bill Sweet	WS4	
Fr:	Steve Offiler	SBO1	(SO)

Sj: Full-Round Kapton Schedule

WHAT	WHEN	RESP.
* Production-intent samples (punch in model shop)	available now	SO/JD
* (optional) desktdev of square/round combo	02 Nov-15 Jan	Team
* Design/build round Kapton punch tooling	02 Nov-08 Jan	MS
* Tooling install / debug	11 Jan-15 Jan	MS
* Build val parts, init char	18 Jan-22 Jan	SO/JD
* Approval of similarity claims	T - 8 - 0	DO'D
* Impulse, TC, misc tests, similarity claims	25 Jan-12 Feb	SO/JD
* Compl Final char	15 Feb-19 Feb	SO/JD
* Report writeup	22 Feb-25 Feb	SO
* Build ISR samples	22 Feb-25 Feb	Prod.
* Ship ISR package & samples	26 Feb 93	SO/JW
* ISR & samples MRD @ BCIA	12 Mar 93	

Regards, Steve O.

-MSG #= 356727 FR=VAGB TO=COPY SENT=10/27/92 09:30 AM
ST=C DIV=0050 CC=00134 BY=VAGB AT=10/27/92 09:30 AM

TO: STEVE OFFILER SB01

CC: BILL SWEET PCME
DAVE CZARN ZARN
AGNES CARDOZO ADC

FM: [redacted] SELLERS PCME

RE: 77PS ROUND KAPTON

STEVE,

CONSIDERING THE AGGRESSIVE SCHEDULE FOR ROUND KAPTON INTRODUCTION - WE WILL NEED TO GET RAW MATERIAL IN HOUSE ASAP. DO WE HAVE PRINTS OF RAW STRIP MATERIAL AND ROUND KAPTON PIECES BEING DRAWN UP. ORDERS FOR MATERIAL NEED TO BE PLACED THROUGH AGNES CARDOZO, AND MECHANIZATION WILL HAVE TO GET MOVING ON TOOLING FOR THE SENSOR BELT. CAN YOU HAVE PRINTS FORWARDED AS SOON AS THEY ARE AVAILABLE.

REGARDS . . . MATT
X1245

-MSG Nb= 00526662 FR=SBO1 TO=SBO1 SENT=10/30/92 02:09 PM
SN=040 ST=C DIV=0050 CC=00101 BY=SBO1 AT=10/30/92 02:09 PM

TO:	Peter Burner	SAGT	Danny O'Driscoll	DOD	
CC:	Dave Cramm	SABH	Matt Sellers	MJB2	
	Charlie Douglas	CW1	Martha Sullivan	MMS	
FR:	Steve Offiler	SBO1			

SJ: Response to MSG # 502856

The test that has been requested by John Peck in his fax of 30 Oct 92 has already been completed. The test that we ran to characterise diaphragm life under 0.4 mBar (=0.3 mmHg) vacuum meets the requirements John has called out, specifically:

* six devices, standard diaphragm configuration
* one vacuum cycle held for 60 sec
* 0.3 - 0.5 mmHg vacuum level
* 500,000 cycles @ EB Impulse parameters

Our test parameters were as above, using 0.3 mmHg, plus, we actually ran beyond 500K cycles, to failure (defined as fluid leakage).

John states "If results of these tests are satisfactory then Ford will accept switch any 94AB-9F924-AB in its current form." In our test, the first failure occurred at 848K cycles. I assume "satisfactory" means no failures up to 500K cycles, and therefore no diaphragm modification is required. However, there are several things to keep in mind:

* Our life characterization compared the high-vacuum results with a "control" lot, which saw NO vacuum. Statistically, the minimum life of the high-vacuum lot was calculated (using Weibull techniques) as 501.3K cycles at 90% reliability with 90% confidence (per EB) versus the "control" lot which was 1044.7K cycles. (actual failure data for each lot, and statistics, available upon request)

* This wide discrepancy, 501.3K versus 1044.7K, shows that vacuum has a large impact on diaphragm life, and is why we highlighted this as a potential life issue to Ford Australia.

* However, the "control" lot produced artificially good results, since it saw NO vacuum, whereas in the actual application every switch always sees one vacuum cycle during the factory fill procedure. A true control lot probably should run to the EB vacuum level....

* Tim Andreasen (NAAO Pass-Car Brake Eng.) has been brought into the loop by Ford Australia. Alerted to a potential issue, and with no data at the EB-specified vacuum (3 mm Hg) he has requested that we run a life test to this level. We are proceeding with this test, but at this point we are not comprehending it within the schedule for ISR for Australia.

As far as timing options, I think it is safe to put the round Kapton program on hold as long as we get quick confirmation that Ford/BCIA consider the test results to be satisfactory. If so, we are going ahead with the standard diaphragm configuration. If not, we'll proceed with the schedule to meet ISR to BCIA in mid-March with the round Kapton design.

As far as risk to TI, we have taken the conservative position that

diaphragm life MAY be compromised under high vacuum, and we have presented our best efforts at potential improvements and the costs associated with these improvements. It seems the ultimate choice, and hence the risk, belongs to Ford Australia. My own opinion is that the diaphragm life test is extremely strenuous to the diaphragm, and actual life in the field is likely to be significantly better than the life we measure. This is because:

* The test runs to 1450 psi, which I believe is a typical pressure only in an extreme, panic-stop situation.

* The test requirement of 500K cycles means 5 brake applications per mile for 100,000 miles, which seems unrealistically high.

* The test runs at a continuous 121C ambient and 135C fluid temp. While ambients may reach or exceed 121C, it is unlikely that the fluid temp would reach 135C, and if so, it is extremely unlikely that it would remain this hot for any extended period. We have previously shown increased fluid temperature reduces life, hence the converse is that lower temperatures should have a positive impact on life.

Regards, Steve O.

Ford Motor Company of Australia Limited
A.C.N. 004 116 [illegible]

Rapifax Transmission

cc: R. [illegible]
R. [illegible]
J. [illegible]

OUR REF.

PAGE 1 OF 2

RECEIVED 30 SEP 1992

FROM: [illegible] POLIC.

DEPT: CAR [illegible] ENG'G.

RAPIFAX NO: (052) 788129

TO: BARRY SUMNER - BCIA

cc. (C. CAREY) V. STOIOS / P. WILLIAMS

FAX: cc. T. TREVOR. WORTHINGTON / P. ROBERTS

DELIVERY: ☐ NORMAL ☐ RUSH-CALL FOR PICKUP

DATE: 30/9/92

SUBJECT - SWITCH ASY - SPEED CONTROL DEACTIVATE.
94 JA - 9F924 - AB.
OUR REF: 1921084

REVIEW OF ES SPECIFICATION E7LC-9F924-AA SHOWS THIS SPECIFICATION TO BE SOMEWHAT MORE SEVERE IN SOME AREAS THAN SPECIFICATIONS APPLYING TO THE BRAKE MASTER CYLINDER, PARTICULARLY WHEN THE VACUUM TEST (III.K) IS APPLIED FOR 5 CYCLES AT 0.2 - 0.6 MM Hg. AS THE EVAC/FILL PROCESS IS ONLY EVER APPLIED TO A VEHICLE ONCE, THEN 5 CYCLES REQUIRED BY THE ES SPEC MAY BE EXCESSIVE. FOR THIS REASON I AM PROPOSING THE FOLLOWING PLAN :-

1). THAT TEXAS INSTRUMENTS BE REQUESTED TO TEST A MINIMUM OF SIX STANDARD SWITCHES TO ONE CYCLE OF VACUUM TEST (III.K) AT A VACUUM OF 0.3 - 0.5 MM Hg., FOLLOWED BY 500 000 CYCLES TO IMPULSE TEST (III.E). IF RESULTS OF THESE TESTS ARE SATISFACTORY THEN FORD WILL ACCEPT SWITCH ASY 94 JA - 9F924 - AB IN ITS CURRENT FORM.

2) IF ANY FLUID LEAKAGE IS EVIDENT FROM THE SWITCH DURING THE IMPULSE TEST THEN NOTE THE ONSET OF LEAKAGE (NUMBER OF CYCLES), TEARDOWN DEFECTIVE SWITCH & ESTABLISH IF THERE HAS BEEN ANY MOVEMENT OF OUTER CORNERS OF KAPTON DIAPHRAM.

3) PROGRAM MUST BE PROTECTED IN THE EVENT OF FAILURE IN 1) ABOVE. N.O. SIR. SAMPLES AND SUBMISSION OF REVISED SWITCH MUST BE COMPLETED PRIOR TO 14/4/93. PREFERRED DIRECTION IS TO ADOPT A FULL ROUND KAPTON DIAPHRAM. IF PROGRAM TO DEVELOP THIS REVISED SWITCH CAN BE HELD FOR DURATION OF 1) ABOVE AND STILL SUPPORT 14/4/93 DATE, THEN WE REQUEST THAT THE

OCT 30 '92 14:08 TEXAS INSTRUMENTS ... P.5/4

OCT 30 '92 ...

Ford Motor Company of Australia Limited
A.C.N. 004 116 223

Rapifax Transmission

OUR REF. ....
PAGE 2 OF 2
FROM ....
DEPT: ....
RAPIFAX No.: (SEE OVER)
A/C: .... DATE: ....

TO: ....

FAX: ...... / ......

DELIVERY: ☐ NORMAL ☐ RUSH-CALL FOR PICKUP

PROGRAM BE PUT ON HOLD. IF TIMING IS CRITICAL THEN PROGRAM ~~SH~~ MUST CONTINUE AS REQUIRED FOR PROGRAM SUCCESS

CAN WE PLEASE DISCUSS TODAY

REGARDS

[signature]

RECEIVED 30 OCT 1992

TI-NHTSA 011365

Post-it® brand fax transmittal memo 7671 | # of pages > 2

To John Shockey	From Elaine Rose
Co. K-H	Co. T. I.
Dept.	Phone # 508 699 1907
Fax # 313 684-5374	Fax # 508 699 3153

REPORT

	3136845374
	11. 02. 92 09:06 AM
	01:13
MODE	
PAGE	02
CODE	GOOD

TI-NHTSA 011386

10/30/92

John Shockey

K-H

FAX# (313)684-5374

To: Jerri

Date ______ Time 1:57 AM / PM

WHILE YOU WERE OUT

M John Shirley

of ______

Phone (____) ______
Area Code Number Extension

TELEPHONED	✓	PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	

RETURNED YOUR CALL

Message [illegible]

Operator

TI-NHTSA 011368

11/17/92

Elaine,

Please FAX to John Shirkey,
(Kelsey Hayes) - FAX No. (313)
684-5376

a.) Copy of Cp/Cpk
(He misplaced the last one you sent)

b.) Print out of Actual data points -
Actuation/Release (300 data points)
for: 77PSL2-1 (F2VC9F924)
57PSF3-3 (E75C-3N824)

Thx,

Jim West

PART NUMBER: F2VC-9F924-AB

ACTUATION SPEC: 90 – 160 PSI
RELEASE SPEC: 20 PSI MIN.

	ACTUATION	RELEASE
	138.0	60.1
	143.2	74.8
	145.0	54.5
	143.2	50.8
	144.0	51.6
	138.4	54.5
	137.0	52.8
	137.0	52.2
	131.4	56.7
	136.6	57.1
	139.9	56.3
	142.4	66.6
	132.4	50.9
	136.8	58.8
	139.5	48.2
	150.9	54.9
	148.3	54.6
	135.4	45.2
	141.5	61.7
	154.1	47.2
MIN.	131.4	47.2
MAX.	150.9	74.8
STD DEV:	4.7666	5.9169

Act	Rel
138.0	60.1
143.2	74.8
145.0	54.5
143.2	50.6
144.0	51.6
138.4	54.5
137.0	52.8
137.0	52.2
131.4	56.7
138.6	57.1
136.9	56.3
142.4	55.6
132.4	50.9
136.3	58.6
139.3	48.2
150.9	54.3
146.3	54.6
136.4	48.2
141.5	61.7
134.1	47.2

-MSG M#= 2218073 FR=DOD TO=MJS2 SENT=11/05/92 12:21 AM
R#=140 ST=C DIV=0071 CC=00270 BY=DOD AT=11/04/92 11:49 PM

To: STEVE OFFILER SBC1

Copy: CHARLIE DOUGLAS CMP1
DAVID CZARN ZARN
PETER BURNER SAGT
MATT SELLERS MJS2

From: DANNY O'DRISCOLL DOD

Subj: FORD AUST VACUUM ISSUE

AFTER DISCUSSING YR RESPONSE WITH JOHN PECK AT FORD HE HAS COMMUNICATED THAT FORD WILL ACCEPT THE CURRENT LEVEL CCPS, PROVIDING TI IS ABLE TO SUPPLY A CCPS THAT CAN LAST 500K ES IMPULSE CYLCES (BASED ON 90% REL & 90% CONF) AFTER THE VACCUM HAS BEEN APPLIED FOR ONE CYCLE ONLY -- BUT -- ONLY SUBJECTING THE CCPS TO 750 PSI IMPULSE NOT 1450 PSI.

QU> DO YOU NEED TO RUN ANOTHER SERIES OF TESTS TO FEEL CONFIDENT THAT THE CCPS CAN WITHSTAND 500K CYCLES at 750 psi AFTER THE CCPS HAS BEEN A VACUUM OF 0.3 - 0.5 mmHg FOR ONE 60 SEC CYCLE ?
OR DO YOU THINK THAT WE HAVE ENOUGH TEST DATA TO FEEL CONFIDENT THAT THE CCPS CAN COMPLY WITH THE FORD AUSTRALIA REQUIREMENT WITH A SUITABLE FACTOR OF SAFETY?

QU> IF YOU ARE CONFIDENT THAT OUR CCPS CAN WITHSTAND 0.3-0.5 mmHg VACUUM FOR 60 SEC AND LAST 500K IMPULSE CYCLES AT 750 PSI THEN DO YOU FEEL CONFIDENT THAT PCD CAN COMPLETE THE ES VALIDATION (REMEMBER THE 330 OTS LEVEL SAMPLES WE SENT BCIA A FEW MONTHS AGO?) BY THE 2WK IN MARCH ??
QU> PLEASE OUTLINE THE AREAS WHICH YOU WILL CLAIM SIMILARITY ON FOR THE VALIDATION PACKAGE ? NOTE : FORD AUSTRALIA ARE WILLING TO ACCEPT SIMILARITY CLAIMS ONLY IF IT IS BASED ON NADD PRODUCTS.

CALL ME IF YOU ARE CONFUSED. NOTE THAT THE TIME DIFFERENCE IS +14.5HRS. I THINK IT WOULD BE BETTER IF YOU CALLED ME THE SAME TIME THAT I CALLED YOU THE OTHER DAY.

REGDS, DANNY

MSG NO= 02212 FR=SB01 TO=MJS2 SENT=11/05/92 09:48 AM
RE=142 ST=C DIV=0050 CC=00101 BY=SB01 AT=11/05/92 09:48 AM

TO: Danny O'Driscoll DOD

CC: Peter Burner SAGT Charlie Douglas CMP1
Dave Czarn ZARN Matt Sellers MJS2
Jeff DiDomenico DIDO

FR: Steve Offiler SB01

SJ: Ford Aust. Vacuum - Yr MSG 2218073

Danny, thank you for your quick attention to this matter. I think we're getting somewhere. I'm very pleased that you've been able to get Ford Australia to recognize the extreme nature of the Impulse cycling parameters, and make the logical decision to reduce one (pressure) to a more realistic level.

In answer to your questions:

QU> Do I need to run another series of tests to feel confident that the CCPS can withstand 500K cycles at 750 psi w. 0.3-0.5 mmHg vac for 60 sec?

ANS> No. Although I have never run any testing at 750 psi, I feel pressure reduction will have a large positive impact on diaphragm life. I don't see a need for additional development/confirmation testing at 750 psi based on the recent good results at 1450 psi. I'd like to run one Impulse test (at 750 psi after one cycle of vacuum to 0.3 - 0.5 mmHg), and I'd like to use it as part of the official validation test.

QU> Or, do I think we have enough test data to feel confident that the CCPS can comply with the requirement with a suitable factor of safety?

ANS> As far as my confidence, it's pretty high. I previously explained to you that in the past we've seen quite a bit of variability in the diaphragm life of different lots, and I suspect this situation hasn't changed; however, with the pressure reduction, I feel this will put us far enough ahead that the variability shouldn't be a problem.

The factor of safety is actually built into the statistics. The high vacuum test lot (6 devices) with a Weibull-calculated 501.3K cycle life at 90% rel & 90% conf. didn't start failing until 846K cycles. The official validation test uses 24 devices which provides much better statistics. The following equation indicates the sample size required to pass a test ("success testing") with a given confidence (C) and reliability (R):

$$n = \frac{\ln(1-C)}{\ln(R)} = \frac{\ln(1-.9)}{\ln(.9)} = 22$$

I'm quite sure the ES-dictated sample size of 24 is based on this. All I have to do is get 24 devices to run 500K cycles with no failures and I have demonstrated the required reliability and confidence. There's no need to carry the test through to failure for application of Weibull.

QU> Am I confident that we can complete the ES validation by 2nd wk March?

ANS> Yes. And a question for you, Danny: since we already submitted 330 parts, do we need to send any more (as part of the validation) ?

QU> Please outline the areas which I will claim similarity on for the

[illegible] similarity claims are definitely based on [illegible] products which use essentially indentical materials, design, and process.

This info is based on my MSG 110501 dt 14 Aug 92. The only differences between the Capri part (L6-1) and the quiet NAAO part (L3-1) are the color of the base (same material, GE "Noryl" modified PPO) and the o-ring vs. the SAE J512 metal-to-metal seal.

These differences have no effect on external tests or terminal/contact tests: Fluid resistance, Humidity, Salt Spray, Terminal Strength, and Vibration. We'll claim similarity on these.

Tests which are affected are those relating to the fluid seal: Burst, Vacuum, Thermal Cycle, and Impulse. We will run these, using the production O-ring of course. I will combine the Vacuum and Impulse as I mentioned above, using the new parameters.

Regards, Steve O.

PS Danny, is the time diff 14.5 hours? We just went off daylight svs and I believe you went on at about the same time, if so 13.5 becomes 15.5. When you called the other day it was about 3:15 pm here, and I thought you said it was 6:45 am there.

-MSG MS= 00234120 FR=SBO1 TO=SBO1 SENT=11/08/92 03:12 PM
SS=085 ST=C DIV=0050 CC=00101 BY=SBO1 AT=11/08/92 03:12 PM

TO: Danny O'Driscoll DOD

CC: Peter Burner SAGT
Dave Czarn ZARN
Jeff DiDomenico DIDO
Charlie Douglas CMP1
Chris Wagner CDW3

FR: Steve Offiler SBO1

SJ: 77PSL6-1 yr MSGs 2232434 & 2233019

PRESSURE CHANGE FROM 1450 TO 750 TO 1000:
I communicated that the reduction to 750 psi would help to improve our confidence in diaphragm life test results, and as you might expect I think the 1000 psi will be better than 1450 psi but worse than 750 psi. According to the John Peck fax (dt 6 Nov 92) FOA is basing the 1000 psi pressure on the requirements of the master cylinder, which makes sense. Since he states that both RS temp. and pressure are far more severe than Capri field requirements, maybe we could reach a compromise on the temperature as well? I'd propose the parameters to be something like 500K cycles at 1000 psi and about 100 C fluid temp, to-be-determined by actual Capri field requirements.

PRINT UPDATE:
I previously completed a print update, adding the O-ring note and the slight length increase (I was waiting for an okay from FOA on the length, then I just went ahead with it). [redacted] I plan to send this print [redacted] with the Impulse cycling pressure and temperature parameters (above). I should be able to get the print to Australia within a couple of weeks after we agree on the test parameters and the content of the note.

O-RING:
We are working to define the style of marking the O-ring and working with purchasing to define a supplier. The same EPDM O-ring will be used for 57PSL3-6, which we sell to Dana-Weatherhead here in the US. Therefore, we are trying to limit our supplier selection to one who is on Dana's preferred supplier list. Chris Wagner (design resp. for 52PS/57PS) is heading this effort. He's discovered the best solution seems to be a pigmented Teflon coating. It is superior in terms of visual indentification relative to paint marks or dots because it is nearly 100% coated, in virtually any color we choose. It also facilitates automatic feeding and installation, which for uncoated O-rings requires talc powder to keep things moving smoothly. We have received quotes from several suppliers, and we think we've identified the low quote. I have given Chris an estimate of my short-term needs, and I believe he is obtaining a quantitiy of these parts. I'll have them for my validation testing.

L6-1 330 pc OTS:
Yes, we made these parts to the NHAO silent spec's.

As for timing, whether these were made after NHAO validation is a good question. We shipped the OTS in mid-July. We started the L3-1/L5-2 validation testing on 15 April, but did not complete the writeup until 17 August. The reason the writeup was not completed sooner is because we actually began shipping L3-1's to meet an emergency need in the March

timeframe; so the validation work was really just a low-priority paper exercise. Will John Peck accept the fact that his OTS were built after about 3-4 months of production shipments of silent devices to NHAO ?

I have not yet been able to check if we have any data on the hexports used for the OTS. I'll have to get back to you on this in a day or two.

TIMING CHART FOR ISR:
My timing chart for the full-round Kapton, MSG 328908 dated 26 Oct 92, is still the preferred timing on my end. I realise we no longer need time which this schedule allowed to tool up the round Kapton. However, I have other programs which also need my cycler, and I've planned out its capacity using these timing assumptions. Also, it seems we're still not done with negotiations for the vacuum and Impulse, so my original timing (which provides the ISR to BCIA by 12 March) allows time to get all this worked out as well. PLUS O-RING.... & up....

Regards, Steve O.

-MSG M#= 02356175 FR=DOD TO=SBO1 SENT=11/17/92 11:17 PM
R#=145 ST=C DIV=0050 CC=00101 RT=DOD AT=11/17/92 11:11 PM

To: STEPHEN B. OFFILER SBO1

Copy: DAVID CHARN XARN
CHARLIE DOUGLAS CMP1

From: DANNY O'DRISCOLL DOD

Subj: CCPS - CADSI

STEVE, THIS WILL BE A QUICK NOTE AS I AM REALLY BUSY TODAY. I WILL GET BACK TO YOU IN DETAIL TOMORROW.

> FOA DO NOT WANT TO STRAY ANY FURTHER FROM THE NAAO SPEC THAN THEY HAVE. CONSEQUENTLY, THEY WANT TO KEEP THE TRUP WHERE IT IS. DO YOU FEEL CONFIDENT THAT WE CAN MEET THE [redacted]

CHARLIE >> FOA NOTIFIED ME TODAY THAT WE HAVE THE BUSINESS ON THE FALCON (BIG SURPRISE!) GIVEN THAT THEY WILL PLACE THE TOOLING ORDER FOR THE HEXPORT IN THE NEXT TWO WEEKS, CAN WE MEET AN APPROX 50 PCS VP BUILD MID OF 4/1/93 ? REGS,DANNY

-MSG MS= 00583946 FR=SB01 TO=SBC1 SENT=11/19/92 02:58 PM
SB=092 ST=C DIV=0050 CC=00101 BY=SB01 AT=11/19/92 02:58 PM

TO: Danny O'Driscoll DOD

CC: Dave Czarn ZARN Charlie Douglas CHD1

FR: Steve Offiler SB01

SJ: Capri Impulse Specifications (ref yr msg # 2358175)

Danny, I'd like to relay my thoughts on the Impulse cycling parameters.

1) Pressure: I have no experience with anything other than 1450 psi. The strains/stresses on the Kapton diaphragm arise from its travel during pressure application. With a device like Capri operating around 125 psi, suffice it to say most of the diaphragm travel occurs below a few hundred psi. There is additional minor travel as the sensor internal components are deflected by exposure to elevated pressures beyond disc actuation. Diaphragm life is related directly to the amount of flexure, which is related directly to travel. Bottom line is reduction of pressure will have some effect, but not a large effect, on diaphragm life until you get down towards the actuation pressure (which is unrealistic).

2) Temperature: We have run some tests up to 170 C fluid temp, and saw a sharp reduction in diaphragm life. Specifically, the Weibull characteristic life on 12 parts run at 170 C was 240K cycles, while the very same lot of parts were over a million at 121 C. And, we've generally seen no issue at all with diaphragm life on the production cyclers (which are used for piloting, looking for disc cracking, etc) which run just above room temp, about 40-50 C. Bottom line is any concession at all we can win on the temperature spec will have a much larger impact on diaphragm life than pressure.

I've got reason to believe 135 C was accidentally carried over from an old power-steering spec. John Peck et. al. should have a feel for the max fluid temp seen in the master cylinder, and the spec. for the switch should be set accordingly. I don't think an unwillingness to stray from the NAAO spec is a very good answer from an engineering standpoint.

So, if you're still trying to get a straight answer on my confidence in passing the Impulse/Vacuum combined test - it's only fair for 1450 psi/135C; and it will go up slowly with pressure reduction and quickly with temperature reduction. 1000 psi and 120 C will be a real winner in my mind; again, I'd like to see these parameters set based on the real requirements of Capri !

Regards, Steve O.