HIGHLIGHTS
Stephen B. Offiler
Week Ending 01/05/90

Reviewed 1/8/90

<u>FORD MY92 CRUISE CONTROL PRESSURE SWITCH EX3423</u>

CCPS/CONVERTER DESIGN: Design of the hybrid twist-terminal base, two stationary terminals, and single movable terminal is in progress. Drafting has been notified, and will be able to give priority to the creation of prints in an effort to meet 01/12/90.

To test spring life, devices were built using 57PS sensors and hand-modified CCPS bases. These originally ran 500K pinned incorrectly (as reported 12/14/89) and subsequently ran another 500K pinned correctly. One spring out of ten failed during the second 500K. This was apparently caused by the spring being formed improperly (these are Model Shop springs); when built originally it had the highest preload force by far. The surviving nine were visually inspected and looked excellent. These have been placed back on test again, with the goal of running to failure and doing a Weibull analysis. They have passed another 533K cycles, for a total of 1.533 M, without failure.

An EX drawing of the J512 hexport for the 57PS has been created and sent to Elco for quote. Ken Carlson was here 12/20, and he verbally committed to turn this around quickly and provide 50 no-charge samples. The J512 inverted flare precludes use of the recommended thread lead-in angle. We will look into raising the 4.5 in-lb torque spec and putting whatever chamfer possible on the lead-in.

Ford Light Truck has apparently decided to go with a 57PS for the first year of production (MY91.75), paying the premium price to save tooling charges. Their plan is to switch to the cheaper CCPS once Pass-Car has picked up the tooling bill. We have created the 57PSL3-1 for this purpose. It uses the special J512 hexport and requires the offset polarity tab, however. Mfg. Eng. and Mkt. are working on a cost estimate for this new device. Ford has granted "Conditional Approval" for tooling, and their tooling auditor will be visiting Attleboro on 01/22 and 01/23.

Stan Hornol is working with APCC Disc Dept. to create discs to meet the 250 +/- 50 psi actuation spec.

CCPS/APT DESIGN: Third-iteration devices are have completed a 500K Impulse test. These devices are built with two discs, and various lubricants. Periodic characterization shows some drift over life, but all remained well within the +/- 50 psi spec. These devices are now being cycled to failure, and they've passed an additional 500K at this time. The true goal of this test is to test the rubber diaphragm hydraulic seal. Although high-temp Impulse cycling results are excellent, thermal cycling has shown a leak problem at low temp which will be addressed with material durometer iterations.

The Model Shop has completed 10 zinc/aluminum alloy and 10 steel powdered metal disc seats. The P/M parts have been returned to Norwalk for steam-treating. The strength of these parts will be tested using Impulse cycling and Burst testing. They were built using the old CCPS design, so the results will compare directly with the brass disc seats which are a known quantity.

TI-NHTSA 000832

JVD 11/8/90

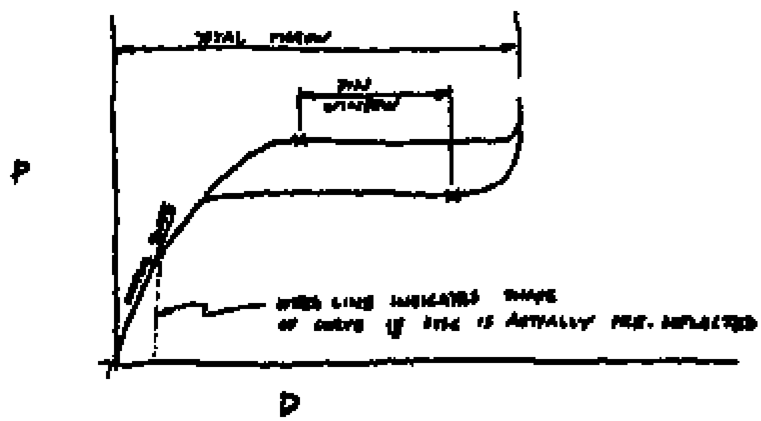
DISC PRE-DEFLECTION, RETAINING CUPS

TWO APPROACHES TO QUANTIFYING THIS:

1) CONTROLLED PRESSURE VS. DEFLECTION EXPERIMENT

2) DIMENSIONAL ANALYSIS OF COMPONENTS

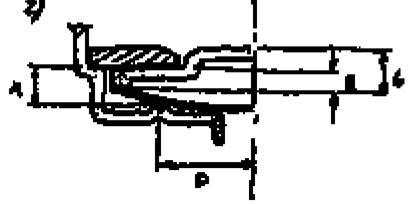
1)



25 PSI DISCS

* DO A PRES-DEG CHAR ON ANY LOT IN STOCK (PREFERABLY ONE NOT USED FOR CUSTOMER SAMPLES, OR IN PARTICULARLY SHORT SUPPLY) COME UP WITH 12 DISCS WITH VERY CONSISTENT ACTUATION/RELEASE VALUES (ACT ± 0.5 PSI, REL ± 1.0 PSI IF POSSIBLE) THEIR FRAME HEIGHTS SHOULD ALSO BE VERY CONSISTENT. (±.0005)
* BUILD 6 SENSORS W/ RETAINING CUPS AND 6 CONTROLS. USE CONVERTER/WASHER COMBINATIONS WITH VERY CONSISTENT BUTTON HEIGHTS, MIX + MATCH AS NECESSARY.
* CHAR. W/ O.P. TO AT LEAST 800 PSI AS USUAL (1/2 MANF)
* RECORD PRESS/DEFL CURVES FOR EACH DEVICE W/ X-Y RECORDER

2)



HIGHLIGHTS
Stephen B. Offiler
Week Ending 01/12/90

Handwritten initials and date beside the heading: [illegible]

<u>**FORD MY92 CRUISE CONTROL PRESSURE SWITCH EX3423**</u>

AUTOMATED BASE DESIGN: The date for print completion has slipped. Sketches are presently at approx. 70% completion and receiving highest priority. The effort encompasses creation of three terminals, revisions to the present CCPS base mold, and consideration of the design of the calibration equipment. Since these components all fit together, the design of each must progress in parallel.

CCPS/57PS HYBRID: The spring-life test continues to progress, using cycling equipment on the 57PS line. To date, we have observed: one failure between 500K and 1KK cycles, spring broken at bend; one failure at 1.6KK cycles, spring broken at bump; nine survivors have passed 2.1KK cycles.

SAE J512 HEXPORT: Envelope drawings showing detail of the J512 inverted flare feature were created and sent to Ford. George Randall (Light Truck Eng.) has informed me that the wrong set of J512 specs were used. It seems there are two different types of J512 inverted flare features: one is a "plug" and the other is a "nut". We incorrectly used the specs for the nut. The envelope prints are being revised, as well as the EX drawing which was sent to Elco. This could potentially work in our favor, since the correct design, the plug, has a protrusion beyond the threads which may serve to protect the thread similar to the lead-in angle proposed by Elco. Joe Schenk indicates that Ford expects the revised envelope drawings Tuesday morning; they must go out today via overnight.

CCPS/AFT DESIGN: The rubber diaphragm test continues to progress, using CCPS cycling equipment. One device had a continuity failure discovered after 3KK cycles; it was known good at 500K. Inspection showed the switch cavity slightly wet, and the diaphragm noticeably worn at the center, approaching complete failure. The six survivors have passed 3.8KK cycles.

We have built prototype devices using both steel powdered metal and zinc disc seats. Three of each have undergone a burst test, and another three of each are running on the Impulse test with the AFT devices above. Burst results were excellent: the zinc parts burst at an average of 9150 psi; the P/M parts burst at an average of 8350 psi. Both exceed the typical value for brass screw-machine parts, which is about 7700 psi. The parts running the Impulse test have passed 768K cycles without problem.

CCPS CYCLER: With roughly 10KK cycles on the equipment, the brake-fluid piston has begun to leak internally. Dick Trottier indicates that this is very normal. His brake-fluid cyclers normally are rebuilt at 5-6KK cycles. Jeff is presently rebuilding this piston; downtime about one day. John Haynes has approached me to run an 57PS requalification Impulse test on this equipment. This will be no problem once the cycler is back up, since we are also running an Impulse test using the same parameters.

TI-NHTSA 000634

IMPULSE/TEMP. CYCLE HYBRID TEST OF APT-STYLE CCPS DEVICES TEST 40-15-09

DEVICE #	FORCE GRAMS	SPRING DFLECT	DIA-PHRAM	TRANS PIN	PINNED AT	DISC LUBE	PROOF
40-15-01	240	0.006	0.068	232	+8	GRAPHITE	PASS
40-15-02	200	0.004	0.049	232	+8	TEFLON	PASS
40-15-03	175	0.004	0.068	232	+9	PASTE	PASS
40-15-04	190	0.004	0.047	240	+5	GRAPHITE	PASS
40-15-05	205	0.005	0.047	237	+5	TEFLON	PASS
40-15-06	185	0.005	0.047	238	+5	PASTE	PASS
40-15-07	170	0.004	0.078	216	+5	GRAPHITE	PASS
40-15-08	180	0.004	0.078	213	+5	TEFLON	PASS
40-15-09	225	0.005	0.081	213	+5	PASTE	PASS
AVG.	197	0.004	0.064	228			
STD.	22.1	0.000	0.013	10.3			

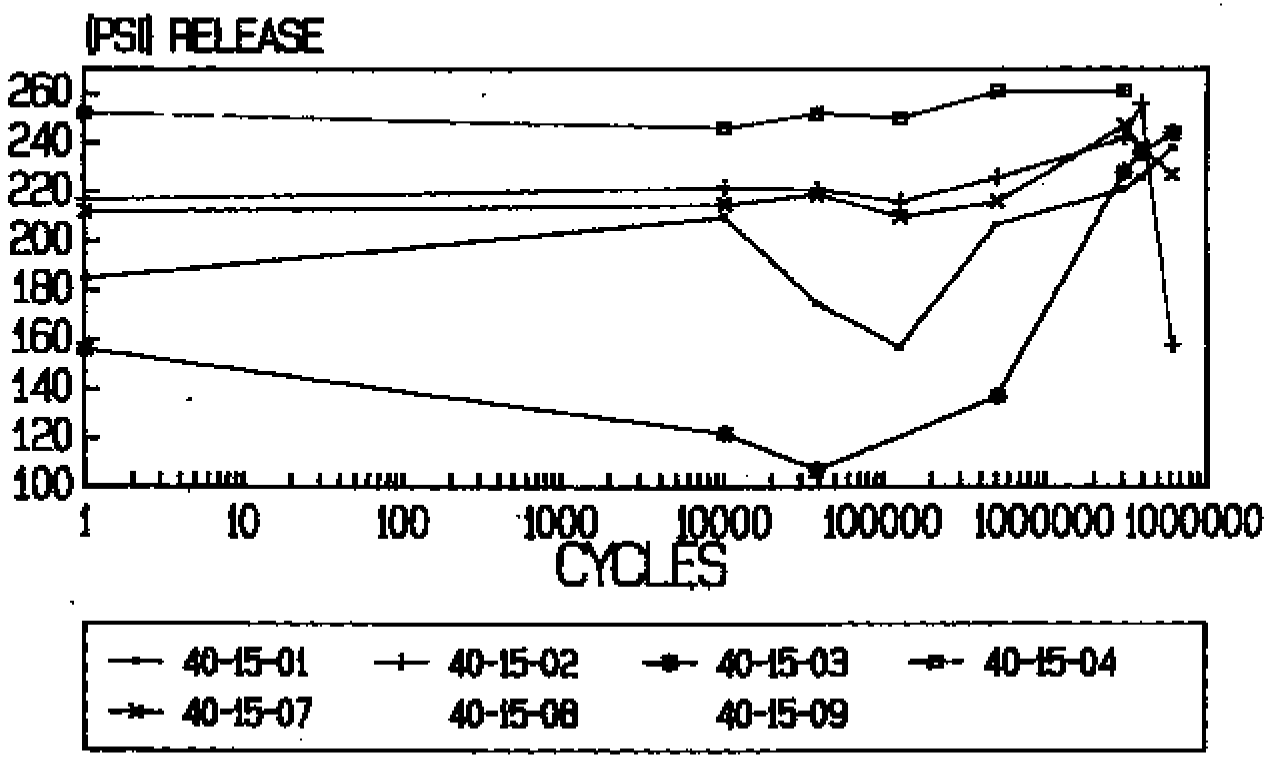
TI-NHTSA 000635

IMPULSE/TEMP. CYCLE HYBRID TEST OF APT-STYLE CCPS DEVICES TEST 40-15-09

	CHARACTERIZATIONS											
	0K CYC		10K CYC		38K CYC		125K CYC		500K CYC		3.0KK CYC	
DEVICE #	ACT	REL	ACT	REL	ACT	REL	ACT	REL	ACT	REL	ACT	REL
40-15-01	214	185	230	210	237	175	171	157	234	207	241	221
40-15-02	234	217	242	222	244	221	243	216	252	226	276	242
40-15-03	187	156	130	122	121	107			203	137	253	228
40-15-04	271	252	284	246	278	252	278	250	293	261	307	261
40-15-05	261	245	271	236	262	241	269	246				
40-15-06	260	243	263	244	270	248	272	249				
40-15-07	232	212	242	215	241	219	238	210	244	216	284	247
40-15-08	240	223	254	219	248	227	253	227	267	241	201	174
40-15-09	259	238	261	238	267	237	225	168	263	243		
AVG.	240	219	242	217	241	214	244	215	251	219	260	229
STD.	25	30	42	36	44	44	32	34	26	37	34	28

	CHARACTERIZATIONS			
	3.9KK CYC		6.1KK CYC	
DEVICE #	ACT	REL	ACT	REL
40-15-01	247	226	274	238
40-15-02	280	256	186	158
40-15-03	253	236	280	244
40-15-04	142	126		
40-15-05				
40-15-06				
40-15-07	279	238	279	227
40-15-08	168	144	49	38
40-15-09				
AVG.	228	204	214	181
STD.	54	50	90	78

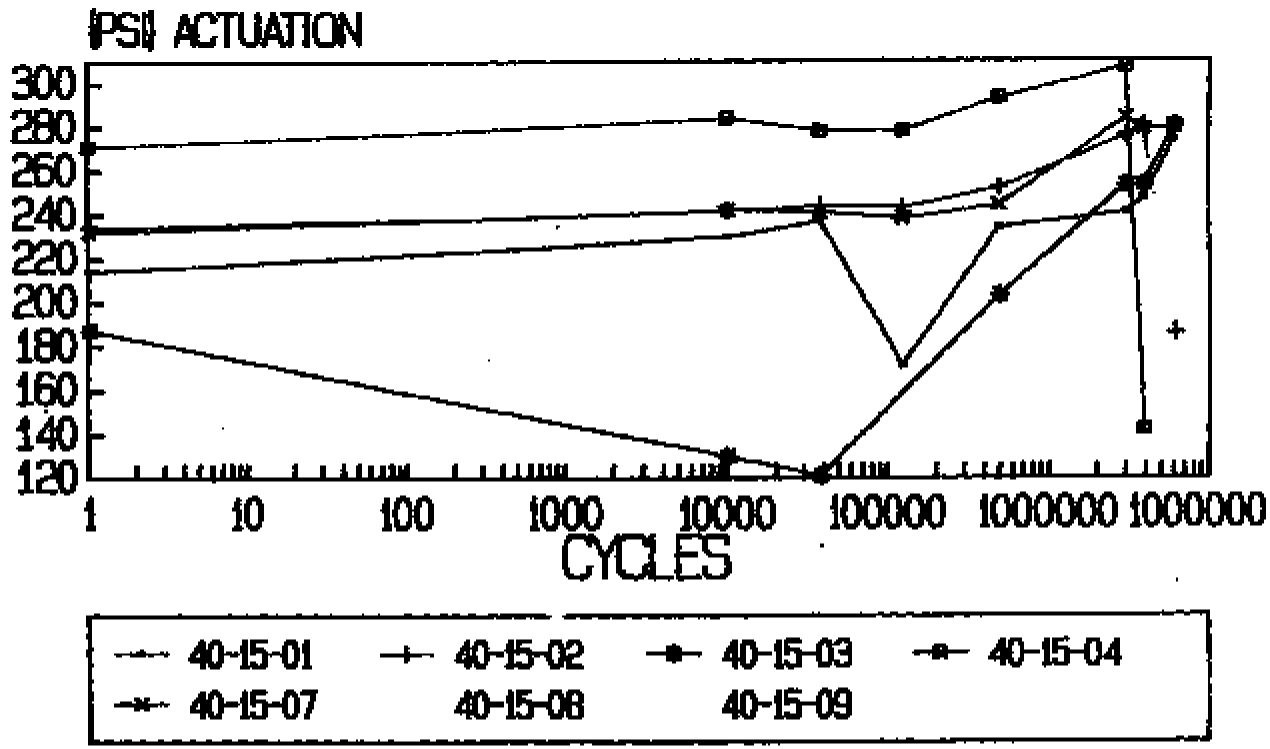
DOUBLE DISC DEVICES
RELEASES



JAD 1-11-90

TI-NHTSA 000037

DOUBLE DISC DEVICES
ACTUATIONS



JAD 1-11-90

TI-NHTSA 000838

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 41-04-06

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3423	1/4/90	[illegible]	—

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
[illegible]	1/4/90	1/ /99	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: Burst pressure

- New-style double step crimp ring
- powder metal and Zinc disc seat

PROCEDURE: assemble w/standard pressure cavity and burst

Device #	Disc Seat Material	Treatment	Burst					
41-04-01	Zinc	—	9000	Crimp lot 38		Seat [illegible]		[illegible]
02	Zinc	—	9200	"	"	"		.0015
03	Zinc	—	9200	"	"	"		.0095
41-04-04	Powder metal	Steam	8300					
05	P/M	Steam	8300	Disc Seat cracked				
41-04-06	P/M	Virgin	9500					

TI-NHTSA 000639

PRESSURE SWITCH DATA Form 21605 TEST NO. 41-03-05

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
E73413?	1/?/90	[illegible]	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD?	1/1?/90	1/14/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: To test Zinc and powder metal disc seats

PROCEDURE: assemble and impulse

Device #	Force (grams)	Spring (inches)	Trav Points	Disc Seat	Proof	Act	Rel	Mv Disc	Leak at
41-03-01	170	.004	237	Zinc	Pass	134	118	5.0	
-02	170	.004	236	Zinc	↓	141	126	4.4	899K Cy
-03	210	.005	222	Vinsey?		151	112	4.1	
-04	205	.004	216	Vinsey?		135	118	4.5	1729K cyc
-05	145	.004	221	[illegible] seat		141	125	4.3	1173K cyc
-06	210	.004	235	Zinc		147	132	7.0	
	-899	K cycles			→			3079	K Cycles
Device #	Act	Rel						Act	Rel
41-03-01	Fractured disc; cracked disc seat								
02	Fractured disc; cracked disc seat								
03	126	118						110	117
04	119	103	T-[illegible] Kapton		- [illegible]				
05	136	125	ripped	Kapton	- Fractured disc				
06	Fractured disc; cracked disc seat								
	Cycles								
	~~[illegible]~~								
	~~[illegible]~~								
	1683K?								
	2079K								

IMPULSE TEST OF ZINC AND POWDERED METAL DISC SEATS TEST 42-03-06

STICK #	TORQUE GRAMS	SPRING DEFLECT	TRANS FIB+S	DISC SEAT	PROOF	INITIAL ACT	INITIAL REL	[illegible]	TOTAL CYCLES	898K CYC ACT	898K CYC REL	3.1KK CYC ACT	3.1KK CYC REL
42-03-01	170	0.004	229	ZINC	PASS	134	120	5.0	898K				
42-03-01	170	0.004	236	ZINC	PASS	142	126	4.4	898K				
42-03-01	220	0.005	222	[illegible]	PASS	131	116	4.1	3.1KK	126	110	120	113
42-03-01	205	0.004	220	[illegible]	PASS	125	110	4.5	1.7KK	118	102		
42-03-01	165	0.004	221	S/T	PASS	141	128	4.3	1.2KK	136	125		
42-03-01	200	0.004	235	ZINC	PASS	147	132	7.0	898K				
AVG.	188	0.004	229			136	122	4.883		126	112		
STD.	20.5	0.000	7.94			7.4	7.4	0.945		7.3	9.5		

TI-NHTSA 000641

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 43-09-40

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PS	1/14/90	SBD	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAB	1/15/90	1/31/90	

PROJECT TITLE: Cruise Control Pressure Switch

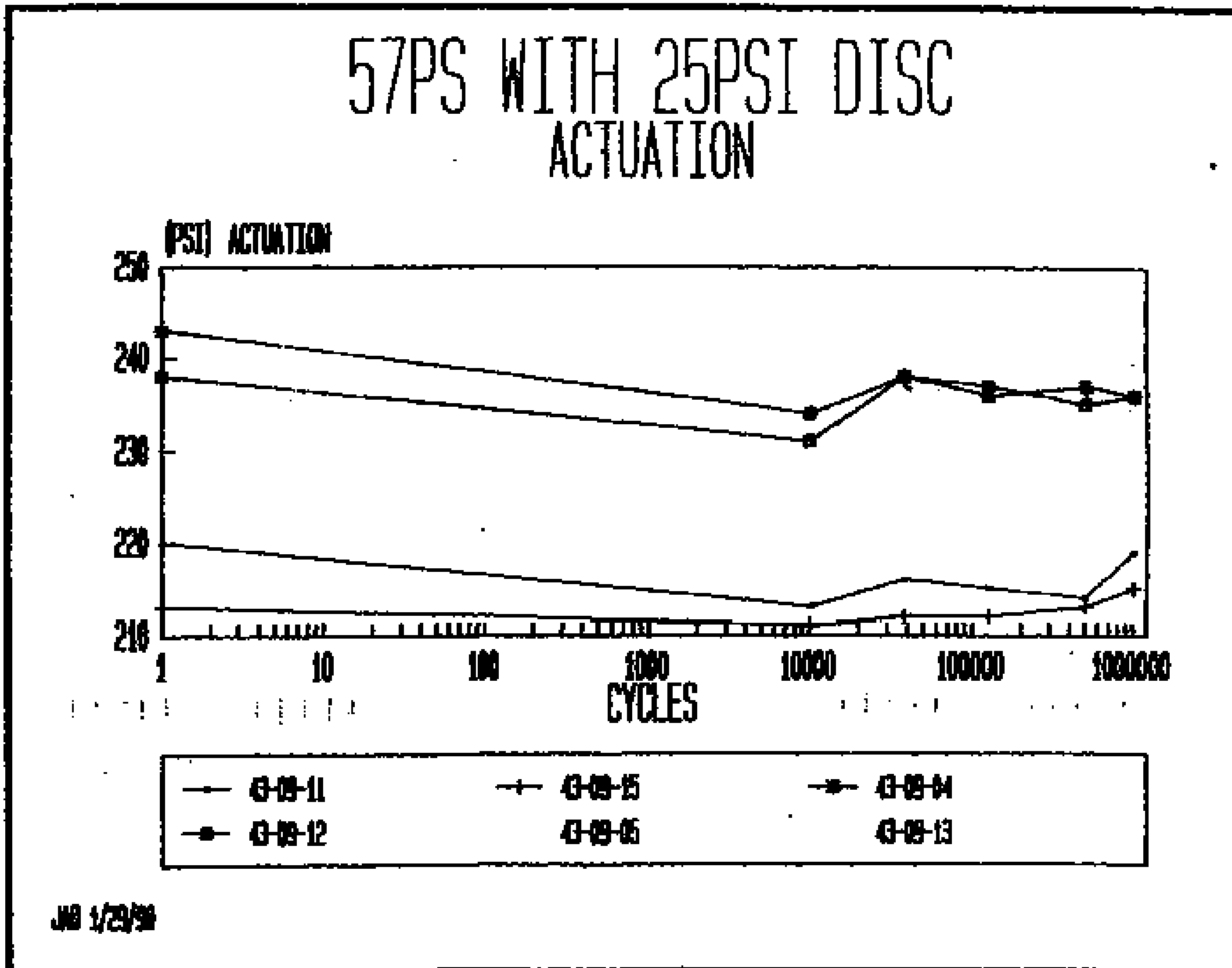
CUSTOMER: [redacted]

PURPOSE OF TEST: To test discs which put a 57PS into our 250 ± 50 PSI Spec.

PROCEDURE: Have 2 lots of 57PS's built. One w/25psi discs one w/30psi discs.

Device #	Ball Disc	Act	Rel	To be cycled	10 K cycle Act	Rel	50 K Act	Rel	
43-09-01	25 PSI	250	75						
02		244	97						
03		232	97						
04		242	94	✓	239	100	239	100	
05		249	79	✓	232	93	237	92	
06		225	53						
07		246	104						
08		240	93						
09		230	85						
10		248	92						
11		226	62	✓	213	71	216	74	
12		239	98	✓	231	92	238	76	
13		249	86	✓	221	94	241	99	
14		224	91						
15		217	96	✓	211	99	212	99	
16		236	92						
17		210	98						
18		248	94						
19		249	94						
20		[illegible]	[illegible]						
43-09-21	30 PSI	311	152	✓	295	169	308	173	
-22		294	149						
23		296	139						
24		299	150	✓	276	151	279	153	
25		294	151						
26		298	142						
27		305	144	✓	[illegible]	[illegible]	[illegible]	[illegible]	

TI-NHTSA 000642



57PS WITH 25PSI DISC
ACTUATION
(PSI) ACTUATION
250
240
230
220
210
1
10
100
1000
10000
100000
1000000
CYCLES
43-09-11
43-09-15
43-09-04
43-09-12
43-09-05
43-09-13
JAB 1/29/98

57 PS DEVICES WITH 25 AND 30 PSI DISCS TEST 43-09-40

	INITIAL		10K CYC		38K CYC		125K CYC		500K CYC		1.0KK CYC	
DEVICE #	ACT	REL	ACT	REL	ACT	REL	ACT	REL	ACT	REL	ACT	REL
43-09-04	243	98	234	100	238	100	236	103	237	103	236	105
43-09-05	249	78	232	93	237	97	234	97	236	97	234	101
43-09-11	220	62	213	71	216	74	215	75	214	73	219	72
43-09-12	238	92	231	92	238	96	237	97	235	97	236	98
43-09-13	249	86	238	94	242	98	241	102	243	102	240	104
43-09-15	213	96	211	98	212	99	212	101	213	100	215	100
43-09-21	311	152	296	168	300	173	300	175	302	172	305	177
43-09-24	278	150	276	151	278	153	278	156	274	155	276	159
43-09-27	306	144	292	164	294	166	297	168	295	177	298	178
43-09-30	293	154	298	147	302	160	289	170	293	169	291	177
43-09-35	294	148	287	157	287	158	291	163	292	163	293	170
43-09-39	276	158	281	158	281	159	283	164	282	164	285	174

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 44-10 ~~[illegible]~~ -90

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PS	2/4/90	RBO	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	2/6/90	7/2/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: To measure the [illegible] window on 57PS's w/ 25 +30 PSI [illegible]

PROCEDURE: Take 6 manual devices from test 43-09-90. Cut them open and perform [illegible] window test

Device #	lower limit	upper limit	window
43-09-10	147	153	.007"
-13	149	151	.003"
-17	147	154	.008"
43-09-27	149	153	.006"
33	149	155	.009"
40	149	154	.007"

Device #	[illegible] Act	Rel	@ 125°C Act	Rel	@ -40°C Act	Rel	@ Room Temp Act	Rel
43-09-01	226	70	210	95	324	105	227	96
-03	244	93	237	87	251	110	246	99
-47	265	88	223	89	244	143	235	97
-56	231	67	215	63	234	93	227	78
-67	241	118	222	95	265	117	250	110
43-09-22	317	157	271	149	311	170	290	165
-23	291	152	269	140	297	169	288	160
-25	277	151	272	145	303	172	295	161
-26	297	147						
-29	291	161						

/ JO 2/2/90

<u>57 PS TESTING</u> CYCLED 12 TO 1KK

1) RECHARACTERIZE EXISTING PARTS AFTER 2 OVERPRESSURE CYCLES TO 800 PSI 10 DEV; 5 OF EA.

2) DISASSEMBLE X DEVICES FROM EACH LOT + PERFORM PIN-WINDOW EXPERIMENT

3) PLACE 10 DEVICES IN MANIFOLD IN ENV. CHAMBER. SOAK @ -40°C; CHARACTERIZE EACH SOAK @ +121°C; CHAR EACH.

14 EACH LOT, TOT 28

5 EACH O/P, HI/LO TEMP TEST

3 EACH PIN WINDOW

TI-NHTSA 00064

PIN-WINDOW OF 57PS WITH 25 & 30 PSI DISCS TEST 44-10-06

DEVICE #	LOWER LIMIT	UPPER LIMIT	WINDOW	
43-09-17	0.147	0.154	0.008	
43-09-18	0.149	0.156	0.008	25 PSI
43-09-19	0.147	0.153	0.007	Discs
43-09-37	0.148	0.153	0.006	
43-09-38	0.148	0.155	0.008	30 PSI
43-09-40	0.148	0.154	0.007	discs
		AVG.	0.007	

TI-NHTBA 000849

CHARACTERIZATIONS AT HIGH AND LOW TEMP.

DEVICE #	ACTUATION INIT	125C	CHANGE	% CHANGE	-40C	CHANGE	% CHANGE	ROOM TEMP	CHANGE	% CHANGE
43-01-01	226	210	-16	-7.08	228	2	0.88	223	-3	-1.33
43-01-02	248	237	-11	-4.44	251	3	1.21	246	-2	-0.81
43-01-03	235	223	-12	-5.11	242	7	2.98	235	0	0.00
43-01-06	231	215	-16	-6.93	236	5	2.16	227	-4	-1.73
43-01-07	246	222	-24	-9.76	265	19	7.72	250	4	1.63
43-01-08	248	237	-11	-4.44	251	3	1.21	236	-12	-4.84
43-01-09	230	220	-10	-4.35	236	6	2.61	226	-4	-1.74
43-01-10	246	255	9	3.66	259	13	5.28	242	-4	-1.63
43-01-14	234	230	-4	-1.71	251	17	7.26	246	12	5.13
43-01-16	236	227	-9	-3.81	243	7	2.97	235	-1	-0.42
43-01-22	287	271	-16	-5.57	311	24	8.36	290	3	1.05
43-01-23	281	269	-12	-4.27	297	16	5.69	288	7	2.49
43-01-25	287	272	-15	-5.23	303	16	5.57	295	8	2.79
43-01-26	298	289	-9	-3.02	305	7	2.35	291	-7	-2.35
43-01-28	284	275	-9	-3.17	303	19	6.69	286	2	0.70
43-01-29	294	283	-11	-3.74	307	13	4.42	295	1	0.34
43-01-31	287	287	0	0.00	305	18	6.27	291	4	1.39
43-01-32	295	279	-16	-5.42	300	5	1.69	281	-14	-4.75
43-01-33	290	267	-23	-7.93	316	26	8.97	280	-10	-3.45
43-01-34	295	286	-9	-3.05	312	17	5.76	295	0	0.00
AVG.			-11.2	-4.3		12.2	4.5		-1.0	-0.4
STD.			7.13	2.79		7.17	2.52		6.46	2.43

DEVICE #	RELEASE INIT	125C	CHANGE	% CHANGE	-40C	CHANGE	% CHANGE	ROOM TEMP	CHANGE	% CHANGE
43-01-01	90	85	-5	-5.56	105	15	16.67	96	6	6.67
43-01-02	93	89	-4	-4.30	110	17	18.28	99	6	6.45
43-01-03	88	84	-4	-4.55	108	20	22.73	97	9	10.23
43-01-06	61	63	2	3.28	83	22	36.07	78	17	27.87
43-01-07	119	85	-34	-28.57	117	-2	-1.68	115	-4	-3.36
43-01-08	82	84	2	2.44	103	21	25.61	97	15	18.29
43-01-09	85	83	-2	-2.35	98	13	15.29	92	7	8.24
43-01-10	92	83	-9	-9.78	106	14	15.22	102	10	10.87
43-01-14	91	86	-5	-5.49	101	10	10.99	96	5	5.49
43-01-16	82	82	0	0.00	104	22	26.83	96	14	17.07
43-01-22	151	149	-2	-1.32	170	19	12.58	165	14	9.27
43-01-23	152	149	-3	-1.97	169	17	11.18	160	8	5.26
43-01-25	151	148	-3	-1.99	172	21	13.91	161	10	6.62
43-01-26	143	159	16	11.19	173	30	20.98	162	19	13.29
43-01-28	156	159	3	1.92	174	18	11.54	168	12	7.69
43-01-29	151	154	3	1.99	177	26	17.22	167	16	10.60
43-01-31	160	157	-3	-1.88	176	16	10.00	169	9	5.63
43-01-32	127	127	0	0.00	152	25	19.69	152	25	19.69
01-33	144	148	4	2.78	163	19	13.19	156	12	8.33
01-34	164	163	-1	-0.61	178	14	8.54	173	9	5.49
AVG.			-2.3	-2.2		17.9	16.2		11.0	10.4
STD.			8.81	7.30		6.51	7.74		5.95	6.52

TI-NHTSA 00065

CHARACTERIZATIONS AT HIGH AND LOW TEMP.

DEVICE #	INIT	121C	CHANGE	% CHANGE	-40C	CHANGE	% CHANGE	ROOM TEMP	CHANGE	% CHANGE	
43-01-01	226	210	-16	-7.08	228	2	0.88	223	-3	-1.33	A
43-01-02	248	237	-11	-4.44	251	3	1.21	246	-2	-0.81	C
43-01-03	235	223	-12	-5.11	242	7	2.98	235	0	0.00	T
43-01-06	231	215	-16	-6.93	236	5	2.16	227	-4	-1.73	U
43-01-07	246	222	-24	-9.76	265	19	7.72	250	4	1.63	A
43-01-08	248	237	-11	-4.44	251	3	1.21	236	-12	-4.84	T
43-01-09	230	220	-10	-4.35	236	6	2.61	226	-4	-1.74	I
43-01-10	246	255	9	3.66	259	13	5.28	242	-4	-1.63	O
43-01-14	234	230	-4	-1.71	251	17	7.26	246	12	5.13	N
43-01-16	236	227	-9	-3.81	243	7	2.97	235	-1	-0.42	
43-01-22	287	271	-16	-5.57	311	24	8.36	290	3	1.05	
43-01-23	281	269	-12	-4.27	297	16	5.69	288	7	2.49	
43-01-25	287	272	-15	-5.23	303	16	5.57	295	8	2.79	A
43-01-26	298	289	-9	-3.02	305	7	2.35	291	-7	-2.35	C
43-01-28	284	275	-9	-3.17	303	19	6.69	286	2	0.70	T
43-01-29	294	283	-11	-3.74	307	13	4.42	295	1	0.34	U
43-01-31	287	287	0	0.00	305	18	6.27	291	4	1.39	A
43-01-32	295	279	-16	-5.42	300	5	1.69	281	-14	-4.75	T
43-01-33	290	267	-23	-7.93	316	26	8.97	280	-10	-3.45	I
43-01-34	295	286	-9	-3.05	312	17	5.76	295	0	0.00	O
44-10-41	231	225	-6	-2.60	245	14	6.06	239	8	3.46	N
44-10-42	230	225	-5	-2.17	248	18	7.83	235	5	2.17	
10-43	237	234	-3	-1.27	256	19	8.02	247	10	4.22	
44-10-44	244	246	2	0.82	263	19	7.79	241	-3	-1.23	
44-10-45	247	238	-9	-3.64	270	23	9.31	256	9	3.64	A
44-10-46	236	229	-7	-2.97	252	16	6.78	250	14	5.93	C
44-10-47	228	221	-7	-3.07	243	15	6.58	233	5	2.19	T
44-10-48	228	216	-12	-5.26	241	13	5.70	230	2	0.88	U
44-10-52	233	231	-2	-0.86	250	17	7.30	236	3	1.29	A
44-10-53	231	216	-15	-6.49	251	20	8.66	227	-4	-1.73	T
44-10-54	237	241	4	1.69	246	9	3.80	242	5	2.11	I
44-10-55	256	252	-4	-1.56	266	10	3.91	254	-2	-0.78	O
44-10-56	219	215	-4	-1.83	235	16	7.31	222	3	1.37	N
44-10-57	235	237	2	0.85	253	18	7.66	245	10	4.26	
44-10-58	237	233	-4	-1.69	247	10	4.22	243	6	2.53	
44-10-59	237	228	-9	-3.80	251	14	5.91	231	-6	-2.53	
44-10-61	278	275	-3	-1.08	293	15	5.40	293	15	5.40	A
44-10-62	274	262	-12	-4.38	287	13	4.74	281	7	2.55	C
44-10-64	290	285	-5	-1.72	316	26	8.97	298	8	2.76	T
44-10-65	297	294	-3	-1.01	325	28	9.43	323	26	8.75	U
44-10-66	286	274	-12	-4.20	308	22	7.69	289	3	1.05	A
44-10-67	308	294	-14	-4.55	327	19	6.17	307	-1	-0.32	T
44-10-68	297	289	-8	-2.69	309	12	4.04	294	-3	-1.01	I
44-10-69	295	285	-10	-3.39	307	12	4.07	290	-5	-1.69	O
44-10-73	286	281	-5	-1.75	296	10	3.50	288	2	0.70	N
44-10-74	286	275	-11	-3.85	300	14	4.90	285	-1	-0.35	
44-10-75	290	282	-8	-2.76	301	11	3.79	291	1	0.34	
44-10-76	302	287	-15	-4.97	323	21	6.95	302	0	0.00	
-10-77	296	277	-19	-6.42	303	7	2.36	288	-8	-2.70	
44-10-78	290	273	-17	-5.86	310	20	6.90	294	4	1.38	
AVG.			-8.9	-3.4		14.5	5.5		1.9	0.7	
STD.			6.51	2.47		6.26	2.32		7.16	2.69	

CHARACTERIZATIONS AT HIGH AND LOW TEMP.

DEVICE #	INIT	125C	CHANGE	% CHANGE	-40C	CHANGE	% CHANGE	ROOM TEMP	CHANGE	% CHANGE	
43-01-01	90	85	-5	-5.56	105	15	16.67	96	6	6.67	R
43-01-02	93	89	-4	-4.30	110	17	18.28	99	6	6.45	E
43-01-03	88	84	-4	-4.55	108	20	22.73	97	9	10.23	L
43-01-06	61	63	2	3.28	83	22	36.07	78	17	27.87	E
43-01-07	119	85	-34	-28.57	117	-2	-1.68	115	-4	-3.36	A
43-01-08	82	84	2	2.44	103	21	25.61	97	15	18.29	S
43-01-09	85	83	-2	-2.35	98	13	15.29	92	7	8.24	E
43-01-10	92	83	-9	-9.78	106	14	15.22	102	10	10.87	
43-01-14	91	86	-5	-5.49	101	10	10.99	96	5	5.49	
43-01-16	82	82	0	0.00	104	22	26.83	96	14	17.07	
43-01-22	151	149	-2	-1.32	170	19	12.58	165	14	9.27	
43-01-23	152	149	-3	-1.97	169	17	11.18	160	8	5.26	
43-01-25	151	148	-3	-1.99	172	21	13.91	161	10	6.62	R
43-01-26	143	159	16	11.19	173	30	20.98	162	19	13.29	E
43-01-28	156	159	3	1.92	174	18	11.54	168	12	7.69	L
43-01-29	151	154	3	1.99	177	26	17.22	167	16	10.60	E
43-01-31	160	157	-3	-1.88	176	16	10.00	169	9	5.63	A
43-01-32	127	127	0	0.00	152	25	19.69	152	25	19.69	S
43-01-33	144	148	4	2.78	163	19	13.19	156	12	8.33	E
43-01-34	164	162	-2	-1.22	178	14	8.54	173	9	5.49	
44-10-41	87	93	6	6.90	103	16	18.39	93	6	6.90	
44-10-42	81	80	-1	-1.23	90	9	11.11	86	5	6.17	
10-43	78	87	9	11.54	102	24	30.77	94	16	20.51	
44-10-44	70	78	8	11.43	96	26	37.14	103	33	47.14	
44-10-45	100	98	-2	-2.00	110	10	10.00	105	5	5.00	R
44-10-46	88	82	-6	-6.82	91	3	3.41	82	-6	-6.82	E
44-10-47	83	82	-1	-1.20	99	16	19.28	93	10	12.05	L
44-10-48	93	94	1	1.08	120	27	[illegible]	102	8	8.60	E
44-10-52	84	88	4	4.76	97	13	15.48	100	16	19.05	A
44-10-53	85	85	0	0.00	96	11	12.94	104	19	22.35	S
44-10-54	92	97	5	5.43	109	17	18.48	104	12	13.04	E
44-10-55	90	82	-8	-8.89	105	15	16.67	102	12	13.33	
44-10-56	92	87	-5	-5.43	104	12	13.04	97	5	5.43	
44-10-57	81	83	2	2.47	99	18	22.22	89	8	9.88	
44-10-58	98	84	-14	-14.29	102	4	4.08	94	-4	-4.08	
44-10-59	83	78	-5	-6.02	93	10	12.05	95	12	14.46	
44-10-61	143	146	3	2.10	164	21	14.69	143	0	0.00	R
44-10-62	148	143	-5	-3.38	165	17	11.49	157	9	6.08	E
44-10-64	152	147	-5	-3.29	164	12	7.89	159	7	4.61	L
44-10-65	151	156	5	3.31	180	29	19.21	163	12	7.95	E
44-10-66	148	144	-4	-2.70	168	20	13.51	160	12	8.11	A
44-10-67	159	149	-10	-6.29	167	8	5.03	164	5	3.14	S
44-10-68	143	159	16	11.19	170	27	18.88	164	21	14.69	E
44-10-69	146	152	6	4.11	169	23	15.75	161	15	10.27	
44-10-73	156	152	-4	-2.56	176	20	12.82	169	13	8.33	
44-10-74	149	154	5	3.36	174	25	16.78	167	18	12.08	
44-10-75	164	161	-3	-1.83	179	15	9.15	175	11	6.71	
1**-10-76	154	159	5	3.25	180	26	16.88	161	7	4.55	
-10-77	157	154	-3	-1.91	173	16	10.19	167	10	6.37	
44-10-78	157	149	-8	-5.10	167	10	6.37	161	4	2.55	
AVG.			-1.1	-0.9		17.1	15.5		10.4	10.0	
STD.			7.50	6.64		6.59	7.35		6.80	6.52	

TI-NHTSA 000652

HIGHLIGHTS

Stephen B. Offiler
Week Ending 01/19/90

<u>FORD MY92 CRUISE CONTROL PRESSURE SWITCH EX3423</u>

CUSTOMER ISSUES: Significant activity within Ford this week. Pass-Car brake engineers have finally gotten involved with drafting the specification. I've spoken at length with Bruce Pease regarding the spec., particularly exceptions we've suggested in order to make testing more realistic or expedient. Now that the ball is rolling, I expect activity to continue until we've got it on paper.

Light Truck Brake Eng. and Pass-Car Brake Eng. have differing philosophies which may ultimately result in splitting this program into two fundamentally separate programs. Pass-Car insists upon an O-ring seal, a snubber lexport, an actuation spec in the original 150 psi neighborhood, and an offset polarity tab. Light Truck insists upon an SAE J512 seal (which precludes use of a snubber), actuation of 250 psi, and a centered polarity tab. At this point, the brake guys are realizing how little they know about the system. A major internal meeting has been called between the Next Generation Speed Control group, Truck, and Pass-Car brake eng. in order to bring everyone up to speed on system operation and requirements.

Kendall Blanck, Ford tooling auditor, will visit Attleboro this Monday (01/22) to review our tooling plans. This is necessary to release tooling money.

AUTOMATED BASE DESIGN: The prototype design of the N/C stationary terminal and the movable terminal is complete. EX drawings have been transferred to Mfg. Eng. in preparation for a meeting with Baader, to take place early next week. Drawings and flat sketches have also been delivered to the Model Shop, in order to Wire-EDM terminal prototypes. The N/O stationary terminal will be created on a lower-priority basis, since it is nearly identical to the N/C. The spring design, essentially complete, will be set up on CAD also on a lower priority basis. The design of the base is progressing well. Preliminary drawings were completed by Drafting, and a meeting was held today with AFCC Molding. Their inputs will be used to finish the base design mid-next week.

Weekly status meetings with Mechanization have commenced. Topics receiving immediate attention include a prototype terminal twist fixture and calibrator. It is T-B-D whether our Model Shop and I, or Mechanization will do the design/build. Several minor detail changes to the terminals and base were suggested and implemented.

CCPS/57PS HYBRID: The spring-life test continues to progress, using cycling equipment on the 57PS line. To date, we have observed: one failure between 500K and 1KK cycles, spring broken at bend; one failure at 1.6KK cycles, spring broken at bump; nine survivors have passed 2.9KK cycles.

CCPS/APT DESIGN: The rubber diaphragm test continues to progress, using CCPS cycling equipment. One device had a continuity failure discovered after 3KK cycles (it was known good at 500K). Another device began to leak at 3.9KK cycles, failure mode T-B-D. The five survivors have passed 4.8KK cycles. One of these five was found to have a cracked disc at 3.9KK cycles. Severe cracks were discovered at 890K cycles in all three devices built with zinc disc seats. Of three devices built with powdered metal disc seats, two have failed (at 1.2KK and 1.7KK cycles) as a result of Kapton rupture. These P/M disc seats look excellent. The P/M survivor has passed 1.8KK cycles.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 01/26/90

FORD MY92 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: A major meeting was held internally at Ford this week to bring together Speed Control, Light Truck Brake, and Pass-Car Brake. The Truck actuation of 250 +/- 50 psi will remain. The Pass-Car actuation spec. needs some testing to finalize, but at present is 150 +/- 50 psi. I spoke with Gary Klingler, who informed me that Pass-Car testing is ongoing, receiving high priority, and he will have a definite spec. next week. I also reminded Gary that Pass-Car was again talking about using the rubber hexport, and we cannot meet $2.05 if this feature is required. Another Ford meeting is being held today to review the rough-draft specification, consider my proposed revisions, and develop a finalized spec.

AUTOMATED BASE DESIGN: After a print review with AFCC Molding, this iteration of the base design was completed. The proto mold will be modified to include a 57PS flange, as well as all changes made necessary by the auto-insert terminals. AFCC has a copy of the print, and work will commence when the work order is received from Mfg. Eng.

A print review was held with Bessler on the terminal designs. Minor revisions have been made based on inputs from Bessler and from Mechanization. Drafting is presently cleaning up all these terminal prints as well as the spring print.

CALIBRATION: Specific issues regarding the mechanical calibration concept are being addressed. I have completed calculations of tolerance stack-ups which shows how much calibration travel is required. In addition, I will be getting together with Steve McCoosy and Wayne Carlson to perform experimentation meant to determine the best place to apply force and how much springback to expect. Prototype terminals have been wire-EDM'ed and will be used in the above experiment. It is being recommended that Mechanization collaborate with me on the design of a prototype calibrator, and that they do the build. Same is true for a prototype terminal twist machine.

SPRING TESTING: We have aborted the spring life test after 3.2KK cycles. Proto springs made of .006", .008", and .010" material were tested in hybrid devices: CCPS switch ass'y with 57PS sensors. We observed one failure very early, a .008" spring, at 925K. This failure was attributed to an improperly made spring. The only other failure was a legitimate fatigue failure at 1.6KK cycles. This was a .006" spring, pinned to the high end of the window. The surviving nine devices were dissected, and the springs checked for force. The .008" and .010" springs were found to have relaxed by an average of 54%, with a very tight sigma of 2.4%. Relaxation of the .006 springs was significantly worse. Development work will proceed using .008" springs.

250 PSI LIFE TESTING: 57PS's were built using two lots of prototype AFCC discs. These were 12 mil, 3/4" discs with 500F heat-treat, with act/rel of 25/11 and 30/18. These produced devices with act/rel of 237/85 and 291/150 respectively. Six samples of each lot have completed 500K cycles with no failures. Drift is generally small, although the 30/18 lot shows quite a bit of drift upward on release. These devices will continue to accumulate cycles over the weekend. Also, we'll determine pin-window using uncycled devices.

CCPS/APT DESIGN: Test aborted after 6.1KK cycles. Three devices completed the test successfully; two more had cracked discs; one leaked at 3.9KK cycles.

57PS/CCPS HYBRID DEVICES
.006" SPRING ARM

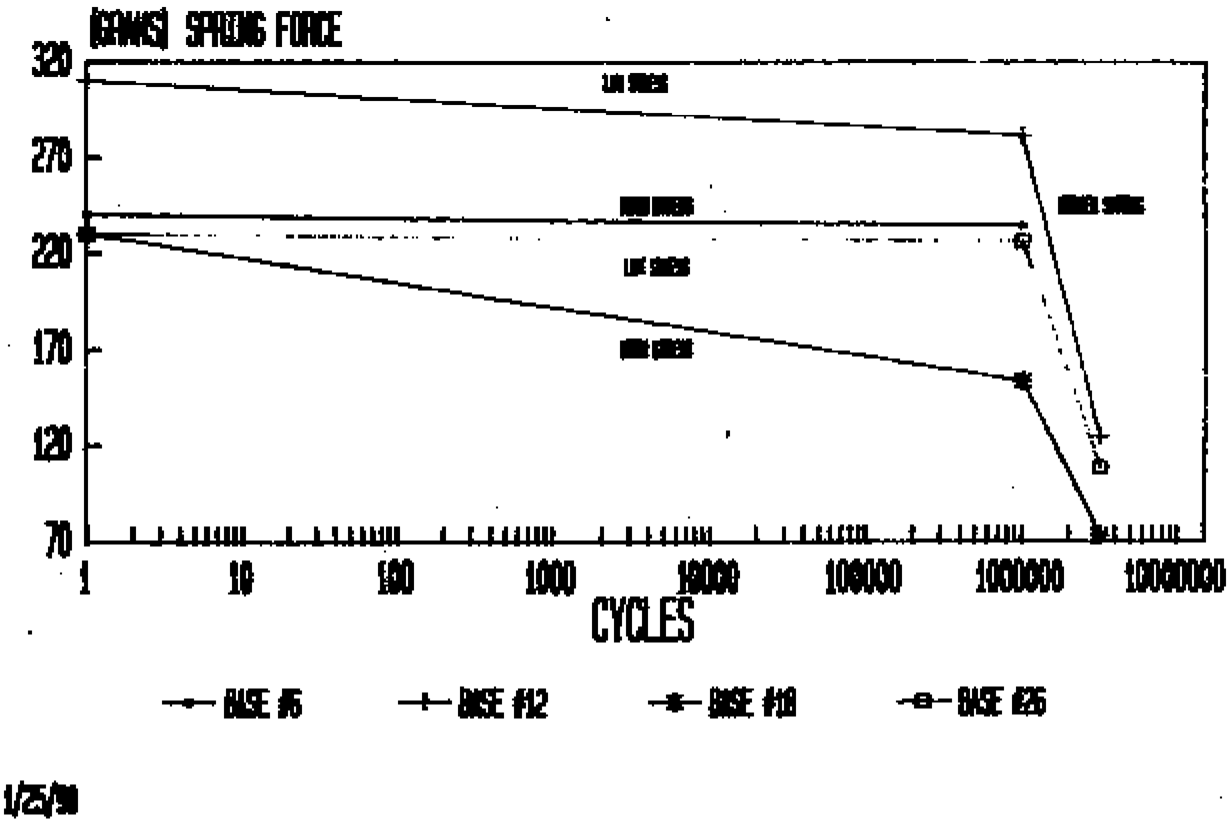


EXHIBIT NO. 58

HIGHLIGHTS

Stephen B. Offiler
Week Ending 02/02/90

FORD MY92 CRUISE CONTROL PRESSURE SWITCH EX3423

FINANCIAL NEWS: Marketing has drafted a letter to Ford Purchasing, formally requesting that the tooling money be released immediately. The letter summarizes the positive nature of our engagement to date, and highlights the significant schedule impact that the tooling money has created.

SPECIFICATIONS: Significant activity at Ford this week. Our proposed specification was finally scrutinized by the key players at both Pass-Car and Light Truck. Negotiating through Joe Schnack, we were able to win concessions in at least three areas of major importance to us: The proof spec. was lowered to 4K psi (from 5K); the humidity spec. was revised to follow MIL-STD-202F; and Ford's proposal to raise the pressure during the Temperature Cycle test (from present 1450 psi to 2K) was shot down.

One area where Ford maintained a relatively firm position is the Impulse test temperature spec., which was given as 107 C ambient and 135 C fluid temperature (+/- 14). We have been conducting all tests at 121 C ambient *and* fluid temperature, which is the intersection of the two spec's. We requested that the spec be changed to 121 +/- 14 for both ambient and fluid, but all Ford would do is change the ambient from "107 +/- 14" to "107 minimum". We have two choices: run the test at 135 C and accept the detrimental effects of the hotter ambient; or build a heater into the manifold to obtain the 135 C fluid temperature while maintaining a 107 ambient. We are now looking into a means to build an appropriate heater into the manifold.

The actuation and release spec's for Light Truck have been solidified at 250 +/- 50 psi and 40 psi minimum, respectively. Pass-Car has not been solidified, although they are presently pushing for 125 +/- 25 psi and we are responding with 125 +/- 40 psi. Gary Klingler is doing some testing to determine what the real-world upper and lower limits should be. Pass-Car will also be using the 40 psi minimum spec. for release.

AUTOMATED SWITCH ASSEMBLY: The APCC has been kicked-off to modify the single-cavity base mold to include all of the new features for automated assembly, as well as the 57PS style flange. They indicate that prototypes will be available in three weeks.

Working in conjunction with Mechanization, terminal bending (calibration) experiments were begun. This is to determine the optimum design, in terms of cal. issues such as springback. We are working with wire-EDM parts, and the model shop is modifying the stationary terminals to include stiffening ribs, bend notches, etc.

Mechanization is strongly in favor of eliminating the rivet which attaches the spring arm to the movable terminal. The technique involves piercing the terminal and leaving a large "burr", which is rolled over in the fashion of an eyelet. Precedence for this design can be found in a device built by TI-Italy. John Kourtesis is obtaining prints from Italy. We will be meeting with Bassler next Tuesday to discuss all these terminal issues.

57PSLS-2: (Light Truck device) Disc life testing was carried out to 1KK cycles, with no failures. Pin window experiments are being carried out. These discs can be used for customer samples which George Randall has unofficially requested (no PO yet). The model shop has modified standard 57PS hexports to include the SAE J512 inverted flare, which are expected back from Plating early next week. Keith Roberts is obtaining black 57PS bases (46412-1) which are out of production but available from the warehouse.

NEW BUSINESS OPPORTUNITY: On a low-priority basis, we are taking a look at an opportunity at GM Truck & Bus for a brake-light pressure switch to replace the brake-pedal mounted position switch. Prototypes are being built using production 58PS discs (17 psi act and 7 psi rel), 55/56/58-type bases, and the APT-Hexport packaging developed for the CCPS program. In-house prototypes will be thrown together, characterized, and cycled per the GM requirement of 100K cycles to 2200 psi and 900K cycles to 800 psi. This will allow us to gain an understanding of the design challenges. Initial volumes are only 25K-50K per year, but long-term potential could be 1KK.

Stephen Offiler 2/2/90

HIGHLIGHTS

Stephen B. Offler
Week Ending 02/08/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH, EX3423

CUSTOMER ISSUES: Information has surfaced that our Light-Truck device will be mounting to the master cylinder, which is sourced from Tokico. Apparently we'll be a second-tier supplier to Tokico. Joe Schuck has met with Tokico people, who gave Joe a list of technical issues. Most were trivial, but a couple significant issues surfaced:

> One, it seems Tokico has envelope dimension constraints and would like 1.75" overall length after installation. This is impossible without significant redesign. The actual dimension is presently 1.815" (nominal), and is officially considered 1.830".
>
> Two, they'd like to see 70K cycles to 1000 psi at -40 C. Ford's spec at -40 C is 250 cycles to 1450 psi. Historically, low-temp hydraulic seal performance is particularly challenging, as Doug Strott reports of his experiences while developing the 57PS, and my own experience concurs.

Our official position, of course, is to continue to conform to the Ford specification.

The Pass-Car actuation specification presently stands at 125 +/- 35 psi. We are putting a plan in place to test a matrix of standard and TRW-type converters with various discs in order to determine our capability to meet the tolerance.

Bruce Pease, Pass-Car Brake Engineer, contacted me regarding our proposed Humidity spec based on MIL-STD 202. His concerns were addressed. He indicated to me that the spec is essentially done, and will forward a copy right away.

AUTOMATED SWITCH: Mechanization indicates that development is definitely required to refine our calibration technique. The stationary terminal presently springs back excessively. We are conducting springback experiments on wire-EDM terminals with various notches and ribs to facilitate bending. We have begun to brainstorm various alternative ideas, such as implementation of a INT style stationary terminal (a known quantity for Mech.).

A productive meeting with Bassler was held. Topics included the above springback concerns, and elimination of the spring rivet by use of either a raised bump to form a rivet, or a pierced hole to form an eyelet. Based on our .025" terminal material and .008" spring, Bassler will review the situation and determine which approach is more appropriate.

GM TRUCK/BUS NBO: We have parts available to build 12 devices. Six will be APT-style with rubber diaphragm, and six will use a standard crimp ring with Kapton seals. We are assembling a variety of configurations to determine our capability to build a device of this type. We will life test according to GM's specs, a total of 1KK cycles, 90% to 800 psi and 10% to 2200 psi. Karl A. has provided 58PS switches with special terminals and springs, and this test will help him get a feel for spring life.

Stephen Offler 2/8/90

TI-NHTSA 000

HIGHLIGHTS
Stephen B. Offiler
Week Ending 02/16/90

[illegible] 2/16/90

__FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EK3423__

CUSTOMER ISSUES: We've received a copy of the Light Truck test specification. Most items previously negotiated with Ford are included. There are still two outstanding issues. One, the electrical cycle spec, Light Truck wants to run 100K even though Gary Klingler calculated a conservative maximum of 12K electrical cycles in 100,000 miles. Two, the humidity spec, Light Truck has retained the old non-standard Ford spec. even though they verbally agreed to our proposed MIL-STD 202. Joe Schnock will address these issues.

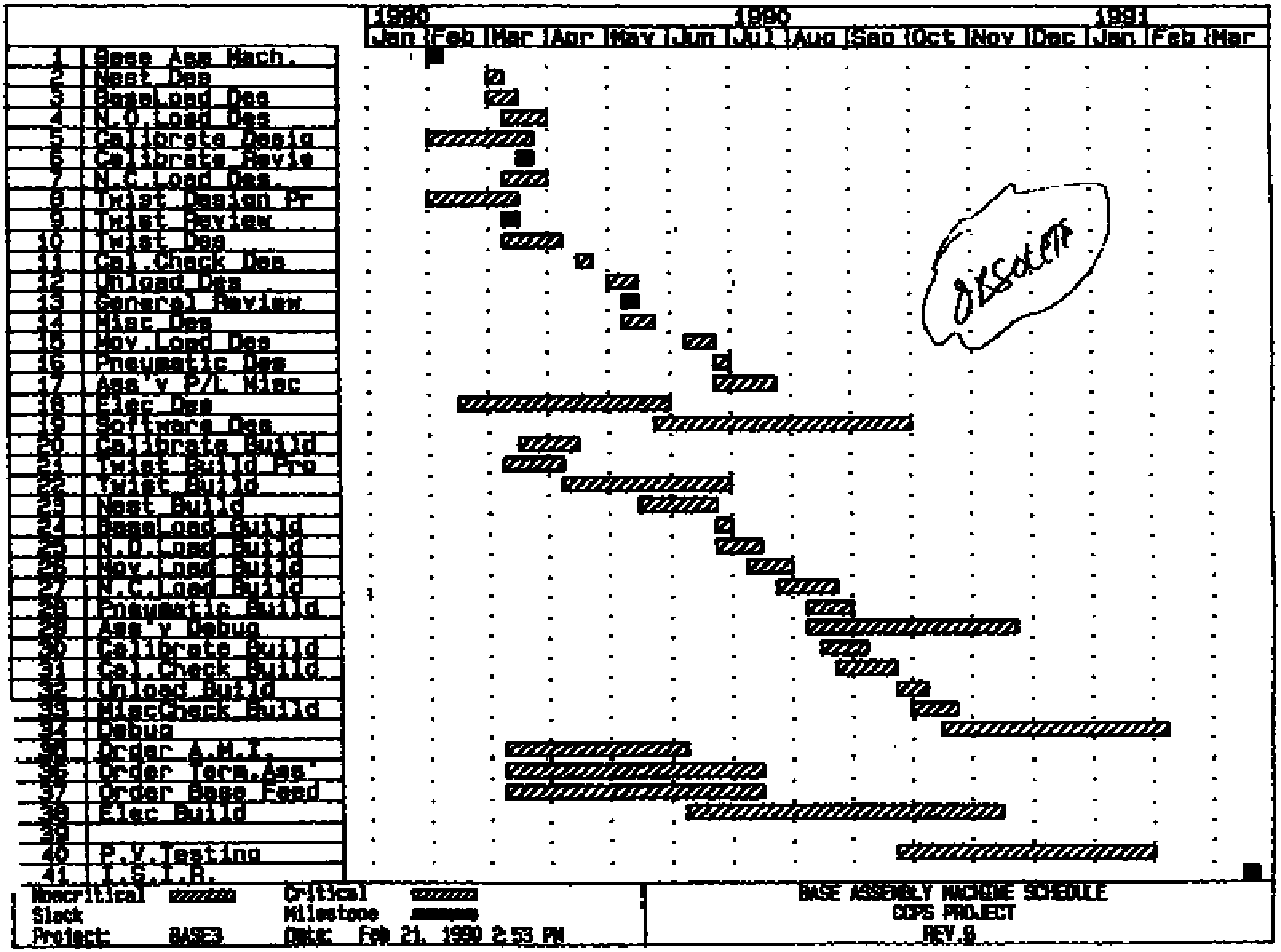
We have responded to a concern expressed by Ford regarding low-temperature performance. Apparently they've had warranty headaches caused by some device (unrelated to TI in any way) which changes drastically at -40 C. We initially characterized a 20-piece lot of 57PS's, soaked at -40 C and characterized them right in the chamber, then back to room temp for a final characterization. We discovered an average of 4.5% increase in the actuation pressure at -40 C, fully reversible.

Pass-Car (no written test specification from them as yet) has suggested that we do a three-way comparison Humidity test: the old Ford spec; MIL-STD 202; and a modified MIL-STD 202 which increases total test time to match the old Ford spec. We originally proposed that the MIL-STD be used for three reasons. One, the intent of the MIL-STD is the same as Ford's, namely to simulate and accelerate tropical conditions. Two, the MIL-STD has been in existence since World War II, and has proven itself to be an adequate and realistic test. Three, our environmental labs can run the MIL-STD much more quickly and economically. Ford wants the comparison done to prove that the MIL-STD produces results comparable with their own test procedure. George O'Lear indicates that the MIL-STD tests will cost about $150 each, but the Ford spec. is another story. One way to run it is via manual control of the humidity chamber, at a cost of approx. $2000. The other way is to use another humidity chamber which is fully programmable, but the problem is that this one is broken and will cost about $2000 to repair.

AUTOMATED SWITCH: New bases which were expected from APCC this week did not arrive. We are following up with them. The terminal twist concept can be prototyped as soon as we get bases. Mechanization is working on the design of the tool which will actually grasp the terminal for twisting.

Efforts are being placed into development of a stationary terminal design which controls or eliminates springback during calibration. Many ideas have been generated, and a test plan is being developed.

TEST EQUIPMENT: While attempting to run devices in our cycler which release at 10 psi, we discovered via continuity measurement that the devices were not releasing. Residual pressure was causing this problem. Rough measurements indicated a force of 230 lbs was required to drive back the hydraulic piston to relieve the residual pressure. With very little space for a spring to develop forces this high, a Bellville spring approach was used. Standard off-the-shelf parts were obtained from Associated Spring. These are being installed on the cycler now.



TI-NHTSA 000060

HIGHLIGHTS

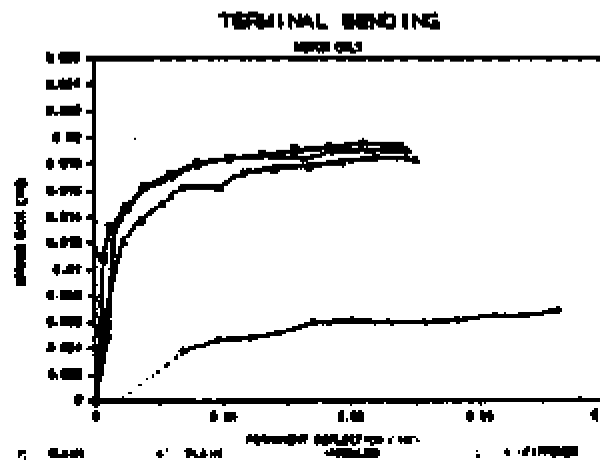
Stephen B. Offiler
Week Ending 02/23/90

FORD MY92 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: A major meeting, the largest to date, took place yesterday at Ford. Charlie Douglas, Joe Schenck, and Steve Major were in attendance for TI. No fewer than eighteen Ford people were there. See Charlie's trip report (MSG#176508) for details. The purpose of this meeting was to get tooling funds released. While this did not actually happen, a very definite and serious game plan was put in place. Another major meeting will take place at Ford next Tuesday. The likely result of this will be a pitch to their "High Finance Committee". Until this transpires, as far as Ford is concerned we have officially stopped working on this program. Unofficially, of course, we are continuing "business as usual" for the short-term.

AUTOMATED SWITCH: The reason that the bases are late is because of an error in the base print, EX3423-44. It was discovered, unfortunately, after the APCC toolroom had already tried to mold the part. The cause of the error was one of the views on the print was rotated 180 degrees about an off-set centerline. This has been corrected and we have communicated with the APCC. They estimate that we will have parts early- to mid-next week.

Mechanization has designed a tool to reach down into the connector to perform the twist. They are building one for next Wednesday, and will be waiting for bases and terminals to actually do the twist (by hand for now). We have about 25 EDM'ed movable terminals which will be used for twist prototyping. We're also putting together a plan to build more terminals.



We have performed another round of terminal-bend tests. We ran some parts which were modified with a stiffener on the cantilever, and some which had been annealed to dead-soft. Using the same procedure as the initial testing allows direct comparison of data to-date. The stiffener had marginally positive affect, with the notched devices still performing best. The annealed parts, predictably, have very low springback but are way too soft to warrant consideration.

Also, some theoretical cantilever-beam bending calculations were run. Results match experience acceptably well. These calc's also help highlight that notches in the thickness of the cantilever will have a greater effect than notches into the width, because the moment-of-inertia equation contains the width to the first power and the thickness cubed. This type of notch will be tried, along with other ideas still under development. One of these is use of a serpentine crush area to push down linearly rather than bend down. Samples of known-hardness brass will be obtained (1/4H, 1/2H, full) to further refine the experiments. Another wire-EDM job will be placed when the material arrives and sketches of the new ideas are completed.

Mechanization has requested cross-section assembly drawings, as well as a 4X actual model of the base/terminals.

<u>GM Truck/Bus NBO:</u>

Old-style (pre-converter) CCPS devices were assembled with 17 psi act./7 psi rel. discs and 58PS switch assemblies, for a brake-light-switch NBO. These devices were cycled to 50K at 2200 psi. To ensure that we got below the release point each cycle, it was necessary to modify the cycler with a Belville-washer return spring. Devices were functioning at the 10K characterization, but were found severely cracked at 50K. We are trying a quick-fix solution by lowering the disc step from .009 to .003. Parts back on test mid-next week.

Steve Offiler 2/23/90

CCPS PROTOS

TEXAS INSTRUMENTS
INCORPORATED

SAMPLE REPORT

REASON FOR REPORT	VENDOR	P.O.	PART NO.	REV.
PART	Acme		Ex 5439-46	
LACEMENT TOOL.	REPORT REQ. BY: Keith Roberts	DATE	INSPECTED BY: [illegible]	DATE: 3-2-90
RECTED TOOL.				
AIRED TOOL.				
[illegible]				
[illegible]				

THE DIMENSIONS INDICATED BELOW REPRESENT TEXAS INSTRUMENTS' FINDINGS REGARDING THE ACTUAL VALUES FOR ALL CHARACTERISTICS MEASURED. IN CASES WHERE ACTUAL VALUES DEVIATE FROM THE SPECIFIED DIMENSIONS, THE DISPOSITION MUST INDICATE THE REQUIRED ACTION FOR EACH NON-CONFORMANCE IN THE APPROPRIATE COLUMN.

	(CIRCLE ALL OUT OF TOLERANCE DIMENSIONS)					DISPOSITION		
1	.762-.748	.7465	small -	locking tabs	*			
	⊕ .010 A	.0057						
2	.660-.652	.6512	small -	connector dim	*			
	⊕ .010 A	.0084						
3	.549-.531	.5298	small -	"bump" on connector				
	⊕ .010 A	.0058						
4	55°-59°	56°						
	⊕ 1° A	1°						
5	4.741-.733	.7208	small -	switch cavity [illegible]				
	⊕ .010 A	.010						
6	.007-.005 2PL	T .0049						
		B .0069						
7	.467-.459	.4602						
	⊕ .010 B	.0034						
8	.267-.263	.2609	small -	connector dim	*			
	⊕ .010 B	.0019						
9	.055-.051	.0529						
10	.055-.051	.0539						
11	.469-.461	.4621						
	⊕ .010 A	.0061						
12	.518-.506	.4952	small -	"bump" on connector				
	⊕ .010 A	.0072						
13	.118-.114	.118						
	⊕ .010 A	.0067						
14	R .030 MAX (4PL)	.030						
		4pl						

RKS AND/OR INSTRUCTIONS:

OSITION: TOOL APPROVED FOR PROD.		RESUBMISSION REQ'	
ENG.:		QRA ENG.:	
		PURCH. AGENT:	

TI-NHTSA 000663

TEXAS INSTRUM[ENTS]
INCORPORATED

SAMPLE REPORT

PAGE 2 OF 3

REASON FOR REPORT	VENDOR	P.O.	PART NO.	REV.
[NEW] PART	Stec[o]		[illegible]34 39-44	
[RE]PLACEMENT TOOL.	REPORT REQ. BY: Nick Roberts	DATE	INSPECTED BY: [illegible]	DATE: 3-2-7[illegible]
[CO]RRECTED TOOL.				
[REP]AIRED TOOL.				
[OTH]ER				
[OTH]ER				

THE DIMENSIONS INDICATED BELOW REPRESENT TEXAS INSTRUMENTS' FINDINGS REGARDING THE ACTUAL VALUES FOR ALL CHARACTERISTICS MEASURED. IN CASES WHERE ACTUAL VALUES DEVIATE FROM THE SPECIFIED DIMENSIONS, THE DISPOSITION MUST INDICATE THE REQUIRED ACTION FOR EACH NON-CONFORMANCE IN THE APPROPRIATE COLUMN.

	(CIRCLE ALL OUT OF TOLERANCE DIMENSIONS)					DISPOSITION		
(15)	R .030 MAX (4R)	.015						
		4 Pl.						
(16)	.118 - .114	.1177						
	⊕ .010 B	.0033						
(17)	.079 - .075	.0759						
	⊕ .010 A	.0077						
(18)	.007 - .005 2R	T .0049						
		B .0069						
(19)	.060 - .050 (2R)	.0504						
		4 Pl.						
(20)	R .083 - .075	.075						
		4 Pl.						
(21)	R .015 MAX	.005						
(22)	R .034 - .028	.030						
(23)	.303 - .297 (2R)	T .2996						
		B .2996						
(24)	No Flash Burrs or Ejector	ok						
	Pins Allowed on This Surf.							
(25)	.120 - .116	.119						
(26)	.049 - .050	.049						
(27)	93° - 88° 16 Pl.	90°						
		All	Surface					
		are	The Same					
(28)	No Ejector Pins Allowed	ok						
	On This Surface							

[REMA]RKS AND/OR INSTRUCTIONS:

[DISPO]SITION: TOOL APPROVED FOR PROD. | RESUBMISSION REQ'D

[Q.C.] ENG.: | DRAFT ENG.:

PURCH. AGENT:

TI-NHTSA 000664

TEXAS INSTRUM[ENTS]
INCORPORATED
ATTLEBORO, MASSACHUSETTS 02703

SAMPLE REPORT

REASON FOR REPORT	VENDOR	P.O.	PART NO.	REV.
[NEW] PART	AFCC		E-5343-H	
[RE]PLACEMENT TOOL.	REPORT REQ. BY: Rick Roberts	DATE	INSPECTED BY: [illegible]	DATE: 3-2-90
[CO]RRECTED TOOL.				
[RET]AINED TOOL.				
[RE]VIEW				
[OTH]ER				

THE DIMENSIONS INDICATED BELOW REPRESENT TEXAS INSTRUMENTS' FINDINGS REGARDING THE ACTUAL VALUES FOR ALL CHARACTERISTICS MEASURED. IN CASES WHERE ACTUAL VALUES DEVIATE FROM THE SPECIFIED DIMENSIONS, THE DISPOSITION MUST INDICATE THE REQUIRED ACTION FOR EACH NON-CONFORMANCE IN THE APPROPRIATE COLUMN.

	(CIRCLE ALL OUT OF TOLERANCE DIMENSIONS)					DISPOSITION		
1 M.								
29	⌀ 1.050-1.035	1.0445						
	⊕ ⌀ .010 A	.0022						
30	⌀ 1.166-1.154	1.1592						
3?	⊕ ⌀ .010 A	.0014						
31	⌀ .98-.912	.982	A16 - ID @ upper surface					
32	R .085 MAX	.010	Both the Same					
33	.031-.027	.029						
34	.20-.26	.2657						
35	.193-.189	.1894						
36	.011-.010	.007						
37	.039-.028 [illegible]	.0315	Terminals at left	Post	[illegible]	Post Shown		
	4?-12° [illegible]	.0331						
		.035						
		.032						
		.033	terminal at the		Right			
		.0302		bottom				
		.0323		Right				
		.0320						
		.0319	terminal	at the top				
		.0319						
		.0316						
		.0313						
38	.320-.312	.3193						
39	.160-.156	.1569						

[REM]ARKS AND/OR INSTRUCTIONS:

[DISPO]SITION: TOOL APPROVED FOR PROD.

REQUISITION REQ'D

[D]ESIGN ENG.:

QRA ENG.:

PURCH. AGENT:

TI-NHTSA 000665

TEXAS INSTRUM...
INCORPORATED

PAGE 1 OF 2

SAMPLE REPORT

REASON FOR REPORT	VENDOR	P.O.	PART NO.	REV.
... PART	AFco		2K4483-44	
...LACEMENT TOOL	REPORT REQ. BY: Keith Roberts	DATE	INSPECTED BY: [illegible]	DATE: 2-2-90
...RECTED TOOL				
...AIRED TOOL				
...IEW				
...ER				

THE DIMENSIONS INDICATED BELOW REPRESENT TEXAS INSTRUMENTS' FINDINGS REGARDING THE ACTUAL VALUES FOR ALL CHARACTERISTICS MEASURED. IN CASES WHERE ACTUAL VALUES DEVIATE FROM THE SPECIFIED DIMENSIONS, THE DISPOSITION MUST INDICATE THE REQUIRED ACTION FOR EACH NON-CONFORMANCE IN THE APPROPRIATE COLUMN.

	(CIRCLE ALL OUT OF TOLERANCE DIMENSIONS)					DISPOSITION		
40	.031 - .027 (2 PL)	L .0295						
		R .031						
41	⌀ .582 - .590 2 Plcs	.5777						
	1 Place only							
	⌖ ⌀ .010 A	.0032						
42	.215 - .209	L .2117	Painted	on Print	Shown	for Cavity	View	
43		R .2117						
44	.291 - .285	.2897						
45	.072 - .068	.0684						
46	.143 - .137	.142						
47	.117 - .109	.1093						
48	.105 - .095	.1026						
49	.150 - .149	.150						
50	.103 - .099	.0027						
51	.038 - .032 2PL	[illegible] .0316	[illegible] .032					
		[illegible] .031	[illegible] .0316					
52	.103 - .100	[illegible] .0021	[illegible]					
		[illegible] .001	[illegible] .0024					
53	R .055 - .045	.050	Small - radius @	screw interface				
54	R .010 MAX	.010	Both the Same					
55	.071 - .065	.068						
56	.423 - .415	.4209						
57	.110 - .100	.105						
58	27° - 23° 2PL	25°	Both Sides					

...KS AND/OR INSTRUCTIONS:

...SITION: TOOL APPROVED FOR PROD.	RESUBMISSION REQ'D
...ENG.:	QRA ENG.:
	PURCH. AGENT:

TI-NHTSA 000686

TEXAS INSTRUM
INCORPORATED

SAMPLE REPORT

REASON FOR REPORT	VENDOR		P.O.	PART NO.	REV.
... PART	...			Ex 5423-99	
...PLACEMENT TOOL.	REPORT REQ BY	DATE	INSPECTED BY		DATE
...RECTED TOOL.	Keith Roberts		Mary ...		3-2-90
...AIRED TOOL.					
...VIEW					
...HER					

THE DIMENSIONS INDICATED BELOW REPRESENT TEXAS INSTRUMENTS' FINDINGS REGARDING THE ACTUAL VALUES FOR ALL CHARACTERICS MEASURED. IN CASES WHERE ACTUAL VALUES DEVIATE FROM THE SPECIFIED DIMENSIONS, THE DISPOSITION UNIT INDICATE THE REQUIRED ACTION FOR EACH NON-CONFORMANCE IN THE APPROPRIATE COLUMN.

	(CIRCLE ALL OUT OF TOLERANCE DIMENSIONS)					DISPOSITION		
59	.095-.085 2 pl.	L .095	R .0944					
60	.340-.330	.3374						
61	.510-.499	.5025						
62	.060 BR	.060						
63	30-25° Continuous	30°						
		All Sides The Same						
		"						
64	R .030-.020	.030						
65	.044-.036	.029						
	Continuous (4 Sides)	.046						
	Bottom	.029						
		.029						
66	.029-.016 Top	.023						
	Continuous (4 Sides)	.023						
	Bottom	.026						
	Right	.029						
67	.024-.016	.0242						
	Continuous 4 Sides	.023						
	Bottom	.0215						
	Right	.024						
68	45°-43° (Continuous 4 Sides)	45°						
		All Sides the Same						
69	.128-.112 (2 PL) L	.125						
	R	.121						
70	R .055-.045	.055						
		typ.						

...RKS AND/OR INSTRUCTIONS:

...SITION: TOOL APPROVED FOR PROD. RESUBMISSION REQ'D

ENG.: QRA ENG.:

PURCH. AGENT:

TI-NHTSA 000667

TEXAS INSTRUM
INCORPORATED

SAMPLE REPORT

REASON FOR REPORT	VENDOR	P.O.	PART NO.	REV.
PART	AFCC		EX5423-19	
LACEMENT TOOL.	REPORT REQ. BY: Keith Schultz	DATE	INSPECTED BY: Gary J. Woodley	DATE: 3-2-9
RECTED TOOL.				
IRED TOOL.				
IER				
ER				

THE DIMENSIONS INDICATED BELOW REPRESENT TEXAS INSTRUMENTS' FINDINGS REGARDING THE ACTUAL VALUES FOR ALL CHARACTERISTICS MEASURED. IN CASES WHERE ACTUAL VALUES DEVIATE FROM THE SPECIFIED DIMENSIONS, THE DISPOSITION MUST INDICATE THE REQUIRED ACTION FOR EACH NON-CONFORMANCE IN THE APPROPRIATE COLUMN.

	(CIRCLE ALL OUT OF TOLERANCE DIMENSIONS)					DISPOSITION		
21)	Gate #1 located on this surface	OK						
22)	R .030-.020	.050	N/G - radius (est.) flange mold housing				X	
23)	.033-.027 R	.030						
24)	.003 MAX	.0019						
	R	.0014						
25)	.023-.017	.0335	N/G	[illegible] mismatch		X		

KS AND/OR INSTRUCTIONS:

TION: TOOL APPROVED FOR PROD.

RESUBMISSION REQ'D

NG.:

QRA ENG.:

PURCH. AGENT:

TI-NHTSA 000668

HIGHLIGHTS
Stephen B. Offiler
Week Ending 03/02/90

Steve Off 3/1/90

<u>FORD MX91.75 CRUISE CONTROL PRESSURE SWITCH EX423</u>

CUSTOMER ISSUES: Charlie Douglas has drafted a letter to the buyer at Ford, [redacted] The letter details the tooling and piece-price scenarios between Pass-Car and [redacted] and between full-manual, semi-automated, and fully automated assembly. Furthermore, the letter highlights the criticality of Ford's delay in releasing funding. It warns that we will only work on the program for one more week (from today) unless important decisions are made at Ford and we get financial commitment.

Working through Joe Schock, I was asked to contact George Randell to tie up loose ends of the Engineering Specification. George really wasn't aware that loose ends existed. We went over the spec together, point by point. I am confident that our thinking is now aligned. George will go ahead and produce the final version of the Light Truck ES. We won't be able to finalize the Pass-Car ES in a like manner until we move forward with the planned Humidity test comparison.

AUTOMATED SWITCH: The APCC delivered molded bases this week. This enabled us to begin work on the terminal twist concept. Using prototype EDM terminals, the twist concept was exercised for the first time using production-intent materials and geometries. No twist tool is available from Mechanization yet, so terminals were hand-twisted with needle-nose pliers. Results are promising. The movable terminal appears to be affixed very firmly. The stationary terminal (which is still under development) is somewhat sloppy, but this can be remedied with the next iteration.

Calibration efforts are progressing. We are presently obtaining sample quantities of brass in soft, 1/4H and 1/2H, to be used in the next-iteration EDM job. New designs for the deformable part of the terminal are being investigated, including: a transverse notch in the cantilever design; a 1NT-style "bridge"; and a serpentine design. Where possible we are hand-prototyping these ideas for expediency.

SENSOR: A test will be run, with the intent of roughly determining our ability to meet 125 +/35 actuation with a low-ratio converter. Stan Homol has provided me with sketches of his work on the TRW 6:1 converter. We will have the model shop make a quantity of these. Approx. 21 psi discs will be obtained from our stock or from the APCC. The problem with this effort is that it will be time-consuming and expensive for the model shop to build a sufficient quantity of parts to draw meaningful statistics from.

TESTING: We are in the process of upgrading our cycler manifolds. The old steel manifolds presented very significant thermal mass, and caused thermal cycle testing to progress very slowly. New manifolds are made of aluminum. Since repeated use would tend to damage a female aluminum thread, Heli-coil inserts were used. We have received and installed the controller for the manifold heater, and are now waiting for the immersion heaters to arrive.

TI-NHTSA 000069

<u>GM TRUCK/BUS BRAKE-LIGHT-SWITCH NBO:</u>

After last week's disc failures, devices were rebuilt with smaller disc stage. This quick-fix limits disc travel, which limits stresses and increases life; but also limits pin-window and manufacturability. Devices have successfully passed 50K cycles at 2200 psi and 80K cycles at 800 psi. The cycling goal is a total of 1KK as follows: 50K @ 2200 psi plus 900K @ 800 psi plus 50K @ 2200 psi.

SENSOR TESTING

GOAL:
The goal of this test is to provide information which will help to determine if the low-ratio-converter (LRC) will be appropriate to meet the Ford Pass-Car actuation spec. of 125 psi +/- 35.

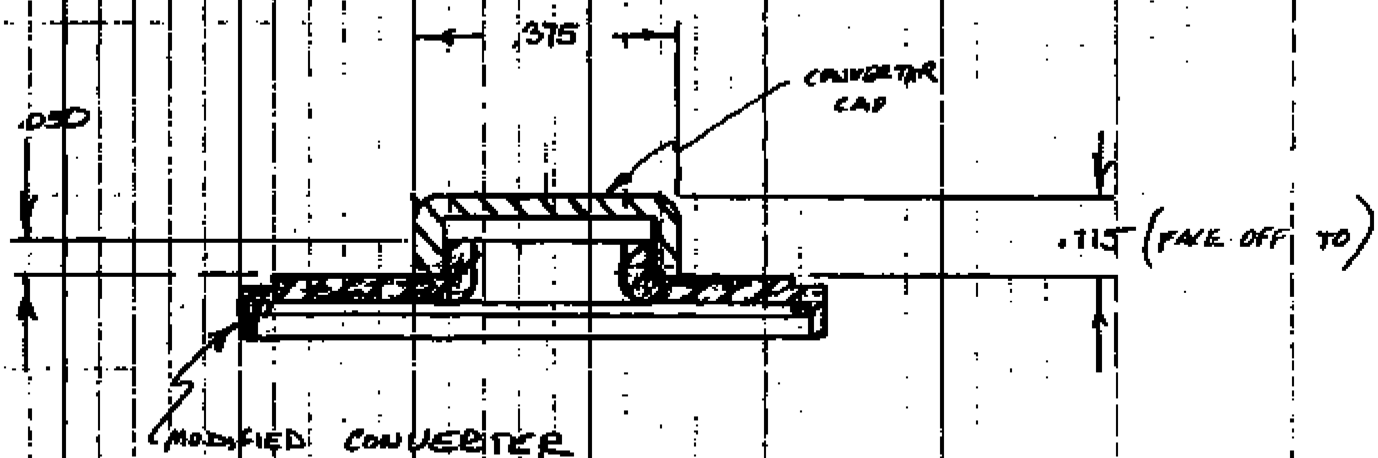
SCOPE:
Two sensor lots will be run: one, using model-shop modified converters and washers to provide the lower ratio; and two, a control group which uses the same discs but standard production converters and washers. This test will be run on sensors only; no switch assemblies are needed. The test will cover an initial characterization, then a proof test, then a cycle test.

PROCEDURE:
1) Have model shop modify 20 converters and washers.
2) Working with a disc lot we have in inventory (22.3/9.1), characterize 30 in the free state.
3) Disc actuations will cover a range, theoretically in the neighborhood of 22.3 psi. If any disc(s) are obviously drastically different, remove them and replace with other discs from the same lot.
4) Sort the 30 discs by actuation and number them. Separate into two lots of 15 by taking all even-numbered discs for the first lot and all odd-numbered discs for the second.
5) The actuation sigma on each lot should be very similar. If not, identify why not and correct.
6) From the first disc lot, build the control group using production parts.
7) From the second disc lot, build the test group using the model-shop modified parts.
8) Characterize all 30 sensors. Use 2 overpressure cycles to 800 psi, then switch 3 more times and read the 6th.
9) Proof all 30 sensors to 4000 psi for 30 seconds.
10) Recharacterize all 30, switching 3 times and reading the 4th.
11) Take 5 devices from each lot and run 500K cycles on production equipment, no intermediate characterizations.
12) At this point, a decision will be made whether to run the rest of the devices to 500K cycles.
13) Recharacterize.

DATA:
Record the following for each test lot; calculate average and standard deviation of each column of data: Free disc actuation; Virgin sensor actuation; Proofed sensor actuation; Cycled sensor actuation.

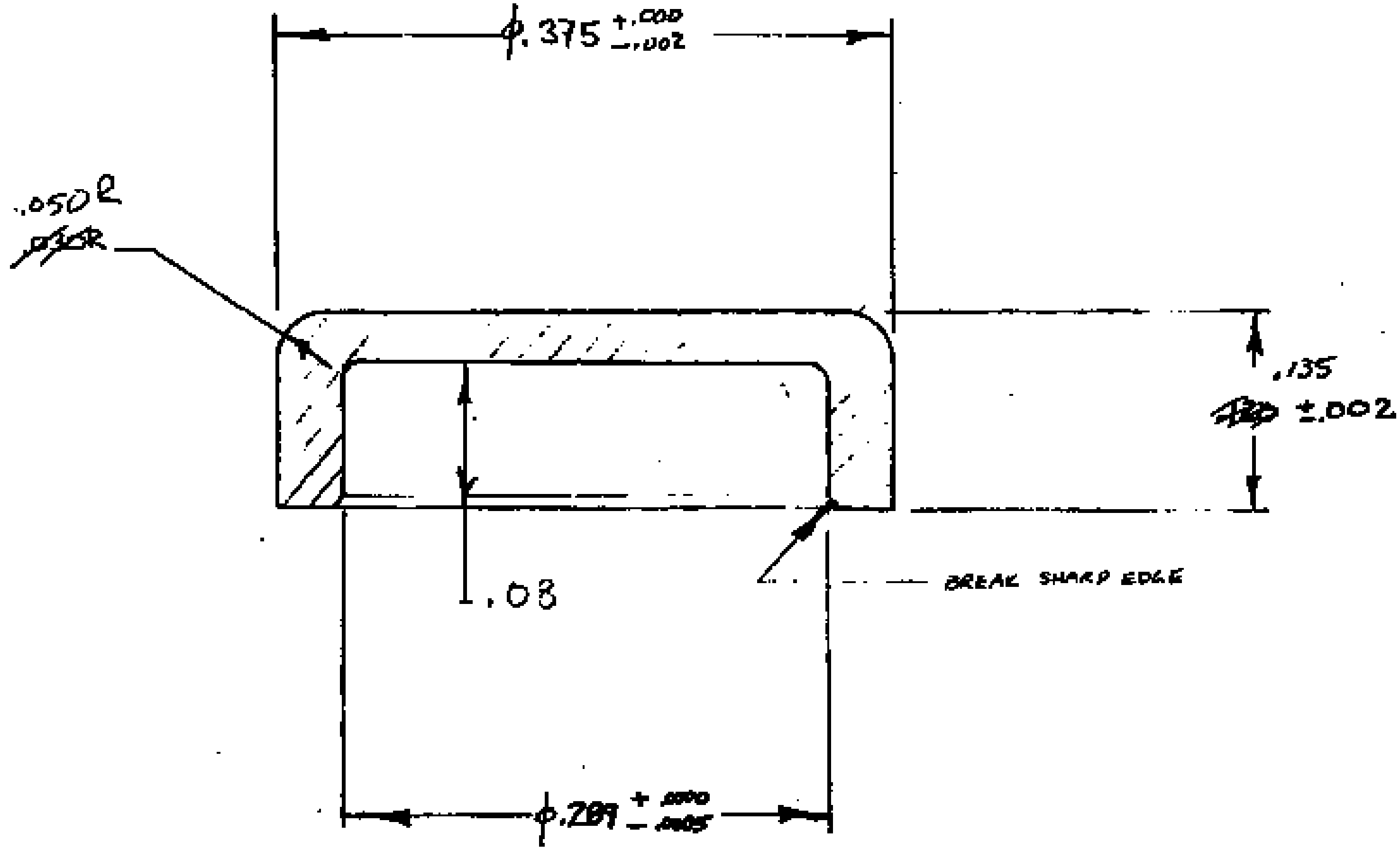
Calculate the following from the above; again calculate avg and st dev of each column: Converter ratio (virgin sensor / free disc); % change from virgin to proofed; and % change from virgin to cycled.

So SBO 03/07/90



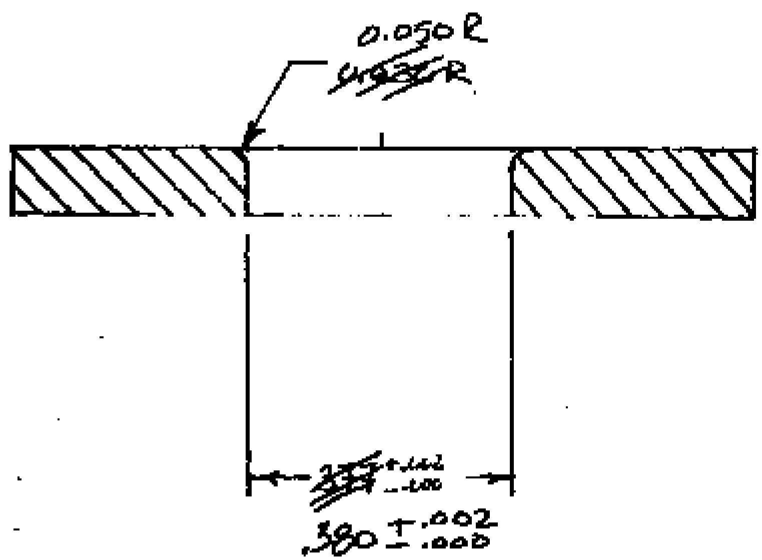
TI-NHTSA 000871

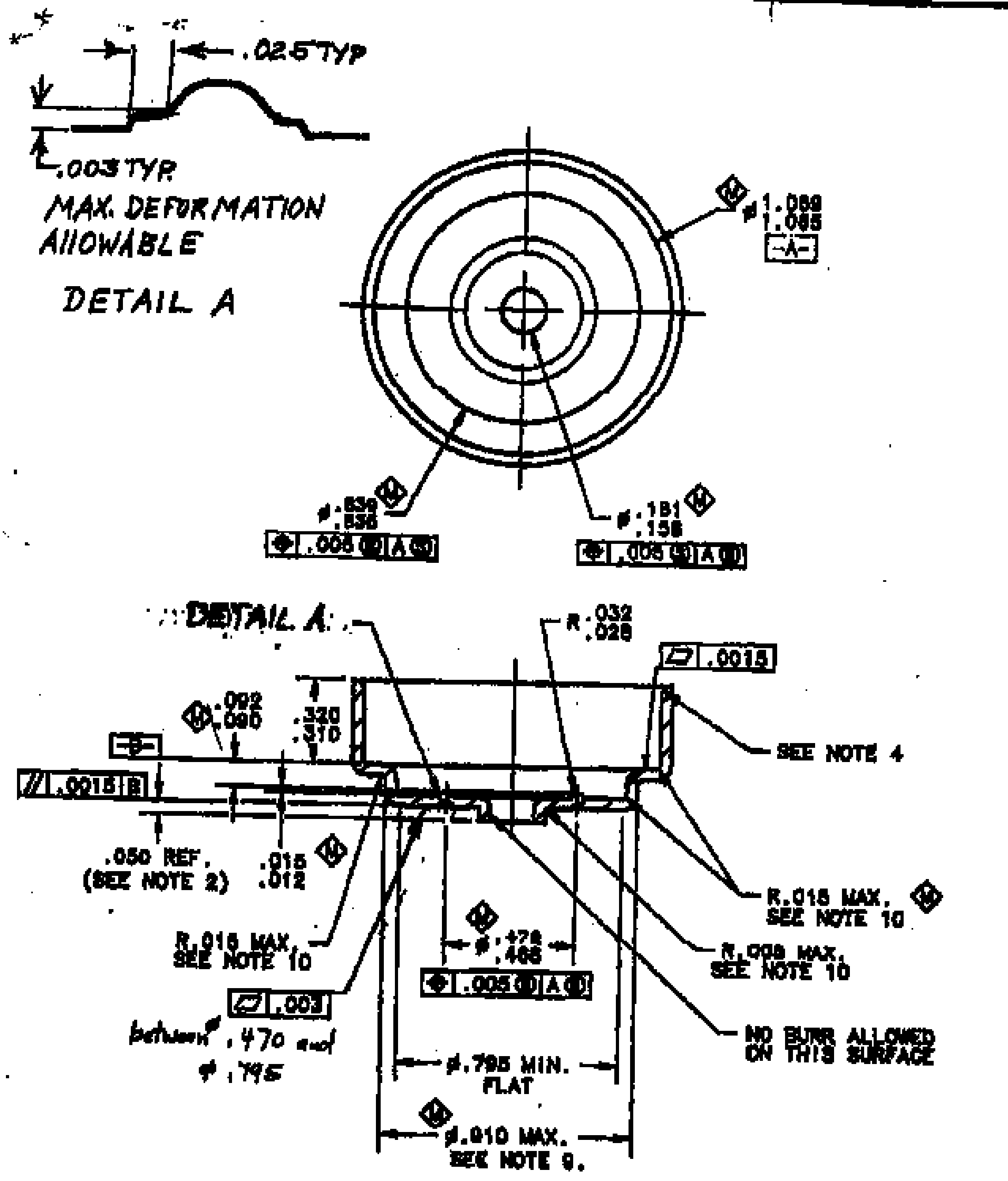
CONVERTER CAP



TI-NHT8A 000872

MODIFIED WASHERS





THIS DWG. SUPERSEDES 27713 REV. "A" DATED 11-2-90

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 41-15-90

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 7923	3/7/90	SAA	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	3/14/90	3/23/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: Following Page

PROCEDURE: Following Page

Converter height

Device #	Free disc deformation	Converter No.	Converter height	6th Cycle	Proof	4th Cycle	500 Inductor	Direct same disc	Disc after 4th
41-15-01	22.0	3	.0101	137/25	Pass	116/31			
02	22.0	17	.0101	140/34		118/39		19.9	
03	22.1	11	.0102	142/27		112/37	104 RM		19.5
04	22.2	6	.0109	141/21		121/20			
05	22.3	13	.0111	127/35		123/34		20.1	
06	22.5	10	.0115	140/25		126/20	109/11		19.7
07	22.7	7	.0116	150/41		127/28		20.1	
08	22.7	15	.0113	150/37		109/29			
09	22.9	20	.0117	143/46		129/44	113/45		21.4
10	22.9	16	.0118	139/45		122/42		20.2	
11	22.9	19	.0118	140/42		131/43			
12	22.9	11	.0122	158/44		128/25	No snap		
13	22.9	9	.0114	142/42		130/44		20.3	
14	23.0	5	.0115	145/35		133/34			
15	23.1	18	.0116	142/42		120/23	117/26		20.4
Control Product									
Device #									
41-15-16	—			202/65		202/69			
17				201/77		199/81			
18				209/61		136/109	197/57		21.1
19				213/69		213/72			
20				201/65		214/69			
21				214/70		211/74	201/74		21.9
22				221/73		209/92			
23				209/57		206/58			
24				213/54		201/69	[illegible]		[illegible]

TI-NHTSA 000675

SENSOR TESTING

GOAL:
The goal of this test is to provide information which will help to determine if the low-ratio-converter (LRC) will be appropriate to meet the Ford Pass-Car actuation spec. of 125 psi +/- 35.

SCOPE:
Two sensor lots will be run: one, using model-shop modified converters and washers to provide the lower ratio; and two, a control group which uses the same discs but standard production converters and washers. This test will be run on sensors only; no switch assemblies are needed. The test will cover an initial characterization, then a proof test, then a cycle test.

PROCEDURE:

- ✓1) Have model shop modify 20 converters and washers.
- ✓2) Working with a disc lot we have in inventory (22.3/9.1), characterize 30 in the free state.
- ✓3) Disc actuations will cover a range, theoretically in the neighborhood of 22.3 psi. If any disc(s) are obviously drastically different, remove them and replace with other discs from the same lot.
- ✓4) Sort the 30 discs by actuation and number them. Separate into two lots of 15 by taking all even-numbered discs for the first lot and all odd-numbered discs for the second.
- ✓5) The actuation sigma on each lot should be very similar. If not, identify why not and correct.
- ✓6) From the first disc lot, build the control group using production parts.
- ✓7) From the second disc lot, build the test group using the model-shop modified parts.
- ✓8) Characterize all 30 sensors. Use 2 overpressure cycles to 800 psi, then switch 3 more times and read the 6th.
- ✓9) Proof all 30 sensors to 4000 psi for 30 seconds.
- ✓10) Recharacterize all 30, switching 3 times and reading the 4th.
- 11) Take 5 devices from each lot and run 500K cycles on production equipment, no intermediate characterizations.
- 12) At this point, a decision will be made whether to run the rest of the devices to 500K cycles.
- 13) Recharacterize.

DATA:
Record the following for each test lot; calculate average and standard deviation of each column of data: Free disc actuation; Virgin sensor actuation; Proofed sensor actuation; Cycled sensor actuation.

Calculate the following from the above; again calculate avg and st dev of each column: Converter ratio (virgin sensor / free disc); % change from virgin to proofed; and % change from virgin to cycled.

So SEO 03/07/90

TI-NHTSA 000676

LBC SENSOR TESTING: ACTUATION DATA · TEST 46-15-30

DEVICE #	VIRGIN DISC	VIRGIN SENSOR	ACTUAL RATIO	AVG. RATIO	SENSOR AFTER PROOF	% CHANGE	DISC AFTER PROOF	% CHANGE	SENSOR AFTER SOAK	% CHANGE	DISC AFTER SOAK	% CHANGE
46-15-01	22.0	137	6.23	6.07	116	-15.33						
46-15-02	22.0	140	6.36	6.20	118	-15.71	19.9	-9.545				
46-15-03	22.1	142	6.43	6.29	123	-13.38			104	-26.76	19.5	-11.76
46-15-04	22.2	141	6.35	6.24	121	-14.18						
46-15-05	22.3	137	6.14	6.07	123	-10.22	20.1	-9.865				
46-15-06	22.5	148	6.58	6.55	126	-14.86			104	-29.72	19.7	-12.44
46-15-07	22.7	150	6.61	6.64	127	-15.33	20.1	-11.45				
46-15-08	22.7	150	6.61	6.64	129	-14.00						
46-15-09	22.6	143	6.27	6.33	127	-11.19			122	-14.68	21.4	-6.140
46-15-10	22.8	138	6.05	6.11	122	-11.59						
46-15-11	22.8	149	6.54	6.60	131	-12.08	20.2	-11.40				
46-15-12	22.8	158	6.93	7.00	128	-18.99			NO GRAPH: FRAGMENTED DISC			
46-15-13	22.9	142	6.20	6.29	135	-4.93	20.3	-11.35				
46-15-14	23.0	145	6.30	6.42	123	-15.17						
46-15-15	23.1	143	6.19	6.33	125	-12.59			113	-20.97	20.4	-11.68
AVG.	22.58	144.2	6.39	6.39	124.9	-13.30	20.1	-10.72	111	-23.03	20.2	-10.50
STD.	0.36	5.65	0.22	0.25	4.74	3.08	0.13	0.84	7.46	5.76	0.74	2.54

DEVICE #	VIRGIN DISC	VIRGIN SENSOR	ACTUAL RATIO	AVG. RATIO	SENSOR AFTER PROOF	% CHANGE	DISC AFTER PROOF	% CHANGE	SENSOR AFTER SOAK	% CHANGE	DISC AFTER SOAK	% CHANGE
46-15-16	—	208	—	9.23	202	-2.88	—	—				
46-15-17	—	201	—	8.92	198	-1.49	—	—				
46-15-18	—	204	—	9.05	196	-3.92	—	—	197	-3.431	21.1	—
46-15-19	—	217	—	9.63	213	-1.84	—	—				
46-15-20	—	214	—	9.49	214	0.00	—	—				
46-15-21	—	214	—	9.49	211	-1.40	—	—	201	-6.074	21.9	—
46-15-22	—	223	—	9.89	208	-6.73	—	—				
46-15-23	—	209	—	9.27	206	-1.44	—	—				
46-15-24	—	212	—	9.41	206	-2.83	—	—	203	-4.245	21.6	—
46-15-25	—	198	—	8.78	195	-1.52	—	—				
46-15-26	—	207	—	9.18	203	-1.93	—	—				
46-15-27	—	205	—	9.09	200	-2.44	—	—	197	-3.902	22	—
46-15-28	—	204	—	9.05	197	-3.43	—	—				
46-15-29	—	204	—	9.05	196	-3.92	—	—				
46-15-30	—	203	—	9.01	198	-2.46	—	—	206	1.4778	21.7	—
AVG.	22.54	208.2	—	9.24	202.8	-2.55	—	—	201	-3.235	21.7	-3.904
STD.	0.336	6.46	—	0.29	6.25	1.51	—	—	3.49	2.52	0.31	-11.66

[illegible]

[illegible] SENSOR TEST

----ALL DISCS----		50 DISCS	GROUP 1	GROUP 2
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	22.2		22.2
[illegible]	[illegible]	[illegible]	22.5	
[illegible]	[illegible]	22.6		22.6
[illegible]	22.9	22.7	22.7	
[illegible]	22.9	22.7		22.7
[illegible]	[illegible]	22.7	22.7	
[illegible]	[illegible]	22.8		22.8
[illegible]	[illegible]	22.8	22.9	
[illegible]	[illegible]	[illegible]		22.8
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	22.9	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]			
[illegible]	[illegible]		AVG [illegible]	[illegible]
[illegible]	[illegible]		STD. [illegible]	[illegible]
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
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[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			

[illegible]

PRESSURE SWITCH DATA Form 21605 TEST NO. 41-15-90

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 7913	3/7/90	SBD	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	3/14/90		

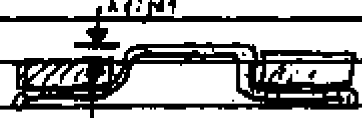
PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: Following Page

PROCEDURE: Following Page

Converter height



Cpk (group 2) X̄ = 142.6, σ = 4.06 — 160 − 142.6 / 3(4.06) = 1.43

Cpk (group 1) X̄ = 144.1, σ = 4.04 — 160 − 145 / 3(4.04) = 1.30

NSC method 125/6.39 = 19.6 PSI

Cpk using 125±35: 160 − 144.1 / 3(5.6) = 0.946

Device #	Free dia. Actuator	Converter No.	Converter Height	1st Cycle	Actual Ratio Pivot	Ratio using NSC Avg = 22.58 10th Cycle			
41-15-01	22.0	3	.0101	137/25	6.27	6.47			
02	22.0	19	.0101	140/24	6.36	6.20			
03	22.1	11	.0102	142/27	6.42	6.29			
04	22.2	6	.0109	141/21	6.35	6.24			
05	22.3	13	.0111	137/35	6.14	6.07			
06	22.5	10	.0115	140/25	6.38	6.55			
07	22.7	7	.0116	150/42	6.61	6.64			
08	22.9	15	.0117	150/37	6.61	6.64			
09	22.9	20	.0119	143/46	6.27	6.33			
10	22.9	16	.0119	139/45	6.05	6.11			
11	22.9	14	.0110	149/42	6.49	6.55			
12	22.9	17	.0103	150/44	6.37	7.00			
13	22.9	9	.0114	142/42	6.20	6.25			
14	23.0	5	.0115	145/35	6.30	6.46			
15	23.1	18	.0116	143/42	6.19	6.33			
			X̄ = 144.1	X̄	6.382	6.382	σ/X̄ = .441%		
			σ = 4.04	σ	0.130	0.156			
Control Group									
Device #			σ/X̄ = 2.8%		RATIO (using NSC avg.)		22.54		
41-15-16				200/65		9.23			
17				201/77		8.92			
18				204/61		9.05			
19				217/69		9.62			
20				206/65		9.09			
21				214/70		9.49			
22				222/73		9.85			
23				209/57		9.17			
24				213/[illegible]		[illegible]			

TI-NHTSA 000679

Device #				ETL Cycle	Word	[illegible]	
41-15-25				198/40		4.78	
26				202/52		9.18	
27				205/53		9.09	
28				214/71		9.05	
29				204/52		9.05	
30				203/54		9.01	
			$\bar{x}$ =	208.2	$\bar{x}$ =	9.236	σ/x̄ = 3.2%
			σ_{n} =	6.46	σ_{n} =	0.296	
			σ/x̄ =	3.1%			

HIGHLIGHTS
Stephen B. Offiler
Week Ending 03/09/90

<u>FORD MX91.75 CRUISE CONTROL PRESSURE SWITCH EX3423</u>

CUSTOMER ISSUES: It appears that both Pass-Car and Light Truck are blaming ELD for adding this pressure switch to the brake system, and are taking the position that tooling money should come from ELD. Resolution of this issue probably won't be quick. The fallback approach, using a manually-assembled 57PS with appropriate hexport, connector, and sensor configurations, could potentially be pursued for the first model year (approx 400K units).

Light Truck will be placing an order ~~[illegible]~~ for about 70 samples, and will require the P.I.S.T. and P.I.P.C. exercise on six devices again. Our Quality department has been alerted of this. I have 50 model-shop modified hexports with the SAE J512 inverted flare feature. We must determine immediately if we can get samples from Eloo (as promised when Ken Carlson was here on 12/21/89) or if we need to place another model shop job.

AUTOMATED SWITCH: Although Mechanization has been stopped pending resolution of the tooling money, in order to continue with the twist concept we need to complete the prototype twist tool. The design of this tool was underway when the stop order came down. John K. indicates that completion of design/build should cost $1K at the most, and we have decided to expense it so we can continue terminal development. [illegible]

We should have sample quantities of brass in soft, 1/4H and 1/2H early next week. This will allow us to EDM the next iteration of stationary terminal prototypes so that calibration development can progress. We have tested an actual 1NT terminal for springback, and discovered it has a relatively flat curve with a constant springback of .0055" from .015" to .045" of permanent deflection. Other terminal designs we've tested typically have double this amount of springback.

I've spoken to Bessler regarding the rivetless assembly technique. They feel that the eyelet is a better approach than the raised slug, due to our terminal thickness : spring thickness ratio of about 3:1. The TI Italy part we've looked at has a ratio of 6:1. Bessler has given me typical dimensions to work from.

SENSOR: The model shop is presently working on modifying 57PS converter parts for the low-ratio design. A test plan has been created, the goal of which is to determine if we can meet the Pass-Car spec of 125 +/- 35. Two 15-piece lots will be run: the modified parts and standard production parts as a control group. The test will cover stabilization, characterization, a proof test, and a cycle test.

<u>GM TRUCK/BUS BRAKE-LIGHT-SWITCH NBQ</u>
Six second-iteration devices (with disc step reduced to .003" for increased life) have completed the 1KK cycle test. Three devices survived; the fourth was intact but no longer snapped on actuation; the fifth had begun to leak around 1KK and had very high contact resistance because it was full of fluid; and the final device had begun to leak due to ruptured Kapton around 950KK and was removed from the test. These results are promising enough to warrant build of customer samples.

Steph Offiler 3/9/90

[illegible]

HIGHLIGHTS
Stephen B. Offiler
Week Ending 03/16/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

SWITCH ASSEMBLY: Sample quantities of brass in soft, 1/4H and 1/2H have arrived. We're having stationary terminals EDM'ed, focusing on the 1NT - style concept based on preliminary evaluation of alternatives. Also, the model shop will build a small forked tool which will be used to apply bending force to the terminal in the correct locations.

Regarding the movable terminal and the rivetless "eyelet" concept, I will check with the model shop and in parallel Keith Roberts will check with Bausler to find out the best way to proceed with prototyping this.

Mechanization indicates that the designs for the twist tool are complete, and have been transferred to the toolroom for build. Parts are expected mid-next week.

SENSOR: The sensor evaluation, to determine our capability to meet 125 +/- 35 with the low-ratio-converter design, is partially complete. Fifteen LRC sensors and fifteen production parts (control group) have been built and initially characterized. The actual average LRC ratio measured is 6.4, which indicates a disc of about 20 psi act. is needed. Test parts were built with 22.5 psi discs, producing parts with an average actuation of 144 psi and a Cpk of 0.95. Use of the proper 20 psi discs should push Cpk well over 1.33. Comparing LRC's with production sensors shows very similar characteristics in terms of variation in actual ratio and variation in the final device. Next, we will proof-test all devices to 4000psi, recharacterize, cycle to 500K, and recharacterize.

SPECIFICATIONS: The three-way humidity test is underway in the Environmental Labs. George O'Lear indicates that we'll have results by the end of March. Ford is keeping abreast of this through Joe, who contacts me regularly.

57PSL5-X: The first six parts, built for the Light-Truck P.I.S.T./P.I.P.C. evaluation, should be ready to turn over to Quality mid-next week, with a goal of completing the work and shipping by 03/28/90. These will use hexports modified from standard production parts by the model shop. The balance of 64, due 05/05/90, will be built using hexports either modified by AFCC Screw Machine or from Elco samples, availability to-be-determined.

GM TRUCK/BUS BRAKE-LIGHT-SWITCH NBO:
John Pechonis has handed over Marketing responsibility to Tom Taylor since it fits within his area of specialty, single-function free-disc devices. We are proceeding with a sample build of six devices, using existing parts where possible to save time and effort. Target completion date is 03/23/90.

Steve Offiler 3/16/90

TI-NHTSA 000682

03. 20. 90 04:19 PM *T I DETROIT P06

Please pass to
Charlie Douglas.
FR: Del Schmidt

Purchasing
Ford North American
Automotive Operations

Ford Motor Company
Parkside Drive at Southfield
P.O. Box 1507
Dearborn, Michigan 48121

March 19,1990

To:

Mr. M. Bugajski
Mr. D. Flack
Mr. R. Franz
Mr. G. Holmes
Mr. F. Janosi
Mr. A. Krummerer
Mr. J. Larson
Mr. N. Modi
Mr. B. Pease
Mr. G. Randall
Mr. R. Shaw
Mr. R. Smith
Mr. J. Wilk

Mr. K. Brown
Mr. T. Feeley
Mr. D. Harrington
Mr. D. Holland
Mr. G. Klingler
Mr. B. Kravec
Ms. A. Mc Nuck
Mr. C. Murdoch
Mr. M. Pikus
Mr. J. Schuck
Mr. C. Smith
Mr. D. Wheatley

From: [redacted]

Subject: "Product Alert" Next Generation Cruise Control Deactivation Switch F2VC-9C388-AA and F3TA-9C388-AA Tooling Funds Availability of $1.32 million.

This "Product Alert" is issued to notify Product Engineering, Program Management and Purchasing that Texas Instrument has stopped all tooling automation development work on the new Cruise Control Deactivation Switch. This work stoppage is do to the excessive financial exposure that Texas Instrument has experienced during the development of this program in the absence of appropriate Ford funding. However, due to their on-going spirit of support to the Ford UBC timing, Texas Instrument has elected to continue with their switch design development.

Due to inconsistent direction from the different areas within Ford, Texas Instrument has been left with no choice but to stop all development work until Ford program management assured Texas Instrument that funding for this program will be made available. This delay in the development on this part will jeopardize Texas Instruments ability to support Fords program timing for the following 1992 vehicles.

TI-NHTSA 000683

03 20 90 04:21 PM P06

HIGHLIGHTS

Stephen B. Offiler
Week Ending 03/23/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: Joe Schuck indicates that Pass-Car has finally accepted our proposed Engineering Test Specification. The Humidity spec. they've agreed to is a modified MIL-STD 202F. We will continue with our Humidity comparison test.

Light Truck steadfastly insists upon a sample size of 50 for the low-temperature drift test. We did 20 parts and presented initial results, which wasn't good enough for Ford. This test originally was supposed to be done in a quick-and-dirty manner until bureaucracy stepped in. However, I have resolved the issue of the mis-applied Cpk numbers with Joe Schuck and now feel more comfortable about completing the test on 30 more parts.

AUTOMATED SWITCH: The three outstanding issues at present are calibration, twist, and rivetless assembly. We are waiting for EDM parts and a special dial-indicator tip in order to proceed with the stationary terminal design for calibration. We are waiting for Mechanization to complete the twist tool in order to move forward with this concept. I have roughed out a test plan for the twist concept as soon as the tool arrives. Sketches are underway for the movable terminal with an eyelet for rivetless assembly, which the model shop will be able to form.

SENSOR: We have completed the test of the low-ratio-converter. . Fifteen LRC test devices and 15 controls were built, stabilized, characterized, proofed, and cycled. Results are not encouraging. After the proof test (to 4000 psi) the LRC devices were found to have decreased in actuation by 13.3% while the controls decreased by 2.5%. Some LRC devices were disassembled and the free disc recharacterized. These discs were found to have decreased by 10.7%, indicating that the proof test actually deformed the discs. After cycling, the LRC sensor actuations had fallen by another 9.7% beyond proof (total 23.0%). However, we found that the discs had not changed further, which indicates this drift is probably related to the Kapton seal/converter button interface. Minimal changes were observed in the control group throughout this test. It appears necessary to design a positive stop into the converter to protect the disc during proof testing.

57PSL5-2: We have built a quantity of parts for the PIST/PIPC exercise. These production-built devices use black 57PS "L" bases, model-shop modified SAE J512 hexports, and special discs to produce 250 psi actuation. These have been transferred to Quality, and are expected to be ready to ship next Tuesday. This will allow us to just meet the deadline of 03/28/90.

GM TRUCK/BUS NBO:

We are in the process of building six prototypes, expected 03/28/90. We should be able to meet this if all goes well. A data sheet will accompany these parts, with information on actuation and release, contact current rating, and a brief summary of testing performed.

Steve Offiler 3/23/90

HIGHLIGHTS

Stephen B. Offiler
Week Ending 03/30/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: The tooling money issue has finally been resolved at Ford. We will get paid upon completion of ISIR testing. The hold on Mechanization will be lifted effective immediately.

We have completed the cold-temp calibration shift test on all 50 devices at Ford's request. Results are: average of 5.5% increase in actuation at -40°C, sigma of 2.3.

George O'Lear indicates that our humidity comparison test is presently running the MIL-STD-202F portion. His programmable equipment, needed to run the custom Ford portion of the test, will be repaired next week. Final results the week after.

57PSL5-X: The FIST/FIPC evaluation has been completed for Light Truck (-2), with good results. We are required to meet 85% of the print dimensions at this stage of development, and these six parts fall in the 86-90% ballpark. We did not meet all dimensions because the production 46412 base was used, whereas the print actually shows the new base design. A "corrective actions" summary was prepared which basically states this fact. These parts will ship Monday, after Quality organizes all the paperwork.

We have received a request for 10 samples from Kelsey-Hayes, which is Pass-Car's supplier. (It is unclear what has happened to Pitts.) These are -3 devices, with offset polarity tab and 125 psi actuation. Devices are required 05/11/90, which buys us some time to resolve the low-ratio-converter approach.

AUTOMATED SWITCH: Outstanding issues are calibration, twist, and rivetless assembly. We are waiting for INT-style stationary terminals from the Model Shop (expected mid-next week) and a special dial-indicator tip which is used to deform these terminals. Steve McCoosy informs me that the toolmaker has built the twist tool, and they are now trying it out and tweaking as necessary. The sketch of the movable terminal with the rivetless "eyelet" feature is not yet complete.

SENSOR: Stan Homol informed me that his low-ratio-converter testing used 455SS discs, and he first noted deformation problems at a proof pressure of 4600 psi. My initial testing used 301SS discs and problems arose at a proof pressure of 4000. I have ordered 455SS discs from the Disc Dept. to continue with the LRC effort.

Keith Roberts did a quick-and-dirty experiment using machined zinc (ZA-8) converters. Cycling caused an increase in actuation pressure, possibly related to a deformation of the converter. These parts were cycled at room temperature on the 57PS line. This test is now going to be re-run, using knowledge gained from Keith's test to better control the variables. The new test will be run in my cycler, at elevated temperature.

We have (finally) received the quote from Elco on the J512 hexport. It is roughly equivalent to the cost of the snubber hexport. We are taking steps to negotiate with Elco on this, since we feel that the J512 feature is not nearly as difficult to produce as the snubber.

TESTING: Jeff DiDomenico has completed modifications to the cycler. This includes aluminum manifolds equipped with thermocouples and heaters, and a controller for the heaters. Jeff has wired the controller in such a way that we can now automatically start the pump when the brake fluid reaches the required temperature. This alleviates the need for someone to come in after hours or on weekends just to hit the "start" button.

<u>GM TRUCK & BUS NBO</u>
We shipped six prototypes on-schedule. These use old-style CCPS free-disc parts, with production 5SPS discs (17/7 act/rel). They were accompanied by a simple data sheet listing key data such as act, rel, contact current rating, and a summary of cycle testing performed.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 49-01-20

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Fx 3923		SBB	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	4/4/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Customer Sample for Kelsey Hayes

PROCEDURE: 57PS w/
1) JSN Flair fitting Support
2) 6:1 Low ratio converter
3) 22 PSI Disc
4) L-Type base: normally closed

Proof to 1500 PSI before characterization

Devices 11-20 old-style direct acting discs

Device #	Proof	Act	Rel		Device #	Transfer %	Proof	Act	Rel
49-01-01	Pass	116	36		49-01-11	212	Pass	134	124
02		112	37		12	212		127	118
03		123	40		13	212		144	123
04		119	43		14	213		122	124
05		129	44		15	216		135	124
06		115	40		16	216		129	115
07		119	43		17	214		123	114
08		136	43		18	216		137	123
09		116	44		19	213		140	122
10		119	37		20	215		124	117
	$\bar{x}$	122.5	40.9				$\bar{x}$	132.5	120.9
	σ_{n-1}	7.1	4.6				σ_{n-1}	6.2	4.5
	Cpk:	$\frac{122.5-90}{3(7.1)}$	= 1.53				Cpk:	$\frac{90-132.5}{3(6.2)}$ ≥ 1.40	

TI-NHTSA 000687

HIGHLIGHTS
Stephen B. Offiler
Week Ending 04/06/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: A revised schedule is forthcoming, reflecting some updated information such as Job 1 dates for car and truck and for 57PS and CCPS, etc. Both Ford groups have requested prints of each switch, which Drafting is presently working on. We've gotten feedback from Ford on the cold-temp drift test - they're very pleased with the results, and Joe indicates that we seem to finally have the key Ford personnel on our side.

Acting on information that the 10 Kelsey/Hayes parts are needed ASAP, we assembled ten devices using the Low Ratio Converter prototypes. These are known to have proof-pressure limitations. Using off-the-shelf discs with somewhat wide differential, the final devices ended up with excellent actuation values (avg of 122.5 psi) but release values fell below 40 psi which is the spec. limit. Marketing and Field Sales are assessing the criticality of K/H's need. These parts will be useful as long as their limitations are conveyed. Additionally, we're looking into reducing the release spec. on Pass-Car from 40 psi to 20.

AUTOMATED SWITCH: Weekly Mechanization meetings have been started up again. Their prototype twist tool has been built, and they are using it to create a small number of devices which we will use to test terminal strength. (I have photos of the tool if anyone is curious). Mech. has proposed that we look into increasing the internal dimensions of the connector, which will allow the twist tool to be larger and stronger. Marketing will pursue this change with the customer, and I am working with Molding.

Mechanization is strongly in favor of utilizing some kind of continuous dimensional data to control the calibration, rather than using discrete data (continuity). We are studying this, and attempting to develop a design. However, since continuity change is the fundamental parameter which calibration addresses, it seems obvious that we can't design it out of the calibration procedure.

Steve McCoosy has indicated that the spring design does not lend itself to being bowl-fed. This points us in the direction of reel-feeding.

We are still waiting for the Wire-EDM prototypes of the INT-style stationary terminal. Testing will proceed immediately upon receipt of parts and the tool needed to deform them.

SENSOR: In order to determine the extent of the proof-pressure problem with the LRC, a test will be run in which devices will be built, initially characterized, then split into several groups. Each successive group will be subject to incrementally higher proof pressures, starting around 1500 psi and going up in 500 psi increments. A final characterization completes the test.

45385 discs, which were expected today, have not arrived. These may prove to be more resistant to deformation under proof loads, based on some earlier LRC testing.

Steve Offiler 4/6/90

TI-NHTSA 000688

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 51-15-20

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PS	7/11/90	[illegible]	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
[illegible]	7/11/90		

PROJECT TITLE: Cruise control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: On Following page

PROCEDURE: On Following page

Crown Height

Sensor #	Disc Material	Disc #	Disc Act	Disc Rel	Crown Height	Initial Act	Initial Rel	Proof
51-15-01	455 SS	18	20.0	9.9	.017	127	52	None
02		20	20.0	10.1	.017	130	52	None
03		21	20.0	10.1	.017	127	52	2000
04		12	20.1	9.9	.017	124	50	2000
05		14	20.1	9.9	.017	124	49	3000
06		2	20.1	9.9	.017	125	57	3000
07		4	20.1	10.0	.017	128	56	3500
08		18	20.1	10.0	.017	127	58	3500
09		22	20.1	10.0	.017	128	52	4000
10		15	20.1	10.1	.017	131	53	4000
11	301 SS	49	21.1	7.7	.019	137	37	None
12		39	21.2	8.0	.019	135	42	None
13		47	21.3	7.7	.019	136	44	2000
14		7	21.3	7.9	.019	132	44	2000
15		25	21.3	8.0	.019	139	44	3000
16		34	21.3	8.4	.019	144	42	3000
17		3	21.4	6.9	.018	142	35	3500
18		43	21.4	7.8	.019	130	40	3500
19		37	21.4	8.4	.019	135	47	4000
20		19	21.4	8.2	.019	128	40	4000

Sensor #	[illegible]	After Act	[illegible] Rel	Disc Act	Disc Rel	[illegible] Mid
51-15 01	[illegible]	13[illegible]	55	20.0	10.0	.027
02	[illegible]	127	52	20.0	10.0	.027
03	1000	125	55	19.9	10.1	.027
04	2000	125	54	20.0	10.0	.027
05	2000	122	54	19.9	9.9	.026
06	[illegible]	126	53	19.9	9.9	.027
07	3500	121	55	19.6	10.0	.026
08	3500	122	57	19.5	9.2	.026
09	4000	112	63	19.3	7.9	.025
10	4000	116	66	19.1	9.1	.025
51-15 - 11	[illegible]	124	44	20.5	8.7	.029
12	[illegible]	129	46	20.5	8.0	.029
13	1000	135	46	20.4	8.8	.027
14	2000	132	45	20.4	8.9	.027
15	3000	126	47	20.1	8.8	.027
16	2000	130	46	20.2	8.7	.027
17	1500	131	40	20.2	8.1	.027
18	2500	126	40	20.2	8.4	.027
19	4000	125	45	20.0	8.1	.027
20	4000	122	44	19.9	8.0	.027

LOW RATIO CONVERTER PROOF TEST

GOAL:
To determine the maximum proof pressure that the LRC can withstand with either 301SS or 455SS.

SCOPE:
Preliminary testing of the LRC showed what appeared to be disc (301SS) deformation under proof loads, resulting in permanent actuation shifts downward (rel. not measured) on the order of 10%. This test will attempt to quantify the magnitude of the problem. Information from Stan Homol indicates that 455SS may help the situation, so the test will use both SS materials. Test devices will be subject to increasing proof loads, with appropriate initial and final characterizations.

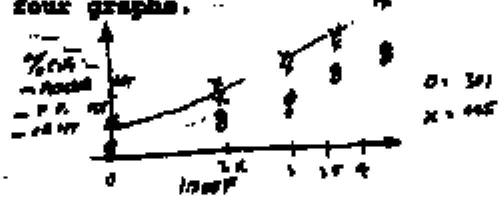
(Note: for this entire test, "characterization" means both actuation and release values.)

PROCEDURE:

1) Obtain 20 LRC's from model shop (expected 04/16/90).
2) Obtain 301SS discs, same as from previous test (22 psi).
3) Obtain 455SS discs from Disc Dept. (expected 04/18/90).
4) Initially characterize a quantity of each disc in the free state, then hand-pick 10 discs for each test lot which are very similar in characteristics.
5) Measure the crown height of all 20 discs.
6) Build a total of twenty sensors, ten of each disc mat'l.
7) Initially characterize all 20 sensors as follows: 2 overpressure cycles to 800 psi, switch three more times, take the sixth reading.
8) Separate the sensors and proof test as follows: two of each lot are controls (no proof test); proof two of each to 2000 psi, 3000 psi, 3500 psi, and 4000 psi.
9) Recharacterize all sensors as follows: switch three times, take the fourth reading.
10) Decrimp all sensors, remove the discs, and recharacterize them in the free state, and remeasure the crown heights.

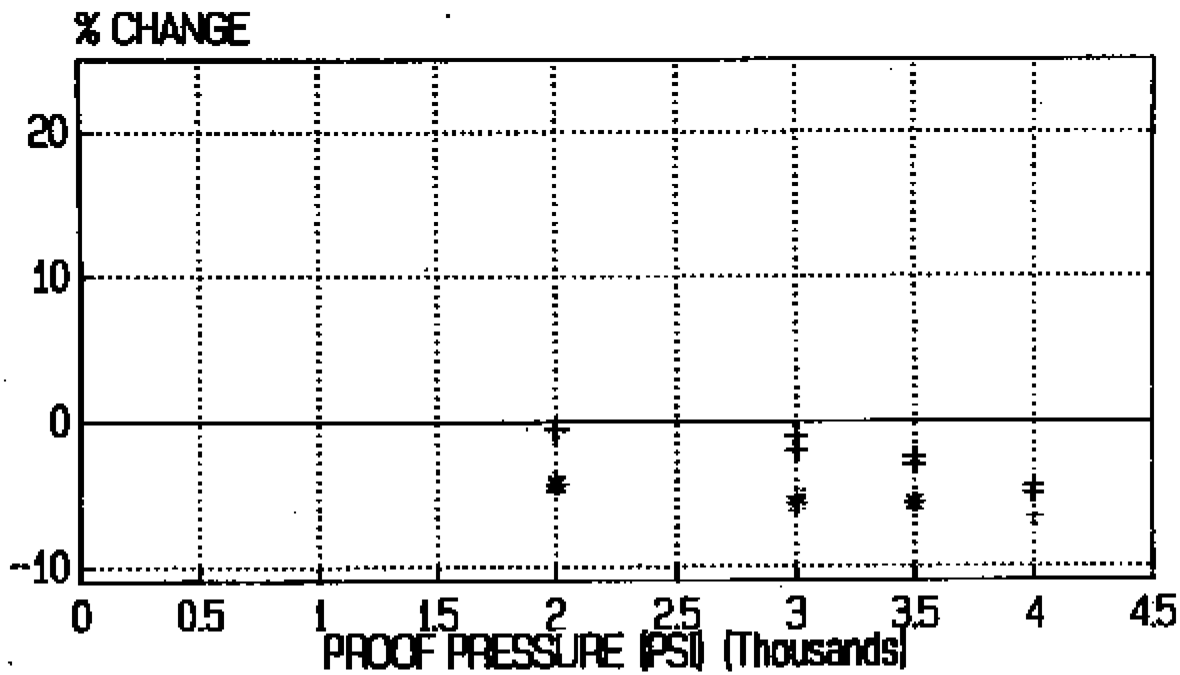
DATA:
Column headings are as follows: Initial free disc act/rel; initial crown height; initial sensor act/rel; final sensor act/rel (after proof); final ~~free~~ disc act/rel; final crown height; % chg sensor; ACT/REL and % chg free ~~disc~~; % chg crown height. Do not calculate any avg's and std dev's for the columns. Instead, draw four scatter graphs (no lines between data points). ~~These graphs are for~~ the sensor data. ~~We will determine later~~ if free disc data or crown height data need to be
YES examined. ~~One covers 301 actuation, one covers 301 release, and the other two cover 455SS.~~ The x-axis is proof pressure, and the y-axis is % chg. Use % chg numbers directly, so that there will be two data points for each of the five proof pressures (counting the controls @ zero proof pressure) for each of the four graphs.

(Filename: LRCPROOF) SBO 04/10/90



TI-NHTSA 000691

LOW RATIO CONVERTER PROOF TEST
FREE DISC ACTUATION



+ 455 DISCS   301 DISCS

JAD 5/2/90

LOW RATIO CONVERTER PROOF TEST

GOAL:
To determine the maximum proof pressure that the LRC can withstand with either 301SS or 455SS.

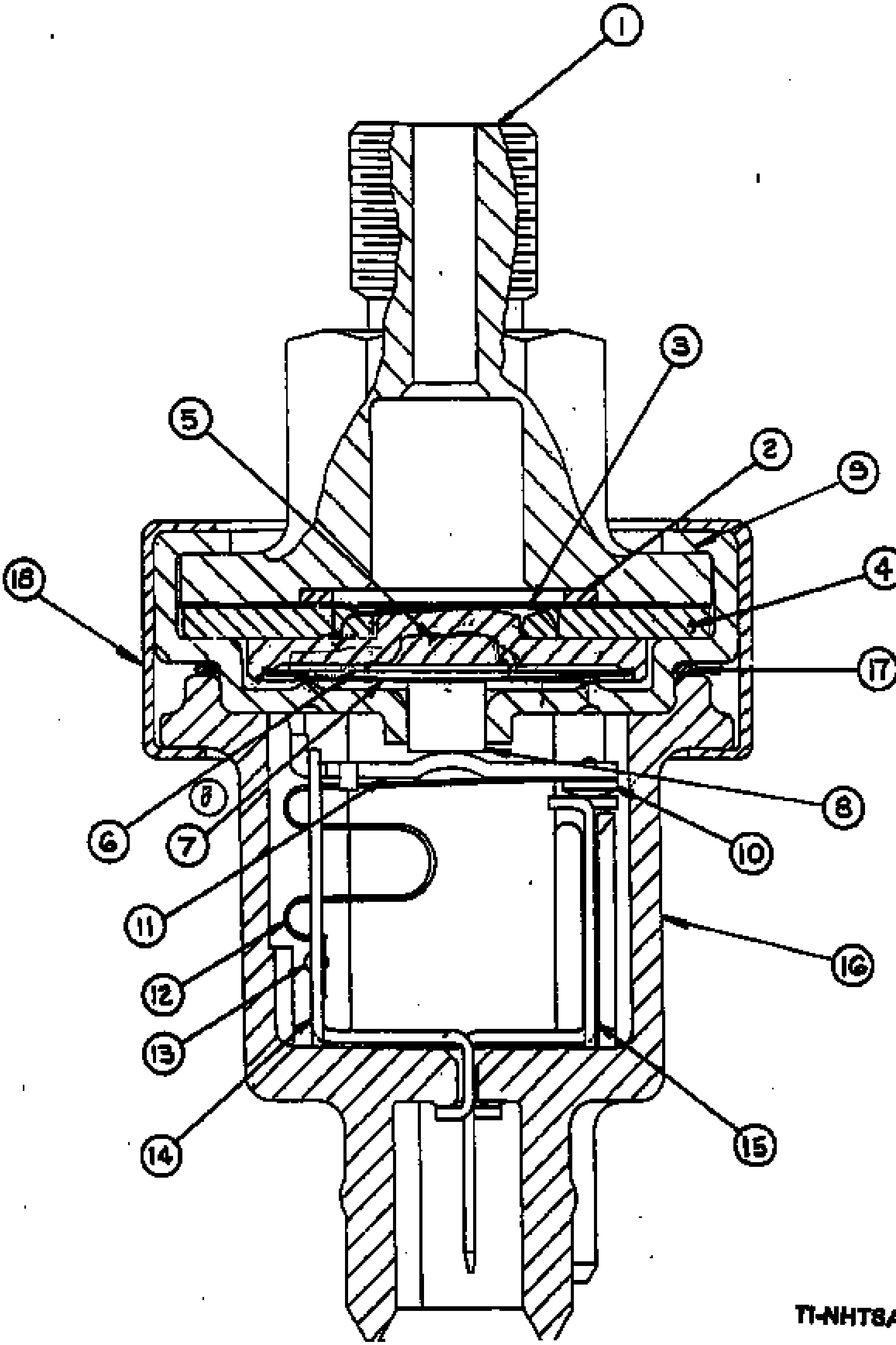
SCOPE:
Preliminary testing of the LRC showed what appeared to be disc (301SS) deformation under proof loads, resulting in permanent actuation shifts downward (rel. not measured) on the order of 10%. This test will attempt to quantify the magnitude of the problem. Information from Stan Homol indicates that 455SS may help the situation, so the test will use both SS materials. Test devices will be subject to increasing proof loads, with appropriate initial and final characterizations.

(Note: for this entire test, "characterization" means both actuation and release values.)

PROCEDURE:
1) Obtain 20 LRC's from model shop (expected 04/18/90).
2) Obtain 301SS discs, same as from previous test (22 psi).
3) Obtain 455SS discs from Disc Dept. (expected 04/18/90).
4) Initially characterize a quantity of each disc in the free state, then hand-pick 10 discs for each test lot which are very similar in characteristics.
5) Measure the crown height of all 20 discs.
6) Build a total of twenty sensors, ten of each disc mat'l.
7) Initially characterize all 20 sensors as follows: 2 overpressure cycles to 600 psi; switch three more times, take the sixth reading.
8) Separate the sensors and proof test as follows: two of each lot are controls (no proof test); proof two of each to 2000 psi, 3000 psi, 3500 psi, and 4000 psi.
9) Recharacterize all sensors as follows: switch three times, take the fourth reading.
10) Decrimp all sensors, remove the discs, and recharacterize them in the free state, and remeasure the crown heights.

DATA:
Column headings are as follows: Initial free disc act/rel; initial crown height; initial sensor act/rel; final sensor act/rel (after proof); final free disc act/rel; final crown height; % chg sensor; and % chg free disc; % chg crown height. Do not calculate any avg's and std dev's for the columns. Instead, draw four scatter graphs (no lines between data points). These graphs are for the sensor data. We will determine later if free disc data or crown height data need to be examined. One covers 301 actuation, one covers 301 release, and the other two cover 455SS. The x-axis is proof pressure, and the y-axis is % chg. Use % chg numbers directly, so that there will be two data points for each of the five proof pressures (counting the controls @ zero proof pressure) for each of the four graphs.

(Filename: LRCPROOF) SBO 04/10/90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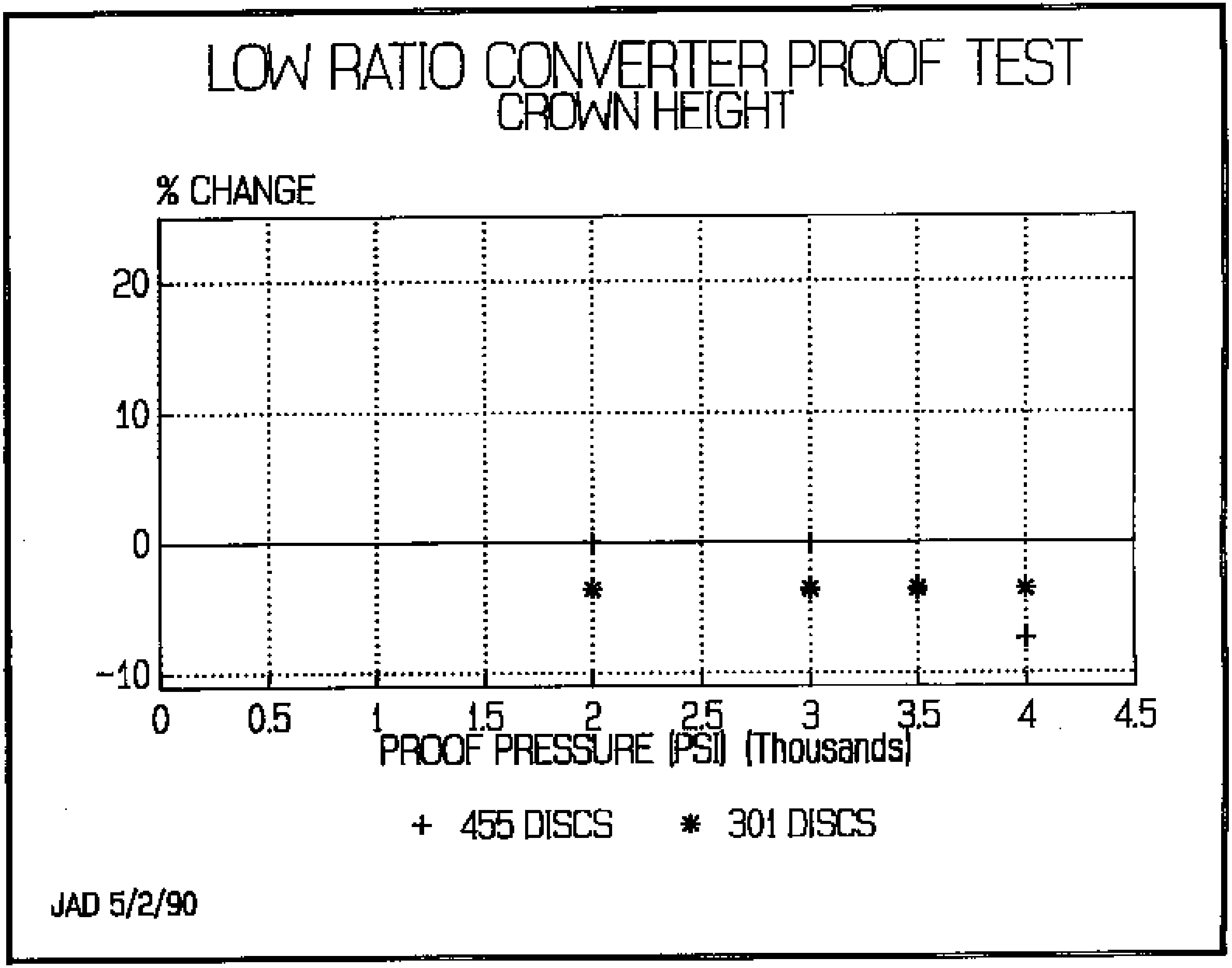
LOW-RATIO CONVERTER PROOF TEST

DEVICE #	FREE DISC INITIAL ACT	FREE DISC INITIAL REL	INITIAL CROWN HEIGHT	SENSOR INITIAL ACT	SENSOR INITIAL REL	SENSOR FINAL ACT	SENSOR FINAL REL	FREE DISC FINAL ACT	FREE DISC FINAL REL	FINAL CROWN HEIGHT	SENSOR % CHG ACT	SENSOR % CHG REL	FREE DISC % CHG ACT	FREE DISC % CHG REL	% CHG CROWN HEIGHT	PROOF	4
51-15-01	20.0	9.9	0.027	127	52	132	55	20.0	10.0	0.027	3.94	5.77	0.00	1.01	0.00	---	5
51-15-02	20.0	10.1	0.027	120	52	127	52	20.0	10.0	0.027	5.83	0.00	0.00	-0.99	0.00	---	5
51-15-03	20.0	10.2	0.027	122	52	125	55	19.9	10.1	0.027	2.46	5.77	-0.50	-0.98	0.00	2000	
51-15-04	20.1	9.9	0.027	134	53	135	54	20.0	10.0	0.027	0.75	1.89	-0.50	1.01	0.00	2000	D
51-15-05	20.1	9.9	0.027	124	49	122	54	19.7	9.9	0.026	-1.61	10.20	-1.99	0.00	-3.70	3000	I
51-15-06	20.1	9.9	0.027	125	57	126	59	19.9	9.9	0.027	0.80	3.51	-1.00	0.00	0.00	3000	S
51-15-07	20.1	10.0	0.027	126	56	121	55	19.6	10.0	0.026	-3.97	-1.79	-2.49	0.00	-3.70	3500	C
51-15-08	20.1	10.0	0.027	127	56	122	57	19.5	9.9	0.026	-3.94	-1.72	-2.99	-1.60	-3.70	3500	S
51-15-09	20.1	10.0	0.027	122	52	112	53	19.2	9.9	0.025	-8.20	1.92	-4.48	-1.00	-7.41	4000	
51-15-10	20.1	10.1	0.027	131	53	116	56	19.1	9.9	0.025	-11.45	5.66	-4.98	-1.98	-7.41	4000	
51-15-11	21.1	7.3	0.028	127	39	134	44	20.5	8.7	0.028	5.51	12.82	-2.84	19.18	0.00	---	3
51-15-12	21.2	8.0	0.028	133	42	139	46	20.5	9.0	0.028	4.51	9.52	-3.30	12.50	0.00	---	0
51-15-13	21.3	7.7	0.028	135	44	135	46	20.4	8.8	0.027	0.00	4.55	-4.23	14.29	-3.57	2000	I
51-15-14	21.3	7.9	0.028	132	44	132	45	20.4	8.9	0.027	0.00	2.27	-4.23	12.66	-3.57	2000	
51-15-15	21.3	8.0	0.028	128	44	126	47	20.1	8.9	0.027	-1.56	6.82	-5.63	11.25	-3.57	3000	0
51-15-16	21.3	8.4	0.028	128	42	130	46	20.2	9.2	0.027	1.56	9.52	-5.16	9.52	-3.57	3000	I
51-15-17	21.4	6.9	0.028	142	35	138	40	20.2	8.3	0.027	-2.82	14.29	-5.61	20.29	-3.57	3500	S
51-15-18	21.4	7.0	0.028	130	42	126	40	20.2	8.4	0.027	-3.08	-4.76	-5.61	20.00	-3.57	3500	C
51-15-19	21.4	8.4	0.028	135	47	125	45	20.0	9.1	0.027	-7.41	-4.26	-6.54	8.33	-3.57	4000	S
51-15-20	21.4	9.2	0.028	132	44	122	44	19.9	9.0	0.027	-7.58	0.00	-7.01	-2.17	-3.57	4000	

TI-NHTSA 000696



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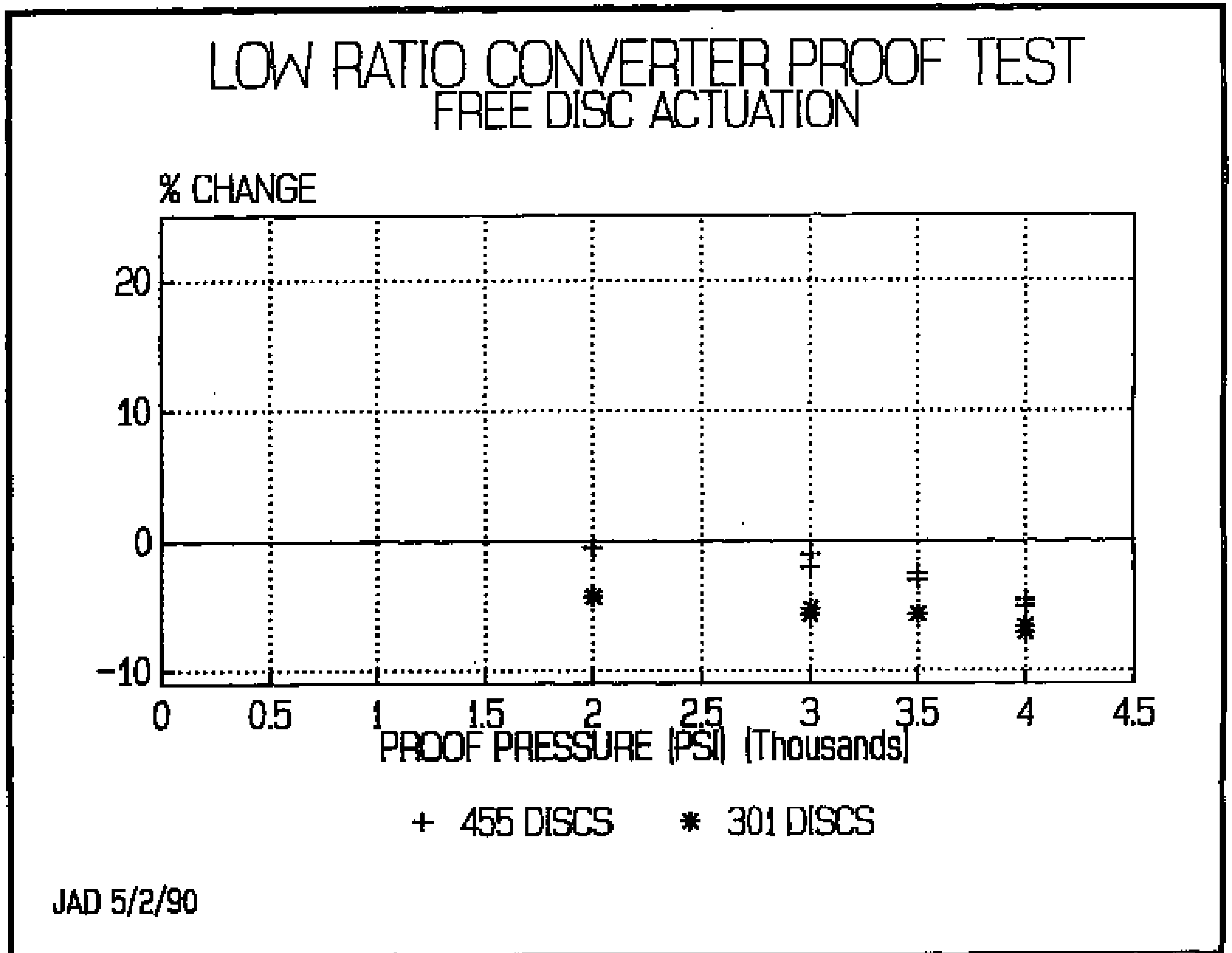
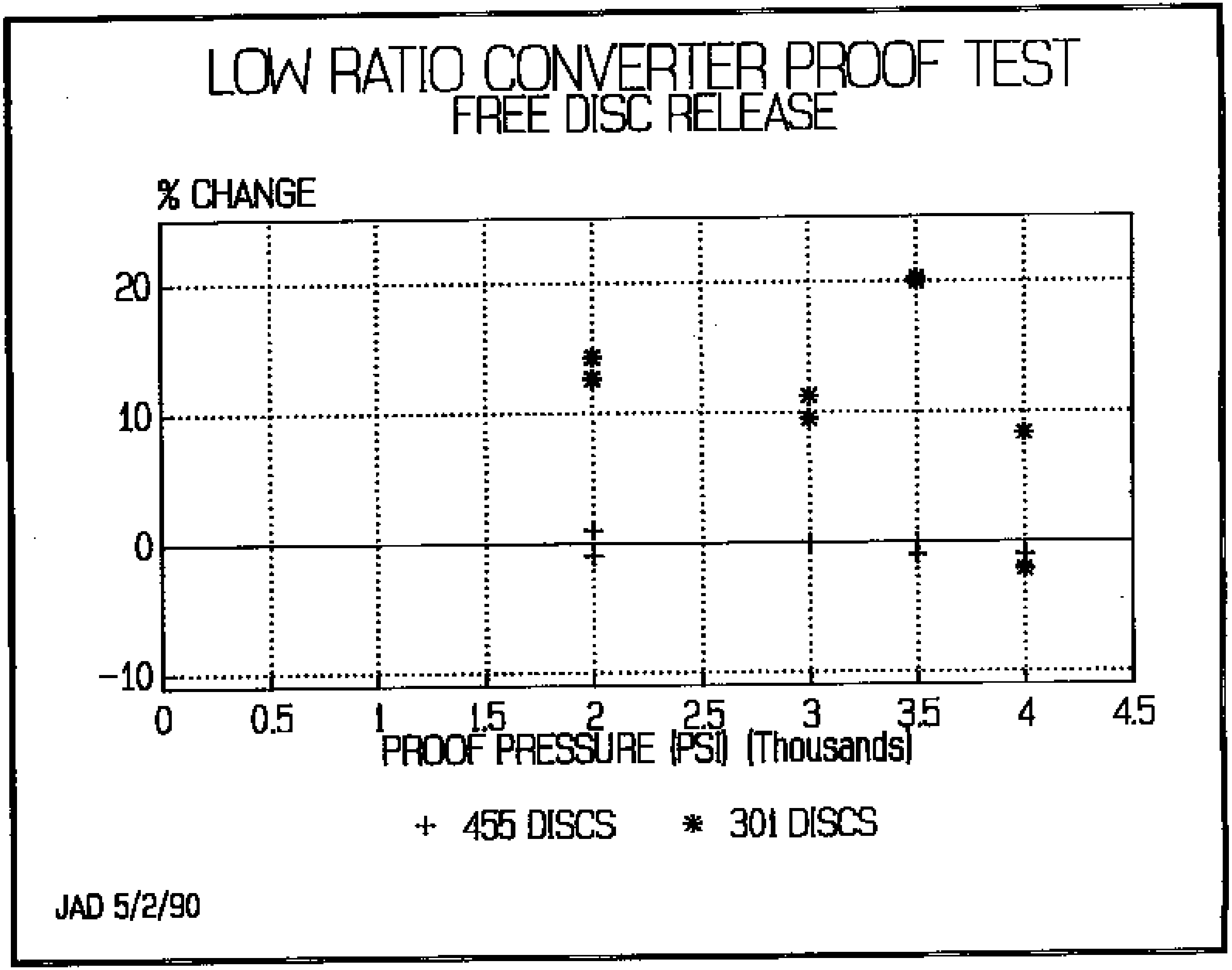

LOW RATIO CONVERTER PROOF TEST
FREE DISC ACTUATION
% CHANGE
20
10
0
-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
PROOF PRESSURE (PSI) (Thousands)
+ 455 DISCS
* 301 DISCS
JAD 5/2/90



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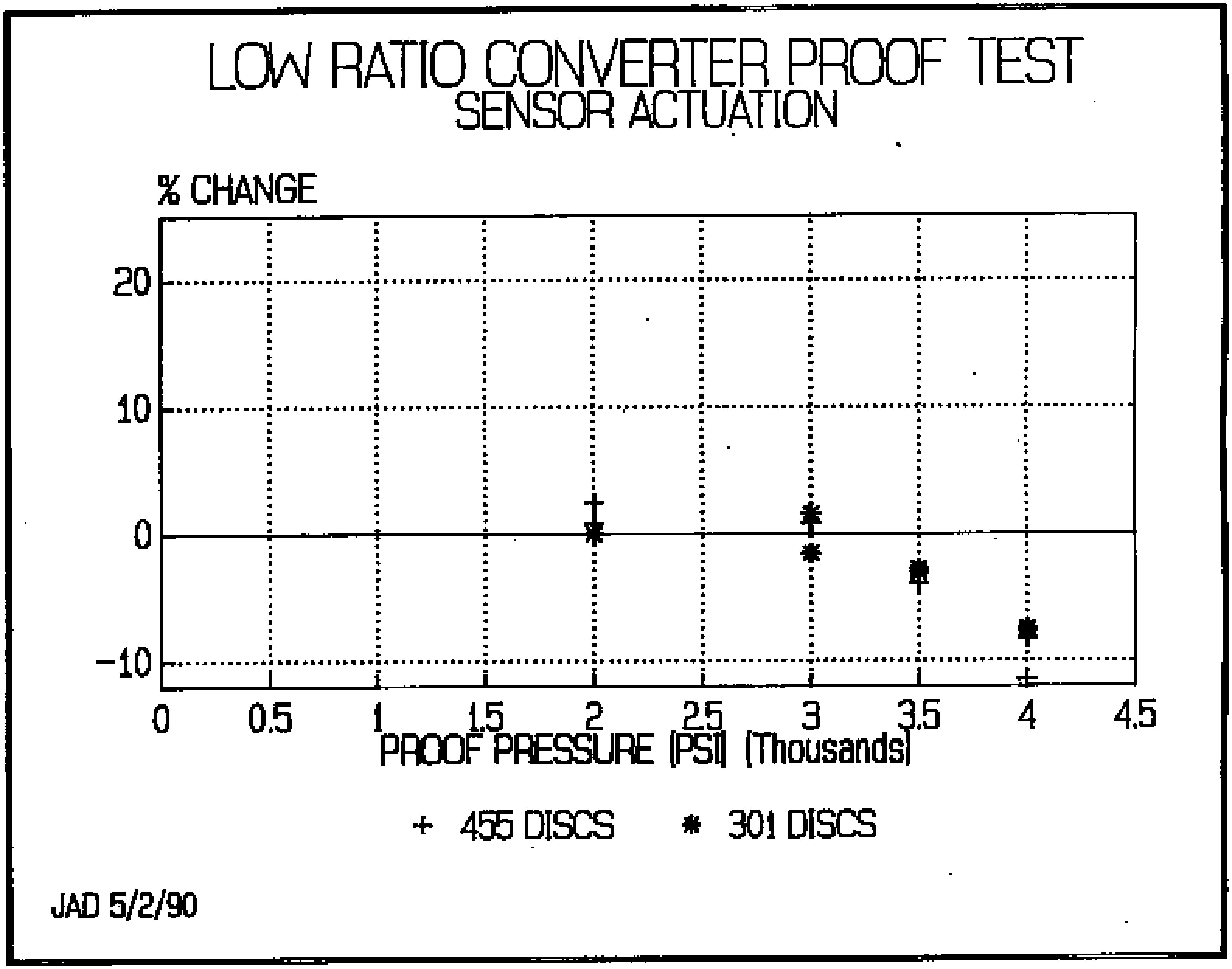

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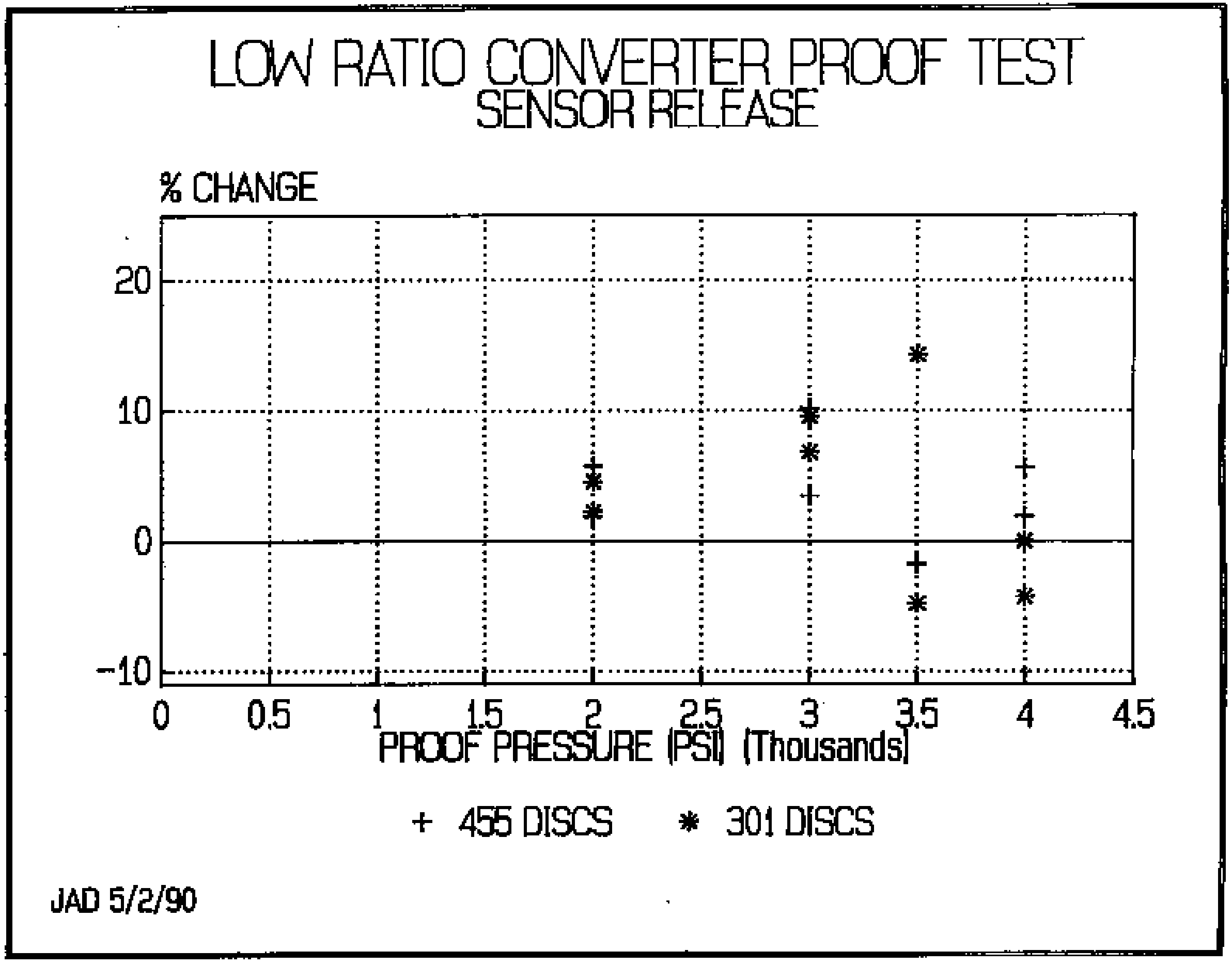

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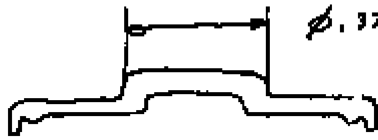


$\phi .375$, ACTUAL AREA ?? (KAPTON WETTING)

ASSUME $A = \frac{\pi}{4}(.375)^2 = .110\ in^2$ $\qquad F = PA$

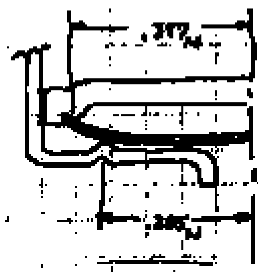
(67% LARGER THAN STD. 'A')

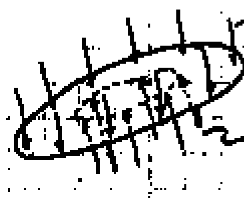
$F = 4000\ \frac{LB}{in^2}(.11\ in^2) = \underline{\underline{440\ LBS}}$

L

R

C





$A = \pi/4\,(.250^2) = .066\ in^2$

$F = 4000\ \frac{LB}{in^2}(.066\ in^2) = \underline{\underline{264\ LBS}}$ (40% SMALLER THAN LRC 'F')

S

T

D

STAINLESS COMPOSITIONS

ELEMENT	301	455
CARBON (C)	.15 MAX	.05 MAX
MANGANESE (Mn)	2.0 MAX	.50 MAX
SILICON (Si)	1.0 MAX	.50 MAX
CHROMIUM (Cr)	16.0 - 18.0	11.0 - 12.5
NICKEL (Ni)	6.0 - 8.0	7.5 - 9.5
PHOSPHORUS (P)	.045 MAX	.04 MAX
SULFUR (S)	.03 MAX	.03 MAX
MOLYBDENUM (Mo)	—	0.5 MAX
COPPER (Cu)	—	1.5 - 2.5
TITANIUM (Ti)	—	.8 - 1.4
NIOBIUM + TANTALUM (Nb+Ta)	—	.1 - .5

SOURCE: ASM METALS HANDBOOK

TI-NHTSA 000703

Table 3. (continued)

UNS number	Common designation	C	Mn	Si	Cr	Ni	P	S	Other
		Composition(a), %							
S31400	314	0.25	2.00	1.5-3.0	23.0-26.0	19.0-22.0	0.045	0.03	...
S31600	316	0.08	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.03	2.0-3.0 Mo; 0.10 N
S31603	316L	0.03	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.03	2.0-3.0 Mo; 0.10 N
S31609	316H	0.04-0.10	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.03	2.0-3.0 Mo
S31620	316F	0.08	2.00	1.00	17.0-19.0	10.0-14.0	0.20	0.10 min	1.75-2.5 Mo
S31635	316Ti	0.08	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.030	5(C+N) min, 0.70 max Ti; 0.10 max N; 2.0-3.0 Mo
S31640	316Cb	0.08	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.030	10 × %C min, 1.10 max (Nb+Ta); 0.10 max N; 2.0-3.0 Mo
S31651	316N	0.08	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.03	2.0-3.0 Mo; 0.10-0.16 N
S31653	316LN	0.03	2.00	1.00	16.0-18.0	10.0-14.0	0.045	0.03	2.0-3.0 Mo; 0.10-0.16 N
S31700	317	0.08	2.00	1.00	18.0-20.0	11.0-15.0	0.045	0.03	3.0-4.0 Mo; 0.10 N
S31703	317L	0.03	2.00	1.00	18.0-20.0	11.0-15.0	0.045	0.03	3.0-4.0 Mo; 0.10 N
S32100	321	0.08	2.00	1.00	17.0-19.0	9.0-12.0	0.045	0.03	5(C+N) min, 0.70 max Ti; 0.10 N
S32109	321H	0.04-0.10	2.00	1.00	17.0-19.0	9.0-12.0	0.045	0.03	4(C+N) min, 0.70 max Ti; 0.10 N
S34700	347	0.08	2.00	1.00	17.0-19.0	9.0-13.0	0.045	0.03	10 × %C min, 1.10 max (Nb+Ta)
S34709	347H	0.04-0.10	2.00	1.00	17.0-19.0	9.0-13.0	0.045	0.03	8 × %C min, 1.10 max (Nb+Ta)
S34800	348	0.08	2.00	1.00	17.0-19.0	9.0-13.0	0.045	0.03	0.2 Co; 10 × %C min, 1.10 max (Nb+Ta)
S34809	348H	0.04-0.10	2.00	1.00	17.0-19.0	9.0-13.0	0.045	0.03	0.2 Co; 8 × %C min, 1.00 max (Nb+Ta)
S38100	18-18-2 (XM-15)	0.08	2.00	1.5-2.5	17.0-19.0	17.5-18.5	0.03	0.03	...
S38400	384	0.08	2.00	1.00	15.0-17.0	17.0-19.0	0.045	0.03	...
N06333	RA-333	0.08	2.00	0.75-1.50	24.0-27.0	44.0-47.0	0.030	0.030	2.5-4.0 Co; 2.5-4.0 Mo; 2.5-4.0 W
N08020	20Cb-3	0.07	2.00	1.00	19.0-21.0	32.0-38.0	0.045	0.035	2.0-3.0 Mo; 3.0-4.0 Cu; 8 × %C min Nb
N08026	20Mo-6	0.03	1.00	0.50	22.0-26.0	33.0-37.0	0.03	0.03	5.0-6.7 Mo; 2.00-4.00 Cu
N08028	Sanicro 28	0.020	2.50	1.0	26.0-28.0	29.5-32.5	0.020	0.015	3.0-4.0 Mo; 0.6-1.4 Cu
N08330	330	0.08	2.00	0.75-1.5	17.0-20.0	34.0-37.0	0.03	0.03	1.0 Cu
N08366	AL-6X	0.035	2.00	1.0	20.0-22.0	23.5-25.5	0.030	0.030	6.0-7.0 Mo
N08700	JS-700	0.04	2.00	1.00	19.0-23.0	24.0-26.0	0.04	0.03	4.3-5.0 Mo; 0.5 Cu; 8 × %C min, 0.50 max Nb; 0.005 Pb; 0.035 Sn
N08904	904L	0.02	2.00	1.00	19.0-23.0	23.0-28.0	0.045	0.035	4.0-5.0 Mo; 1.0-2.0 Cu
...	308L	0.03	2.00	1.00	19.0-21.0	10.0-12.0	0.045	0.03	...
...	317LM	0.03	2.00	1.00	18.0-20.0	13.0-17.0	0.045	0.03	4.0-5.0 Mo; 0.10 N
...	317LMN	0.03	2.00	1.00	17.0-20.0	13.5-17.5	0.045	0.03	4.0-5.0 Mo; 0.10-0.20 N
...	20Mo-4	0.03	1.00	0.50	22.5-25.0	35.0-40.0	0.035	0.035	3.5-5.0 Mo; 0.5-1.5 Cu; 0.15-0.35 Nb
...	302 HQ-FM	0.06	2.00	1.00	16.0-19.0	9.0-11.0	0.040	0.20	1.2-1.4 Cu
...	JS-777	0.04	2.00	1.00	19.0-23.0	24.0-26.0	0.045	0.035	4.0-5.0 Mo; 1.9-2.5 Cu
...	Cronifer 2328	0.04	0.75	0.75	22.0-24.0	26.0-28.0	0.030	0.015	2.5-3.5 Cu; 0.40-0.70 Ti; 2.5-3.0 Mo
...	Nitronic 20	0.25-0.30	1.5-3.5	0.60-0.90	23.0-24.0	7.0-9.0	0.04	0.015	0.25-0.40 N

(a) All single values are maximum values.

Table 4. Compositions of standard precipitation-hardening stainless steels

UNS number	Common designation	C	Mn	Si	Cr	Ni	P	S	Other
		Composition(a), %							
S13800	PH 13-8 Mo (XM-13)	0.05	0.20	0.10	12.25-13.25	7.5-8.5	0.01	0.008	2.0-2.5 Mo; 0.90-1.35 Al; 0.01 N
S15500	15-5 PH (XM-12)	0.07	1.00	1.00	14.0-15.5	3.5-5.5	0.04	0.03	2.5-4.5 Cu; 0.15-0.45 (Nb+Ta)
S15700	PH 15-7 Mo (632)	0.09	1.00	1.00	14.0-16.0	6.5-7.75	0.04	0.03	2.0-3.0 Mo; 0.75-1.5 Al
S17400	17-4 PH	0.07	1.00	1.00	15.0-17.5	3.0-5.0	0.04	0.03	3.0-5.0 Cu; 0.15-0.45 (Nb+Ta)
S17600	Stainless W (635)	0.08	1.00	1.00	16.0-17.5	6.0-7.5	0.04	0.03	0.4 Al; 0.4-1.2 Ti
S17700	17-7 PH (631)	0.09	1.00	1.00	16.0-18.0	6.5-7.75	0.04	0.03	0.75-1.5 Al
S35000	AM-350	0.07-0.11	0.5-1.25	0.50	16.0-17.0	4.0-5.0	0.04	0.03	2.5-3.25 Mo; 0.07-0.13 N
S35500	AM-355	0.10-0.15	0.5-1.25	0.50	15.0-16.0	4.0-5.0	0.04	0.03	2.5-3.25 Mo
S36200	Almar 362	0.05	0.50	0.50	14.00-14.50	6.25-7.00	0.04	0.03	0.55-0.90 Ti
S45000	Custom 450 (XM-25)	0.05	1.00	1.00	14.0-16.0	5.0-7.0	0.03	0.03	1.25-1.75 Cu; 0.5-1.0 Mo; 8 × %C min Nb
S45500	Custom 455 (XM-16)	0.05	0.50	0.50	11.0-12.5	7.5-9.5	0.04	0.03	0.5 Mo; 1.5-2.5 Cu; 0.8-1.4 Ti; 0.1-0.5 (Nb+Ta)
S66286	A286	0.08	2.00	1.00	13.50-16.00	24.0-27.0	0.04	0.03	0.35 Al; 0.0010-0.010 B; 1.00-1.50 Mo; 1.90-2.35 Ti; 0.10-0.50 V

(a) All single values are maximum values.

mechanical properties; selection of the optimum type for a specific application is the key to satisfactory performance at minimum total cost.

Below is a checklist of characteristics to be considered in selection of the proper type of stainless steel for a specific application.

- Corrosion resistance
- Resistance to oxidation and sulfidation
- Strength and ductility at ambient and service temperatures
- Suitability for intended fabrication techniques
- Suitability for intended cleaning procedures
- Stability of properties in service
- Toughness
- Resistance to abrasion and erosion
- Resistance to galling and seizing
- Surface finish and/or reflectivity
- Magnetic properties

Table 2. Compositions of standard ferritic stainless steels

UNS number	Common designation	C	Mn	Si	Cr	Ni	P	S	Others
		Composition(a), %							
S18200	18-2 FM	0.08	2.50	1.00	17.5-19.5	...	0.04	0.15 min	1.50-2.50 Mo
S40500	405	0.08	1.00	1.00	11.5-14.5	0.60	0.04	0.03	0.10-0.30 Al
S40900	409	0.08	1.00	1.00	10.5-11.75	0.50	0.045	0.045	6 × %C min, 0.75 max Ti
S42900	429	0.12	1.00	1.00	14.0-16.0	0.75	0.04	0.03	...
S43000	430	0.12	1.00	1.00	16.0-18.0	0.75	0.04	0.03	...
S43020	430F	0.12	1.25	1.00	16.0-18.0	...	0.06	0.15 min	...
S43023	430FSe	0.12	1.25	1.00	16.0-18.0	...	0.06	0.06	0.15 min Se
S43035	439 (XM-8)	0.07	1.00	1.00	17.00-19.00	0.50	0.040	0.03	0.20 + 4(C+N) min, 1.10 max Ti; 0.015 max Al; 0.04 max N
S43036	430Ti	0.10	1.00	1.00	16.0-19.5	0.75	0.04	0.03	5 × %C min, 0.75 max Ti
S43400	434	0.12	1.00	1.00	16.0-18.0	...	0.04	0.03	0.75-1.25 Mo
S43600	436	0.12	1.00	1.00	16.0-18.0	...	0.04	0.03	0.75-1.25 Mo; 5 × %C min, 0.70 max (Nb+Ta)
S44200	442	0.20	1.00	1.00	18.0-23.0	0.60	0.04	0.04	...
S44400	444, 18-2	0.025	1.00	1.00	17.5-19.5	1.00	0.04	0.03	1.75-2.5 Mo; 0.035 N; 0.2 + 4(C+N) min, 0.80 max (Ti+Nb)
S44600	446	0.20	1.50	1.00	23.0-27.0	0.60	0.04	0.03	0.25N
S44627	E-Brite, 26-1 (XM-27)	0.01	0.40	0.40	25.0-27.5	0.50	0.02	0.02	0.75-1.5 Mo; 0.015 N; 0.2 Cu; 0.5(Ni+Cu); 0.05-0.20Nb
S44635	Monit	0.025	1.00	0.75	24.5-26.0	3.5-4.5	0.04	0.03	3.5-4.5 Mo; 0.20 + 4(C+N) min, 0.80 max (Ti+Nb); 0.035 N
S44660	Sea-cure/Sc-1	0.025	1.00	1.00	25.0-27.0	1.5-3.5	0.04	0.03	2.5-3.5 Mo; 0.2 + 4(C+N) min, 0.80 max (Ti+Nb); 0.035 N
S44700	AL 29-4	0.010	0.30	0.20	28.0-30.0	0.15	0.025	0.02	3.5-4.2 Mo; 0.15 Cu
S44735	AL 29-4C	0.025	1.00	0.75	28.0-30.0	0.50	0.040	0.03	3.50-4.50 Mo; 0.2 + 4(C+N) min, 0.080 max (Ti+Nb)
S44800	AL 29-4-2	0.010	0.30	0.20	28.0-30.0	2.0-2.5	0.025	0.02	3.5-4.2 Mo; 0.15 Cu
...	18SR	0.04	0.30	0.75-1.25	17.0-19.0	...	0.04	0.03	1.75-2.50 Al; 6 × %C min, 0.75 max Ti
...	430FR	0.03	1.25	2.00	16.0-18.0	...	0.04	0.03	0.25-0.75 Mo

(a) All single values are maximum values.

Table 3. Compositions of standard austenitic stainless steels

UNS number	Common designation	C	Mn	Si	Cr	Ni	P	S	Others
		Composition(a), %							
S20100	201	0.15	5.5-7.5	1.00	16.0-18.0	3.5-5.5	0.06	0.03	0.25 N
S20200	202	0.15	7.5-10.0	1.00	17.0-19.0	4.0-6.0	0.06	0.03	0.25 N
S20500	205	0.12-0.25	14.0-15.5	1.00	16.0-18.0	1.0-1.75	0.06	0.03	0.32-0.40 N
S20910	Nitronic 50, 22-13-5	0.06	4.0-6.0	1.00	20.5-23.5	11.5-13.5	0.04	0.03	1.5-3.0 Mo; 0.2-0.4 N; 0.1-0.3 Nb; 0.1-0.3 V
S21400	Tenelon (XM-31)	0.12	14.0-16.0	0.3-1.0	17.0-18.5	1.00	0.045	0.03	0.35 N min
S21460	Cryogenic Tenelon (XM-14)	0.12	14.0-16.0	1.00	17.0-19.0	5.0-6.0	0.06	0.03	0.35-0.50 N
S21600	216 (XM-17)	0.08	7.5-9.0	1.00	17.5-22.0	5.0-7.0	0.045	0.03	2.0-3.0 Mo; 0.25-0.50 N
S21603	216L	0.03	7.5-9.0	1.00	17.5-22.0	5.0-7.0	0.045	0.03	2.0-3.0 Mo; 0.25-0.50 N
S21800	Nitronic 60	0.10	7.0-9.0	3.5-4.5	16.0-18.0	8.0-9.0	0.06	0.03	0.08-0.18N
S21900	Nitronic 40, 21-6-9	0.08	8.0-10.0	1.00	19.0-21.5	5.5-7.5	0.06	0.03	0.15-0.40 N
S24000	Nitronic 33, 18-3-Mn	0.08	11.50-14.50	1.00	17.0-19.0	2.25-3.75	0.060	0.030	0.20-0.40 N
S24100	Nitronic 32, 18-2-Mn	0.15	11.0-14.0	1.0	16.5-19.0	0.5-2.5	0.06	0.03	0.20-0.45 N
S28200	18-18 Plus	0.15	17.0-19.0	1.00	17.5-19.0	...	0.045	0.03	0.75-1.25 Mo; 0.75-1.25 Cu; 0.4-0.6 N
S30100	301	0.15	2.00	1.00	16.0-18.0	6.0-8.0	0.045	0.03	...
S30200	302	0.15	2.00	1.00	17.0-19.0	8.0-10.0	0.045	0.03	...
S30215	302B	0.15	2.00	2.0-3.0	17.0-19.0	8.0-10.0	0.045	0.03	...
S30300	303	0.15	2.00	1.00	17.0-19.0	8.0-10.0	0.20	0.15 min	0.6 Mo (optional)
S30310	303 Plus X (XM-5)	0.15	2.5-4.5	1.00	17.0-19.0	7.0-10.0	0.20	0.25 min	...
S30323	303Se	0.15	2.00	1.00	17.0-19.0	8.0-10.0	0.20	0.06	0.15 min Se
S30345	303 Al-Modified	0.15	2.00	1.00	17.0-19.0	8.0-10.0	0.05	0.11-0.16	0.40-0.60 Mo; 0.60-1.00 Al
S30400	304	0.08	2.00	1.00	18.0-20.0	8.0-10.5	0.045	0.03	0.10 N
S30403	304L	0.03	2.00	1.00	18.0-20.0	8.0-12.0	0.045	0.03	0.10 N
S30409	304H	0.04-0.10	2.00	1.00	18.0-20.0	8.0-10.5	0.045	0.03	...
S30430	18-9-LW	0.10	2.00	1.00	17.0-19.0	8.0-10.0	0.045	0.03	3.0-4.0 Cu
S30451	304N	0.08	2.00	1.00	18.0-20.0	8.0-10.5	0.045	0.03	0.10-0.16 N
S30452	304HN	0.08	2.00	1.00	18.0-20.0	8.0-10.5	0.045	0.03	0.16-0.30 N
S30453	304LN	0.03	2.00	1.00	18.0-20.0	8.0-12.0	0.045	0.03	0.10-0.16 N
S30500	305	0.12	2.00	1.00	17.0-19.0	10.5-13.0	0.045	0.03	...
S30800	308	0.08	2.00	1.00	19.0-21.0	10.0-12.0	0.045	0.03	...
S30815	253MA	0.10	0.80	1.40-2.00	20.0-22.0	10.0-12.0	0.040	0.030	0.03-0.08 Ce; 0.14-0.20 N
S30900	309	0.20	2.00	1.00	22.0-24.0	12.0-15.0	0.045	0.03	...
S30908	309S	0.08	2.00	1.00	22.0-24.0	12.0-15.0	0.045	0.03	...
S30940	309Cb	0.08	2.00	1.00	22.0-24.0	12.0-16.0	0.045	0.03	10 × %C min, 1.10 max (Nb+Ta); 0.10 N
S31000	310	0.25	2.00	1.50	24.0-26.0	19.0-22.0	0.045	0.03	...
S31008	310S	0.08	2.00	1.50	24.0-26.0	19.0-22.0	0.045	0.03	...
S31040	310Cb	0.08	2.00	1.50	24.0-26.0	19.0-22.0	0.045	0.030	10 × %C min, 1.10 max (Nb+Ta); 0.10 N
S31254	254 SMO	0.02	1.00	0.80	19.5-20.5	17.5-18.5	0.030	0.010	6.00-6.50 Mo; 0.50-1.00 Cu; 0.18-0.22 N

(continued)

free-machining types. The unique characteristics of free-machining stainless steels should be considered, particularly as part of an effort to control strength and work hardening.

The structures of low-alloy martensitic and ferritic stainless steels make these types somewhat brittle, resulting in reasonably good chip breakage. However, hardness levels generally are higher than those of annealed low-alloy steels. The low-alloy martensitic stainless steels often must be machined in the hardened-and-tempered condition (up to 38 HRC), which produces excellent dimensional accuracy and surface finish.

Higher-carbon martensitic stainless steels such as types 420 and 440, and particularly type 440C, are progressively more difficult to machine because of their high annealed hardnesses (up to 240 HB) and the presence of hard, abrasive chromium carbides in their microstructures. The high-chromium ferritic stainless steels such as type 446 are difficult to machine because, like austenitic types, they are "gummy" and produce stringy chips.

Austenitic stainless steels such as types 304 and 316 have tensile strengths of 550 to 620 MPa (80 to 90 ksi) in the annealed condition—the same range of strength as that of annealed 1050 carbon steel. However, austenitic stainless steels exhibit much greater spreads between yield and ultimate strengths and much higher work-hardening rates—particularly the leaner alloys such as types 302 and 304.

Precipitation-hardening types vary considerably in machining characteristics because of differences in structure. They may be ferritic, martensitic, austenitic or two-phase, so machining characteristics will be characteristic of the structure that exists at the time of machining. Like martensitic types, precipitation-hardening stainless steels sometimes are machined after being heat treated to high strength in order to produce parts with closer tolerances than those obtainable by machining before heat treatment.

Free-machining stainless steels such as types 416, 430F and 303 are significantly more machinable than their non-free-machining counterparts because they contain small amounts of various free-machining additives. The most common additive is sulfur, which minimizes buildup of metal on cutting edges and promotes chip breakage, thereby permitting higher machining speeds and lower power consumption, and promoting longer tool life. The sulfur is present in nonmetallic inclusions, usually complex manganese sulfides. Selenium has beneficial effects similar to those of sulfur, but generally gives a better surface finish. Selenium also imparts greater ductility to free-machining stainless steels than does sulfur. Other free-machining additives are phosphorus, which reduces matrix "gumminess," and lead, which lubricates tools and facilitates chip breakage. Increases in machinability may be somewhat less for the higher alloys—particularly for the high-carbon martensitic stainless steels such as types 440A, 440B and 440C, for which abrasion from chromium carbides is a primary limiting factor.

Because of the high costs of labor and capital, the economic benefits of free-machining stainless steels can be substantial. The free-machining types are slightly more expensive, but this is more than offset by savings in machining costs when extensive machining is required. As a rule of thumb, a free-machining type may be cost-effective in any application where more than 10% of the material must be machined away.

The characteristics of free-machining types must be carefully considered to ensure that parts will perform satisfactorily in service. These steels have somewhat lower corrosion resistance than their unmodified counterparts, particularly under conditions where nonmetallic inclusions may initiate pitting. Free-machining stainless steels have a limited ability to be cold headed, but selenium-bearing types are more readily cold headed than other free-machining types.

HEAT TREATING

Stainless steels are subjected to various heat treatments depending on the type and on the requirements of the application. These treatments, which include annealing, hardening and stress relieving, restore desirable properties such as corrosion resistance and ductility to metal altered by prior fabrication operations. Heat treatment is often performed in controlled atmospheres to prevent detrimental surface effects.

Annealing. All types of stainless steels can be annealed. Annealing of austenitic types not only recrystallizes the grains and softens the metal, but also takes chromium carbides into solution in the austenite. Because of the latter effect, the process is sometimes referred to as solution annealing. Temperatures must exceed an intermediate range to avoid sensitization due to carbide precipitation along grain boundaries. Annealing temperatures usually are above 1040 °C (1900 °F), although some types may be annealed at closely controlled temperatures as low as 1010 °C (1850 °F) when fine grain size is important. Time at temperature is kept short to hold surface scaling to a minimum and to control grain growth, which can lead to "orange peel" in forming.

Annealing of austenitic stainless steels is occasionally called quench annealing because the metal must be cooled rapidly, usually by water quenching, to prevent sensitization (except for stabilized and extra-low-carbon types). Precipitation of chromium carbides can severely impair corrosion resistance because chromium is depleted in the matrix immediately adjacent to the carbides and/or because the carbides themselves may induce galvanic corrosion. Therefore, if water quenching is not used, thorough investigation is needed to ensure that sensitization does not occur. The investigation must take actual composition into account, because the rate of carbide precipitation varies markedly with composition: a heat of type 304 containing 0.05% carbon may be free of precipitation under cooling conditions that would produce heavy sensitization in the same alloy containing 0.08% carbon. Austenitic stainless steels are softened by recrystallization at the annealing temperature and, unlike most other steels, are not hardened by quenching.

A stabilizing anneal is sometimes performed after conventional annealing for types 321, 347 and 348. Most of the carbon content is combined with titanium in type 321 or with niobium in types 347 and 348 when these types are annealed in the usual manner. A further anneal at 870 to 900 °C (1600 to 1650 °F) for 2 to 4 h followed by rapid cooling precipitates all possible carbon as a titanium or niobium carbide and prevents subsequent precipitation of chromium carbide. It is believed that this special protective treatment is sometimes useful when service conditions are rigorously corrosive—especially when service also involves temperatures from about 400 to 870 °C (750 to 1600 °F).

Before annealing or other heat treating operations are performed on austenitic stainless steels, the steel should be cleaned to remove oil, grease and other carbonaceous residues. Such residues lead to carburization during heat treating, which degrades corrosion resistance.

All martensitic and most ferritic stainless steels can be subcritical annealed (process annealed) by heating into the upper part of the ferrite temperature range, or full annealed by heating above the critical temperature into the austenite range, followed by slow cooling. Usual temperatures are 760 to 830 °C (1400 to 1525 °F) for subcritical annealing, and 845 to 900 °C (1550 to 1650 °F) for full annealing. When material has been previously heated above the critical temperature, such as in hot working, at least some martensite is present even in ferritic stainless steels such as type 430. Relatively slow cooling at about 25 °C/h (50 °F/h) from full annealing temperature, or holding for one hour or more at subcritical annealing temperature, is required to produce the desired soft structure of ferrite and spheroidized carbides. However, parts that have undergone only cold working after full annealing can be subcritically annealed satisfactorily in less than 30 minutes.

The ferritic types that retain predominantly single-phase structures throughout the working temperature range (types 409, 442, 446 and 26Cr-1Mo) require only short recrystallization annealing in the range from 760 to 955 °C (1400 to 1750 °F). The higher-chromium types such as 446 and 26Cr-1Mo require rapid cooling through the range from 540 to 370 °C (1000 to 700 °F) to avoid "885 °F" embrittlement and consequent loss of ductility.

Hardening. Martensitic stainless steels are hardened by austenitizing, quenching and tempering much like lower-alloy steels. Austenitizing temperatures normally are 980 to 1010 °C (1800 to 1850 °F)—well above the critical temperature. As-quenched hardness increases with austenitizing temperature to about 980 °C (1800 °F) and then decreases due to retention of austenite. For some types, the optimum austenitizing temperature may depend on the subsequent tempering temperature.

Preheating before austenitizing is recommended to prevent cracking in high-carbon types and in intricate sections of low-carbon types. Preheating at 790 °C (1450 °F) and then heating to the austenitizing temperature is the most common practice, but very large or extremely intricate parts sometimes are successively preheated at 540 °C (1000 °F) and then at 790 °C (1450 °F) before austenitizing.

Martensitic stainless steels have high hardenability because of their high alloy content. Air cooling from the austenitizing temperature is usually adequate to produce full hardness. Oil quenching is sometimes used, particularly for larger sections. Tempering temperature must be chosen for the optimum combination of hardness, toughness and corrosion resistance. Parts should be tempered as soon as they have cooled to room temperature—particularly if oil quenching has been used—to avoid delayed cracking. Parts sometimes are refrigerated to −75 °C (−100 °F) before tempering, to transform retained austenite—particularly where dimen-

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sional stability is important, such as in gage blocks made of type 440C. Tempering at temperatures above 510 °C (950 °F) should be followed by relatively rapid cooling to below 400 °C (750 °F) to avoid "885 °F" embrittlement.

Some precipitation-hardening stainless steels require more complicated heat treatments than standard martensitic types. For instance, a semiaustenitic precipitation-hardening type may require annealing, trigger annealing (to condition austenite for transformation on cooling to room temperature), subzero cooling (to complete the transformation of austenite) and aging (to fully harden the alloy). On the other hand, martensitic precipitation-hardening types often require nothing more than a simple aging treatment.

Stress Relieving. Stainless steel weldments generally are heated to temperatures below the usual annealing temperature to decrease high residual stresses when full annealing after welding is impossible. Most often, stress relieving is performed on weldments that are too large or intricate for full annealing or on dissimilar-metal weldments consisting of austenitic stainless steel welded to alloy steel. Stress relieving at temperatures below 400 °C (750 °F) is an acceptable practice but results in only modest stress relief.

Stress relieving at 425 to 925 °C (800 to 1700 °F) significantly reduces residual stresses that otherwise might lead to stress-corrosion cracking or dimensional instability in service. One hour at 870 °C (1600 °F) typically relieves about 85% of the residual stresses. However, stress relieving in this temperature range also precipitates grain-boundary carbides, resulting in sensitization that severely impairs corrosion resistance in many media. Sensitized austenitic stainless steels are susceptible to intergranular corrosion or stress-assisted intergranular corrosion even in some media that are considered mild. To avoid these effects, it is strongly recommended that a stabilized stainless steel (type 321, 347 or 348) or a low-carbon type (304L or 316L) be used, particularly when lengthy stress relieving is required.

When austenitic stainless steels have been cold worked to develop high strength, low-temperature stress relieving will increase the proportional limit and yield strength (particularly compressive yield strength). A two-hour treatment at 345 to 370 °C (650 to 700 °F) is normally used; temperatures up to 425 °C (800 °F) may be used if resistance to intercrystalline corrosion is not required for the application. Higher temperatures will reduce strength and sensitize the metal, and generally are not used for stress relieving cold worked products.

Stress relieving of martensitic or ferritic stainless steel weldments will simultaneously temper both weld and heat-affected zones, and for most types will restore corrosion resistance to some degree. However, annealing temperatures are relatively low for these grades, and normal subcritical annealing is the heat treatment usually selected if the weldment is to be heat treated at all.

JOINING PROCESSES

Stainless steels are commonly joined by welding, brazing and soldering. Arc welding is the overwhelming choice for joining stainless steel to stainless steel because it gives a relatively crevice-free joint of high joint efficiency. Resistance welding also is often used for austenitic types, because it produces a mechanically strong joint quickly and inexpensively. Procedures and precautions appropriate for the various types are important if optimum corrosion resistance and mechanical properties are to be attained in the completed assembly. Brazing usually is preferred for joining stainless steels to other metals.

Welding. All stainless steels can be readily welded by any common arc welding process. Major factors that must be considered are (a) corrosion resistance in the weld and heat-affected zones, (b) residual stress, which can lead to distortion, weld cracking or fissuring, and (c) for martensitic and ferritic types, mechanical properties in the weld and heat-affected zones.

Resistance welding of stainless steels also is quite common. In fact, austenitic stainless steels are resistance welded more often than any other metal except carbon steel. The welding currents used in welding austenitic stainless steels are significantly lower than those required for welding carbon steels because of the lower thermal conductivity, higher electrical resistivity and nonmagnetic character of the austenitic types. Distortion is somewhat more troublesome than in resistance welding of low-alloy steels because austenitic stainless steels have greater coefficients of thermal expansion. Corrosion resistance may not be seriously impaired by carbide precipitation, because welding times are too short to produce extensive sensitization. Crevice corrosion, a form of localized corrosion resulting from limited access of oxygen, can be a problem in spot welded sheets when they are exposed to certain media. Martensitic and ferritic types also can be joined by resistance welding, although these types are used for resistance welded components much less commonly than austenitic types. For martensitic types and those ferritic types that form some martensite on cooling after welding, a second heating pulse can be programmed into the welding cycle to temper the weld area.

Stainless steels are rarely joined by gas welding. In oxyacetylene welding of stainless steels, great skill in controlling the welding atmosphere is required to prevent either oxidation or carburization of the weld puddle. Gas welding with an atomic hydrogen torch is less demanding, but such equipment is no longer widely used.

Austenitic types are the most weldable stainless steels, but are also the ones most different in welding behavior from carbon and low-alloy steels. Probably the most important metallurgical factor to consider in planning for austenitic stainless steel weldments is susceptibility to grain-boundary carbide precipitation (sensitization) at moderately elevated temperatures. Material immediately adjacent to the weld will be heated to or above the annealing temperature and will be free of precipitation. At some distance away—perhaps 3 mm (1/8 in.) or more, depending on welding parameters—the base metal is heated to 650 to 870 °C (1200 to 1600 °F) and grain-boundary carbides can precipitate despite the short time at temperature. Carbide precipitation severely impairs corrosion resistance in many media, including the acids most often used for pickling to remove oxide. Nevertheless, because sensitization occurs in such a narrow region of the heat-affected zone, many austenitic stainless steel weldments are used in the as-welded condition without concern.

Free-machining stainless steels are quite difficult to weld, with porosity and segregation being common problems. However, these types can be welded successfully with special consumable electrodes (type 312 electrodes, for instance) if precautions are taken to exclude all traces of hydrogen.

Most precipitation-hardening stainless steels can be arc welded by techniques similar to those used for welding austenitic types. Normally, filler-metal composition is selected to match or nearly match base-metal composition so that response to heat treatment is similar. Welding usually is followed by full heat treatment, although aging alone may be adequate for single-pass welds in some types (such as 17-4 PH). In heat treated weldments, weld strength closely approaches base-metal strength, but toughness and ductility of the weld may be somewhat inferior, especially for material heat treated to high strength. Weldability of the fully austenitic precipitation-hardening stainless steels HNM and 17-10P is limited because these steels are hot short above 1180 °C (2150 °F) and therefore are susceptible to underbead cracking. HNM and 17-10P have been flash butt welded successfully.

Brazing. All stainless steels can be brazed, and this process is frequently used for joining stainless steels to other metals. All brazing techniques can be used, but furnace brazing is employed more often than any other technique because it permits brazing to be done in a protective environment (usually hydrogen or vacuum) that prevents oxidation of the stainless steel. Most brazing of austenitic types is performed at temperatures in the sensitization range, and solution annealing after brazing is impossible. Therefore, stabilized or extra-low-carbon types must be used if service conditions might lead to intergranular corrosion of sensitized material. In brazing of martensitic and ferritic types, a brazing filler metal that melts below the critical temperature of 830 °C (1525 °F) is normally used to avoid martensitic hardening. The heat of brazing will temper, and possibly soften, hardened martensitic stainless steels.

Virtually all types of brazing filler metals are used, including silver, nickel, gold and copper alloys. High-phosphorus copper-base filler metals should be avoided, however, because they have harmful effects on stainless steels. Certain austenitic types (21Cr-6Ni-9Mn, for instance) should not be brazed with any copper-base filler metal because molten copper attacks the stainless steel during brazing.

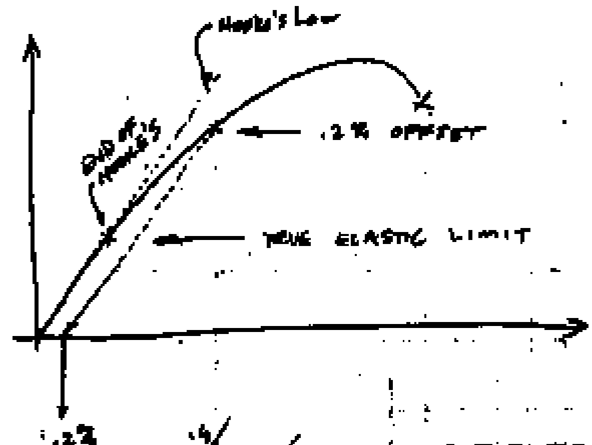
Destructive penetration of stainless steel is possible during brazing. A form of stress-corrosion cracking develops in some types if they are brazed while in a highly stressed condition. Penetration during brazing may be prevented by annealing before brazing, by heating parts slowly enough to relieve stresses before the brazing temperature is reached, or by selecting a brazing filler metal that inhibits such penetration. Grain-boundary penetration may also occur if high-temperature brazing alloys that melt above 980 °C (1800 °F) are used. This problem can be minimized by selecting a favorable brazing alloy, using as little brazing alloy as possible and keeping time at temperature short. Welding through or near a brazed joint can also cause penetration of stainless steel and should be avoided.

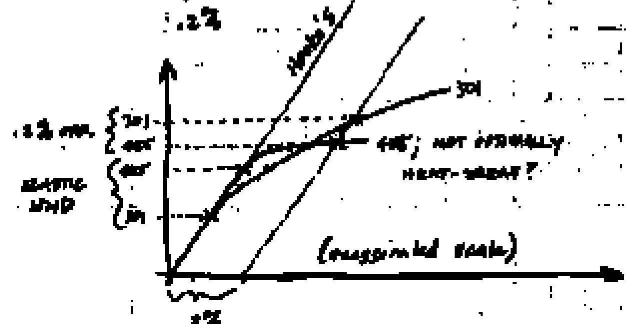
Use of a silver brazing alloy to which nickel has been added helps minimize crevice corrosion of brazed joints exposed to certain corrosive media such as seawater. Complete elimination of this problem in a type 430 basement can be ac-

301 → lower elastic limit; strain-aging susceptible; mat'l gets stronger w/age

455 → higher elastic limit BUT not H.T. to the limit

→ OBTAIN DATA FROM BALLARD





455 - higher ELASTIC LIMIT
lower .2% offset

301 - just the opposite

~~[illegible]~~

recheck 301 for age-hardening (actually strain-hardening) F.D. ~ 3 wks hence
↳ can't do this; no discs

→ try 455 w/ "better" heat-treating

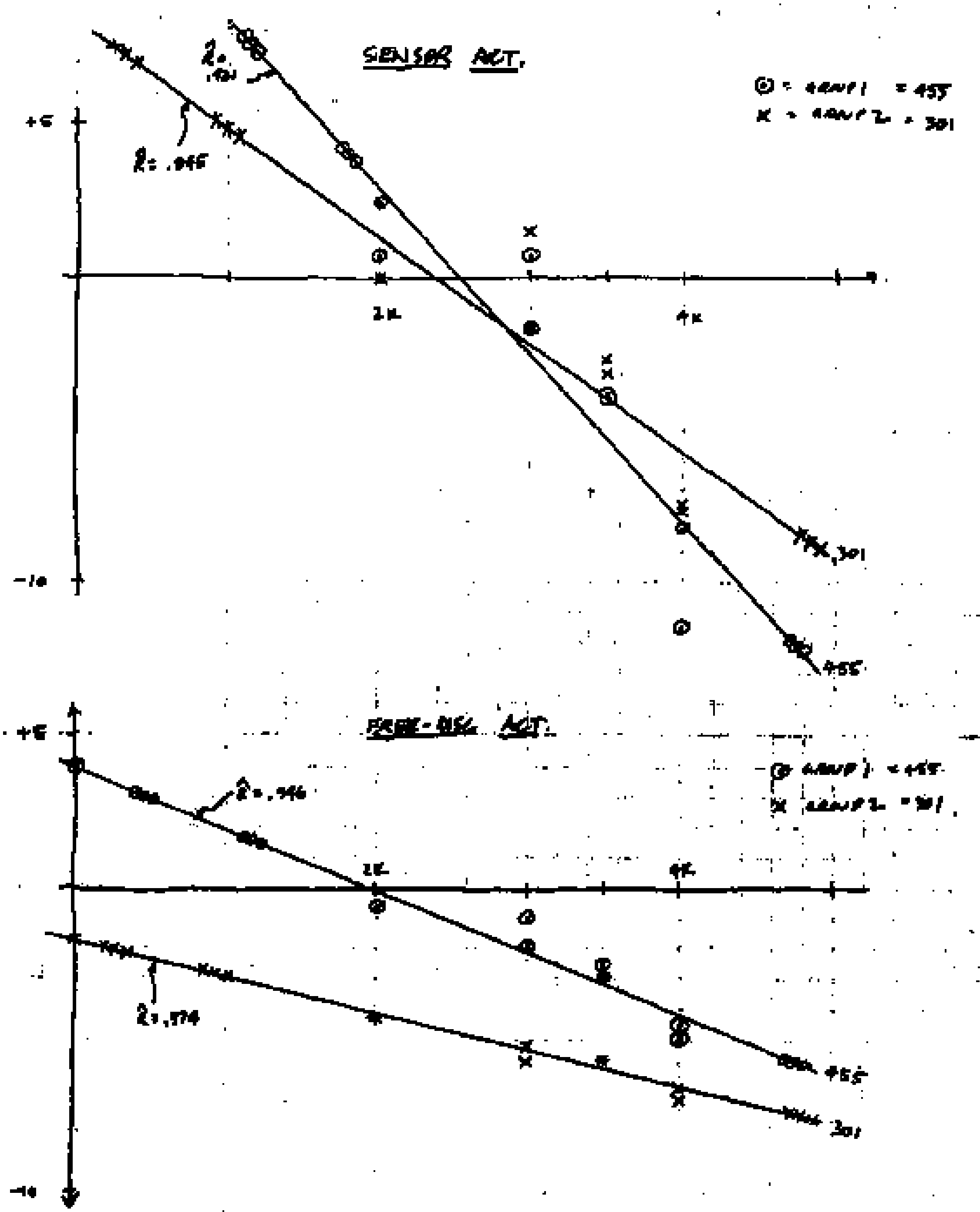
455 H.T. w/ very dry cracked ammonia @ 900°F optimal

Mike Gwin → 850°C limit, "any" atmosphere (1560 °F)

? S/U experiment w/ inputs fr. Ballard, White, Mellon ?

TI-NHTSA 000708

LRC



TI-NHTSA 000709

LOW RATIO CONVERTER PROOF TEST

DEVICE #	FREE DISC INITIAL ACT	FREE DISC INITIAL REL	INITIAL CROWN HEIGHT	SENSOR INITIAL ACT	SENSOR INITIAL REL	SENSOR FINAL ACT	SENSOR FINAL REL	FREE DISC FINAL ACT	FREE DISC FINAL REL	FINAL CROWN HEIGHT	SENSOR % CHG ACT	SENSOR % CHG REL	FREE DISC % CHG ACT	FREE DISC % CHG REL	% CHG CROWN HEIGHT	PROOF
51-15-01	20.0	9.9	0.027	127	52	132	55	20.0	10.0	0.027	3.9	5.8	~~-0.0~~	1.0	0.0	800
51-15-02	20.0	10.1	0.027	120	52	127	52	20.0	10.0	0.027	5.8	0.0	~~-0.0~~	-1.0	0.0	~~800~~
51-15-03	20.0	10.2	0.027	122	52	125	55	19.9	10.1	0.027	2.5	5.8	-0.5	-1.0	0.0	2000
51-15-04	20.1	9.9	0.027	134	53	135	54	20.0	10.0	0.027	0.7	1.9	-0.5	1.0	0.0	2000
51-15-05	20.1	9.9	0.027	124	49	122	54	19.7	9.9	0.026	-1.6	10.2	-2.0	0.0	-3.7	3000
51-15-06	20.1	9.9	0.027	125	57	126	59	19.9	9.9	0.027	0.8	3.5	-1.0	0.0	0.0	3000
51-15-07	20.1	10.0	0.027	126	56	121	55	19.6	10.0	0.026	-4.0	-1.8	-2.5	0.0	-3.7	3500
51-15-08	20.1	10.0	0.027	127	50	122	57	19.5	9.9	0.026	-3.9	-1.7	-3.0	-1.0	-3.7	3500
51-15-09	20.1	10.0	0.027	122	52	112	53	19.2	9.9	0.025	-8.2	1.9	-4.5	-1.0	-7.4	4000
51-15-10	20.1	10.1	0.027	131	53	116	56	19.1	9.9	0.025	-11.5	5.7	-5.0	-2.0	-7.4	4000
51-15-11	21.1	7.3	0.028	127	39	134	44	20.5	8.7	0.028	5.5	12.8	~~-2.8~~	19.2	0.0	~~800~~
51-15-12	21.2	8.0	0.028	133	42	139	46	20.5	9.0	0.028	4.5	9.5	~~-3.3~~	12.5	0.0	~~800~~
51-15-13	21.3	7.7	0.028	135	44	135	46	20.4	8.6	0.027	0.0	4.5	-4.2	14.3	-3.6	2000
51-15-14	21.3	7.9	0.028	132	44	132	45	20.4	8.9	0.027	0.0	2.3	-4.2	12.7	-3.6	2000
51-15-15	21.3	8.0	0.028	128	44	128	47	20.1	8.9	0.027	-1.6	6.8	-5.6	11.3	-3.6	3000
51-15-16	21.3	8.4	0.028	128	42	130	46	20.2	9.2	0.027	1.6	9.5	-5.2	9.5	-3.6	3000
51-15-17	21.4	6.9	0.028	142	35	138	40	20.2	8.3	0.027	-2.8	14.3	-5.6	20.3	-3.6	3500
51-15-18	21.4	7.0	0.028	130	42	126	40	20.2	8.4	0.027	-3.1	-4.8	-5.6	20.0	-3.6	3500
51-15-19	21.4	8.4	0.028	135	47	125	45	20.0	9.1	0.027	-7.4	-4.3	-6.5	8.3	-3.6	4000
51-15-20	21.4	9.2	0.028	132	44	122	44	19.9	9.0	0.027	-7.6	0.0	-7.0	-2.2	-3.6	4000

G1 = 455

G2 = 391

F.D. ACT

X	GR 1 #1	GR 1 #2	GR 2 #1	GR 2 #2
2000	-.5	-.5	-4.2	-4.2
3000	-2.0	-1.0	-5.6	-5.2
3500	-2.5	-3.0	-5.6	-5.6
4000	-4.5	-5.0	-6.5	-7.0

TI-NHTSA 000710

06o#s08

LOW RATIO CONVERTER PROOF TEST

A B

DEVICE #	FREE DISC INITIAL ACT	FREE DISC INITIAL REL	INITIAL CROWN HEIGHT	SENSOR INITIAL ACT	SENSOR INITIAL REL	SENSOR FINAL ACT	SENSOR FINAL REL	FREE DISC FINAL ACT	FREE DISC FINAL REL	FINAL CROWN HEIGHT	SENSOR % CHG ACT (A)	SENSOR % CHG REL	FREE DISC % CHG ACT (B)	FREE DISC % CHG REL	% CHG CROWN HEIGHT	PROOF
51-15-01	20.0	9.9	0.027	127	52	112	55	20.0	10.0	0.027	~~-3.4~~	5.8	~~-0.0~~	1.0	0.0	~~000~~
51-15-02	20.0	10.1	0.027	120	52	127	52	20.0	10.0	0.027	~~-5.8~~	0.0	~~-0.0~~	-1.0	0.0	~~000~~
51-15-03	20.0	10.2	0.027	122	52	125	55	19.9	10.1	0.027	-2.5	5.8	-0.5	-1.0	0.0	2000
51-15-04	20.1	9.9	0.027	134	53	135	54	20.0	10.0	0.027	-0.7	1.9	-0.5	1.0	0.0	2000
51-15-05	20.1	9.9	0.027	124	49	122	54	19.7	9.9	0.026	-1.6	10.2	-2.0	0.0	-3.7	3000
51-15-06	20.1	9.9	0.027	125	57	126	59	19.9	9.9	0.027	0.8	3.5	-1.0	0.0	0.0	3000
51-15-07	20.1	10.0	0.027	126	56	121	55	19.6	10.0	0.026	-4.0	-1.8	-2.5	0.0	-3.7	3500
51-15-08	20.1	10.0	0.027	127	58	122	57	19.5	9.9	0.026	-3.9	-1.7	-3.0	-1.0	-3.7	3500
51-15-09	20.1	10.0	0.027	122	52	112	53	19.2	9.9	0.025	-8.2	1.9	-4.5	-1.0	-7.4	4000
51-15-10	20.1	10.1	0.027	131	53	116	56	19.1	9.9	0.025	-11.5	5.7	-5.0	-2.0	-7.4	4000
51-15-11	21.1	7.3	0.028	127	39	134	44	20.5	8.7	0.028	~~5.5~~	12.8	~~-2.8~~	19.2	0.0	~~000~~
51-15-12	21.2	8.0	0.028	133	42	139	46	20.5	9.0	0.028	~~4.5~~	9.5	~~-3.3~~	12.5	0.0	~~000~~
51-15-13	21.3	7.7	0.028	135	44	135	46	20.4	8.8	0.027	0.0	4.5	-4.2	14.3	-3.6	2000
51-15-14	21.3	7.9	0.028	132	44	132	45	20.4	8.9	0.027	0.0	2.3	-4.2	12.7	-3.6	2000
51-15-15	21.3	8.0	0.028	128	44	126	47	20.1	8.9	0.027	-1.6	6.8	-5.6	11.3	-3.6	3000
51-15-16	21.3	8.4	0.028	128	42	130	46	20.2	9.2	0.027	1.6	9.5	-5.2	9.5	-3.6	3000
51-15-17	21.4	6.9	0.028	142	35	138	40	20.2	8.3	0.027	-2.8	14.3	-5.6	20.3	-3.6	3500
51-15-18	21.4	7.0	0.028	130	42	126	40	20.2	8.4	0.027	-3.1	-4.8	-5.6	20.0	-3.6	3500
51-15-19	21.4	8.4	0.028	135	47	125	45	20.0	9.1	0.027	-7.4	-4.3	-6.5	8.3	-3.6	4000
51-15-20	21.4	9.2	0.028	132	44	122	44	19.9	9.0	0.027	-7.6	0.0	-7.0	-2.2	-3.6	4000

GROUP 1 (rows 51-15-03 to 51-15-10)

GROUP 2 (rows 51-15-13 to 51-15-20)

30o#s08

(A)

GROUP 1 SENSOR $\overline{ACT}$

X	$\overline{Y}$
2000	+ 1.6
3000	+ 0.4
3500	-3.45
4000	-9.85

GROUP 2 SENSOR $\overline{ACT}$

X	$\overline{Y}$
2000	0
3000	0
3500	-2.95
4000	-7.5

(B)

GROUP 1 F.D. $\overline{ACT}$

X	$\overline{Y}$
2000	-0.5
3000	-1.5
3500	-2.75
4000	-4.75

GROUP 2 F.D. $\overline{ACT}$

X	$\overline{Y}$
2000	-4.2
3000	-5.4
3500	-6.1
4000	-6.75

B = 13.78
M = -5.407
$\hat{R}$ = .921
Y(L) = 8.36
Y(4) = -13.31

B = 8.343
M = -3.506
$\hat{R}$ = .845
Y(5) = -9.19

B = 3.464
M = -2.029
$\hat{R}$ = .946
Y(5) =
-2.029(5)+3.464
= -6.68

B = -1.764
M = -1.191
$\hat{R}$ = .974
Y(FE) = -1.191(-5) -1.764
= -7.72

TI-NHTSA 000711

HIGHLIGHTS
Stephen B. Offiler
Week Ending 04/12/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER SAMPLES: Although we have built the required 10 device for Kelsey-Hayes (requested ASAP), these use LRC's which have unknown proof performance. Marketing would rather wait to ship these parts until we complete the next round of LRC testing which will give us a better handle on proof limitations.

To address FLT's need for 64 samples by 05/04/90, we need J512 hexports. The plan was to have APCC Screw-Machine modify production 57PS hexports, but they will simply take too long, and they've voiced concerns related to the fact that it's a rework job (concentricity, etc). The model shop will therefore modify just enough to meet the present need, and in parallel we'll have APCC do a quantity for inventory.

AUTOMATED SWITCH: Mechanization reports that they broke the prototype twist tool while trying to build a few devices for terminal strength tests. This highlights the fact that we need to increase the inner dimension of the connector to allow room for a larger tool. Mechanization is going ahead and designing/building a new tool under the assumption that Ford will agree to the dimension change. They'll also build a more sophisticated fixture to locate the tool and the base, which will be representative of the final AMI tool design. I have checked with APCC Molding, and the dimension change is no big deal to them.

For calibration, we have proposed to Mechanization a methodology which avoids use of a continuity measurement. Instead, we can infer contact transfer by looking at the change in spring rate that occurs when the contacts meet and the spring changes from a cantilever-beam to an end-supported beam. They are studying this approach.

We have received 1NT-style stationary terminals from the model shop, and the special tool used to deform them. We have parts made of soft, 1/4H, and 1/2H material. We will proceed with springback testing as soon as possible.

An iteration to the spring design will commence soon. Mechanization indicates that the present design cannot be bowl-fed because the parts will "shingle". To reel-feed, we'd need to form the springs across the strip, meaning bends are parallel to the grain, which is not a desirable situation. We'd also like to try to shape the center portion of the spring as a channel for stiffening to address calibration concerns. It is possible that the channelled spring will be bowl-feedable since the channel itself will interfere with the shingling action. Prototypes of the channel design will be made up and life-tested.

SENSOR: We have received 455SS discs from the Disc Dept. These will be used in the LRC proof testing along with 301SS discs. This test will commence when we receive converter parts from the model shop. It will serve to quantify what proof pressure tends to deform the discs. Ted Ballard indicates that the 455SS has a higher 0.2 % yield-to-tensile ratio than 301SS, meaning it should be more resistant to deformation, everything else assumed equal.

Running in parallel with the above test will be two other lower-priority tests: the zinc converter test, and the rubber-diaphragm test. We have received all parts needed to build and test these devices. Capacity in the cycler is no problem.

CYCLER: We have had all wiring, including the recent addition of manifold heaters, checked-out by a qualified electrician. Everything is in order.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 54-08-09

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PS	4/12/90	SBO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	4/12/90		

PROJECT TITLE: Cruise control Pressure Switch

CUSTOMER:

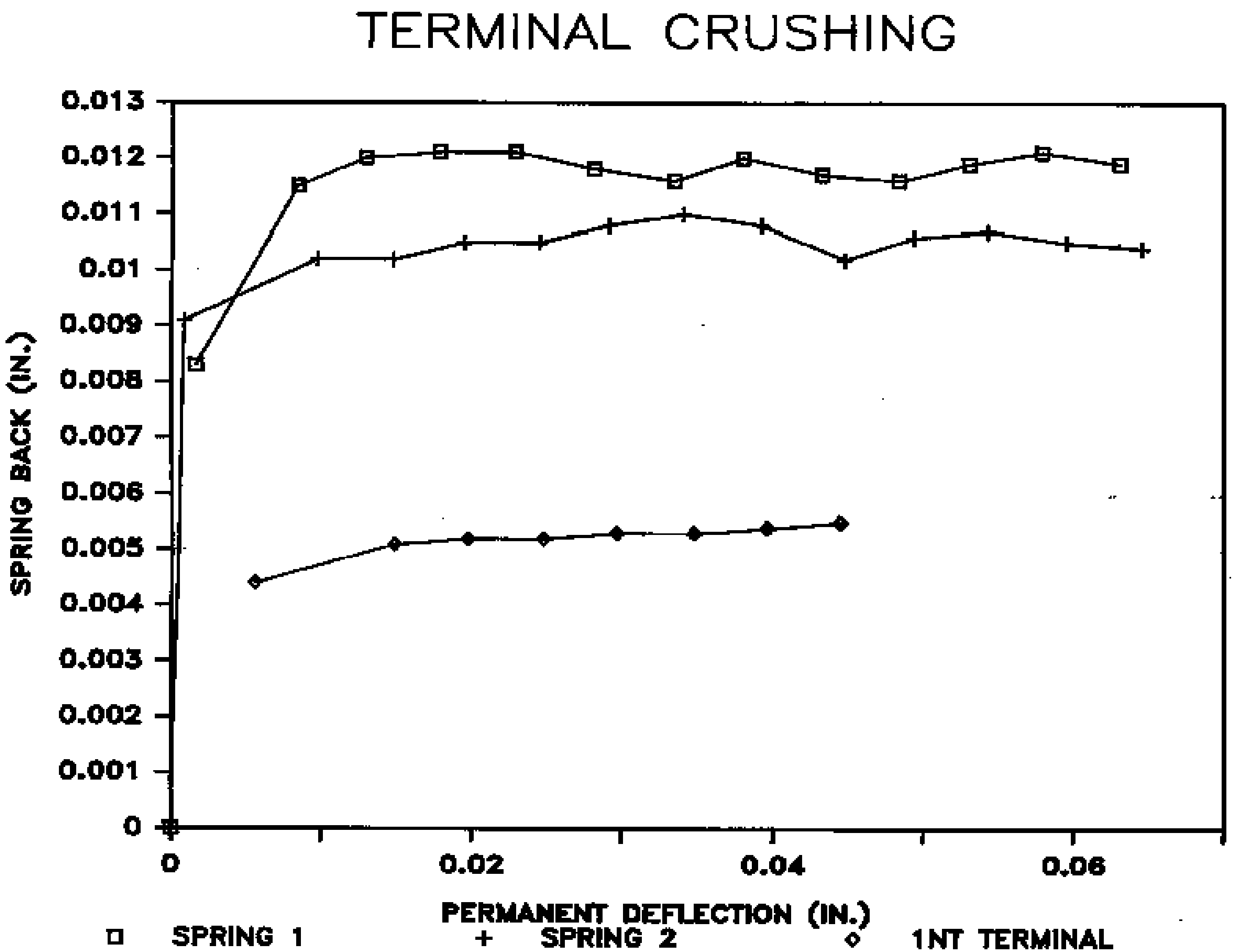
PURPOSE OF TEST: To test 455 SS Discs for Disc life in standard 57PS sensors

PROCEDURE: Have Sensor built with 455 SS Discs cycle with tests 58-15-10 and 53-15-10

Sensor #	0 Cycles Act	0 Cycles Rel	250K Cycles Act	250K Cycles Rel	500K Cycles Act	500K Cycles Rel
54-08-01	268	154	278	158	291	158
02	194	78	207	93	207	91
03	177	70	197	85	208	85
04	194	71	201	90	205	88
05	186	68	213	87	205	89
06	192	73	200	88	199	88
07	191	74	207	95	208	93
09	188	86	202	94	206	94

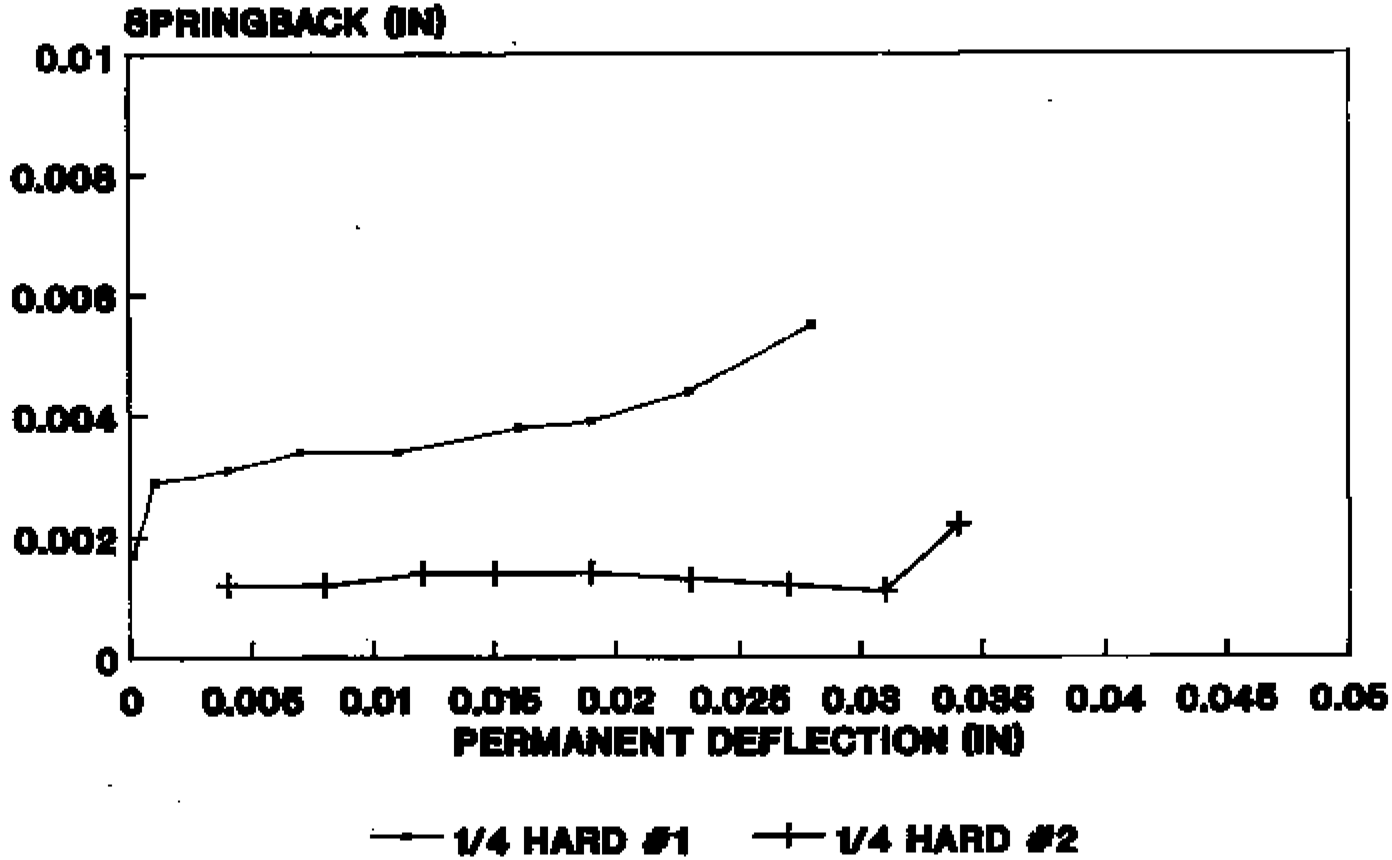
ST Ferm/Cal. Design/Bending

TI-NHTSA 000714



TI-NHTSA 000715

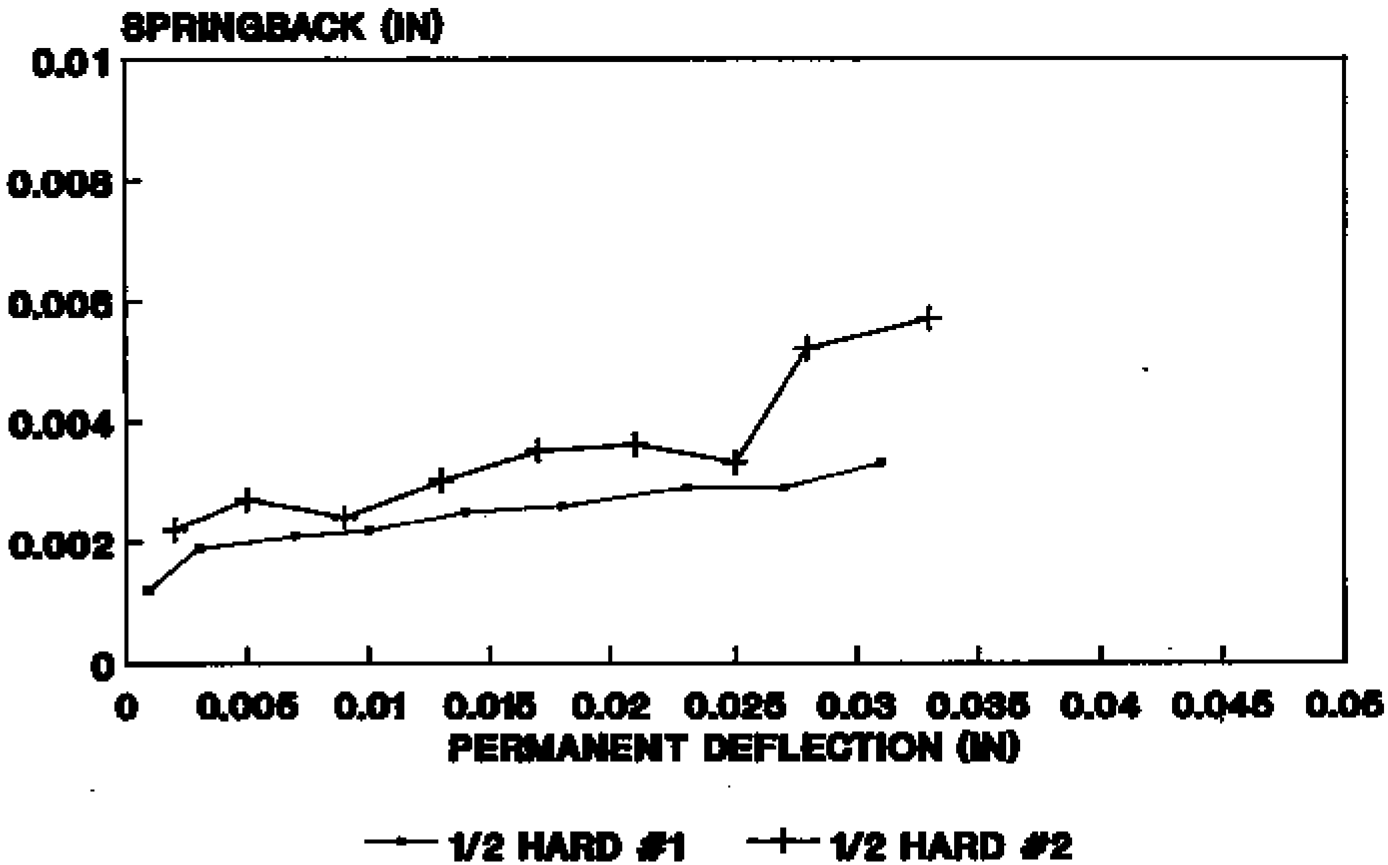
1NT-STYLE SPRINGBACK TESTING
CENTER OF CONTACT



JAD 4/17/90

TI-NHTSA 000716

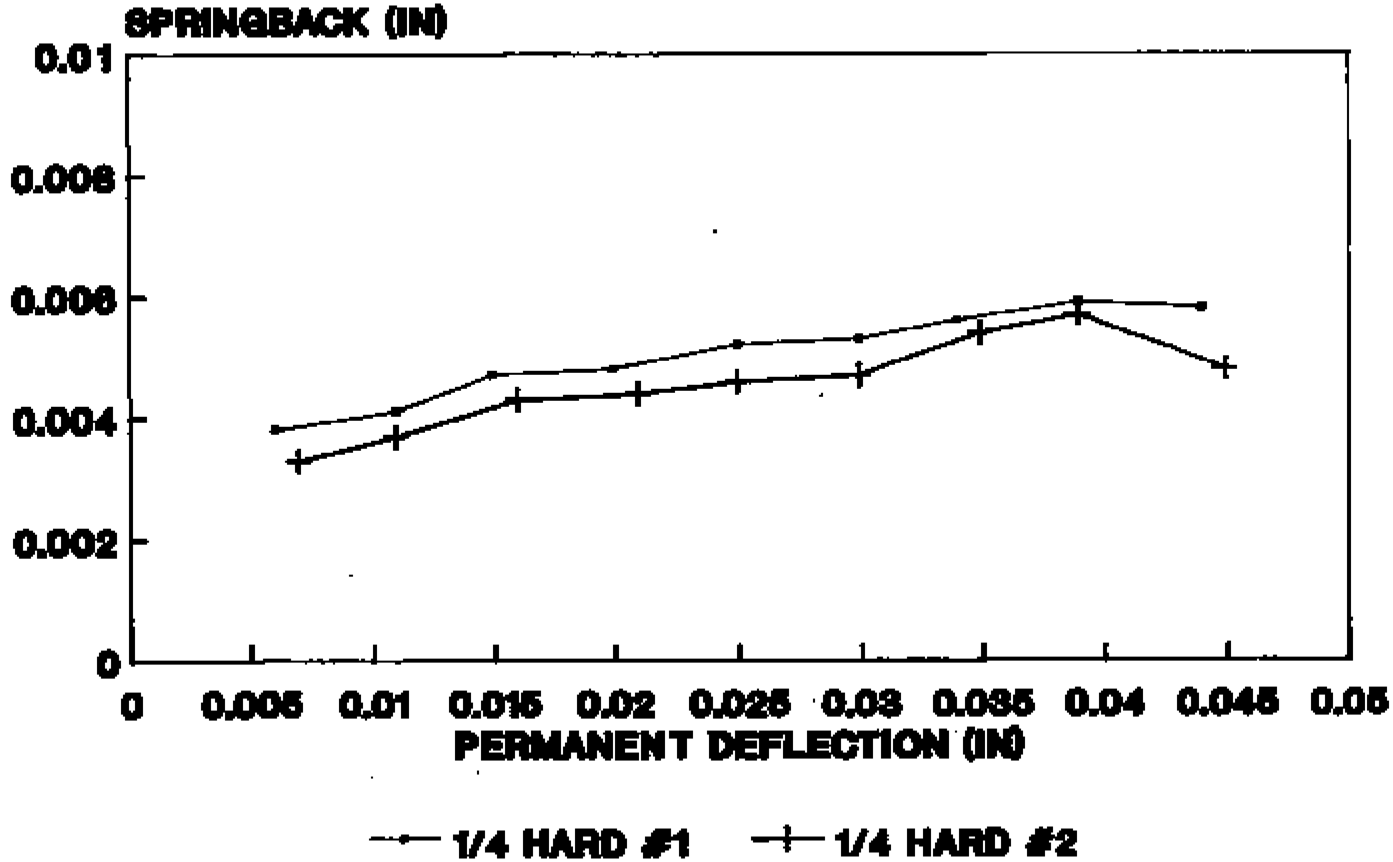
1NT-STYLE SPRINGBACK TESTING
CENTER OF CONTACT



JAD 4/17/90

TI-NHTSA 000717

INT-STYLE SPRINGBACK TESTING
POINT OF CRUSH

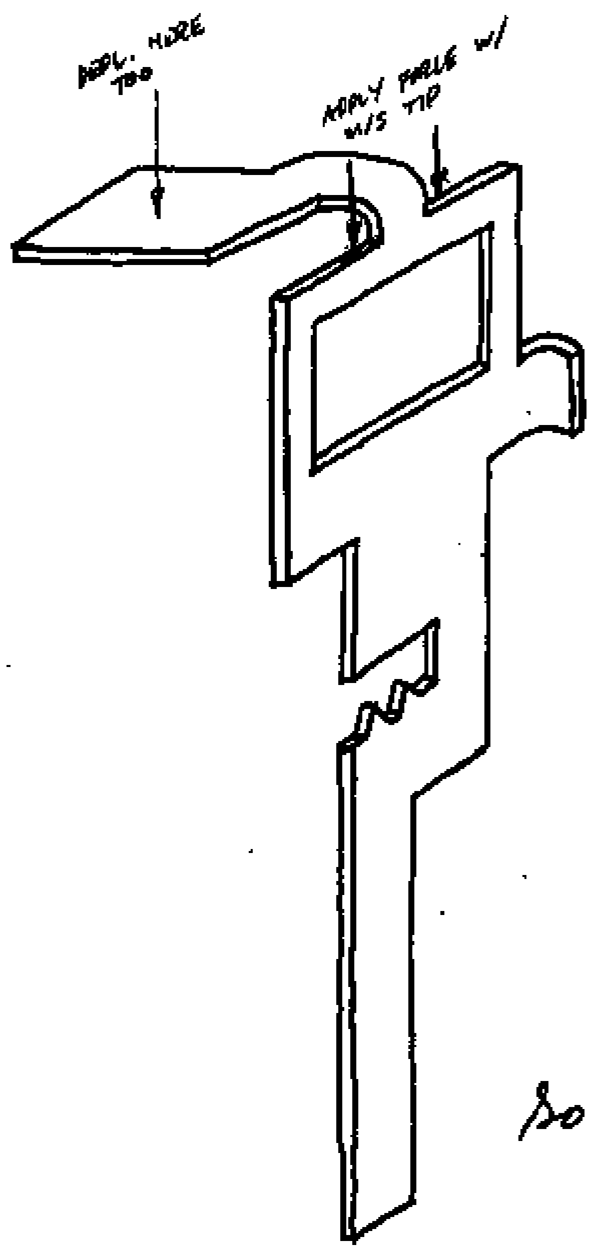


JAD 4/17/90

TI-NHTSA 000716

So 4/12/90

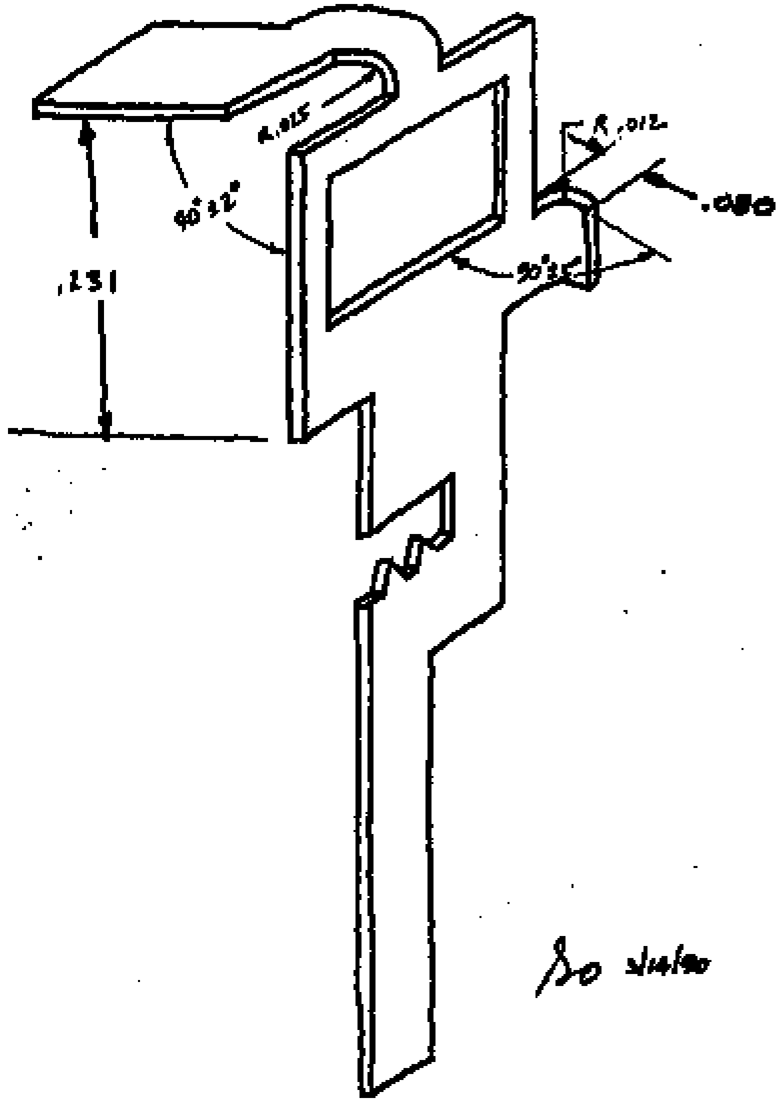
1NT - STYLE SPRINGBACK TESTING



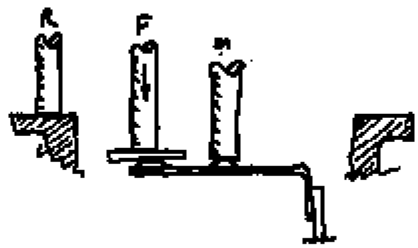
So 3/14/90

* TEST TWO EACH OF SOFT, 1/4H, AND 1/2H MAT'L
* USE SAME PROCEDURE & EQUIPMENT AS PREVIOUS TESTS, WITH ONE EXCEPTION: INSTEAD OF AN "X" AND A "Y" MEASURE, WE'LL DO TWO "Y" - ONE AT POINT OF CRUSH, ONE AT CTR OF CONTACT
* GRAPH AS USUAL, SPRINGBACK VS. PERMANENT DEFL. @ POINT OF CRUSH .... ALSO, SEPARATE GRAPHS USING CTR-OF-CONTACT DATA

BEND DETAIL



So 3/14/90



R = REFERENCE (MULTI-POINT ?)

F = APPLY FORCE DOWN

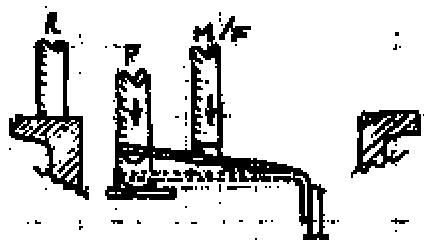
M = MEASURE.

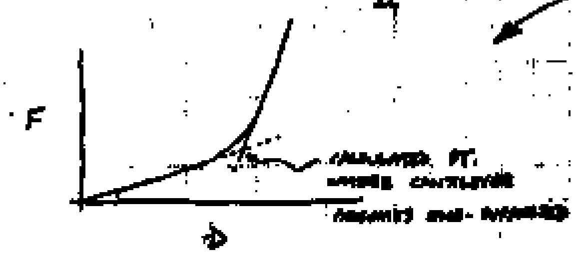
N.C. CASE :

1) ASSUME WE HAVE A VERY CONSISTENT ARM TRAVEL FROM STATIC POINT TO LOSS-OF-CONTINUITY (STIFFENED ARM)

2) "STATIC POINT" ABOVE IS DESIRED LOCATION OF BUMP, DIMENSIONALLY

3) TO CAL, MOVE ST. TERM. DOWN UNTIL BUMP IS IN CORRECT POSITION DIMENSIONALLY





USES "CONTINUOUS" DATA I.E. DIMENSION AND FORCE MEASUREMENTS BUT NEED TO DO SOME LINEAR REGRESSION CALCULATIONS

NO. CASE (CCPO)

1) SPRING ARM MUST BE DEFLECTED TO EITHER :
   - CONTINUITY CHG
   - SPRING CONSTANT INCREASE

2) TAKE MEASUREMENT (M) AT THIS POINT ; COMPARE W/ "TARGET" VALUE

3) MOVE ST. TERM. DOWN BY AMT. INDICATED IN #2 ABOVE, INCLUDING SPRINGBACK FUDGE FACTOR

TI-NHTSA 000722

-MSG M#= 7317 FR=EQBM TO=ELB SENT=04/03/90 01:50 PM
R#=001 ST=C DIV=0050 CC=00869 BY=EQBM AT=04/03/90 01:50 PM

JK90-052
03 APR 90

TO:	KEITH ROBERTS	PCME
	ED KADISEVSKIS	MDES
	STEVE MCCOOEY	MDES
	STEVE OFFILER	ELB
	STAN STELIGA	STEL
	WAYNE CARLSON	AMSD
	STEVE RODNEY	AMSD
	DONNA MOYNIHAN	PCQA
	BILL FARROW	MDES
CC:	JIM ARMSTRONG	EQBM
	JOHN GORMLEY	AMSD
	BILL SWEET	PCME
	RAY TOURANGEAU	PCME
	CHARLIE DOUGLAS	CPPC
	BOB VIENS	MDES
	PAUL MENDES	MDES
	ANDY MCGUIRK	PCQA
	MIKE DEMATTIA	PCQA
	MIKE POHL	FIXB
	[redacted]	TC
FR:	JOHN KOURTESIS	MDES

Steve O.
I don't think this can be done since switch arm is a spring & will not be located in the exact position at contact closure for each switch. I think this is a dead end.
Tom C

SUBJ: WEEKLY CCPS STATUS UPDATE

NEXT MEETING:

DATE: WEDNESDAY, APRIL 11TH
TIME: 8:00AM
PLACE: B20 DESIGN REVIEW AREA

O BASE ASSEMBLY MACHINE:

- TERMINAL TWIST TOOL IS BUILT AND HAVING TIP HARDENED. INITIAL RESULTS WITH TOOL RAISED SOME QUESTIONS AND CONCERNS REGARDING FINDING TERMINAL WITH TOOL TIP SLOT. (TERMINAL MOVE IN BASE.) WE DISCUSSED HAVING TOOL ENTER BASE FIRST AND THEN LOAD IN TERMINAL. STEVE M. WILL DEVELOP TIMING DIAGRAM OF THIS APPROACH. ADDITIONALLY, STEVE O. WILL LOOK AT MODS TO BASE TO ALLOW US TO INCREASE WALL THICKNESS OF THE TOOL TIP. WE ARE CONCERNED THAT TOOL IS DIFFICULT TO MAKE AND TIP MAY BREAK EASILY. WE WILL ALSO EVALUATE A TWO PIECE TIP DESIGN.

- AFTER PARTS ARE HARDENED, STEVE M. WILL BUILD UP SOME TWIST TERMINALS IN BASES WITH CURRENT DESIGN AND SUPPLY TO STEVE O. FOR TESTING. THIS WILL HAPPEN THIS WEEK.

- STEVE O. WILL ALSO LOOK AT ADDITIONAL FEATURES ON THE TERMINALS TO HELP LOCK IN PLACE TO PREVENT ANY INTERNAL MOVEMENT AFTER TWIST LOCK.

- WE HELD AN INFORMAL DISCUSSION ON CALIBRATION APPROACHES IN GENERAL.

TI-NHTSA 000723

OPENING/CLOSING AS PART OF CALIBRATION PROCEDURE.

- LATEST DESIGN OF TERMINAL WITH 1NT TYPE FEATURES IS IN MODEL SHOP FOR SAMPLE BUILD. STEVE O. AND STAN NEED TO EXPEDITE SO WE CAN EVALUATE SPRINGBACK, ETC. ON THIS DESIGN.

- STEVE M. NEEDS TO UPDATE THE SCHEDULE FOR THE BASE ASSEMBLY MACHINE BY NEXT MEETING.

- AS NOTED ABOVE, THERE ARE TWO MAJOR AREAS OF CONCERN:

  1) CALIBRATION CAPABILITY
  2) TERMINAL TWIST LOCK

  WE ARE CONCENTRATING ON THESE AREAS AS WE ALSO PROCEED WITH THE DESIGN OF THE BASE ASSEMBLY MACHINE. IF IT IS NEEDED, WE CAN MEET MORE FREQUENTLY TO DISCUSS THESE ISSUES.

O <u>FINAL ASSEMBLY MACHINE:</u>

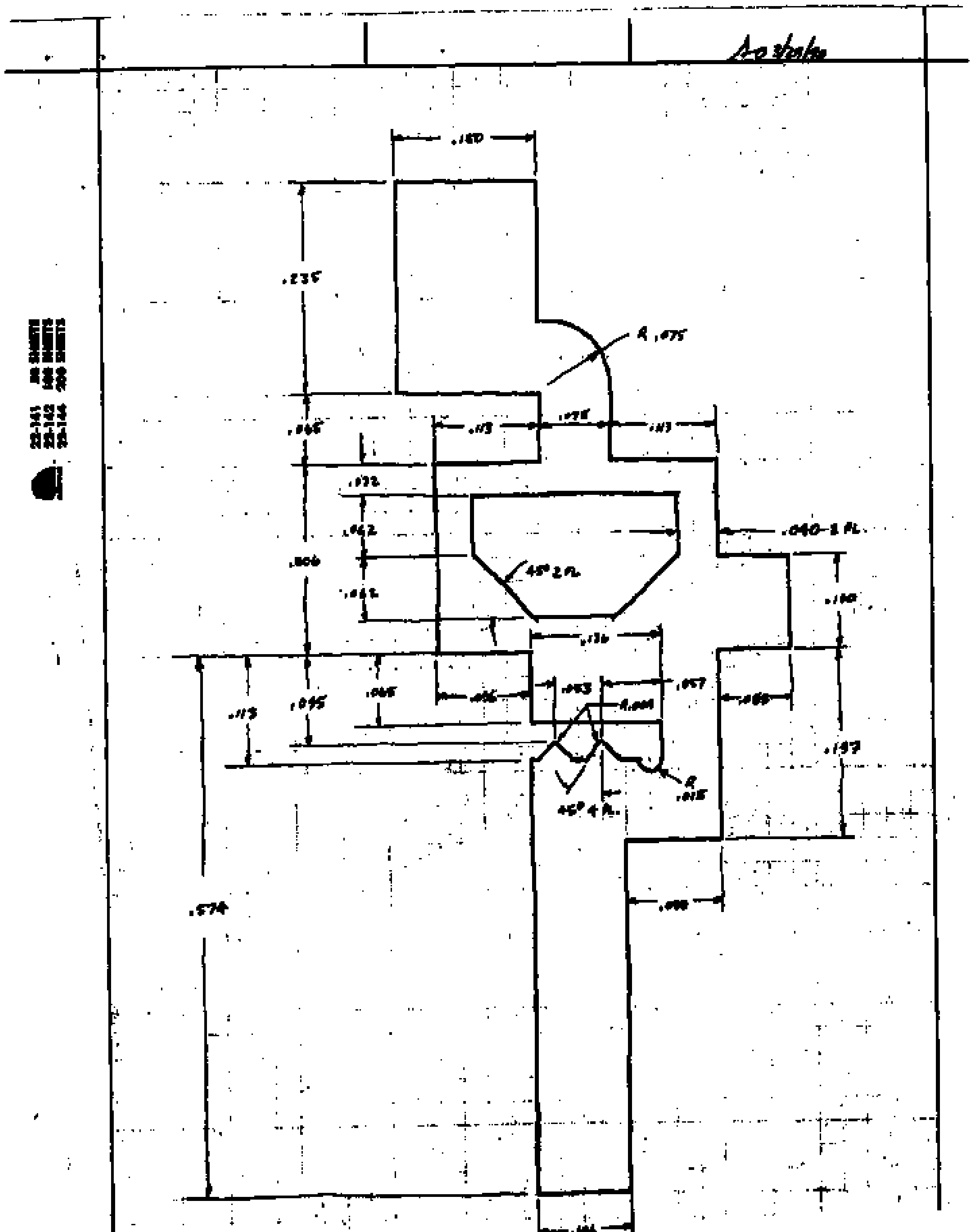
- I WILL REVIEW COMPETITIVE QUOTES BY NEXT MEETING SO WE CAN INPUT ANY QUESTIONS/CONCERNS TO KEITH PRIOR TO MAKING A DECISION ON RELEASING THIS JOB.

O <u>TESTER:</u>

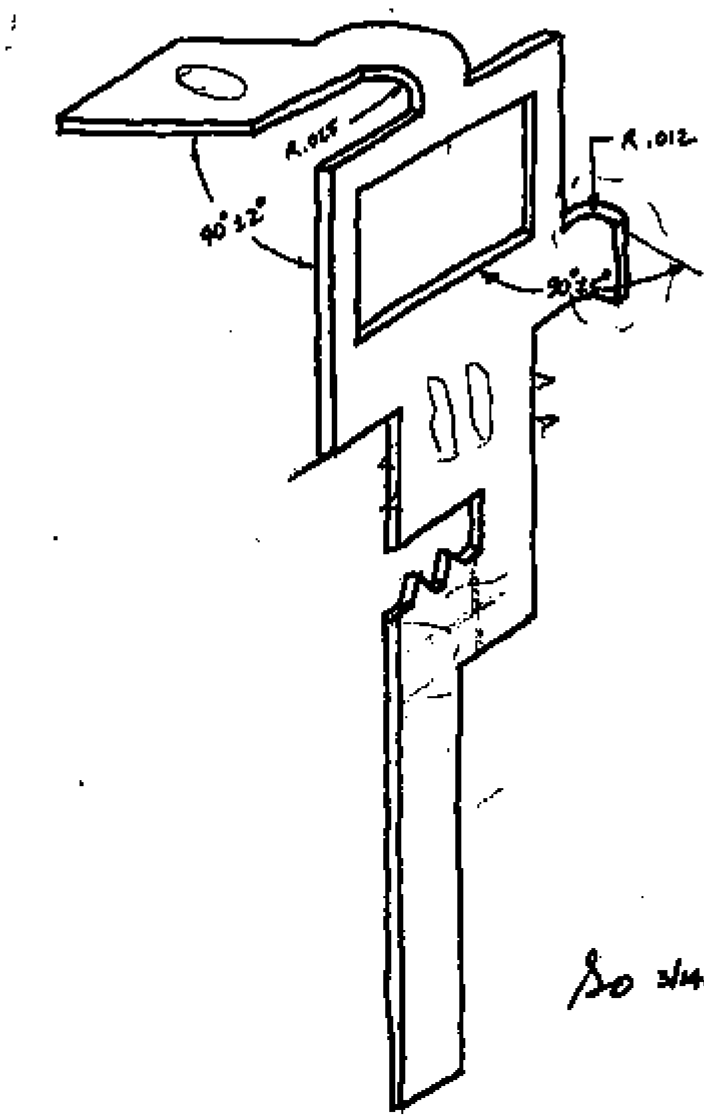
- WE WILL START PROPOSAL AS SOON AS WE RECEIVE A SPECIFICAITON FROM KEITH.

REGARDS,
JOHN

JK:LJP MSG ID: MDES TEL: 699-3679 MS: 20-25


R .075
.040 - 2 PL.
45° 2 PL.
45° 4 PL.
.574

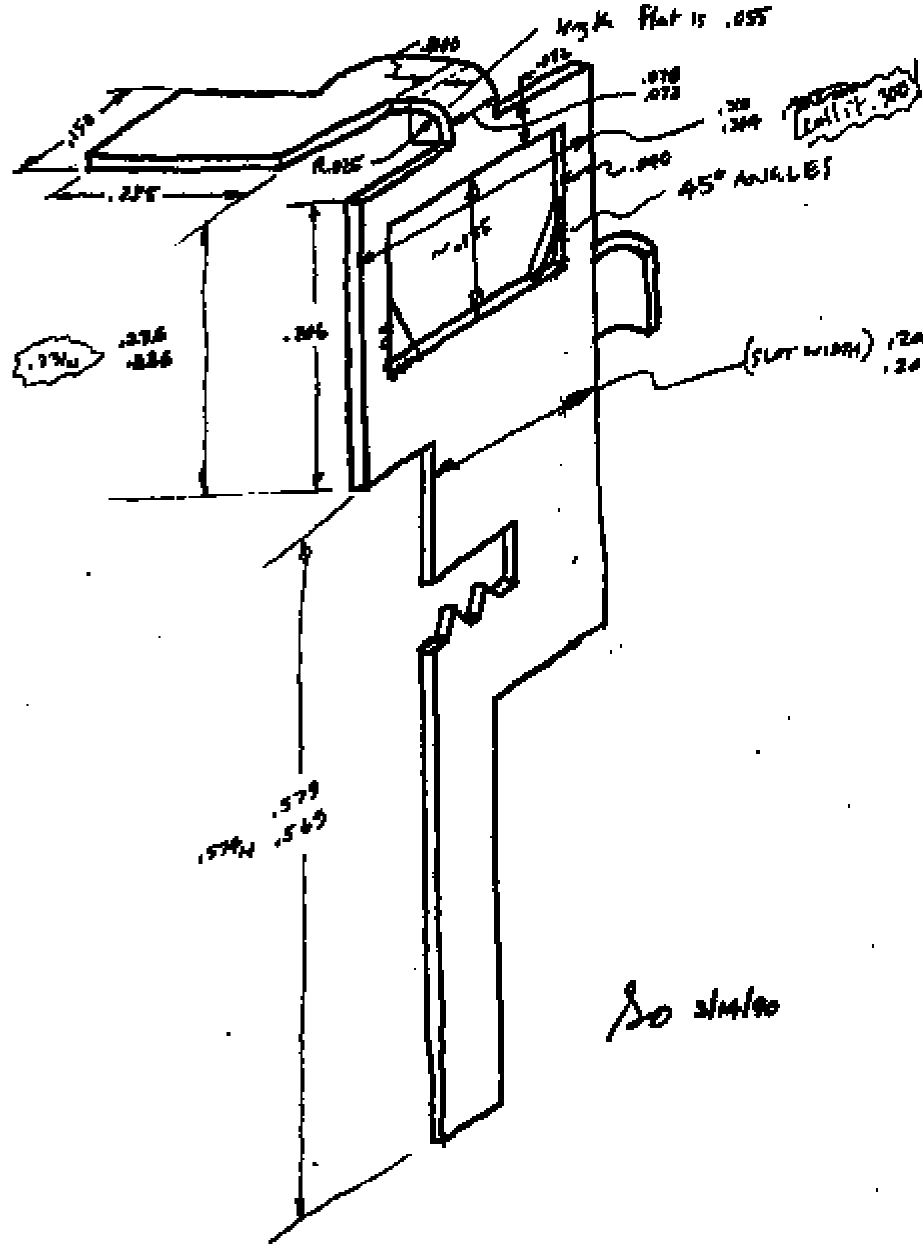
BEND DETAIL



So 3/14/90

TI-NHTSA 000725

(THIS TERM FOR N/O SW ASS'Y)



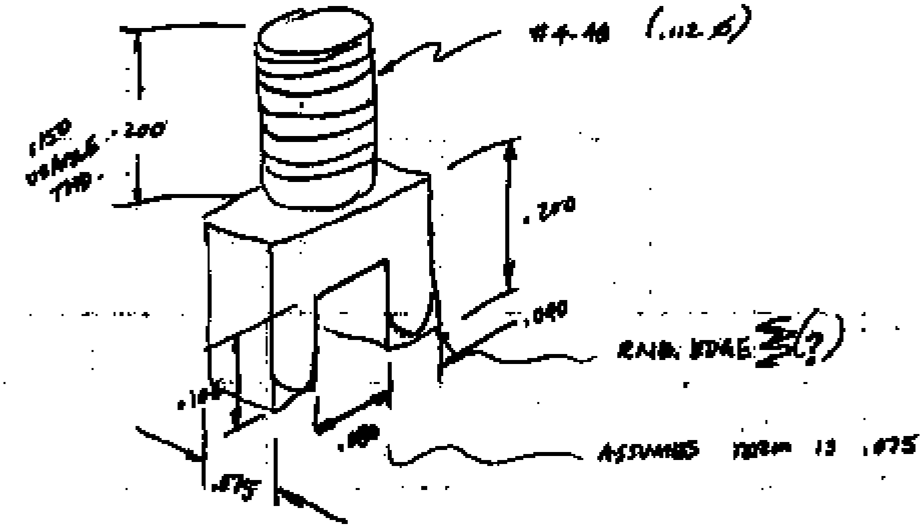
So 3/14/90

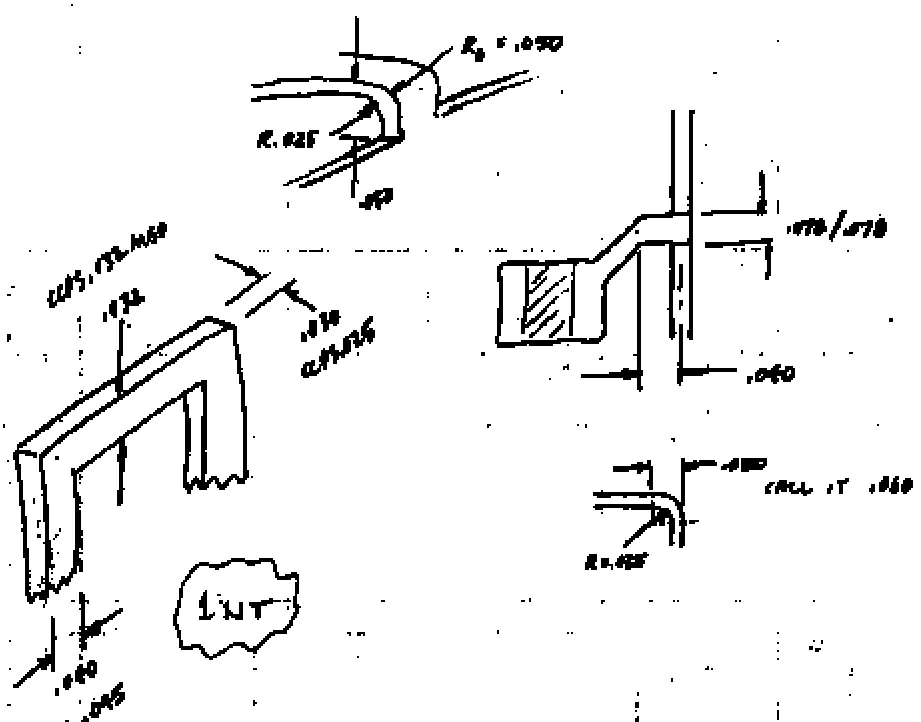
OVERALL LENGTH: .579 + .206 + .055 + .010 + .235 = 1.080"

TI-NHTSA 000727

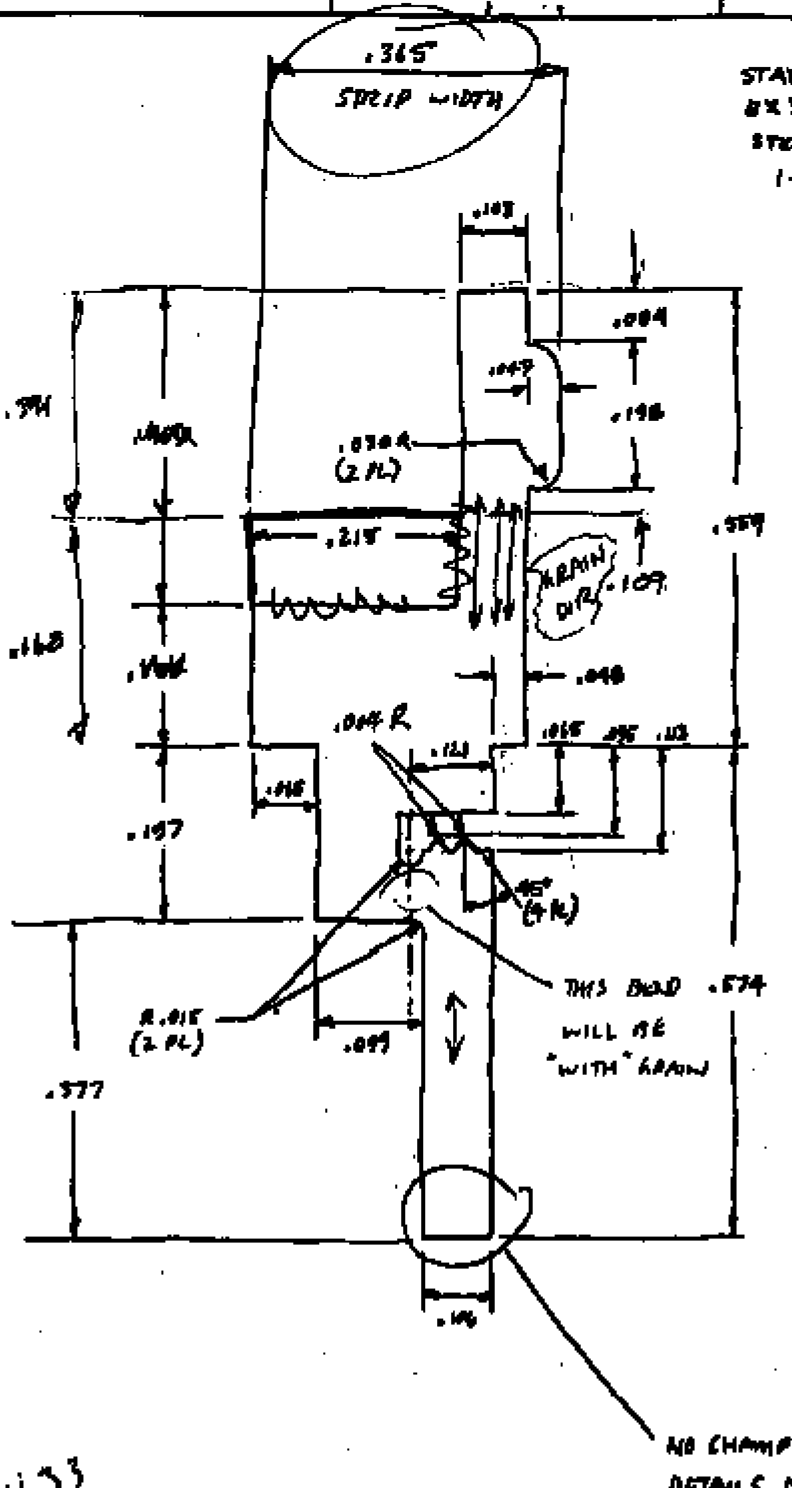
DIAL-IND. TOOL Ø.112 ; #4 SCREW ; 4THD/.005 = 47

TIP IS #4-48TPI





STATIONARY TERMINAL
8X3423-.42 FLAT
STEVE OFFILER X1382
1-19-90



(LIVES 8:00AM
1/30)

BLANK

1133

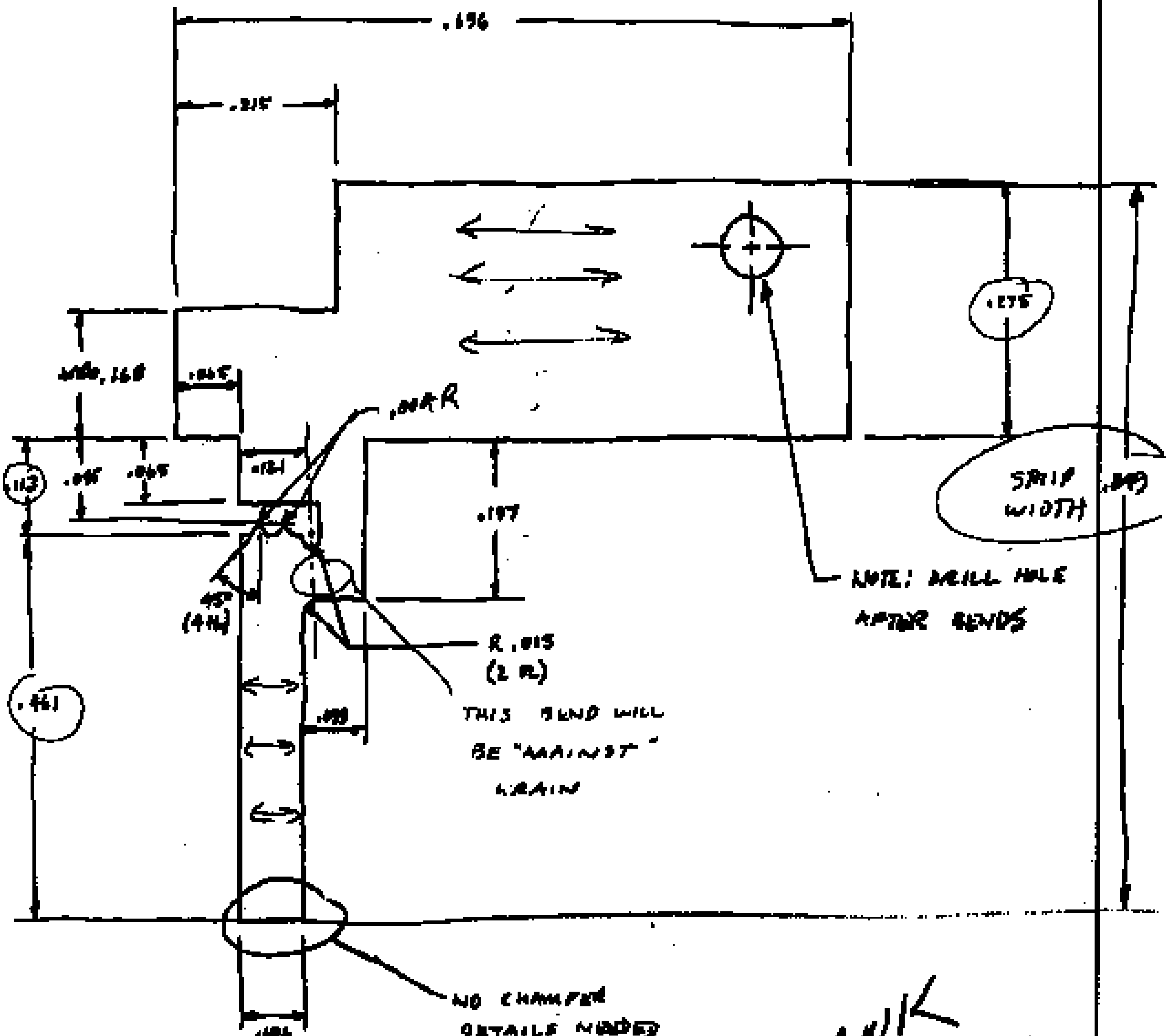
50
EACH

003423052

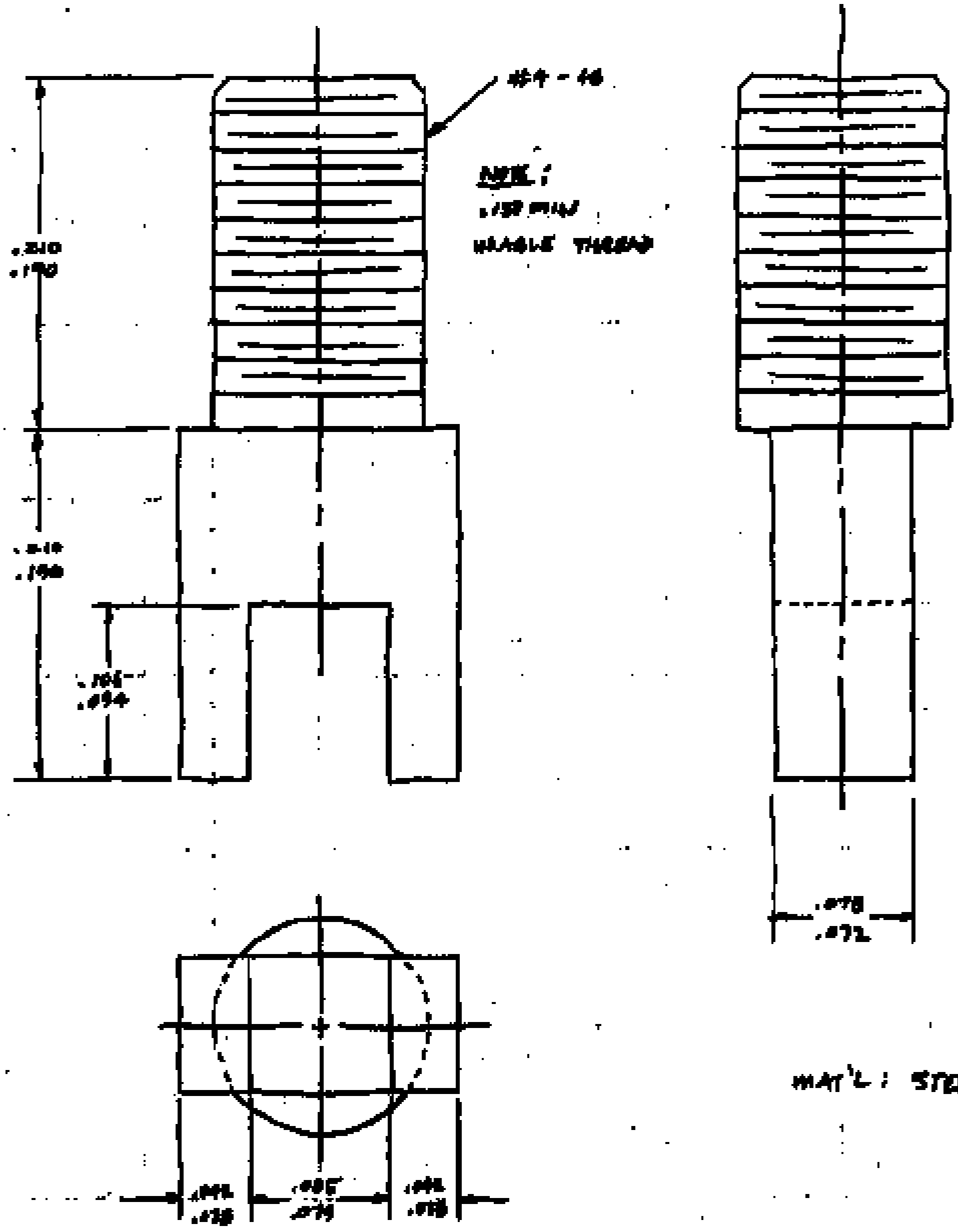
066
PC

101
EC

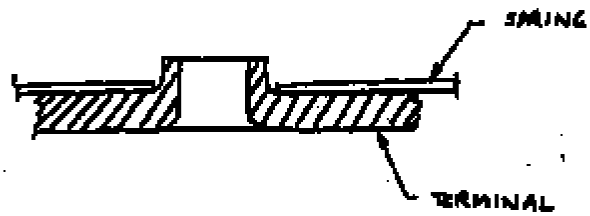
MOVABLE TERMINAL
EX3623-03 FLAT
STEVE OFFILER X1362
1-15-90

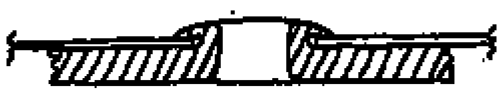


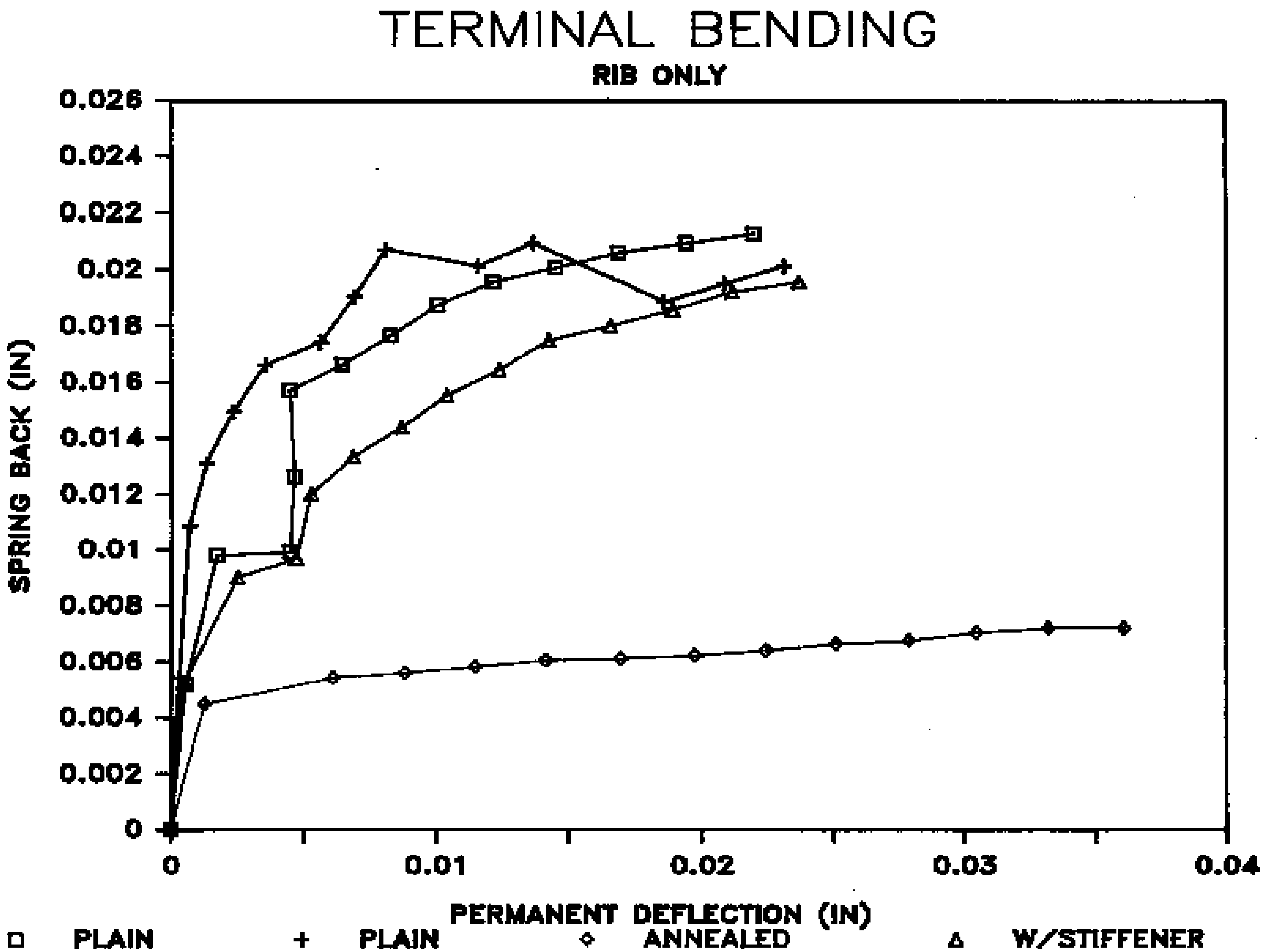
BLANK



TI-NHTSA 000731

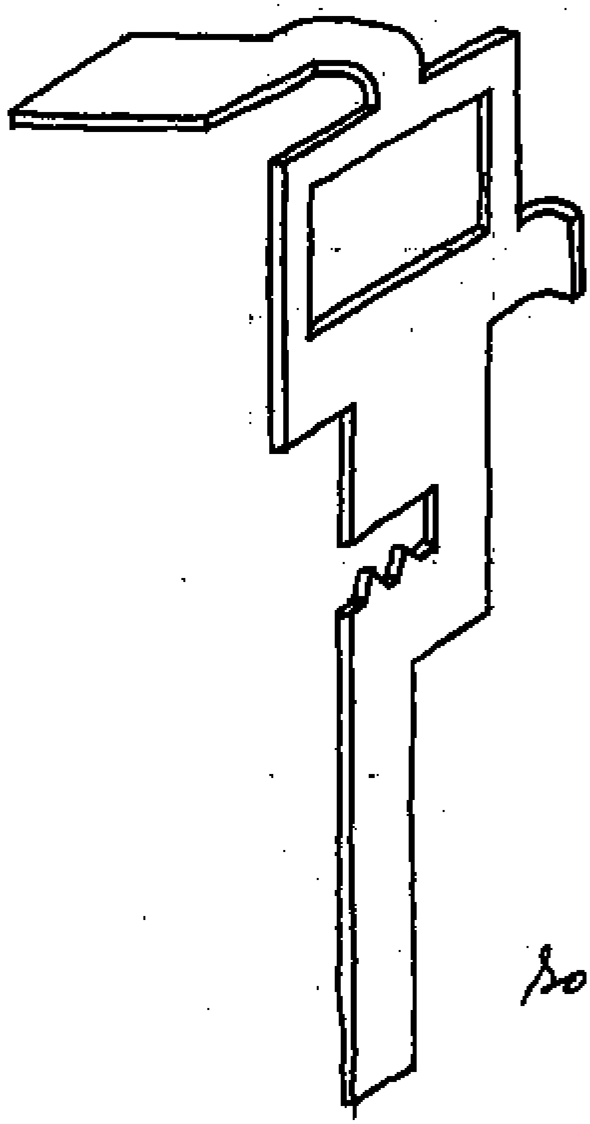

SPRING
TERMINAL



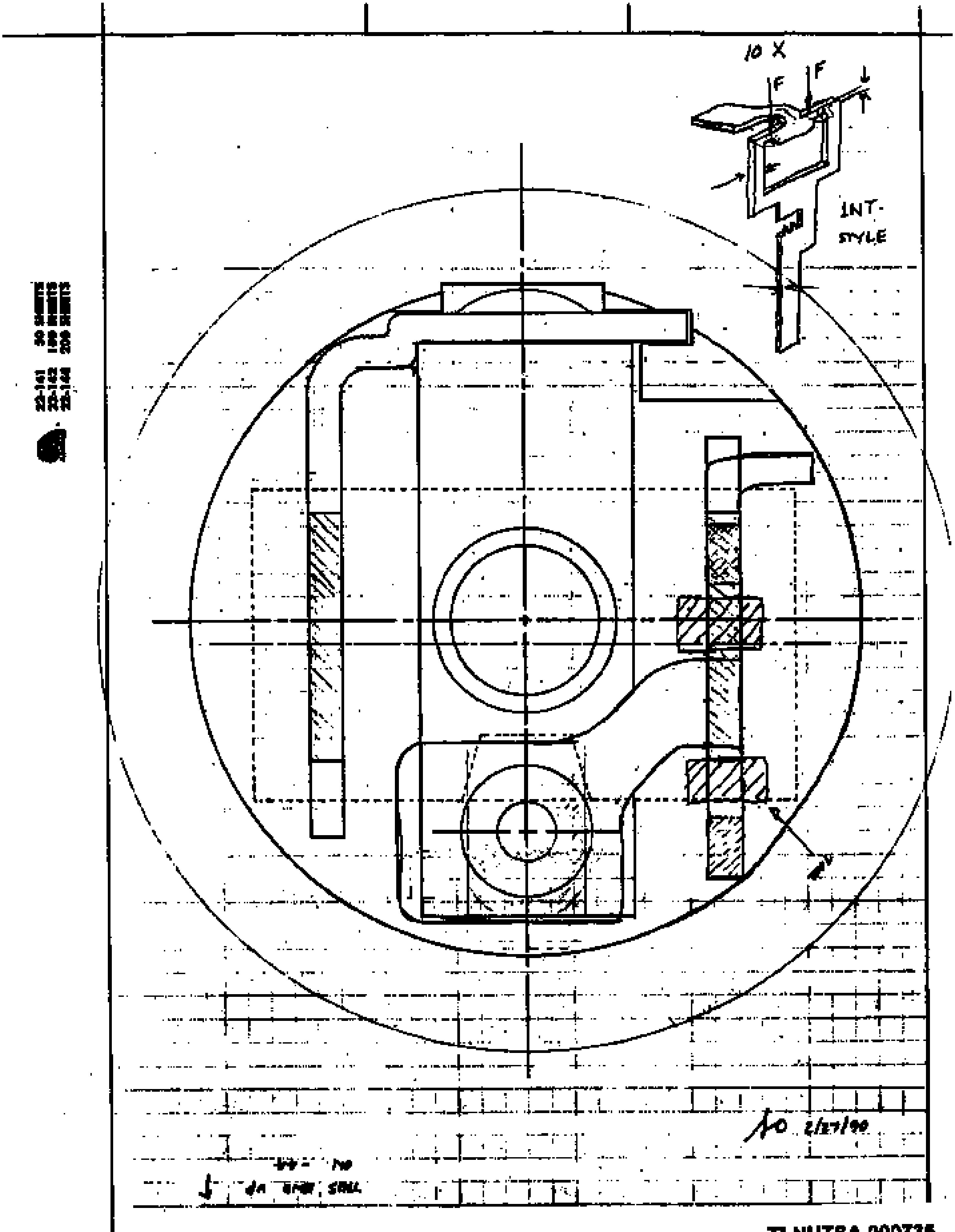


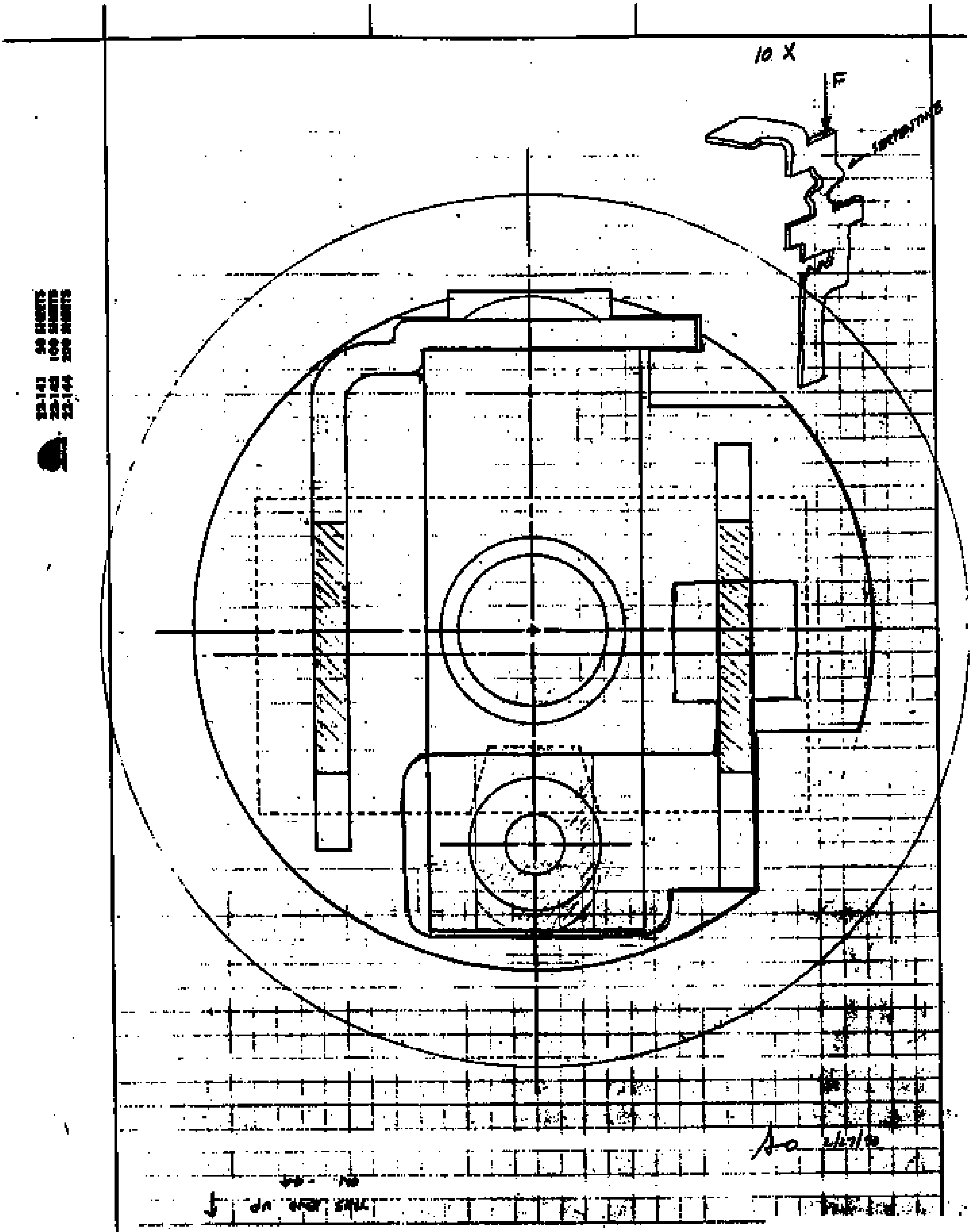
TI-NHTSA 000733

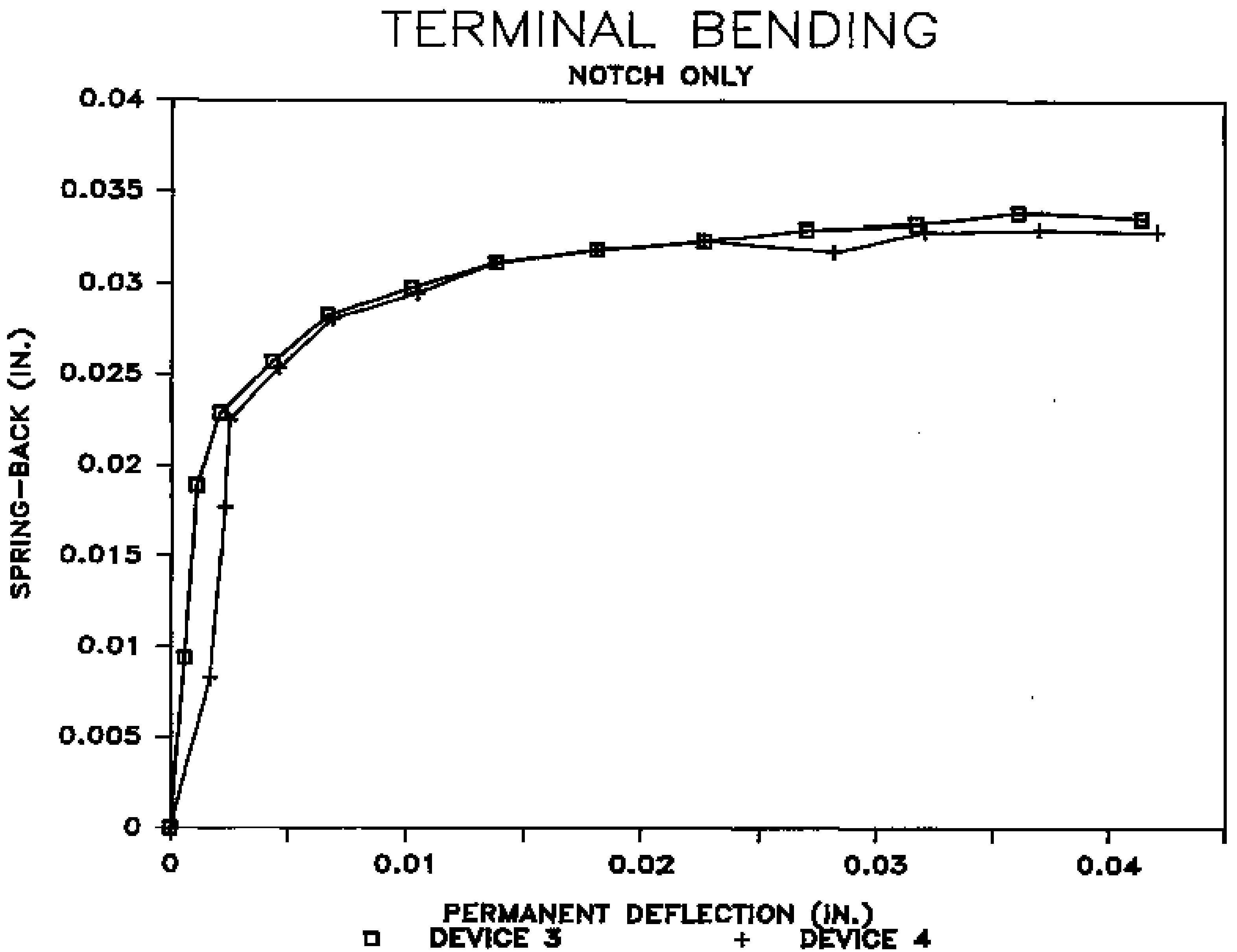
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



So 3/14/90

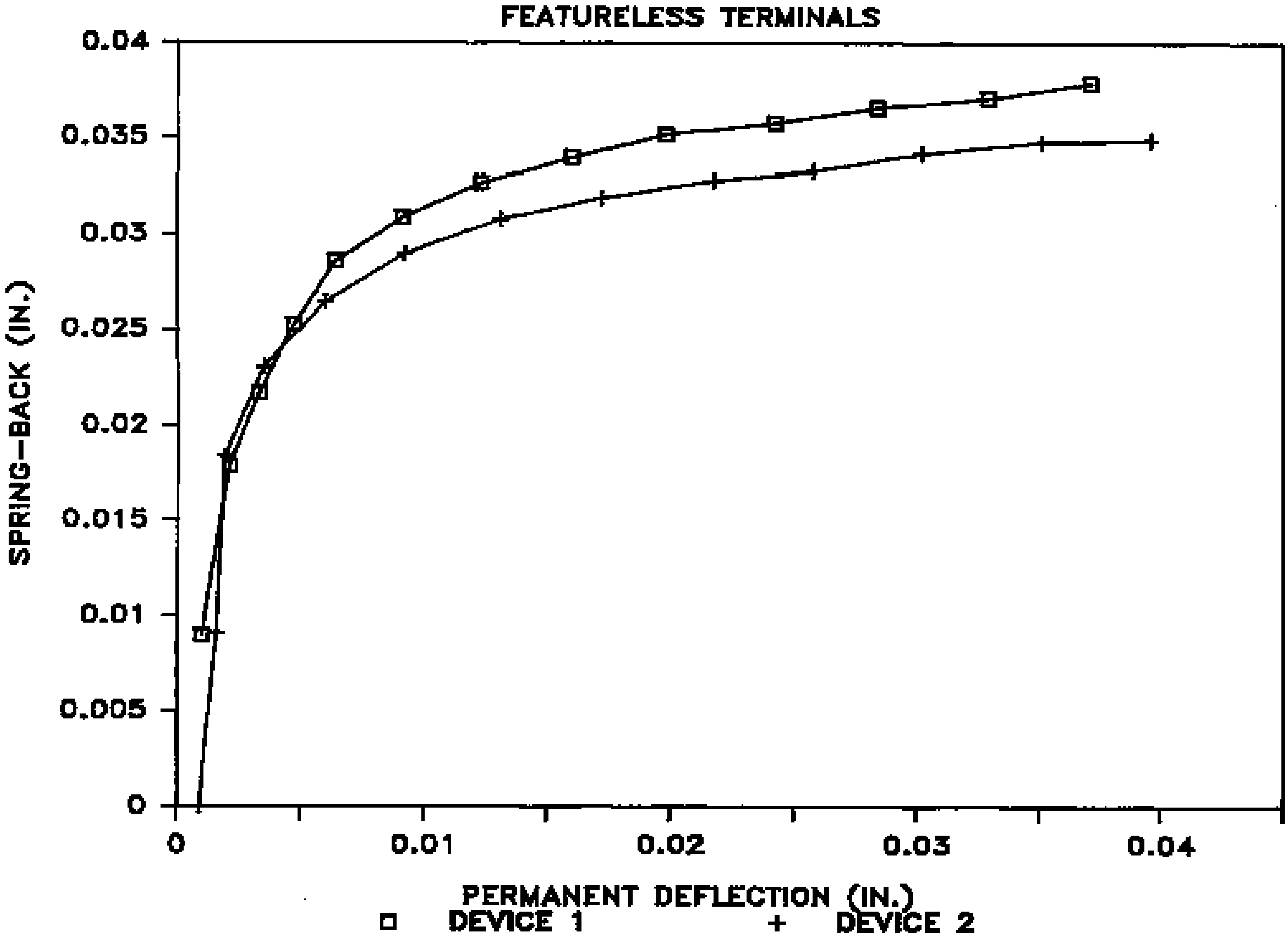

10 X
F
F
INT-
STYLE
2/27/90


10 X
F



TI-NHTSA 000737

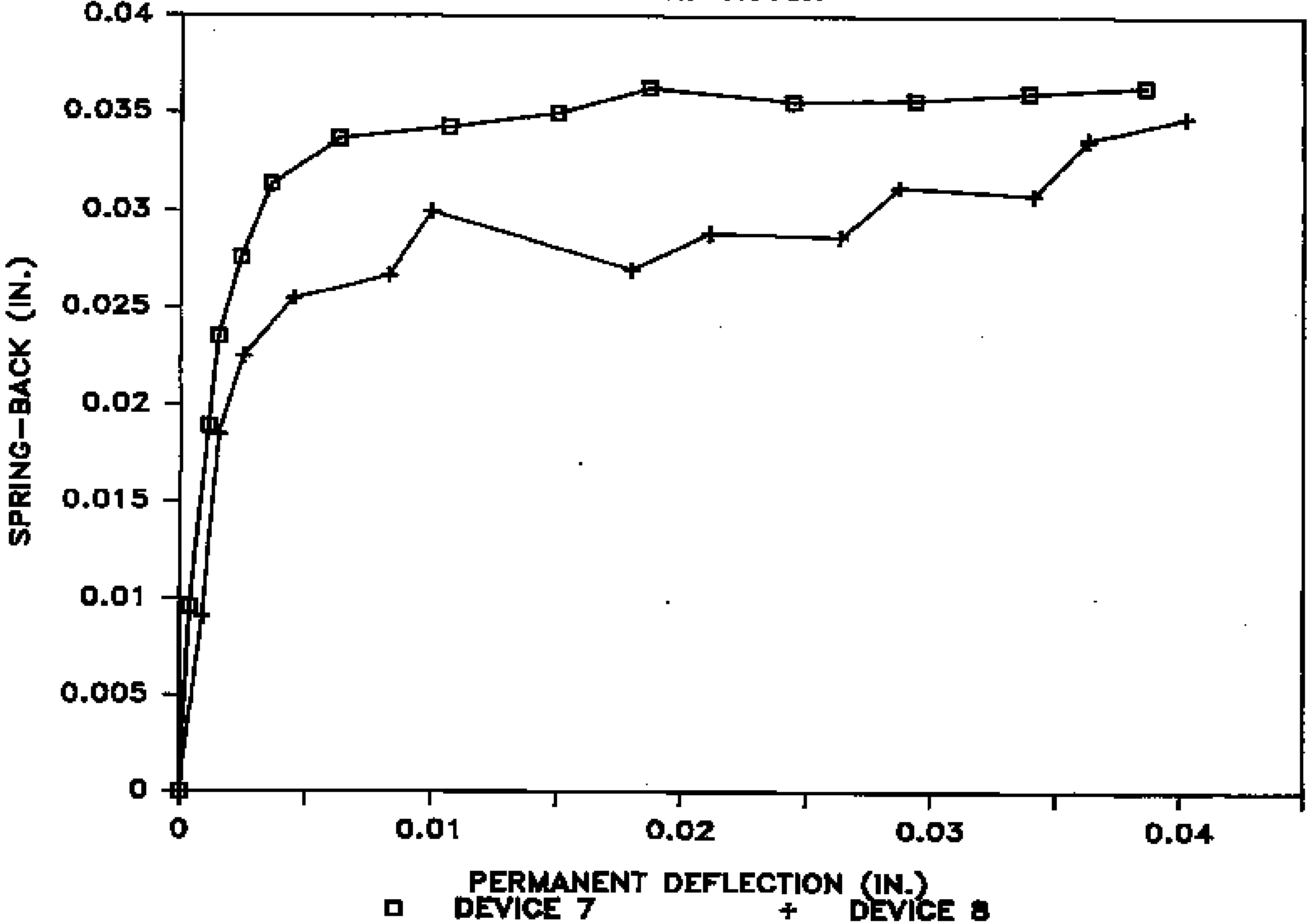
TERMINAL BENDING



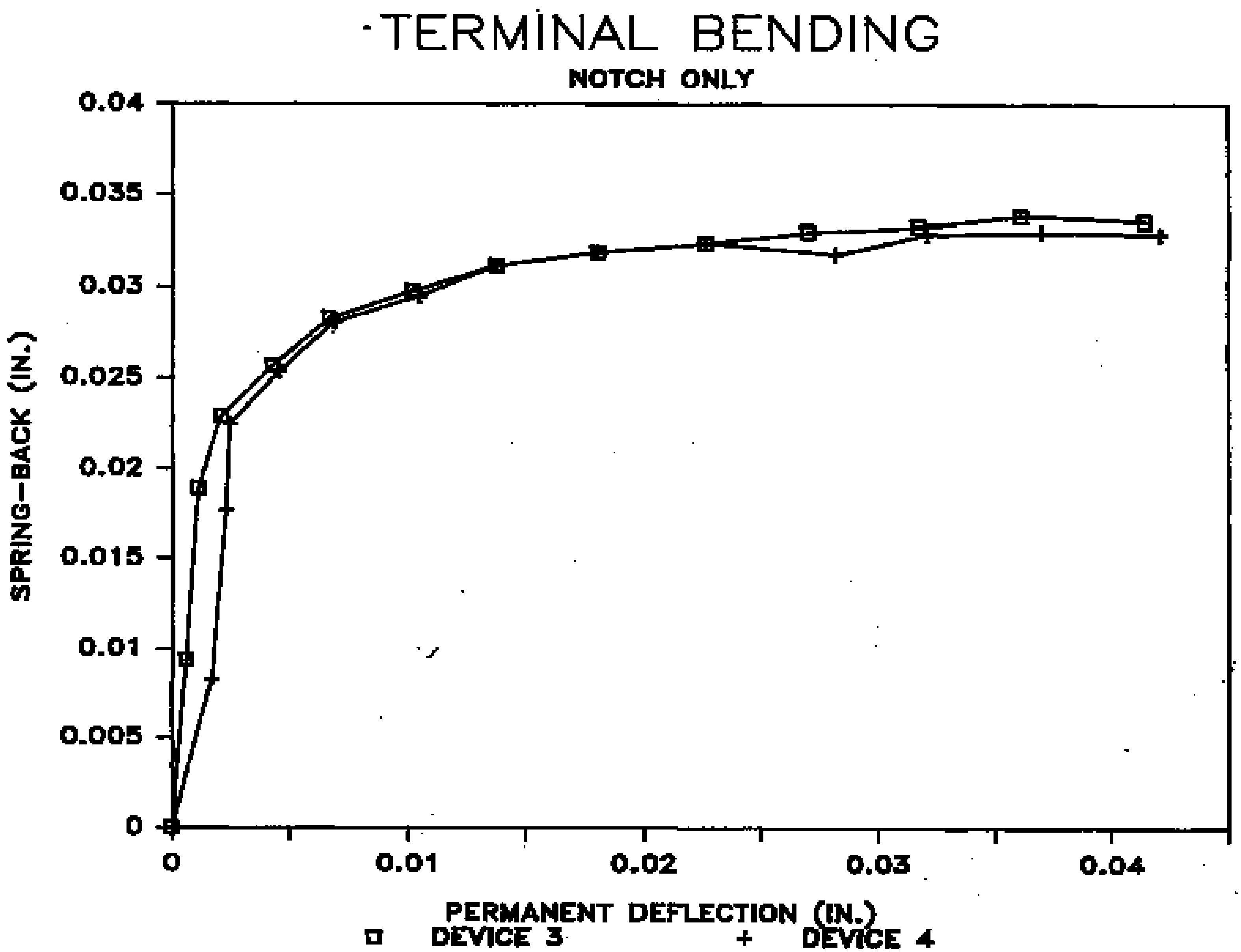
TI-NHTSA 000738

TERMINAL BENDING

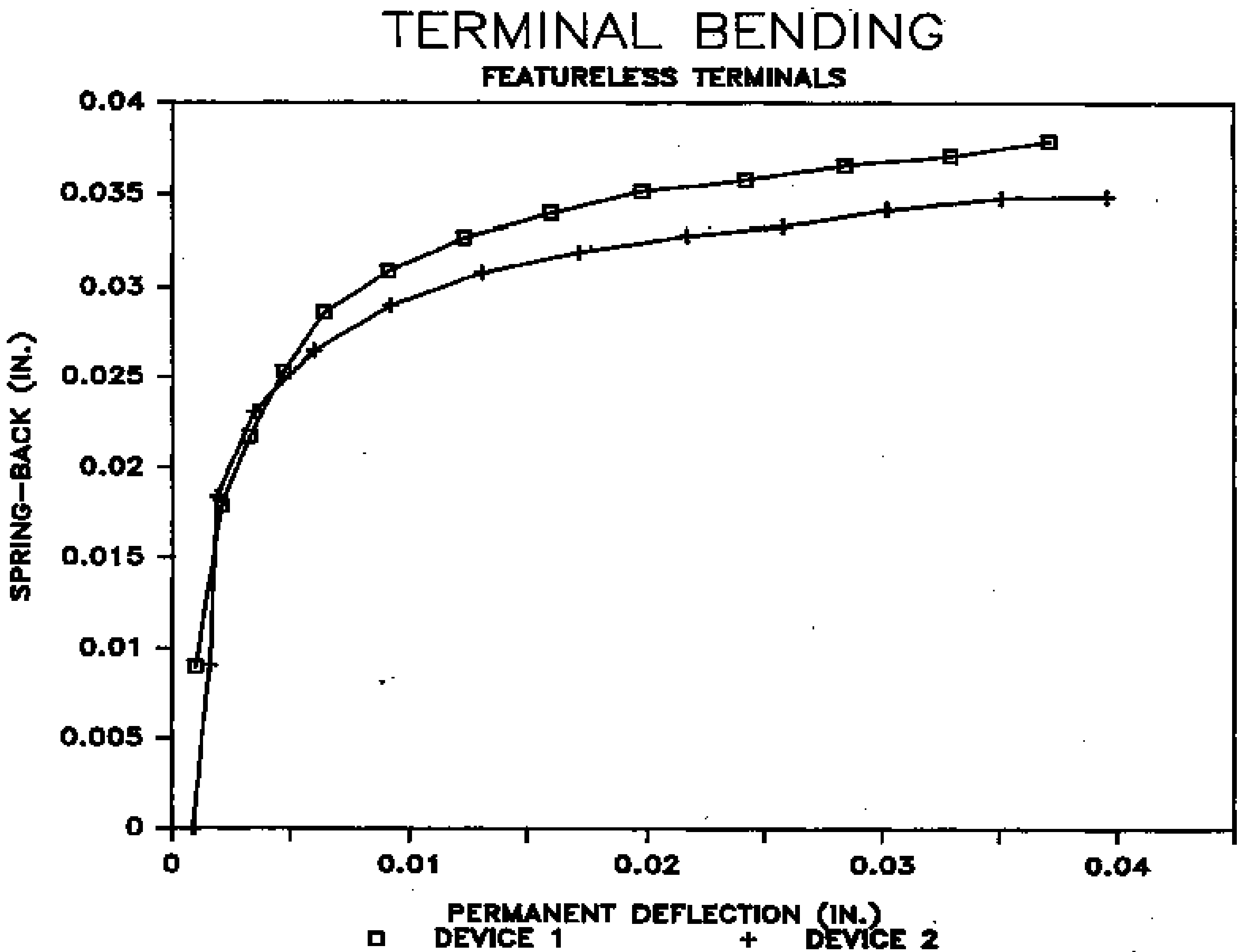
RIB AND NOTCH



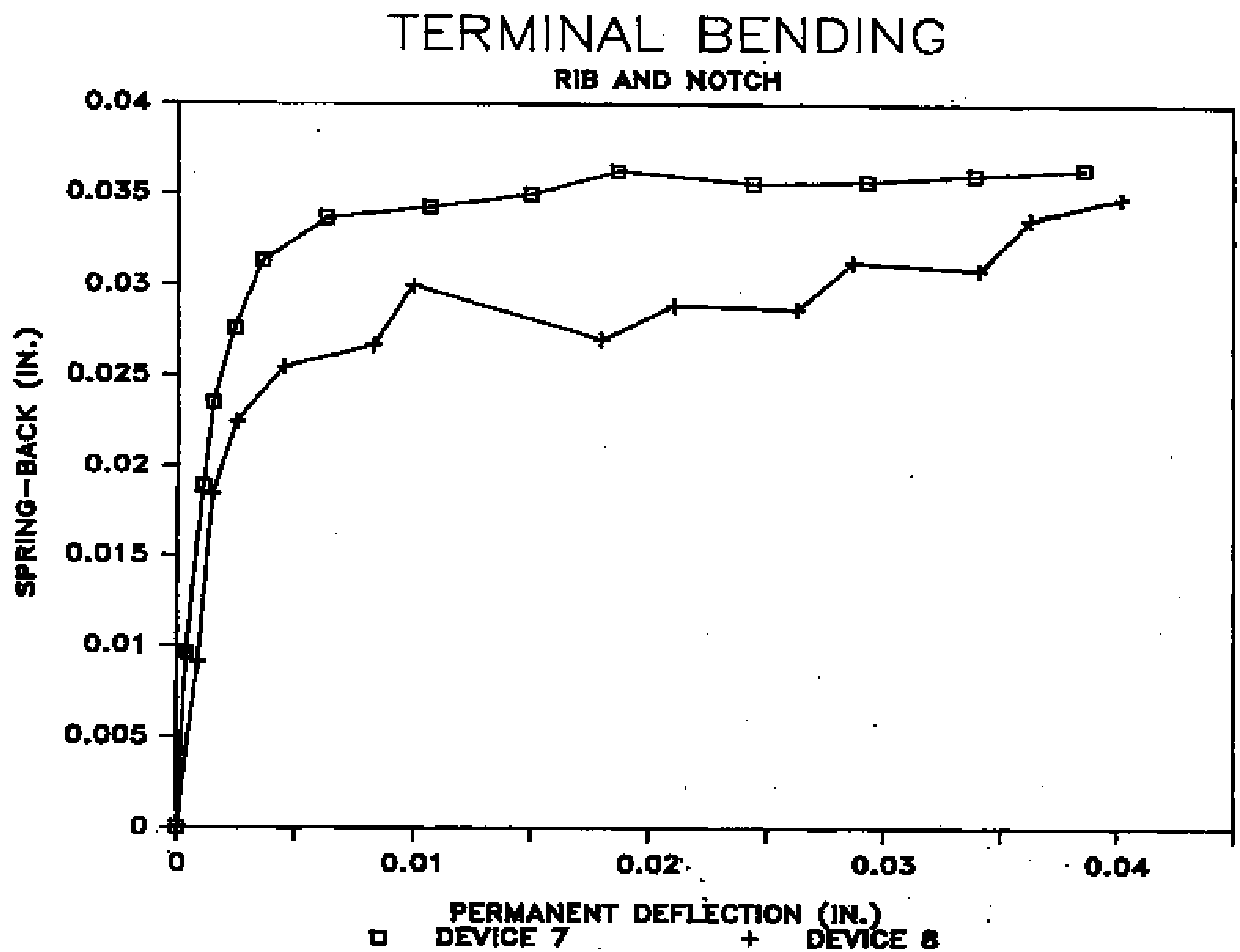
TI-NHTSA 000739

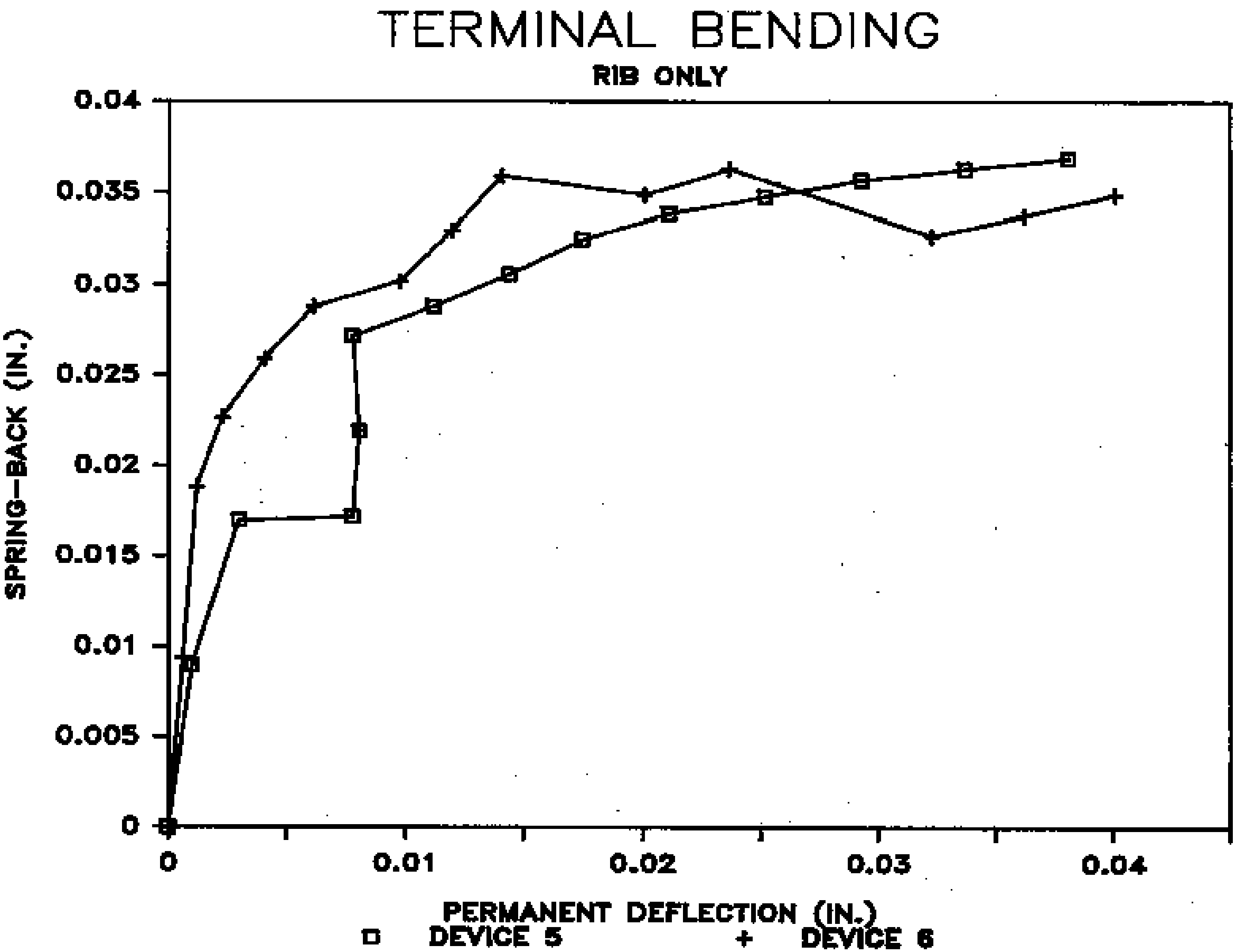


TI-NHTSA 000740

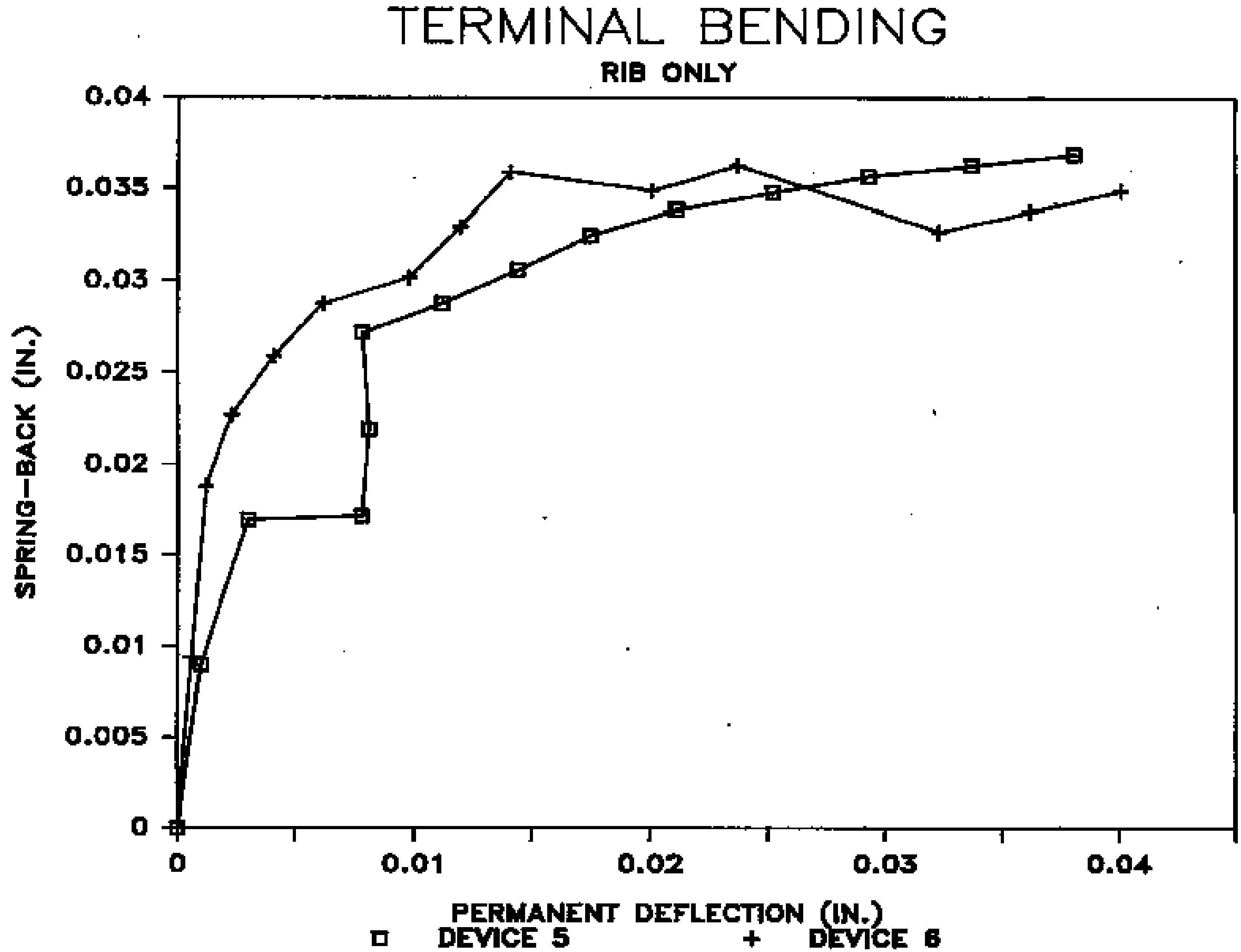


TERMINAL BENDING
FEATURELESS TERMINALS
SPRING-BACK (IN.)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
0.01
0.02
0.03
0.04
PERMANENT DEFLECTION (IN.)
□ DEVICE 1
+ DEVICE 2


TERMINAL BENDING
RIB AND NOTCH
SPRING-BACK (IN.)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.01
0.02
0.03
0.04
PERMANENT DEFLECTION (IN.)
DEVICE 7
DEVICE 8

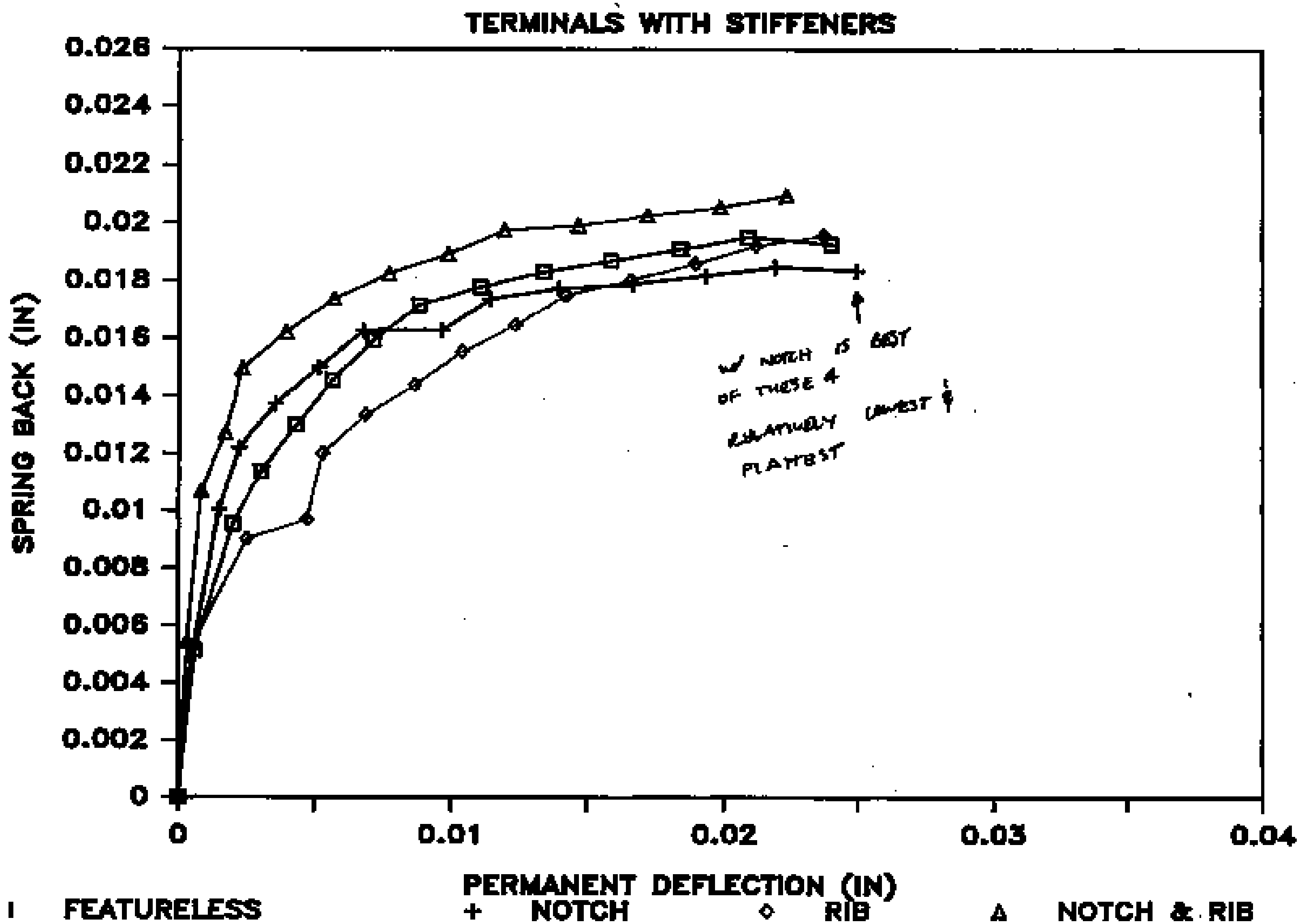


TI-NHTSA 000743

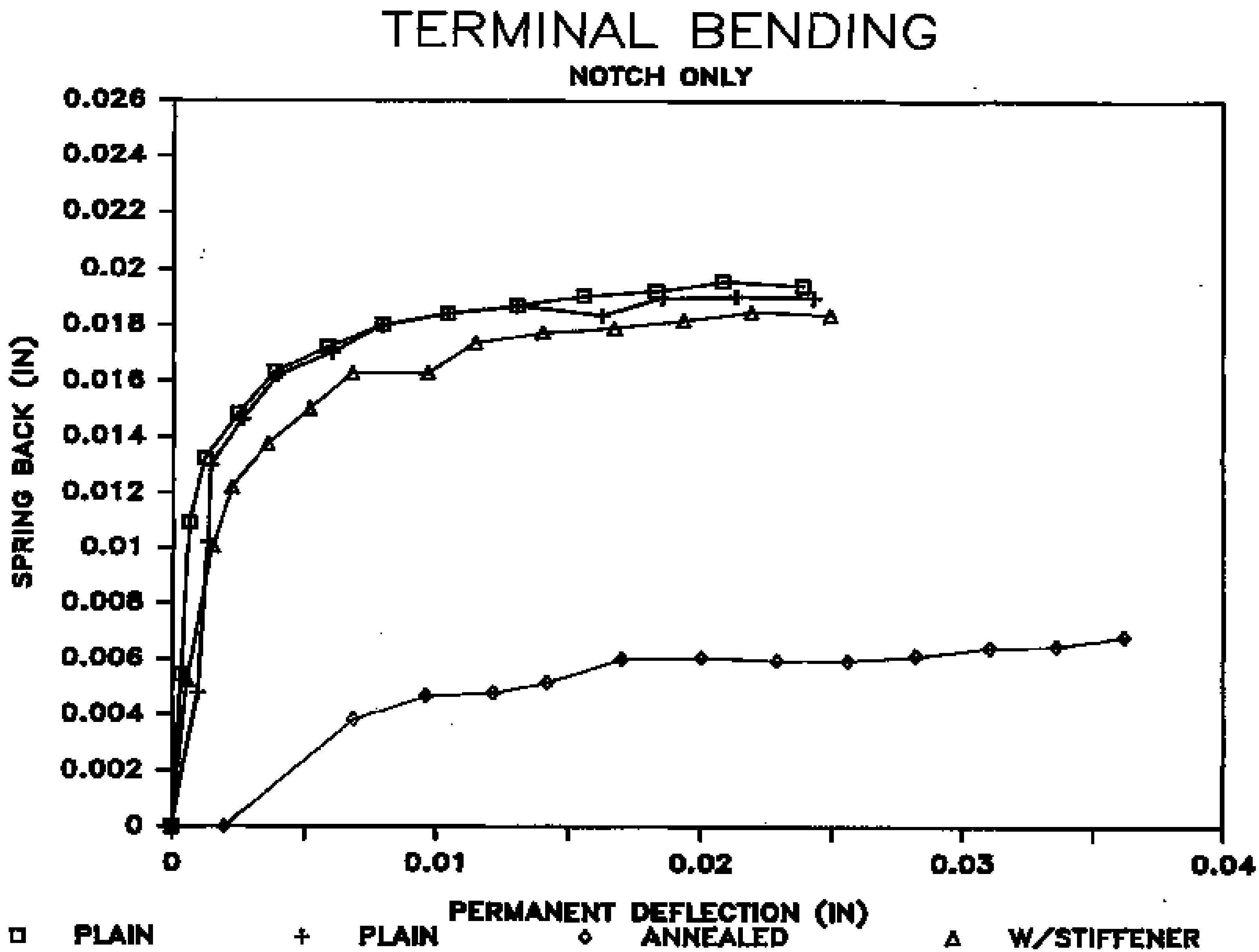


TI-NHTSA 000744

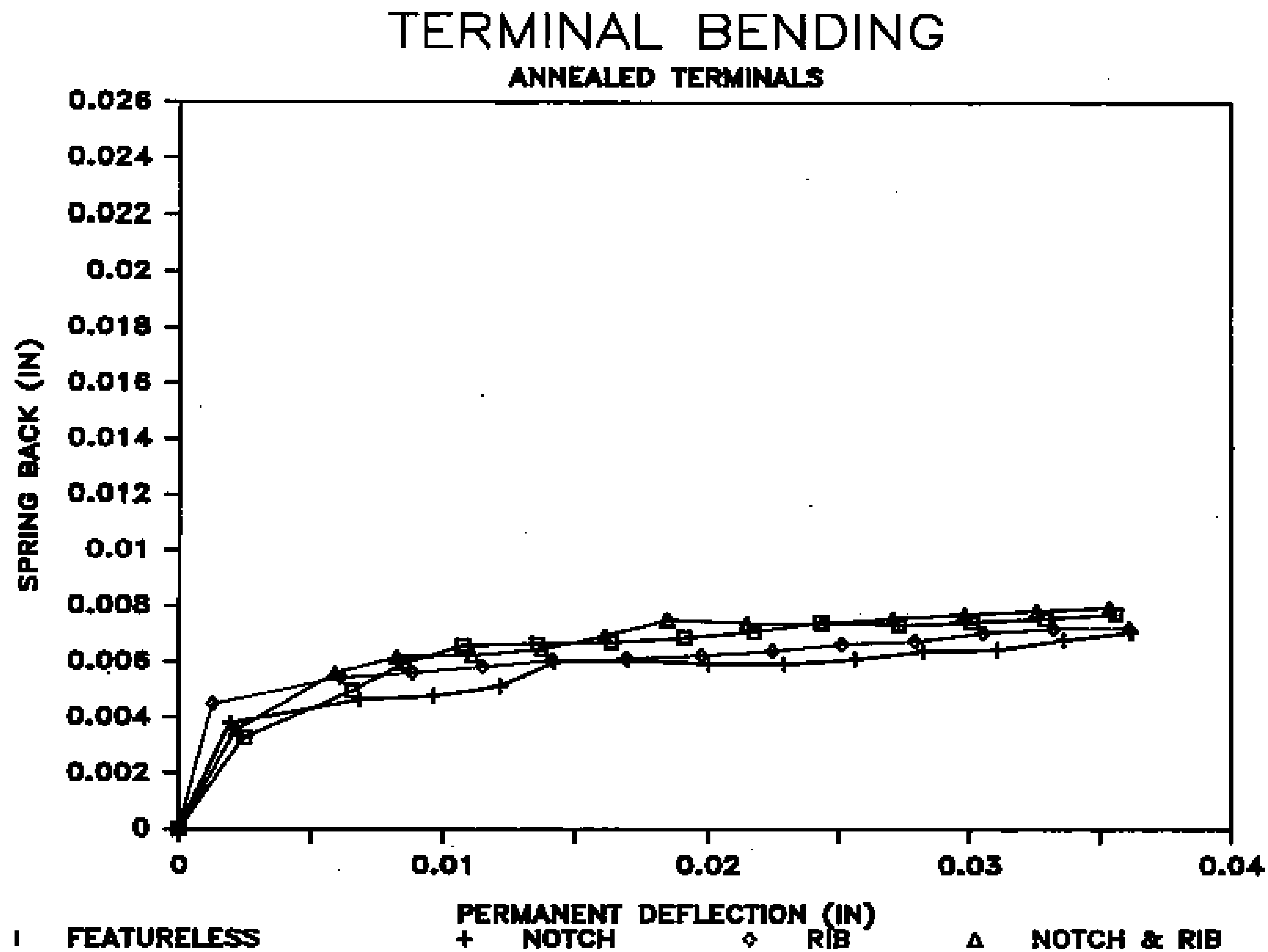
TERMINAL BENDING



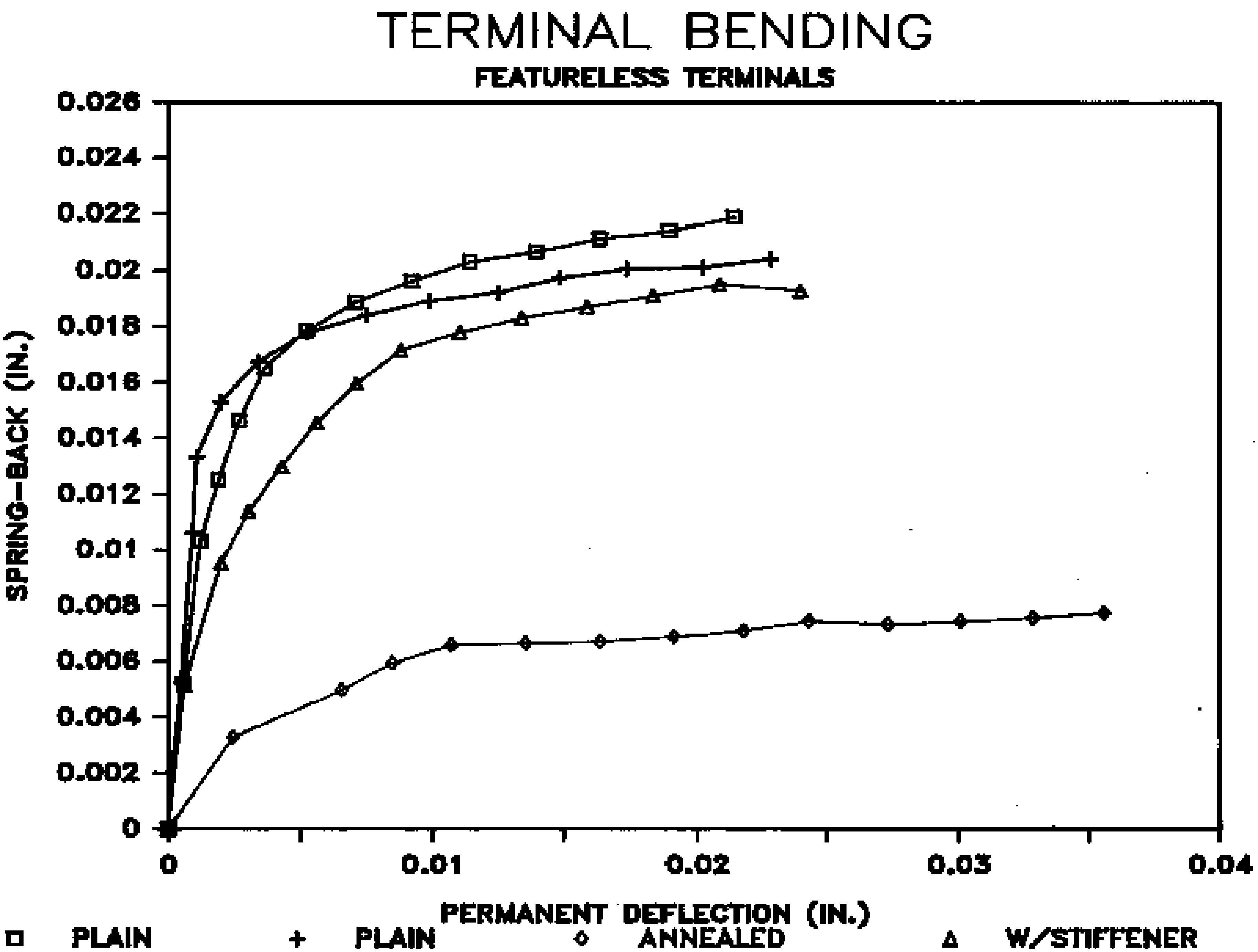
TI-NHTSA 000745



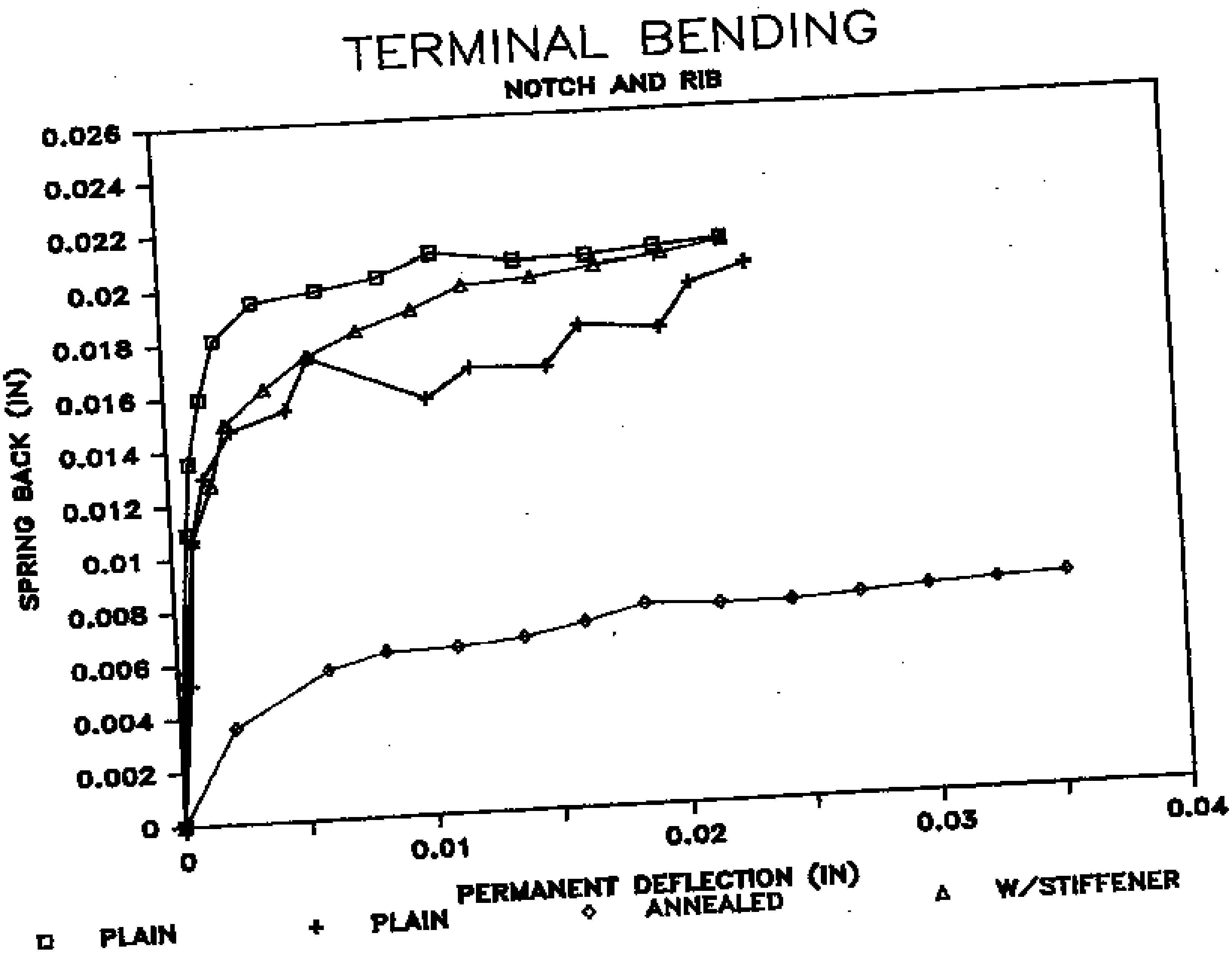
TI-NHTSA 000746



TI-NHTSA 000747

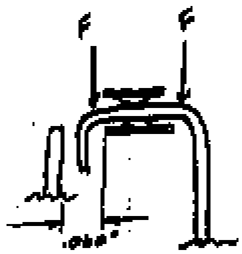


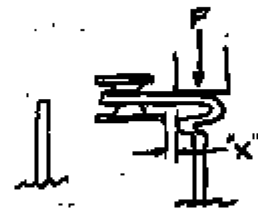
TI-NHTSA 000748

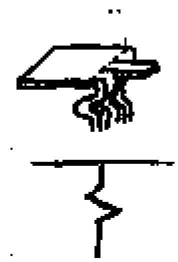

TERMINAL BENDING
NOTCH AND RIB
0.026
0.024
0.022
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
SPRING BACK (IN)
0
0.01
0.02
0.03
0.04
PERMANENT DEFLECTION (IN)
PLAIN
PLAIN
ANNEALED
W/STIFFENER

6/22/90

TERMINAL IDEAS





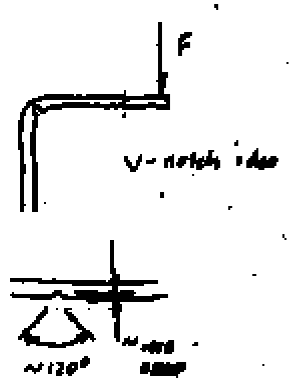


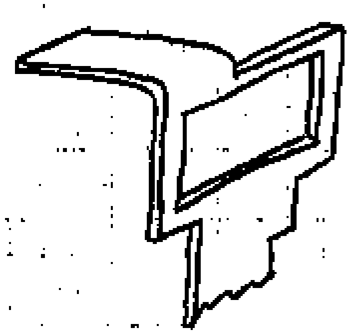
ANT "BRIDGE" STYLE

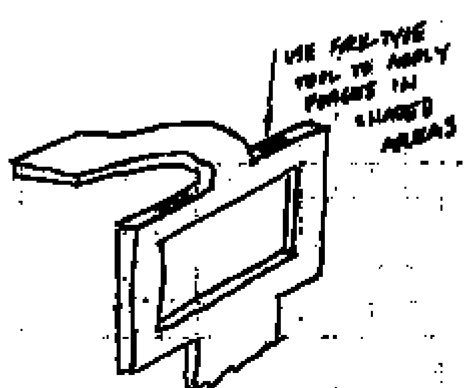
SERPENTINE "CRUSH"

- CANNOT APPLY FORCE @ CENTER
- VERY LITTLE ROOM, ~ .060", BETWEEN SPRING ARM & TERMINAL
- BATTLER INDICATES THIS IS A DIFFICULT TERM TO BUILD

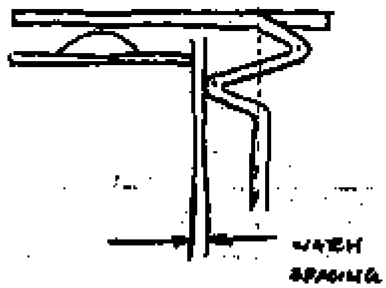
- FORCE APPLIED AWAY FR. SPRING
- NO MORE W/ INTERFERENCE W/ OTHER TERMINAL
- DIFFICULT TO MAKE ?
- NEED TO WATCH OUT FOR SPACING "X"



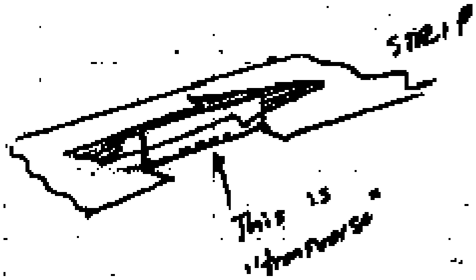




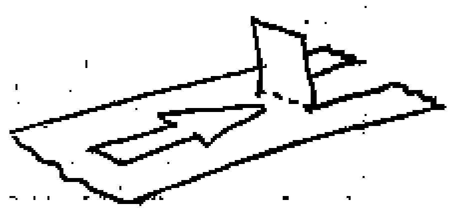
ANT BRIDGE STYLE



"GRAIN" effects: BeCu requires LARGER R/T for transverse bends

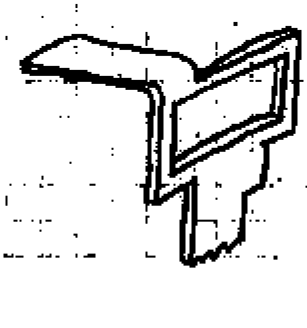


General conclusion — bends should be made across grain

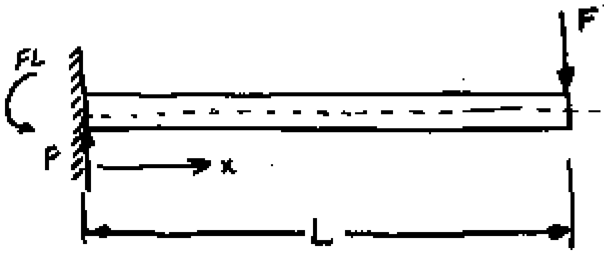


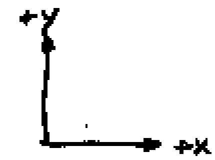
Purchasing:

* Emil 3494
* Jack 1573



CANT. BEAM BENDING





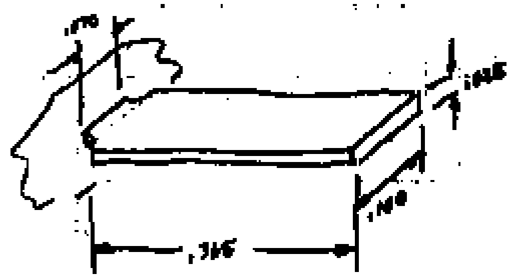
$y^{*} = \frac{Fx^2}{6EI}(x-3L)$ @ $x=L$, $y = \frac{-FL^3}{3EI}$ (customarily drop sign, use inspection to determine direction of deflection)

p334 Statics K.K. Stevens ...

$\sigma = My^{*}/I$ (eq. 8.10)

* THESE TWO 'Y' ARE NOT THE SAME! CORRECTED LATER

- M is the bending moment acting upon the particular X-sect of interest;
- I is the moment of inertia of that X-sect. about the bending axis;
- y is the vertical distance from the bending axis to the particular pt. of interest within the X-sect. (i.e. where shown)



NOTE: SUBSCR. "B" is BEAM, "W" is WALL

$$\sigma_w = \frac{My}{I_w} = \frac{FLy_w}{I_w}$$

$$I_w = \tfrac{1}{12} bh^3$$

$$\sigma_w = \frac{12FLy_w}{b_w h^3}$$

'F' is unknown, but y (defl @ end) is known. Rearrange defl. eq:

$$y = \frac{FL^3}{3EI_B} \qquad F = \left(\frac{3EI_B y_w}{L^3}\right)$$

$$\sigma(y) = \frac{12Ly}{b_w h^3}\left(\frac{3EI_B y}{L^3}\right) = \frac{3y^2E(b_B h_B^3)}{b_w h^3 L^2} = \frac{3y^2E}{L^2}\left(\frac{h_B}{h_w}\right)$$

$$\boxed{\cancel{\sigma(y) = \frac{3y^2E}{L^2}\left(\frac{b_B}{b_W}\right)}}$$

INCORRECT EQ.: PROB w/ 2 DIFF "y"

y = .0125 IN
E = 30E6 LB/IN²
L = .365 IN
b_B = .100
b_W = .070

$$\sigma(y) = y^2 (3)\left(12E6 \frac{LB}{IN^2}\right)\left(\frac{1}{.365^2 (IN^2)}\right)\left(\frac{.100}{.070}\right)$$

$$\sigma(y) = 3.86E8\, y^2 \quad [y \text{ in units of IN}]$$

SOLVE BACKWARD FOR "Y" GIVEN σ yield = 50K (assuming midpoint of 40-60, ½H)

50,000 psi = 3.86E8 y^2 y = .011"

$$\sigma_W = \frac{M_W y_W}{I_W} \quad \text{where} \quad M_W = FL, \quad I_W = \tfrac{1}{12} b_W h_W^3$$

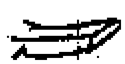
$$\sigma_W = \frac{FLy_W}{\frac{1}{12} b_W h_W^3} = \frac{12 F L y_W}{b_W h_W^3}$$

$$\delta = \frac{FL^3}{3EI_B} \longrightarrow F = \left(\frac{3\delta E I_B}{L^3}\right)$$

$$\sigma_W = \frac{12 L y_W}{b_W h_W^3}\left(\frac{3\delta E}{L^3}\right)\left(\frac{b_B h_B^3}{12}\right)$$

$$\sigma_W = \frac{3 y_W \delta E b_B h_B^3}{b_W h_W^3 L^2}$$

SOLVE THIS FOR "δ"



$$\frac{\sigma\, b_W h_W^3 L^2}{3 y_W E b_B h_B^3} = \delta$$

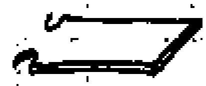
where: σ = 50K PSI
b_W = .070 IN
h_W = .025 IN
L = .365 IN
y_W = .0125 IN
E = 16E6 LB/IN²
b_B = .100 IN
h_B = .025 IN

b_W = .100 IN
h_W = .015 IN
y_W = .0075 IN

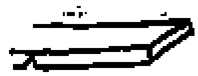
$$\delta_1 = \frac{50K\ \text{lb}}{\text{in}^2} \Big| \frac{.0[illegible]\ \text{in}}{3} \Big| \frac{.[illegible]^3\ \text{in}^3}{.[illegible]\ \text{in}^4} \Big| \frac{.365^2\ \text{in}^2}{.1[illegible]\ \text{in}} \Big| \frac{\text{in}^2}{16E6\ \text{lb}} \Big| \frac{}{.[illegible]^3\ \text{in}^3} \Big| = .008\ \text{IN}$$

$$\delta_2 = \frac{50K\ \text{lb}}{\text{in}^2} \Big| \frac{.100\ \text{in}}{3} \Big| \frac{.016^3\ \text{in}^3}{.0025\ \text{in}^4} \Big| \frac{.366^2\ \text{in}^2}{.100\ \text{in}} \Big| \frac{\text{in}^2}{16E6\ \text{lb}} \Big| \frac{}{.025^3\ \text{in}^3} \Big| = .004\ \text{IN}$$

δ_1 ABOVE IS FOR A CANTILEVER W/ SIDE NOTCHES



δ_2 ABOVE IS FOR A CANT. W/ "V" NOTCH



<08d8n08

TERMINAL BENDING TEST

DEVICE 1: FEATURELESS

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100		0.0010		0.0090
0.0200		0.0021		0.0179
0.0250		0.0033		0.0217
0.0300		0.0047		0.0253
0.0350		0.0064		0.0286
0.0400		0.0091		0.0309
0.0450		0.0123		0.0327
0.0500		0.0160		0.0340
0.0550		0.0198		0.0352
0.0600		0.0242		0.0358
0.0650		0.0284		0.0366
0.0700		0.0329		0.0371
0.0750		0.0371		0.0379

DEVICE 2: FEATURELESS

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0011	0.0009	0.0005	0.0091
0.0200	0.0021	0.0016	0.0009	0.0184
0.0250	0.0023	0.0019	0.0007	0.0231
0.0300	0.0024	0.0035	0.0004	0.0265
0.0350	0.0023	0.0060	0.0005	0.0290
0.0400	0.0022	0.0092	0.0001	0.0308
0.0450	0.0018	0.0131	-0.0001	0.0319
0.0500	0.0015	0.0172	-0.0005	0.0328
0.0550	0.0011	0.0217	-0.0010	0.0333
0.0600	0.0007	0.0258	-0.0012	0.0342
0.0650	0.0001	0.0302	-0.0018	0.0348
0.0700	0.0000	0.0351	-0.0021	0.0349
0.0750	-0.0002	0.0396	-0.0024	0.0354

DEVICE 3: NOTCH ONLY

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0016	0.0006	0.0004	0.0094
0.0200	0.0024	0.0011	0.0008	0.0189
0.0250	0.0025	0.0021	0.0008	0.0229
0.0300	0.0023	0.0043	0.0009	0.0257
0.0350	0.0020	0.0067	0.0003	0.0283
0.0400	0.0018	0.0102	0.0000	0.0298
0.0450	0.0012	0.0138	-0.0004	0.0312
0.0500	0.0007	0.0181	-0.0011	0.0319
0.0550	0.0003	0.0226	-0.0018	0.0324
0.0600	0.0000	0.0270	-0.0021	0.0330
0.0650	-0.0005	0.0317	-0.0028	0.0333
0.0700	-0.0010	0.0361	-0.0031	0.0339
0.0750	-0.0014	0.0414	-0.0032	0.0336

DEVICE4: NOTCH ONLY

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0015	0.0017	0.0009	0.0083
0.0200	0.0028	0.0023	0.0010	0.0177
0.0250	0.0029	0.0025	0.0090	0.0225
0.0300	0.0030	0.0046	0.0090	0.0254
0.0350	0.0030	0.0069	0.0080	0.0281
0.0400	0.0030	0.0105	0.0040	0.0295
0.0450	0.0029	0.0138	0.0010	0.0312
0.0500	0.0026	0.0181	0.0000	0.0319
0.0550	0.0024	0.0226	0.0000	0.0324
0.0600	0.0023	0.0282	0.0000	0.0318
0.0650	0.0023	0.0321	0.0000	0.0329
0.0700	0.0023	0.0370	0.0000	0.0330
0.0750	0.0023	0.0421	-0.0001	0.0329

DEVICE 5: RIB ONLY

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0011	0.0010	0.0004	0.0090
0.0200	0.0021	0.0030	0.0009	0.0170
0.0250	0.0022	0.0078	0.0011	0.0172
0.0300	0.0027	0.0081	0.0011	0.0219
0.0350	0.0029	0.0078	0.0010	0.0272
0.0400	0.0028	0.0112	0.0009	0.0288
0.0450	0.0025	0.0144	0.0008	0.0306
0.0500	0.0022	0.0175	0.0004	0.0325
0.0550	0.0020	0.0211	-0.0001	0.0339
0.0600	0.0018	0.0252	-0.0007	0.0348
0.0650	0.0013	0.0293	-0.0010	0.0357
0.0700	0.0009	0.0337	-0.0014	0.0363
0.0750	0.0004	0.0381	-0.0017	0.0369

DEVICE 6: RIB ONLY

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0016	0.0006	0.0004	0.0094
0.0200	0.0029	0.0012	0.0000	0.0188
0.0250	0.0028	0.0023	0.0000	0.0227
0.0300	0.0028	0.0041	0.0000	0.0259
0.0350	0.0023	0.0062	-0.0004	0.0288
0.0400	0.0019	0.0098	-0.0008	0.0302
0.0450	0.0019	0.0120	-0.0012	0.0330
0.0500	0.0012	0.0141	-0.0017	0.0359
0.0550	0.0009	0.0201	-0.0021	0.0349
0.0600	0.0001	0.0237	-0.0030	0.0363
0.0650	-0.0003	0.0328	-0.0035	0.0327
0.0700	-0.0005	0.0362	-0.0038	0.0338
0.0750	-0.0006	0.0401	-0.0040	0.0349

TERMINAL BENDING TEST

DEVICE 7: NOTCH & RIB

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0009	0.0004	0.0000	0.0096
0.0200	0.0015	0.0011	0.0003	0.0189
0.0250	0.0018	0.0015	0.0004	0.0235
0.0300	0.0021	0.0024	0.0004	0.0276
0.0350	0.0023	0.0036	0.0007	0.0314
0.0400	0.0027	0.0063	0.0009	0.0337
0.0450	0.0029	0.0107	0.0009	0.0343
0.0500	0.0029	0.0150	0.0009	0.0350
0.0550	0.0024	0.0187	0.0007	0.0363
0.0600	0.0014	0.0244	0.0004	0.0356
0.0650	0.0010	0.0293	0.0001	0.0357
0.0700	0.0006	0.0339	-0.0003	0.0361
0.0750	0.0005	0.0386	-0.0008	0.0364

DEVICE 8: NOTCH & RIB

Y-DUR	X-DUR	Y-POST	X-POST	SPRNGBK
0.0100	0.0009	0.0009	0.0001	0.0091
0.0200	0.0014	0.0015	0.0001	0.0185
0.0250	0.0017	0.0025	0.0002	0.0225
0.0300	0.0019	0.0045	0.0001	0.0255
0.0350	0.0019	0.0083	0.0001	0.0267
0.0400	0.0019	0.0100	0.0001	0.0300
0.0450	0.0014	0.0180	0.0000	0.0270
0.0500	0.0012	0.0211	-0.0001	0.0289
0.0550	0.0009	0.0263	-0.0002	0.0287
0.0600	0.0008	0.0297	-0.0002	0.0313
0.0650	0.0004	0.0341	-0.0004	0.0309
0.0700	0.0002	0.0363	-0.0006	0.0337
0.0750	-0.0001	0.0402	-0.0007	0.0348

k00d@w08

TEXAS INSTRUMENTS

April 19, 1990

Lisa Robinson
Ford Motor Company
SEC Annex
15001 Commerce Drive North
Dearborn, MI 48120

Dear Lisa:

Attached, please find quality and reliability information relating to leak, calibration, and temperature drift for the next generation cruise control pressure switch which TI will be supplying to Ford.

As you will note, a significant portion of the reliability data actually revolves around the power steering pressure switch which TI is supplying to Ford. Since the cruise control pressure switch is a future production device, we felt it best to present information for a current production device which is similar in nature. Also, the test methodology described would be identical for both pressure switches.

In regard to the weight and cost information you requested, this is as follows:

	Weight	Selling Price
CCPS	68 grams	$2.05
Modified 57PS	70 grams	$2.97

In designing the cruise control pressure switch, we were tasked to provide a functional switch which utilized the latest in manufacturing technology in order to provide a low piece price. To that end, we feel we have developed a switch which will meet or exceed all the goals Ford has put forth.

If you require additional information or have questions based on the enclosed information, please feel free to contact either myself or Joe Schuck.

Sincerely,

Charles L. Douglas

Charles L. Douglas
Product Marketing Engineer
Precision Controls Department

cc: Joe Schuck, TI-FSE, Farmington Hills, MI
John Haynes, Quality Engineer, Attleboro
Steve Offiler, Design Engineer, Attleboro

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 53-15-10

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PS		SBO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	7/13/90	7/16/90	

PROJECT TITLE: Cruise Control Pressure switch

CUSTOMER:

PURPOSE OF TEST: To see if gasket + backer seal could be replaced with a single diaphragm

PROCEDURE: Modify baseplate for diaphragm.
assemble w/ .045" diaphragm
50% compression on bump
10% compression o.d. bump

Discs $\bar{X}$ 47.5 / 38.47
σ .74 / 11.00

Device #	Initial Act	Clear Act		
53-15-01	544	388	leak @ 13K	
02	568	402	leak @ 13.5K	
03	557	388	leak @ 4100 Cycles	
04	549	416		
05	534	415		
06	540	389	leak @ 11,700	
07	549	412	Leak @ 13,400	
08	529	393	leak @ 11,900	
09	547	400	leak @ 13.5K	
10	537	395		

Test aborted @ 13.5K cycles

TI-NHTSA 000756

HIGHLIGHTS

Stephen B. Offiler
Week Ending 04/20/90

<u>FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423</u>

CUSTOMER ISSUES: We have received a request from Pass-Car for a switch at each end of their actuation range: 90 psi and 160 psi. The purpose is so they may test the performance of the cruise control system deactivation at each end of the tolerance range, to determine if this range is truly acceptable. This mimics testing already done for Light Truck. We are not far enough along with the LRC design and testing to fill this need, however. Two problems exist: one, the proof performance question; and two, the fact that only model shop LRC parts are available, in very limited quantities.

We are still holding the 10 Kelsey-Hayes parts pending the LRC proof testing. We have received an adequate number of J512 hexports from the model shop to fill Light Truck's need for 64 parts.

Joe Schuck will be visiting Ford today on two separate matters. One, he will negotiate with Pass-Car to get the release spec. down from 40 psi (a legacy from the Light Truck spec) to 20 psi. Two, he will meet with Ron Preston, connector guru, to attempt to win approval for opening up the inner dimension on the connector which we need to provide room for the twist tool.

AUTOMATED SWITCH: The twist tool, broken last week, is being rebuilt by Mechanization. It has been made larger, built out of higher strength steel, and is being more carefully heat-treated. It should be complete very soon. I have delivered hand-modified bases to Mech. using the new inner dimension so they may try the new tool as soon as it is done. The plan is to build several proto's to exercise the twist concept, and to test these using established terminal strength tests.

A calibration scheme has been developed by Mech. For the N.O. switch, they plan to push down on the spring with a force T-B-D to close the contacts, then move the deformable stationary terminal down until the spring bump is in the T-B-D correct position. Determining the correct position will need to comprehend spring arm deflections and terminal springback. They plan to incorporate software that will collect data on these unknowns and continuously update the correction factor.

To improve the performance of the cal. scheme, a spring which is more resistant to unwanted deflections is needed. I have developed a stiffened design using a channel cross-section. The model shop is building prototypes of this design from .004, .006, and .008 BeCu 190HM material.

We have received samples of the 1NT - style stationary terminal design, and performed benchtop springback testing. Results are fairly similar to the actual 1NT. These results have been presented to Mech. and were well received. The next steps will be to develop a print, work with Bussler to refine the design for production, as well as to build these terminals into actual bases along with the new spring design for feasibility testing and spring life testing.

We have received simplified prototypes of the "eyelet" rivetless assembly concept from the model shop. These were done using soft brass. As time permits, we will test the concept, probably using a Bracker riveter. Fixturing, etc. is T-B-D.

SENSOR: The gating item is the LRC test. The model shop indicates that we'll have parts by mid-next week, and the next round of testing should be complete by the end of next week. The LRC test will exercise 301 and 455 SS in a matrix to determine the maximum proof pressure we can withstand. Three possible outcomes exist: miserable failure (quantified as proof less than 3250 psi); success (proof greater than the present spec. of 4000 psi) or something in-between. Miserable failure will lead to an emergency re-evaluation of using a converter sensor for Pass-Car, with fall-back to the direct disc design. Mediocre performance will lead to another iteration of the LRC, bringing the ratio from 6 to about 7.5. Of course, success means we proceed immediately with development of final prints and tooling for the converter parts.

Running in parallel with the above is a three-way Impulse test, with devices using zinc converters; devices using rubber diaphragms in place of the gasket and Kapton seals; and regular production devices using the same 455 SS discs as the LRC test above.

MISCELLANEOUS: Keith Roberts continues to refine the overall program schedule. I will be breaking down several of the design-related line items into greater detail so we can determine the true amount of time needed to complete these. QRA inputs are needed to define the PV, ISIR, and IP testing requirements. These are complicated by the fact that we've got two separate programs (Pass Car and Light Truck) and two separate Job-1 dates for each program (modified 57PS and true CCPS).

I am nearing completion of an invention disclosure which encompasses all aspects of the automated switch design.

4/20/90

HIGHLIGHTS

Stephen B. Offiler
Week Ending 04/27/90

<u>FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423</u>

CUSTOMER ISSUES: Joe Schuck has had several meetings with various players at Ford who are involved with the NGSC program. Bad news includes: Pass-Car wants to use a flare fitting called an "isoflare"; this apparently isn't covered in SAE specs. Ford is forwarding info to us. Fred Hendershot is making demands that we pull in our schedule. Good news includes: they have accepted our connector dimension change which allows use of a thicker, stronger twist tool; and Pass-Car has accepted our proposed reduction in release from 40 psi min to 20 min.

SAMPLES: Apparently the need for samples at Kelsey-Hayes was truly immediate; Joe requested that we do whatever it takes to get something in their hands immediately. (Samples destined for K/H were being withheld because of low proof capability). To fulfill the need, we put together 10 parts using the old direct disc design. These were shipped with a disclaimer that the devices were not representative of production.

Sixty-four Light Truck samples are due next week; there should be no problem meeting this need.

SENSOR: Parts for the critical Low Ratio Converter test have not yet arrived from the model shop; however, I have confirmed that they are working on them right now. We should be able to complete the proof test with these parts early next week.

We began a 500K Impulse cycle test this week with four separate lots of devices: zinc converters; zinc hexports; rubber diaphragms; and 455SS discs. Results to-date: all six zinc converters had completely collapsed by 4.2K; 7 of 10 rubber diaphragm devices failed by 13.5K, failure mode is a perforation in the center of the diaphragm probably related to excessive stresses arising from compression during manufacture and aggrivated by reversed stresses during cycling; 1 of 3 zinc hexports failed at 71K cycles, failure mode is related to creep of the zinc which opened up a gap for the gasket to extrude into (the other two expected to fail very soon); finally, the 455SS discs built with production converter parts have passed 71K and are scheduled for a characterization at 250K cycles.

AUTOMATED SWITCH: Mechanization reports that they've completed rebuild of the twist tool. We are awaiting prototypes twisted with the tool which will undergo conventional terminal strength tests.

We've defined action items needed to finalize the design of the switch assembly, including base, terminals, and spring. This includes the following:

Flange for any seal ring too!
BASE (highest priority): shift the connector .020 to make it concentric with the rest of the switch; create feature(s) to locate the stationary terminal; modify the features which locate the movable terminal to improve fit; and take care of inconsistencies in the lock tabs.

TERMINALS AND SPRING: create two new stationary terminal prints using the INT approach (N.O. and N.C.); modify all 5 terminals for compatibility with the centered connector; insure that the pin reference dimension (at transfer) is .095"; finalize the anti-rotation feature between the spring and the movable terminal.

Steve Offiler 4/27/90

HIGHLIGHTS

Stephen B. Offiler
Week Ending 05/04/90

Knowles

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES/SAMPLES: Sixty-four devices for Ford Light Truck were shipped yesterday via overnight. This completes present LT sample needs. Pass-Car has requested special test devices which actuate at the extremes of the tolerance (90 psi and 160 psi). They've been informed that we can meet this need in six weeks. To do so, we plan to use the direct-disc design, employing Dave Brown to develop discs which operate roughly in these two ranges. Karl Abrahamson indicates that a portion of Dave's time can be made available for this effort next week.

Joe Schmuck forwarded to me a "final" copy of the Engineering Specification, which covers both Truck and Car devices. Even after several iterations, I still found a few areas with discrepancies, typos, etc. I've forwarded a MSG to Joe detailing this.

We have still not received any information on the "Isofast" fitting which Pass-Car supposedly favors. This was promised last week, and is holding up progress on hexport design, cost estimates, etc.

We've received word that Ford will require envelope prints to: 1) utilize ANSI Y14.5M-1982 (GDT) and 2) use Metric units. I assume this applies immediately, and any prints submitted from now on must conform to this.

SENSOR: The model shop delivered the Low Ratio Converter parts, and the LRC Proof Test was carried out. Results need some theoretical interpretation (i.e. Shelley White and/or Ted Ballard) but we basically found: 1) Based on crown height measurements, the 301 discs deformed early, but the deformation was constant and independent of proof pressure; whereas the 455SS discs did not show any deformation until about 3K psi proof, then began to increase with increasing pressure as expected. 2) Based on free-disc measurements, the 455 overall deformed less than the 301SS, however it had a greater negative slope (% change vs proof); at 4K psi the 455 and 301 show almost the same deformation. In other words, the 301 deforms predictably and linearly, while the 455 resists deformation longer but then begins to take off. 3) Based on measurements taken on sensors, the 455 again has a greater negative slope, and at 4K psi the % change is worse than the 301. 4) The 4000 psi proofed 455 discs have obvious deformations when observed with the naked eye. One possible conclusion is to go with this LRC design, using 301 discs, and submit every device to a "pre-deformation" proof pressure on the assembly line.

AUTOMATED SWITCH: Work is progressing on iterations and modifications to the base, terminals and switch. At present, it looks like another iteration to the prototype base mold will be required, in order to save time over doing it "right" and completely rebuilding it. This means that the next prototypes will still have offset connectors, but will be useful to test the revisions that are being made to the terminals. Furthermore, this means two complete sets of base and terminal prints, both offset and centered, and the attendant overhead and potential for confusion that this creates. Continuing at my present rate, I plan to be ready to submit CR's to drafting early- to mid-next week.

NODE

At present, it appears that the stiff-spring idea is doomed to failure. Work will progress on the flat spring, including measurements of force vs deflection which are needed by Mechanization to assess the possibility of calibration.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 55-15-01

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
5785	5/11/90	SBB	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAB	6/11/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: To test Powder Metal LRC converters

PROCEDURE:
1. Standard initial characterization.
2. Proof 2 devices to 42 psi.
3. Recharacterize all 4
4. 500K impulse straight through
5. Recharacterize all 4.
6. Rtn to Mfg eng.

Sensor #	I A Act	I A Rel	Proof	After Proof Act	After Proof Rel	500K Act	500K Rel		
CS-11-01	253	242	✓	311	238	Leak	@ 25K		
02	350	250	✓	314	241				
03	346	244		344	241				
04	334	233		340	233	Leak	@ 92.5K	[illegible]	[illegible]

Sensor #	after 253K Act	after 253K Rel
55-15-02 -03	Array [illegible]	

Test aborted @ 253K cycles

TI-NHTSA 000763

HIGHLIGHTS
Stephen B. Offiler
Week Ending 05/11/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: Still no word from Ford on the "isoflare". I've been reminding Joe Schmck of the need for this information via MSG's. Also, metric conversion of the envelope prints is underway. The next print iteration will try to encompass all of Ford's requirements.

AUTOMATED SWITCH: It is generally agreed that the present twist design creates too much of a burr in the plastic. Work is ongoing to try to eliminate this by modifying the twist features, and/or by use of stake features in addition to twist. I have looked into the 55/56/58PS-style stake, and the new *52PS-style* stake. The 52PS is the clear favorite. The problem with the other is the fact that interference exists between the terminals and the base slots, requiring force to insert. This will not work on the CCPS because the force will tend to deform the twistable portion of the terminal during insertion. This staking effort also serves to address the issue of tightening the terminals in the base.

We are running force-deflection curves on 55PS bases with Pete Sampson's help and equipment. These will allow us to take a first-pass look at how the force-to-transfer varies, and how the overtravel dimension varies when choosing a fixed-force. This type of work will be repeated in more detail on actual CCPS springs.

Checking with Stan Homol, I've learned that the present 57PS base material, Gafite 1662Z, will in fact be phased-out over time. The best choice for replacement is Celanex 4300. Therefore, it has been decided to go with the Celanex now, during mold development.

SENSOR: We had a brief meeting with Shelley White to help interpret last week's Low Ratio Converter Proof Test results. Our results showed the 301SS to deform at relatively low proof pressure, and to deform linearly and predictably as proof increased; while the 455SS seemed to resist deformation at lower proof pressures, and to take off non-linearly beyond a certain point. We learned from Shelley that 455SS, when not optimally heat-treated, has a higher elastic limit but a lower .2% yield and ultimate strength compared with 301SS. This fits in perfectly with our observations. Also, better heat-treatment of 455SS will increase its properties substantially above 301. We are particularly concerned with the elastic limit, since raising this value gives better control over "drift" and better cycle life. Another meeting has been set up for early next week with Shelley, Ted Ballard, and Jeff Melton. We will outline an action plan to investigate 455SS heat-treatments, etc.

Mfg. Eng. and Design are collaborating on a test of powder-metal converters. This could prove to be the best way to build low-ratio converters, since the stamping house which makes the present converter claims that our LRC will be very difficult to stamp.

MISC: Ford's spec. now requires us to monitor each switch during cycle testing, to ensure that 1) each switch is opening and closing normally and 2) the pressure actually falls below the release point with each cycle. Jeff DiDomenico has designed a circuit that will do this. It uses the function generator signal as reference, and provides an output to stop the cycler if an abnormality is discovered. Operating on each switch individually, it will detect if any switch is stuck either open or closed.

PRESSURE SWITCH DATA FORM 21605 TEST NO. 312-03-29

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY** Rec'd 5/16/90	

PROJECT TITLE:

CUSTOMER:

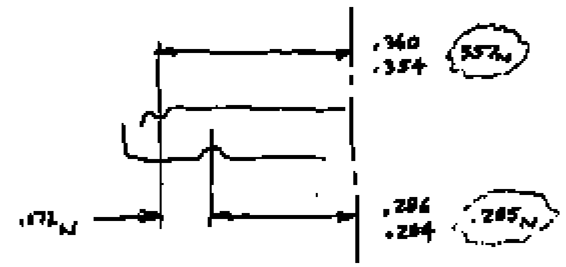
PURPOSE OF TEST: 1-12 ARE LARGE-DIA. BUMPS +.030 ON ORIG. DIA (ϕ BUMPS IN CUP) ϕ.600
13-24 ARE SMALL-DIA BUMPS -.030 " " " ϕ.540

NOM. BUMP IS ϕ.570

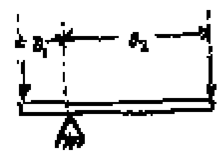
PROCEDURE:

			Sensors (INITIAL)		324,964 CYCLES					
Disc	Act	Rel	Actuation	Release	Actuation	Release	INIT. ACT. RATIO			
1	62.4	45.2	827	589	850	570	13.28			
2	62	46	790	548	780	500	12.92			
3	62.4	45.4	845	598	off	off	13.54			
4	63.2	47	790	560	off	off	12.50			
5	62.4	46	861	591	845	593	13.80			
6	62.0	45	786	560	850	585	12.68			
7	63.0	39	830	565	off	off	13.17			
8	62.8	44.2	830	565	off	off	13.22			
9	63.6	46.2	814	572	INCIPIENT	SNAP	12.80			
10	63.0	46.4	797	575	800	550	12.65			
11	63.2	45.6	785	577	780	537	12.42			
12	62	45	840	574			13.55			
							$\bar{x}$ = 13.00			
							σ = 0.48	%σ = 3.7%		
13	62.8	45.8	532	405	497	365	8.47			
14	64	46.4	510	396	off	off	8.20			
15	62.2	44.3	500	368	off	off	8.04			
16	63.8	47.2	547	410	off	off	8.57			
17	62.6	46.4	534	405	INCIPIENT	SNAP	8.53			
18	63.6	46.2	537	407	INCIPIENT	SNAP	8.50			
19	62.2	46.4	537	405	INCIPIENT	SNAP	8.63			
20	62.8	46.2	550	376	INCIPIENT	SNAP	8.76			
21	63.4	46.2	565	423	off	off	8.91			
22	63	46	536	402	off	off	8.51			
23	63.6	46	582	455 weak	off	off	9.15			
24	63	46.2	546	411	523	374	8.67			
							$\bar{x}$ = 8.59			
							σ = 0.28	%σ = 3.3%		

TI-NHTSA 000765

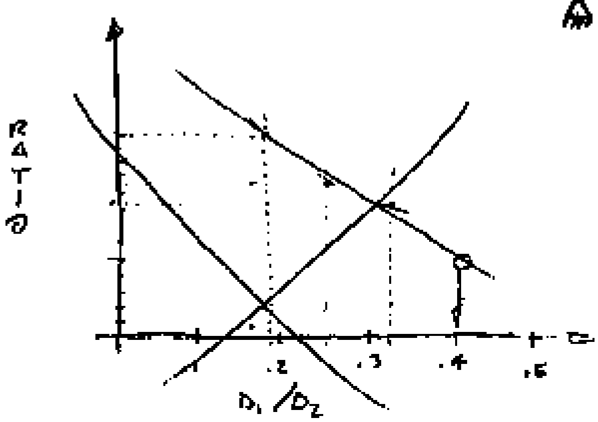


$\boxed{D_1/D_2} = .072/.285 = .253$



Mechanical "disadvantage" = D_1/D_2

LEVER-ARM ANALOGY:



		D_1/D_2	R	D_2/D_1
HI:	.057/.300	.190	13.40	5.26
MID:	.072/.285	.253	9.5	3.96
LOW:	.087/.270	.322	8.6	3.10

$D_1/D_2 \cong .400$ FOR $\cong$ 5:1 RATIO

$\frac{A}{B} = .4 \qquad A+B = .357$

$A = (.357-B)$

$\frac{.357-B}{B} = .4B$

$+B \qquad +B$

$.357 = 1.4B \qquad B = .255$

$A = .102$

SO 5/16/90

DISC MTG II

Thicker disc w/ lower HT (what HT temp?)

Thinner disc w/ higher HT

Mult discs

* Change ~~variables~~ bumps ~~(Ray Marcoux...)~~

* Hole in disc .012 301V for stack (more throw for given pressure)

.012 455 w/ hole ??

* Stay on converter - look @ geometry (STAN)

Is converter bending ?? Analyze

JEFF: hole in disc → spec = 12-15 psi

VRANCX ~~what converter detail, actual converter part~~ ~~Mention disc w/ ... appropriate in ... matl~~

S.O. Cups w/ bumps - mount in; get discs

S.O. Talk to Stan

Note: collect data i.e. ... height, etc.
also Kaman mat'ls

May need Ray later

LOW RATIO CONVERTER PROOF TEST

GOAL:
To determine the maximum proof pressure that the LRC can withstand with either 301SS or 455SS.

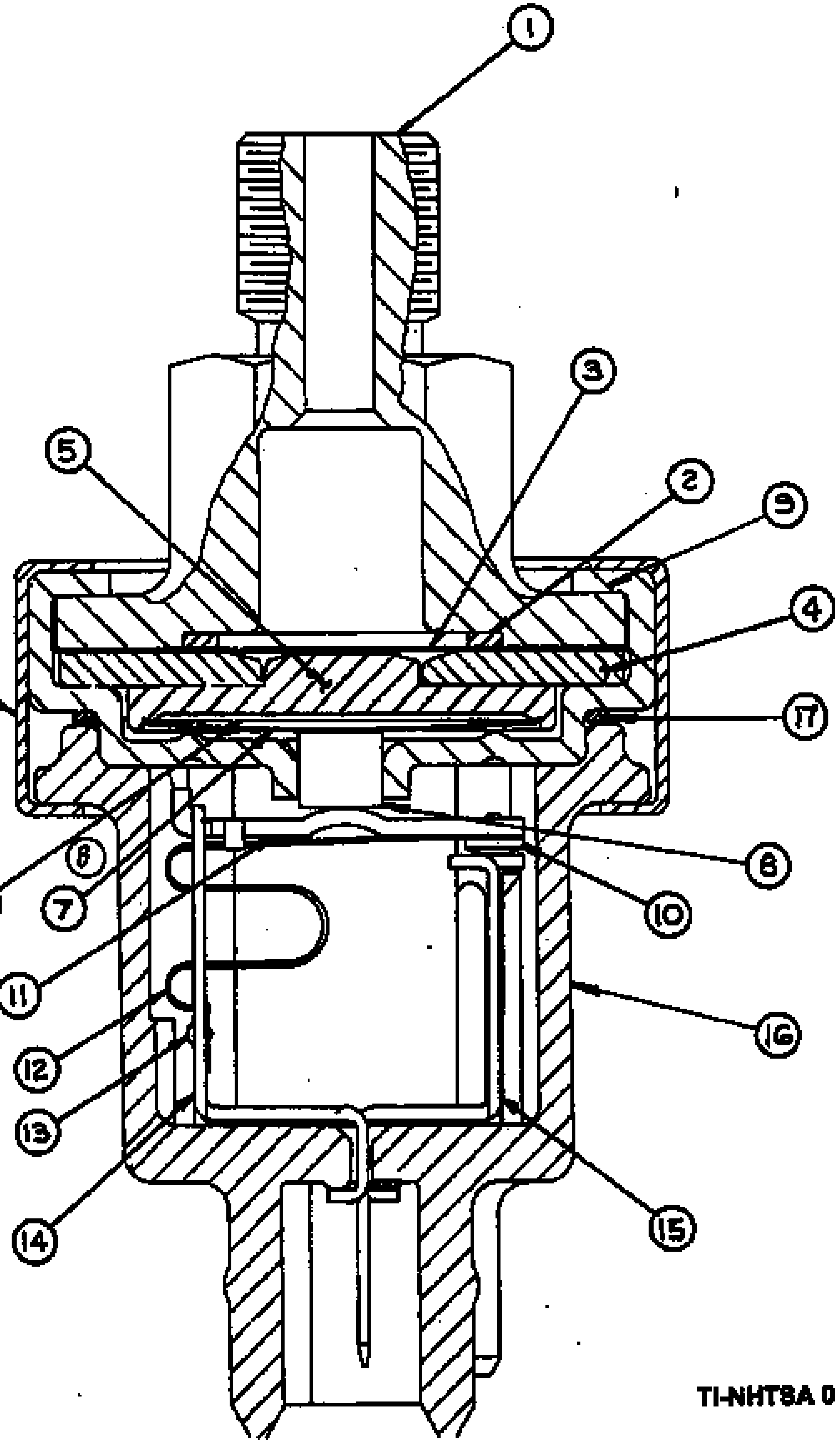
SCOPE:
Preliminary testing of the LRC showed what appeared to be disc (301SS) deformation under proof loads, resulting in permanent actuation shifts downward (rel. not measured) on the order of 10%. This test will attempt to quantify the magnitude of the problem. Information from Stan Homol indicates that 455SS may help the situation, so the test will use both SS materials. Test devices will be subject to increasing proof loads, with appropriate initial and final characterizations.

(Note: for this entire test, "characterization" means both actuation and release values.)

PROCEDURE:
1) Obtain 20 LRC's from model shop (expected 04/18/90).
2) Obtain 301SS discs, same as from previous test (22 psi).
3) Obtain 455SS discs from Disc Dept. (expected 04/18/90).
4) Initially characterize a quantity of each disc in the free state, then hand-pick 10 discs for each test lot which are very similar in characteristics.
5) Measure the crown height of all 20 discs.
6) Build a total of twenty sensors, ten of each disc mat'l.
7) Initially characterize all 20 sensors as follows: 2 overpressure cycles to 600 psi, switch three more times, take the sixth reading.
8) Separate the sensors and proof test as follows: two of each lot are controls (no proof test); proof two of each to 2000 psi, 3000 psi, 3500 psi, and 4000 psi.
9) Recharacterize all sensors as follows: switch three times, take the fourth reading.
10) Decrimp all sensors, remove the discs, and recharacterize them in the free state, and remeasure the crown heights.

DATA:
Column headings are as follows: Initial free disc act/rel; initial crown height; initial sensor act/rel; final sensor act/rel (after proof); final free disc act/rel; final crown height; % chg sensor; and % chg free disc; % chg crown height. Do not calculate any avg's and std dev's for the columns. Instead, draw four scatter graphs (no lines between data points). These graphs are for the sensor data. We will determine later if free disc data or crown height data need to be examined. One covers 301 actuation, one covers 301 release, and the other two cover 455SS. The x-axis is proof pressure, and the y-axis is % chg. Use % chg numbers directly, so that there will be two data points for each of the five proof pressures (counting the controls @ zero proof pressure) for each of the four graphs.

(Filename: LRCPROOF) SBO 04/10/90

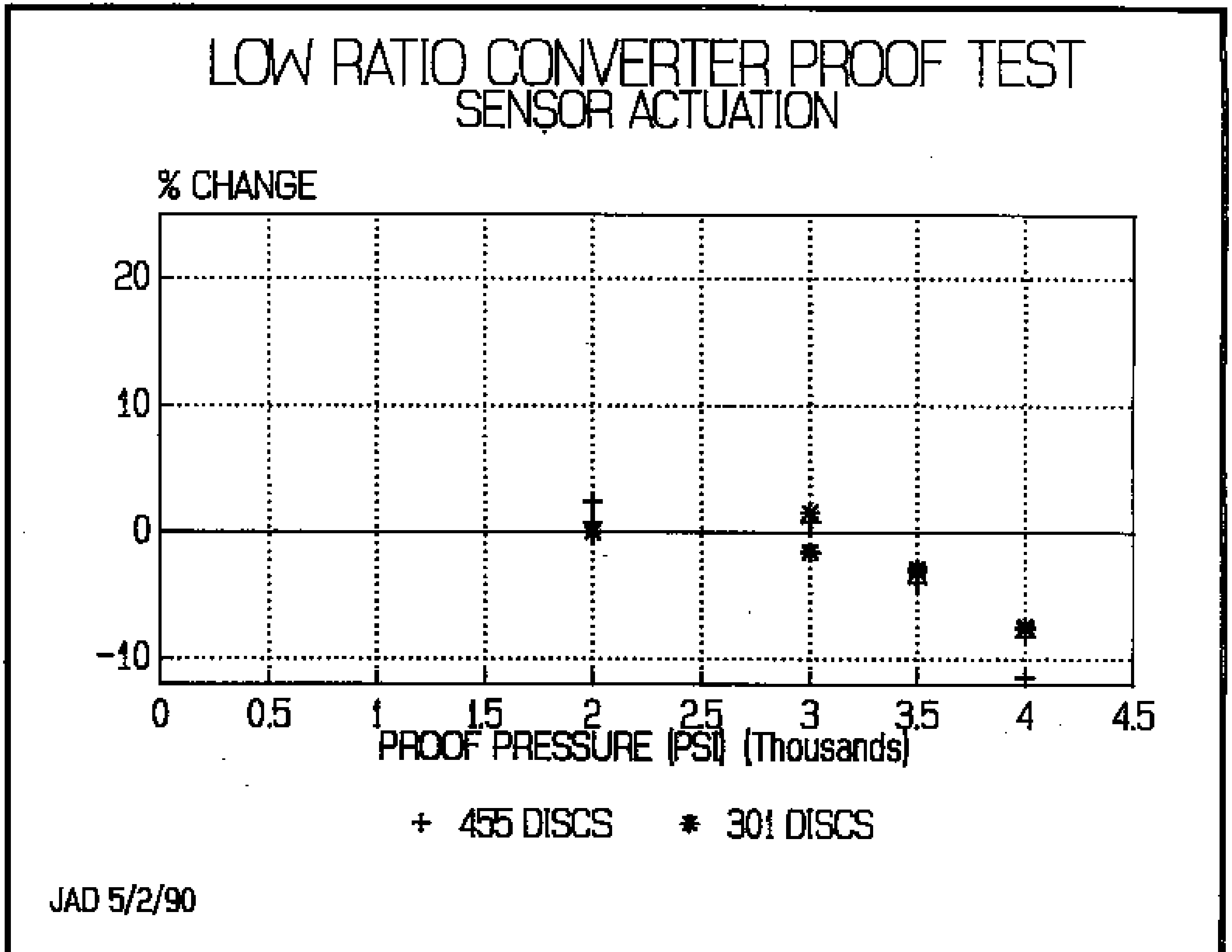


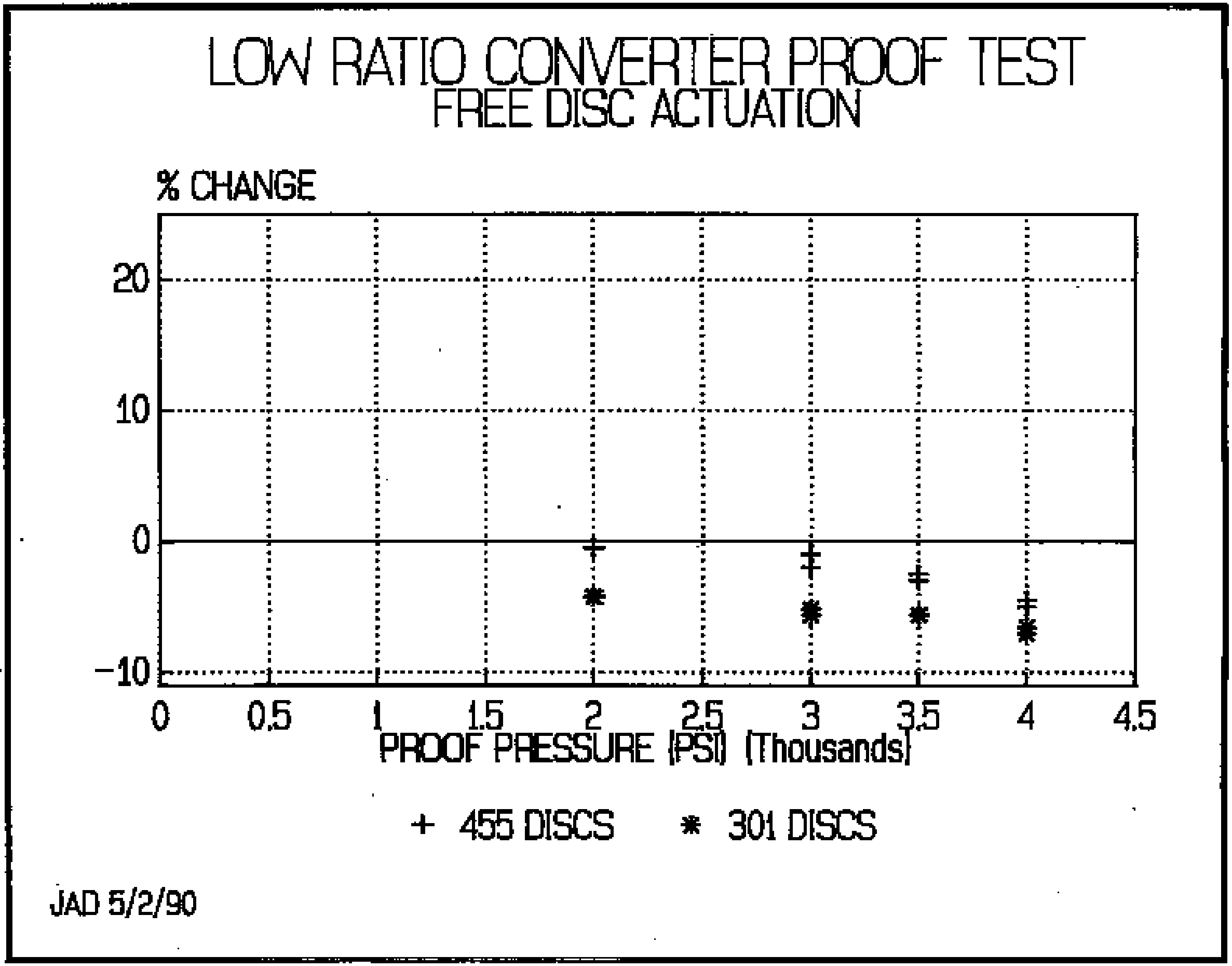
TI-NHTSA 000769

LOW RATIO CONVERTER PROOF TEST

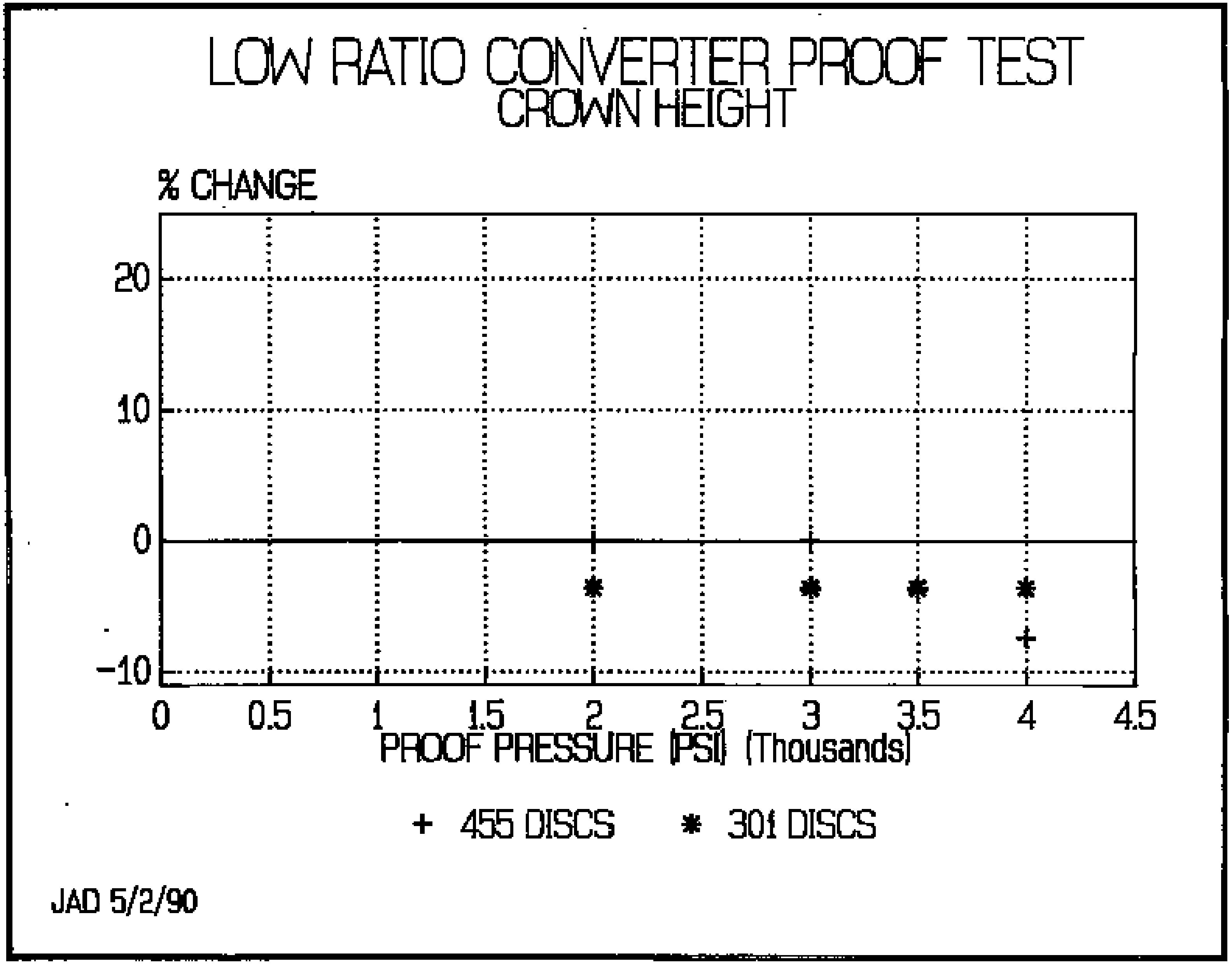
DEVICE #	FREE DISC INITIAL ACT	FREE DISC INITIAL REL	INITIAL CROWN HEIGHT	SENSOR INITIAL ACT	SENSOR INITIAL REL	SENSOR FINAL ACT	SENSOR FINAL REL	FREE DISC FINAL ACT	FREE DISC FINAL REL	FINAL CROWN HEIGHT	SENSOR % CHG ACT	SENSOR % CHG REL	FREE DISC % CHG ACT	FREE DISC % CHG REL	% CHG CROWN HEIGHT	PROOF	4
51-15-01	20.0	9.9	0.027	127	52	132	55	20.0	10.0	0.027	3.94	5.77	0.00	1.01	0.00	---	S
51-15-02	20.0	10.1	0.027	128	52	127	52	20.0	10.0	0.027	5.83	0.00	0.00	-0.99	0.00	---	S
51-15-03	20.0	10.2	0.027	122	52	125	55	19.9	10.1	0.027	2.46	5.77	-0.50	-0.98	0.00	2000	
51-15-04	20.1	9.9	0.027	134	53	135	54	20.0	10.0	0.027	0.75	1.89	-0.50	1.01	0.00	2000	D
51-15-05	20.1	9.9	0.027	124	49	122	54	19.7	9.9	0.026	-1.61	10.20	-1.99	0.00	-3.70	3000	[
51-15-06	20.1	9.9	0.027	125	57	126	59	19.9	9.9	0.027	0.80	3.51	-1.00	0.00	0.00	3000	S
51-15-07	20.1	10.0	0.027	126	56	121	55	19.6	10.0	0.026	-3.97	-1.79	-2.49	0.00	-3.70	3500	C
51-15-08	20.1	10.0	0.027	127	58	122	57	19.5	9.9	0.026	-3.94	-1.72	-2.99	-1.00	-3.70	3500	S
51-15-09	20.1	10.0	0.027	122	52	112	53	19.2	9.9	0.025	-8.20	1.92	-4.48	-1.00	-7.41	4000	
51-15-10	20.1	10.1	0.027	131	53	116	56	19.1	9.9	0.025	-11.45	5.66	-4.98	-1.98	-7.41	4000	
51-15-11	21.1	7.3	0.028	127	39	134	44	20.5	8.7	0.028	5.51	12.82	-2.84	19.18	0.00	---	3
51-15-12	21.2	8.0	0.028	133	42	139	46	20.5	9.0	0.028	4.51	9.52	-3.30	12.50	0.00	---	0
51-15-13	21.3	7.7	0.028	135	44	135	46	20.4	8.8	0.027	0.00	4.55	-4.23	14.29	-3.57	2000	1
51-15-14	21.3	7.9	0.028	132	44	132	45	20.4	8.9	0.027	0.00	2.27	-4.23	12.66	-3.57	2000	
51-15-15	21.3	8.0	0.028	128	44	126	47	20.1	8.9	0.027	-1.56	6.82	-5.63	11.25	-3.57	3000	D
51-15-16	21.3	8.4	0.028	128	42	130	46	20.2	9.2	0.027	1.56	9.52	-5.16	9.52	-3.57	3000	1
51-15-17	21.4	6.9	0.028	142	35	138	40	20.2	8.3	0.027	-2.82	14.29	-5.61	20.29	-3.57	3500	S
51-15-18	21.4	7.0	0.028	130	42	126	40	20.2	8.4	0.027	-3.08	-4.76	-5.61	20.00	-3.57	3500	C
51-15-19	21.4	8.4	0.028	135	47	125	45	20.0	9.1	0.027	-7.41	-4.26	-6.54	8.33	-3.57	4000	S
51-15-20	21.4	9.2	0.028	132	44	122	44	19.9	9.0	0.027	-7.58	0.00	-7.01	-2.17	-3.57	4000	

TI-NHTSA 000770

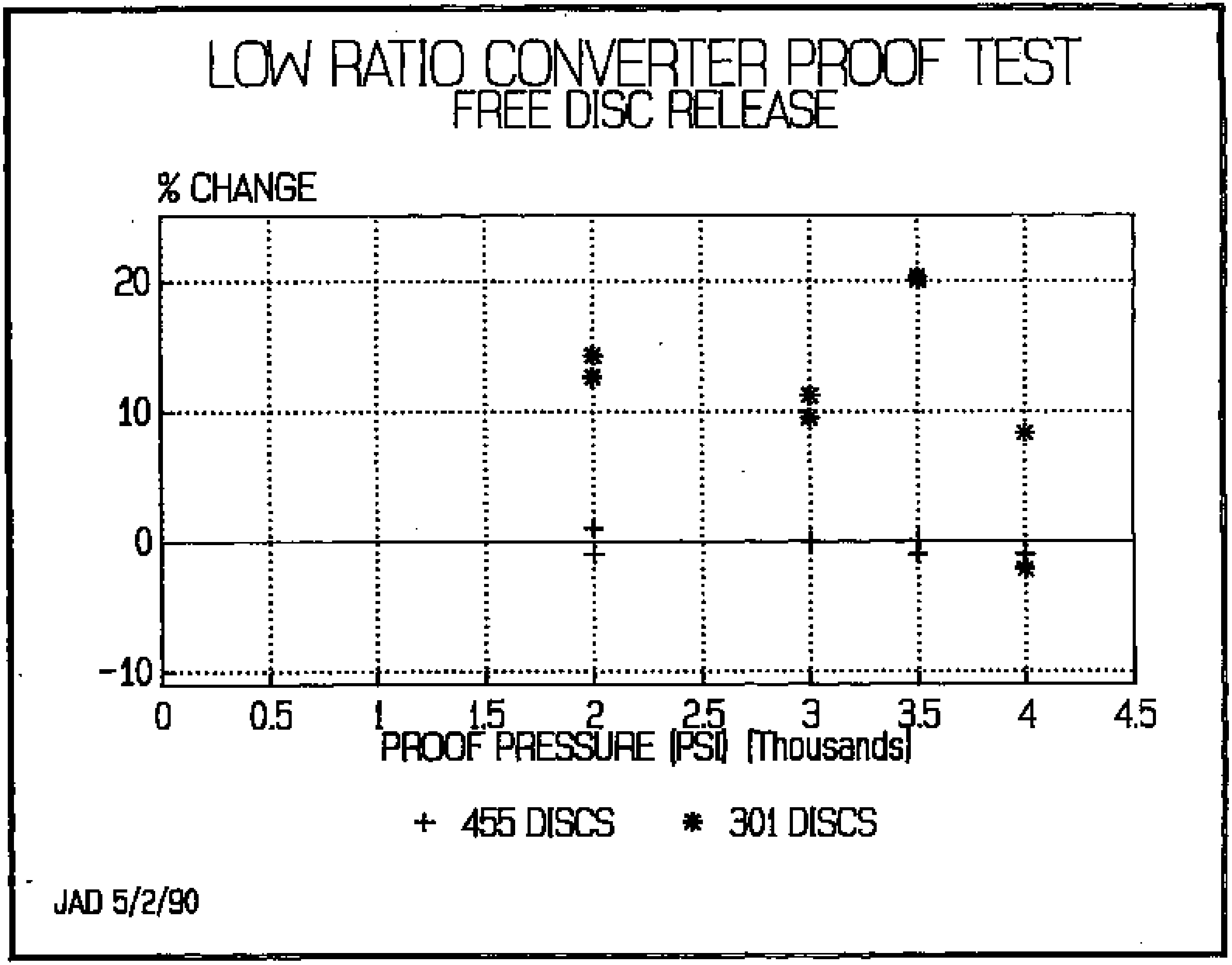

LOW RATIO CONVERTER PROOF TEST
SENSOR ACTUATION
% CHANGE
20
10
0
-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
PROOF PRESSURE (PSI) (Thousands)
+ 455 DISCS
* 301 DISCS
JAD 5/2/90



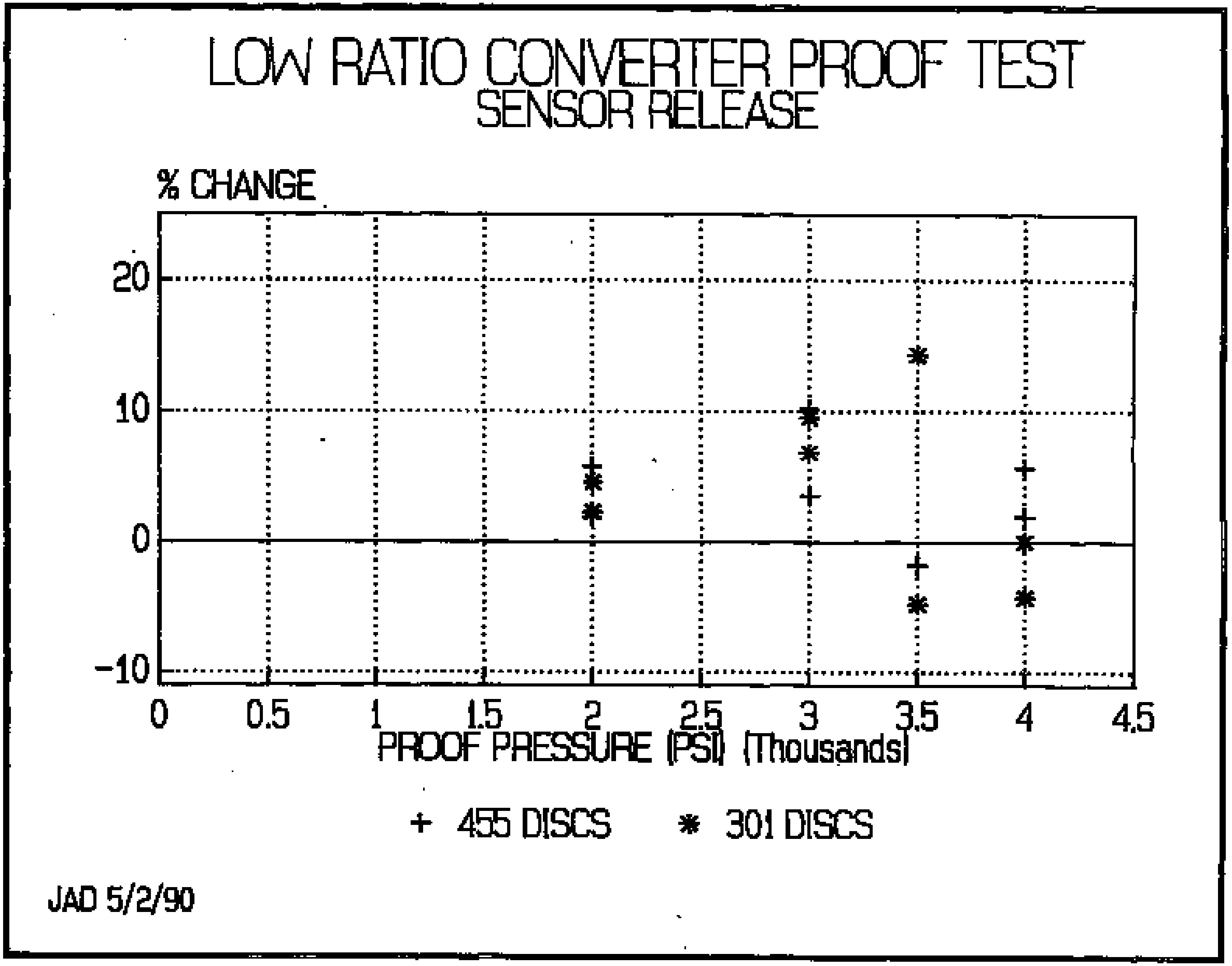
TI-NHTSA 000772



TI-NHTSA 000773



TI-NHTSA 000774


LOW RATIO CONVERTER PROOF TEST
SENSOR RELEASE
% CHANGE
20
10
0
-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
PROOF PRESSURE (PSI) (Thousands)
+ 455 DISCS
* 301 DISCS
JAD 5/2/90

500 °F - ½ HOUR PEO# 0254[illegible]

PART NO. 316456-[illegible]

DATE 4-11-90

CLOCK NO. 3972

QTY. 200

LOT NO. 1

REEL NO. 7

S.S. 455 x.012

MIC. SETTINGS

A. 45.6

R. 62.2-BT:62.0

FREE DISC PRESSURES					
B. H. T.		4TH READING			
ACTUATION	RELEASE	ACTUATION	RELEASE	ACTUATION	RELEASE
		19.6	10.0	19.4	9.1
		19.5	9.2	19.7	9.1
		19.4	9.3	19.3	9.3
		19.1	9.2	19.4	9.5
		19.2	9.2	19.6	9.3

MAT'L I.D. NO. 74371-8

$\bar{x}$ 19.42 / 9.32

σ .18 / .26

FORM 31133

(THESE DISCS USED IN LRC PROOF TEST)

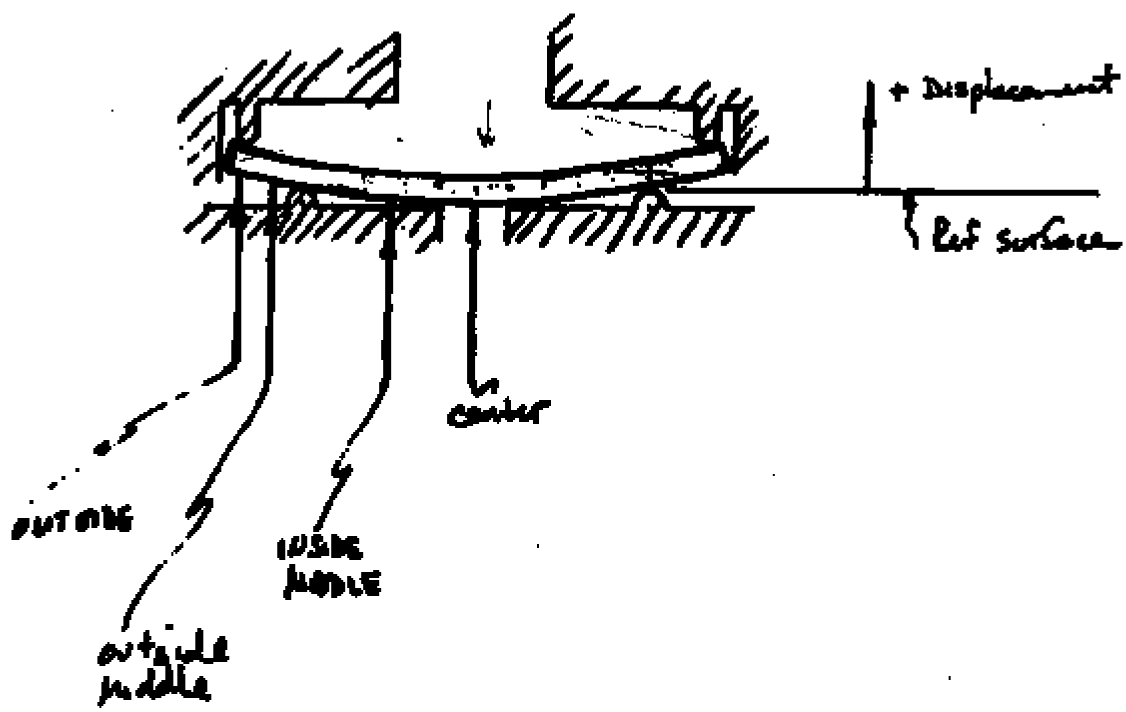
50% CW Hamilton (rolling house) rec'd 12/88

	.2% STR	UTS
AS-REC'D	171 K	181K
500°F	185-190	—
600°F	190-200	—

TI-NHTSA 000776

Rec'd 5/16/90

DISPLACEMENTS LOCATIONS



TI-NHTSA 000777

PRESSURE (PSIG)	DISPLACEMENT CENTER	I MIDDLE	O MIDDLE
0	0.017	0.011	0.0021
100	0.0161	0.0101	0.002
200	0.0148	0.0091	0.0018
300	0.0133	0.0078	0.0015
400	0.0114	0.0064	0.0012
500	0.0088	0.0044	0.0009
600	-0.0154	-0.0102	-0.0014
700	-0.0159	-0.0105	-0.0016
800	-0.0159	-0.0107	-0.0017
900	-0.0158	-0.0107	-0.0017
1000	-0.0158	-0.0108	-0.0018
1100	-0.0156	-0.0107	-0.0018
1200	-0.0155	-0.0107	-0.0018
1300	-0.0154	-0.0108	-0.0019
1400	-0.0152	-0.0108	-0.0019
1500	-0.0151	-0.0108	-0.0019

OUTSIDE EDGE OF DISC IS FIXED

PRESSURE (PSIG)	DISPLACEMENT CENTER	I MIDDLE	O MIDDLE	OUTSIDE
0	-0.0124	-0.0064	0.0025	0.0046
100	-0.0124	-0.0064	0.0017	0.0037
200	-0.0118	-0.0061	0.0012	0.003
300	-0.0111	-0.0056	0.0007	0.0022
400	-0.01	-0.005	0.0002	0.0014
500	-0.0083	-0.0039	-0.0004	0.0005
600	0.0099	0.0047	-0.0041	-0.0055
700	0.01	0.0046	-0.0043	-0.0059
800	0.0098	0.0046	-0.0044	-0.0061
900	0.0095	0.0044	-0.0046	-0.0063
1000	0.0092	0.0042	-0.0048	-0.0066
1100	0.0088	0.0039	-0.005	-0.0068
1200	0.0086	0.0038	-0.0051	-0.0069
1300	0.0082	0.0036	-0.0053	-0.0072
1400	0.0078	0.0034	-0.0055	-0.0074
1500	0.0076	0.0033	-0.0056	-0.0075

DISC IS FIXED AT CUP BUMP

HIGHLIGHTS
Stephen B. Offiler
Week Ending 05/18/90

Dept 4/1/96

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER ISSUES: We have received a fax'ed picture of the ISO flare fitting which Pass-Car will be using. We still should pursue finding the ISO spec which covers this, since the sketch is not completely toleranced, etc. The plan is to develop a metric hexport print using the ISO flare, and send it to Elco as well as pursue overseas suppliers. We have contacts in Japan and Korea. Pass-Car wants a new envelope print showing the ISO flare, and of course meeting all of the Ford env. print requirements.

Before agreeing to our proposed release spec. of 20 psi, Pass-Car wants to know how tight our distribution will be. To answer, I plan to run a quick unilateral Cpk on some existing devices which release well above 20. This will yield almost ridiculously high Cpk numbers, probably between 5 and 10.

AUTOMATED SWITCH: Andy McKenna will be assisting in prototyping the newest twist idea, which is basically to eliminate the barbs. The goal is to completely eliminate formation of plastic particles or chips. We will EDM movable terminals with the new features ASAP, and possibly modify the twist tool as needed. If necessary, we will look into incorporating the 52PS-style stake in addition to the twist.

Pete Sampson completed F/D curves on 12 55PS bases. The purpose was to try to get a better handle on the calibration concept using a fixed weight to hold the contacts closed during stationary terminal deformation. We found that the overtravel distance from the transfer point to the point of application of a chosen force (in this case, 125g) had a relatively tight distribution, with a sigma of 0.4 mils.

Per the Program Review and the newly revised overall schedule issued by Keith Roberts, we have six weeks to complete the design. I will immediately look at all actions needed and come up with a detail design schedule to try to meet the overall schedule.

SENSOR: We held another meeting to expand on the results of the LRC test, including Shelly White, Ted Ballard, Jeff Melton, Ray Mandeville, Keith Roberts, Bill Sweet, and myself. It was agreed that the primary focus will be to move the bump in the cup inward, by a small amount TBD. Jeff is working on a disc for this. Many other ideas have been generated to solve the proof problem, including (in no order): Using the present LRC design (larger button on converter) with a thinner 455SS disc with higher heat-treat; or with a thicker 301 disc with lower heat-treat; or using a positive stop on the converter which bottoms before the disc bends. More creative solutions include working with the customer to establish a maximum drift spec after proof testing and/or to lower the proof spec from 4K psi to some lower value, ideally 3K psi.

Testing of the Powder Metal LRC converters has been aborted due to fractured discs and ripped Kapton. The P/M parts themselves look excellent, dimensionally unchanged.

Design of the sensor is subject to the six week schedule deadline as well as the design of the automated switch. It is important to note that the need for the LRC sensor is more imperative, in order to have a viable product with Pass-Car's 125 psi spec: regardless of the switch assembly that is used.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 56-03-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
5795		JAD	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	5/23/90		

PROJECT TITLE: Cruise control pressure switch

CUSTOMER:

PURPOSE OF TEST: To replace Kapton seals and rubber gasket with a single rubber diaphragm

PROCEDURE: Modify hexports for Diaphram
Assemble w/ .046" Diaphram
50% compression at bead
~20% compression off bead
Discs: $\bar{x}$ 49.5 / 36.47
σ 0.74 / 11.08

characterize, Proof, characterize, cycle (500K straight through) characterize

Sensor #	Initial Act	Initial Rel	Proof	after Proof Act	after Proof Rel				
5603-01	545	392	Pass	537	386				
02	558	355		532	363				
03	543	397		529	362				
04	557	367		527	367		All Failed		
05	555	389		530	375				
06	553	385		541	325				
07	552	370		536	367				
08	547	399		534	382				
09	555	384	Pass	547	389				
10	557	368	Leak:	Bent Hexport					
11	544	403	Pass	553	379				
12	551	394	Pass	532	386				

To much material was removed in order to give the diaphram clearance. Hexports bent.

TI-NHTSA 000760

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 57-09-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EE 3423	5/14/90	RGO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAB	5/14/90	6/1/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: 90/110 Devices: To supply Ford Pass-Car with a device at each end of the actuation spec for performance testing on a vehicle

PROCEDURE: Build 12, w/ E9 lot, Direct Disc
90A & B Pin @ 7.007
110 Pin @ 7.004

5K Proof, Chec. cycle, check @ 10K, 50K, 150K, etc

Device #	Disc Lot	Transfer Pin	Proof	Init. Act	Init. Rel	10K Cycle Act	10K Cycle Rel	50K Cycle Act	50K Cycle Rel
57-09-01	90A	212	Pass	87	81	91	91	91	82
02	90A	210		91	83	91	85	92	83
03	90A	214		90	79	90	80	90	80
04	90A	210		79	73	82	75	83	74
57-09-05	90B	212		76	72	79	73	75	66
06	90B	212		81	76	83	75	81	74
07	90B	210		87	81	89	81	88	80
08	90B	213		82	76	82	76	83	76
57-09-09	110	210		147	133	146	125	146	125
10	110	213		148	136	149	124	146	125
11	110	213		146	135	145	127	148	127
12	110	214		151	139	151	130	150	130

Device	150K Cycles Act	Rel	600K Cycles Act	Rel
[illegible]-01	87	92	90	93
02	91	89	91	85
03	90	90	87	90
04	83	75	80	79
[illegible]-05	79	78	77	71
06	91	72	85	75
07	88	80	72	70
08	93	75	86	76
[illegible]-09	145	123	146	127
10	147	127	150	127
11	146	130	147	130
12	152	132	154	130

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 59-09-20

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PC	5/14/90	SAB	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	5/14/90		

PROJECT TITLE: Cruise Control pressure Switch

CUSTOMER:

PURPOSE OF TEST: To see if Belville discs in standard C2LS devices will meet our actuation spec of 115 ± 25 PSI

PROCEDURE: Production build 20, brake-fluid cleaners, "L" posts. Check all 20, choose 11 to cycle (4 ... , 4 mid, 4 top) Proof to 4K, recheck, cycle, check at ...

by snap

Device #	Open time	Act	Rel	@1000 Time	10 % cycle	Proof	Act	Rel	
59-09-01	1.1 ms	97	53	3.6 ms	✓	Pass	94	65	
02	1.0	93	49	Creep	✓		92	56	
03	1.0	94	53	Creep	✓		99	59	
04	1.3	99	54	Creep	✓		96	59	
05	1.3	93	45	Creep	✓		92	54	
06	1.2	93	53	Creep	✓		95	54	
07	1.0	99	49	Creep	✓		97	57	
08	1.0	97	49	Creep	✓		92	53	
09	1.0	98	43	Creep	✓		99	61	
10	0.9	99	47	Creep	✓		91	59	
11	1.1	98	55	3.7	✓		99	57	
12	1.1	106	54	Creep	✓	Pass	107	64	
13	1.1	94	56	Creep					
14	1.1	97	54	Creep					
15	1.2	96	60	Creep					
16	1.0	90	52	Creep					
17	1.0	91	49	Creep					
18	1.2	92	57	Creep					
19	1.0	97	44	Creep					
20	0.9	98	75	Creep					

TI-NHTSA 000783

Device #	10K cyc Act	10K cyc Rel	50K cycle Act	50K cycle Rel	250K Act	250K Rel	500K Act	500K Rel
CS-19-01	84	51	89	52	78	46	80	47
02	77	49	88	51	78	45	Dead	
03	88	53	89	55	80	49	80	49
04	83	52	88	53	79	48	79	49
05	74	47	78	49	72	44	71	44
06	82	49	85	50	75	44	77	45
07	75	46	80	49	72	43	75	43
08	77	73	89	53	74	48	78	49
09	92	56	87	59	78	53	79	52
10	77	50	81	52	72	45	71	46
11	85	50	88	51	81	46	79	45
12	98	57	96	59	87	53	96	52

Device #	Free discs Act	Free discs Rel
CS-19-01	26	5.0
02	Cracked	
03	7.8	5.3
04	8.9	5.5
05	7.9	5.1
06	9.6	5.5
07	7.7	4.9
08	9.5	5.7
09	10.1	5.6
10	9.5	4.9
11	9.6	4.9
12	11.0	5.6

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 59-09-28

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PC	5/24/90	SRO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	5/24/90		

PROJECT TITLE: Cruise control pressure switch

CUSTOMER:

PURPOSE OF TEST: To see if belville discs in standard C7PS devices will meet our actuation spec of 115 ± 25 PSI

(FIRST ITERATION) 1A

PROCEDURE: Production build 20, brake-fluid sensors, clear all 20, choose 12 to cycle (4 bott, 4 mid, 4 top) proof to 4K, recheck, cycle, check at 10K, 50K, 250K, 500K

ALL ACT MUST FALL WITHIN
117 - 153 PSI WITH $\bar{X} \pm 6$
117-90/6 = 4.5   160-135/6 = 4.5

$\overline{ACT}$ RATIO 92.3/13.2 = 7.0
$\overline{REL}$ RATIO 51.7/7.6 = 6.8
BELVILLE DISCS ALLOWED: 125/7.2 ≈ 17.5 PSI

by snap

$\overline{REL}$ = 20/10 = 4.5 $\overline{REL}$ = 47   DISC = 42/6.0 = 6.9

Device #	Open Trav	Act	Rel	1150 Time
59-09-01	1.1 mS	97	53	3.6 mS
02	1.0	93	49	Creep
03	1.0	94	53	Creep
04	1.3	91	54	Creep
05	1.3	93	45	Creep
06	1.2	93	53	Creep
07	1.0	91	49	Creep
08	1.0	98	48	Creep
09	1.0	96	47	Creep
10	0.9	99	47	Creep
11	1.1	91	55	3.7
12	1.1	106	64	Creep
13	1.1	94	56	Creep
14	1.1	87	54	Creep
15	1.2	96	60	Creep
16	1.0	90	52	Creep
17	1.0	92	49	Creep
18	1.0	86	57	Creep
19	1.0	87	44	Creep
20	0.9	98	45	Creep
	$\bar{X}$	92.25	51.65	
	σ_{n-1}	5.19	5.17	
	σ/$\bar{X}$	5.6%	10.0%	

NOTE: [illegible] 17.5 DISCS AFTER CYCLING ... [illegible] UP IF LIFE IS POOR

NOTE: CYCLE BELV'S TO FAILURE FOR WEIBULL ANAL.

PINNED TOO SHORT??
DIAPHRAGM TEST?

DISC σ/$\bar{X}$ INCREASES 25% IN [illegible]   CHAR = [illegible]% + 25% = 44 [illegible]

TI-NHTSA 000785

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 3 1 07-0 0

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PC	5/24/90	SBO	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	5/24/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: To see if belville discs in standard 57PC devices will meet our actuation spec of 115 ± 25 PSI.

PROCEDURE: Production build 20, brake-fluid sensors, "L" bases. Char all 20, choose 12 to cycle (4 bott, 4 mid, 4 top). Proof to 4K, rechar, cycle, check at 10K, 50K, 250K, 500K

by snap

	INITIAL						FINAL		
Device #	open time	Act	Rel	close time	12 to cycle	Proof	Act	Rel	% chg Act
57-04 01	1.1 ms	97	53	3.6 ms	✓	Pass	94	55	-3.1
02	1.0	93	49	Creep	✓		92	56	-1.1
03	1.0	94	53	Creep	✓		99	59	+5.3
04	1.3	88	54	Creep	✓		96	59	+9.1
05	1.3	93	45	Creep	✓		92	54	-1.2
06	1.3	89	53	Creep	✓		95	54	+6.7
07	1.0	93	49	Creep	✓		87	57	-6.1
08	1.0	93	49	Creep	✓		92	53	-1.1
09	1.0	96	47	Creep	✓		99	61	+3.1
10	0.9	89	47	Creep	✓		91	58	+1.4
11	1.1	95	55	3.7	✓		97	59	+1.0
12	1.1	101	64	Creep	✓	Pass	103	67	+1.9
13	1.1	~~104~~	~~58~~	Creep					
14	1.1	~~87~~	~~54~~	Creep		$\bar{x}$	94.4	57.9	
15	1.2	~~86~~	~~48~~	Creep		σ_{n}	6.44	2.94	
16	1.0	~~90~~	~~52~~	Creep		$\sigma\%\bar{x}$	6.8%	5.1%	
17	1.0	~~98~~	~~49~~	Creep					
18	1.1	~~86~~	~~57~~	Creep					
19	1.0	~~87~~	~~44~~	Creep		% chg	Act = 1.8%		
20	0.9	~~98~~	~~45~~	Creep		% chg	Rel = 12.9%		
	$\bar{x}$	92.75	51.93						
	σ_{n-1}	6.11	5.18						
	$\sigma\%\bar{x}$	6.6%	10.1%						

AFTER PROOF TO 4K:
ACTIVATION COMES UP ~2%; SIGMA WIDENS SLIGHTLY
RELEASE COMES UP ~13%; SIGMA NARROWS TO 60% OF ORIG.

(OVER)

TI-NHTSA 000786

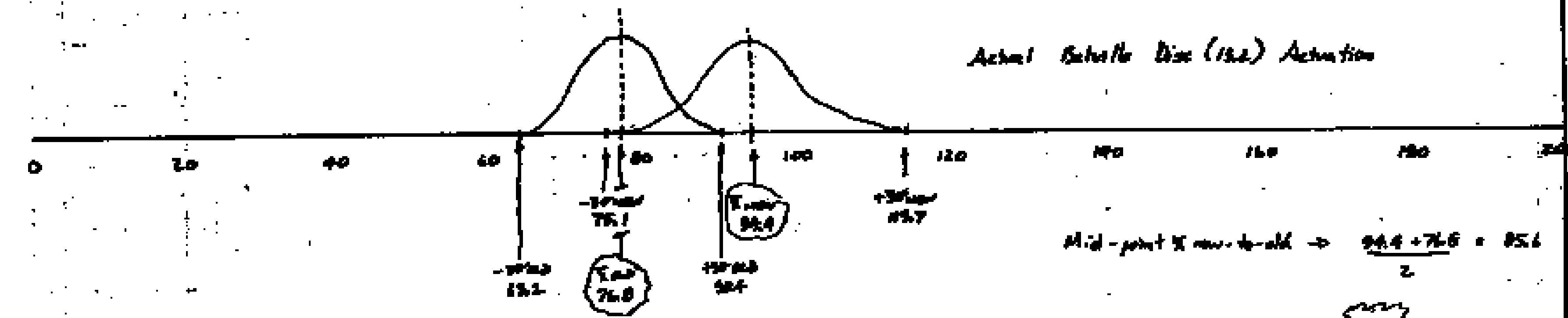
Device #	10K cyc Act	Rel	50K cycle Act	Rel	250K Act	Rel	500K Act	Rel
CT-89-01	88	51	89	52	78	46	80	47
02	77	49	88	51	75	45	Dead	
03	83	53	89	55	80	49	80	49
04	83	52	88	53	79	48	77	49
05	74	47	78	49	72	44	71	44
06	92	49	85	50	75	44	77	45
07	75	46	90	49	73	43	78	43
08	77	~~53~~	84	53	74	48	78	49
09	92	56	97	59	78	53	79	52
10	77	50	91	58	72	45	71	46
1-	93	58	88	61	81	46	79	45
11	90	57	96	59	87	53	86	52
$\bar{x}$	84.75	51.09 (11)	85.67	52.67	76.83	47.08	78.36	47.36
σ_{n-1}	4.75	3.16	4.91	3.23	4.53	3.33	4.46	3.07
$\sigma\%\bar{x}$	5.6%	6.2%	5.7%	6.1%	5.9%	7.1%	5.8%	6.5%

* DEVICE σ_{ACT}'s STAY RIGHT AROUND 6%

* DEVICE $\bar{X}_{ACT}$ SHIFTS FROM 84.4 TO 76.0 %CHG = $\frac{76.0 - 84.4}{84.4}$ = $\boxed{-10.0\ \%}$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

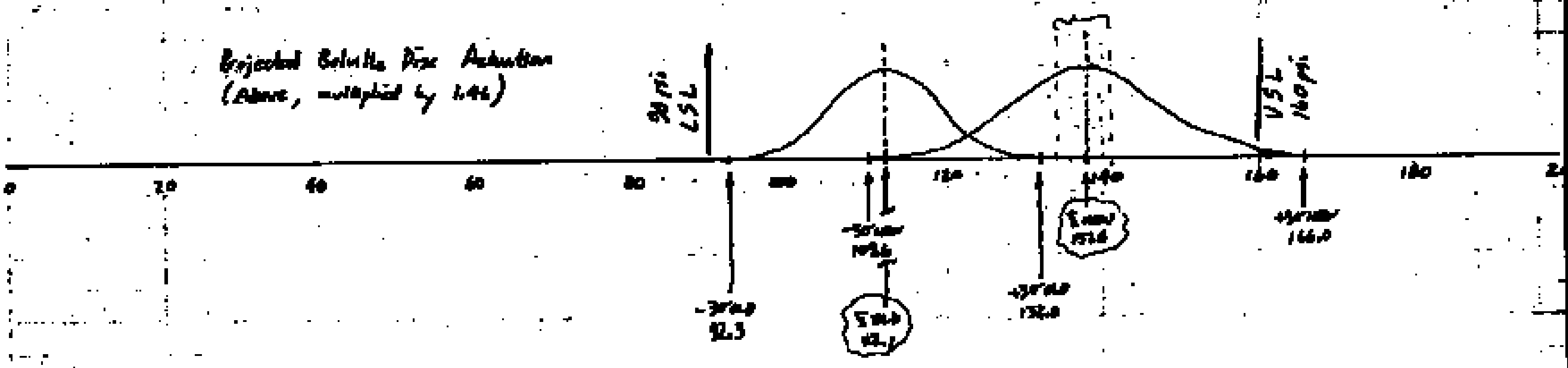
Actual Belleville Disc (13.2) Actuation



Mid-point $\bar{x}$ new-to-old → $\frac{94.4 + 76.8}{2} = 85.6$

$85.6\,x = 125$; $x = \boxed{1.46}$

Projected Belleville Disc Actuation
(Above, multiplied by 1.46)



∴ shoot for $\bar{x}_{new} = 135$ psi

- OBSERVED RATIO, NEW, PRE-PROOF = 7.0
- "GUESS" THAT RATIO WILL INCREASE W/ HIGHER DISC → 7.5

→ 135/7.5 = 18.0 psi. THIS IS NEXT BELV. ITERATION ←
± 5% = 0.9

→ IF RATIO STAYS @ 7.0 ; 135/7 = 19.3

FIRST-ITERATION DISCS, CSL →
$^{75}/_{13.2}$ = 57.1 %
SECOND-ITERATION, CALL IT
60 % MIN
18 × .6 = 10.8 MIN

TI-NHTSA 000788

Device #	10K cyc Act	10K cyc Rel	50K cycle Act	50K cycle Rel	250K Act	250K Rel	500K Act	500K Rel
57-19-01	84	51	89	52	78	46	80	47
02	77	49	83	51	73	45	Dead	
03	87	53	89	55	80	49	80	49
04	83	52	88	53	79	49	79	49
05	74	47	78	49	72	44	71	44
06	82	49	85	50	75	44	77	45
07	75	45	80	49	72	43	78	43
08	77	73	84	53	74	48	76	49
09	92	56	87	59	78	53	79	52
10	77	50	81	52	72	45	71	46
11	85	50	88	51	81	46	79	45
12	90	57	96	59	87	53	86	52

Free Discs @ end test

Device #	Act	Rel		
57-19-01	8.6	5.0	80/8.6	8.33
02	Cracked			
03	9.8	5.3	80/9.8	8.16
04	9.9	5.5	79/9.9	7.98
05	9.9	5.3	71/9.9	7.17
06	9.6	5.5	77/9.6	8.02
07	9.7	4.9	73/9.7	7.53
08	9.8	5.7	76/9.8	7.76
09	10.1	5.6	79/10.1	7.82
10	9.5	4.7	71/9.5	7.47
11	9.6	4.9	79/9.6	8.23
12	11.0	5.6	86/11	7.60
				$\bar{x}$ = 7.92
$\bar{x}$	9.77	5.29		(CHECK)
σ_{n-1}	0.19	0.31		σ = 0.42
σ % $\bar{x}$	6.9%	5.9%		% = 5.3

	RATIO;	RATIO;
	7736/9.77	4736/5.29
	7.9	9.0

ORIGINAL RATIO WAS 7.0; HAS THE RATIO INCREASED ? OR, WAS THIS REFLECT A DIFFERENCE IN TEST METHOD BETWEEN US AND DISC DEPT ? HAVE JEFF CHAD A HANDFUL OF VIRGIN DEVICE'S !

DISC SHIFT:	INIT 13.0	(OUR DATA)	FIN 9.8	→ -24.6%	ACT
	INIT 7.5	" "	FIN 5.3	→ -29.3%	REL
DEVICE SHIFT: (INIT-500K)	INIT 89.4		FIN 78.4	→ -12.3%	ACT
	INIT 53.9		FIN 47.4	→ -12.1%	REL

THIS DATA, 1st ITERATION, WITH SWITCHES

(VIRGIN CHAR)

1st Iteration Belville Discs

Act	Rel
13.0	7.3
13.4	7.7
13.4	7.9
13.0	7.7
13.0	7.9
12.8	7.4
12.9	7.7
12.4	7.1
13.0	7.6
12.7	7.5
13.3	7.5
13.0	7.1
Avg. 13.0	7.53

DISC OGDT AVG WAS 13.2 ∴ GOOD CORRELATION

Jeff D 6/11/90

☒ EXPERIMENTAL ENGINEERING ORDER

☐ NON-SCHEDULED PRIMARY OPERATIONS

№ 025483

NON - STANDARD OPERATIONS ON PURCHASED PARTS ☐

ADDED OPERATIONS ON PRIMARY PARTS ISSUED TO ASSEMBLY ☐

70000 SERIES PARTS ☐

NON - SCHEDULED SMALL ORDERS ☐

PART NUMBER N/A

PART NAME 3/4" OD .090" ID BELVILLE DISC

PRODUCT CODE 93 CC101

DATE REQUIRED 6/13/90

QUANTITY REQ. 200

INSPECTION YES

SUPPLIER DISC DEPT

AVAILABILITY OF TOOLING

EX. NO.

SHOP ORDER 2A

ROUTING:

DATE COMP.

SPECIAL INSTRUCTIONS

ACTUATION: 18.7 PSI ± 0.9

RELEASE: 10.5 PSI MINIMUM

COST NOT TO EXCEED $100—

NO CHARGE AFTER 6/22/90

REQUESTED BY: STEVE OFFILER X1382

(2ND ITERATION)

FORMING PRESS NO.

FORMING TOOLS

FORMING PROCEDURE

OFF TEMPS

UNUSUAL JOBS

DISC SPECIFICATION

QUANTITY REQUIRED {.094 HOLE 600°F H.T. / .062 HOLE 700°F H.T.}

MATERIAL AND THICKNESS DISCRETIONARY

TEMPERATURE SET

HEAT TREAT

ACT. HOURS WORKED

CONTACT NUMBER

DISC BLANK NO.

DISC AND CONTACT ASS'Y.

FINISHED DISC NUMBER

TI-NHTSA 000791

REMARKS

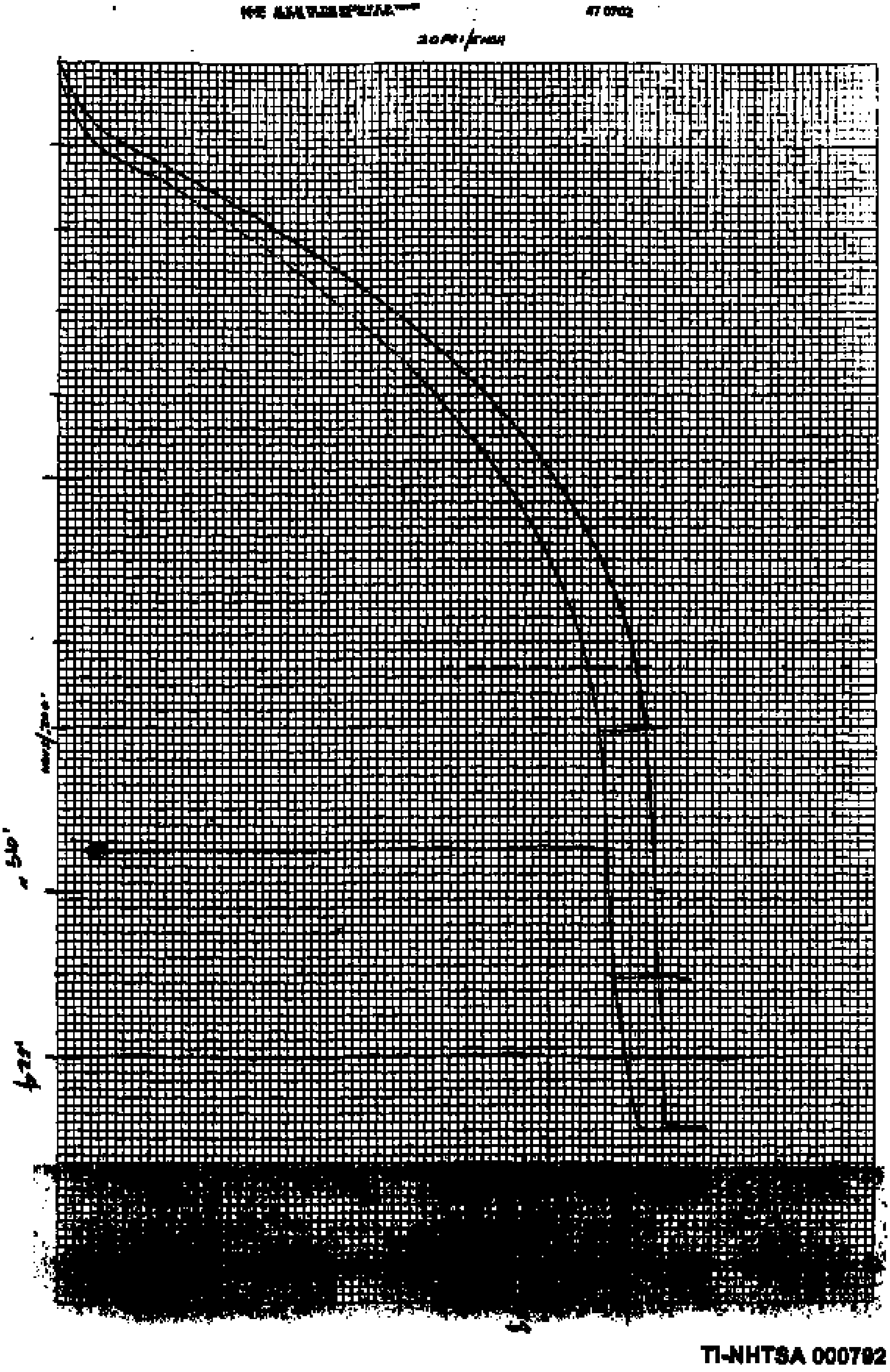
TEMPERATURE SETS EASILY YES NO

DISCS HOLD THEIR SET TEMPERATURE AFTER CYC. YES NO

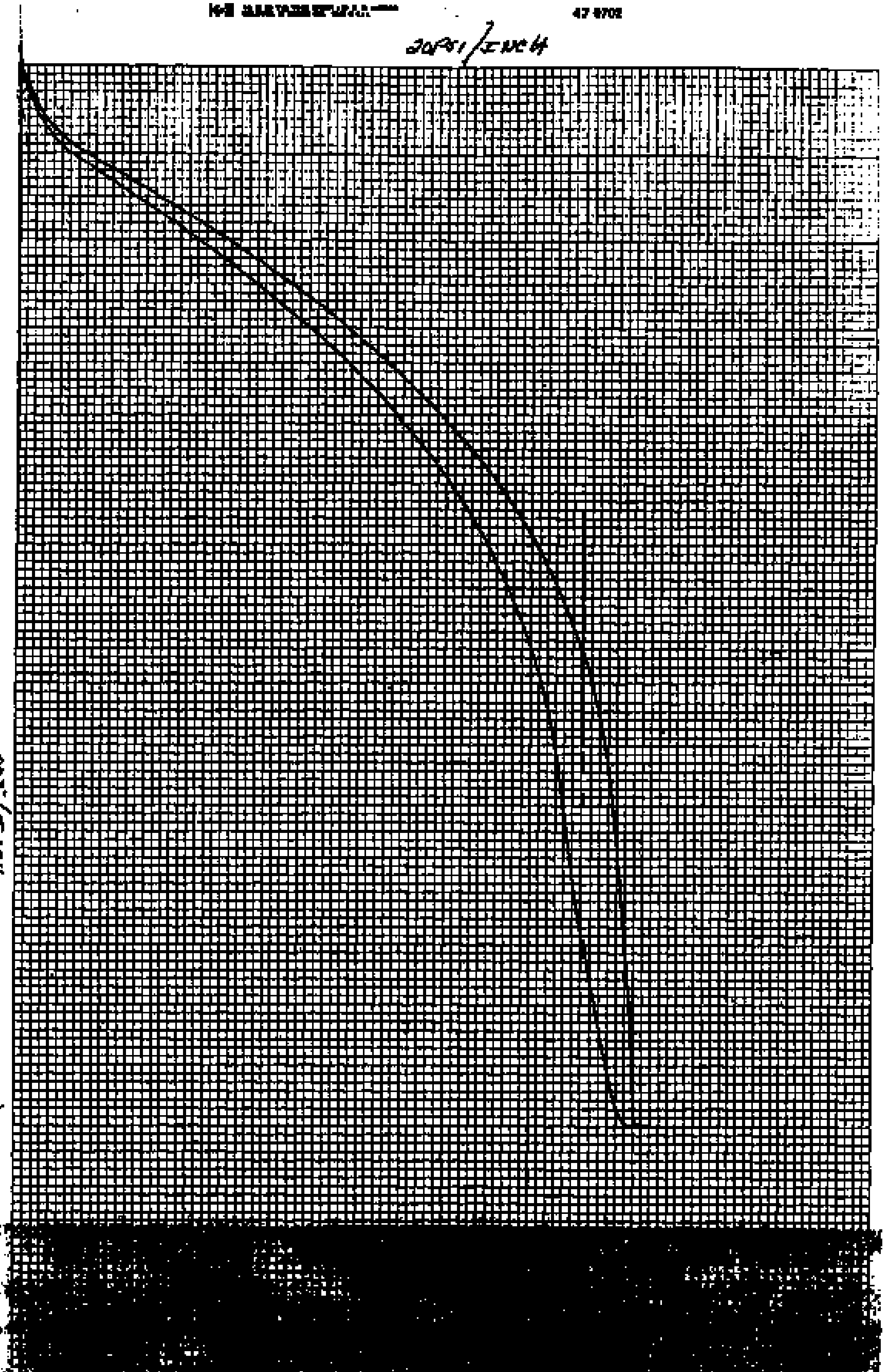
AUTHORIZED BY [signature]

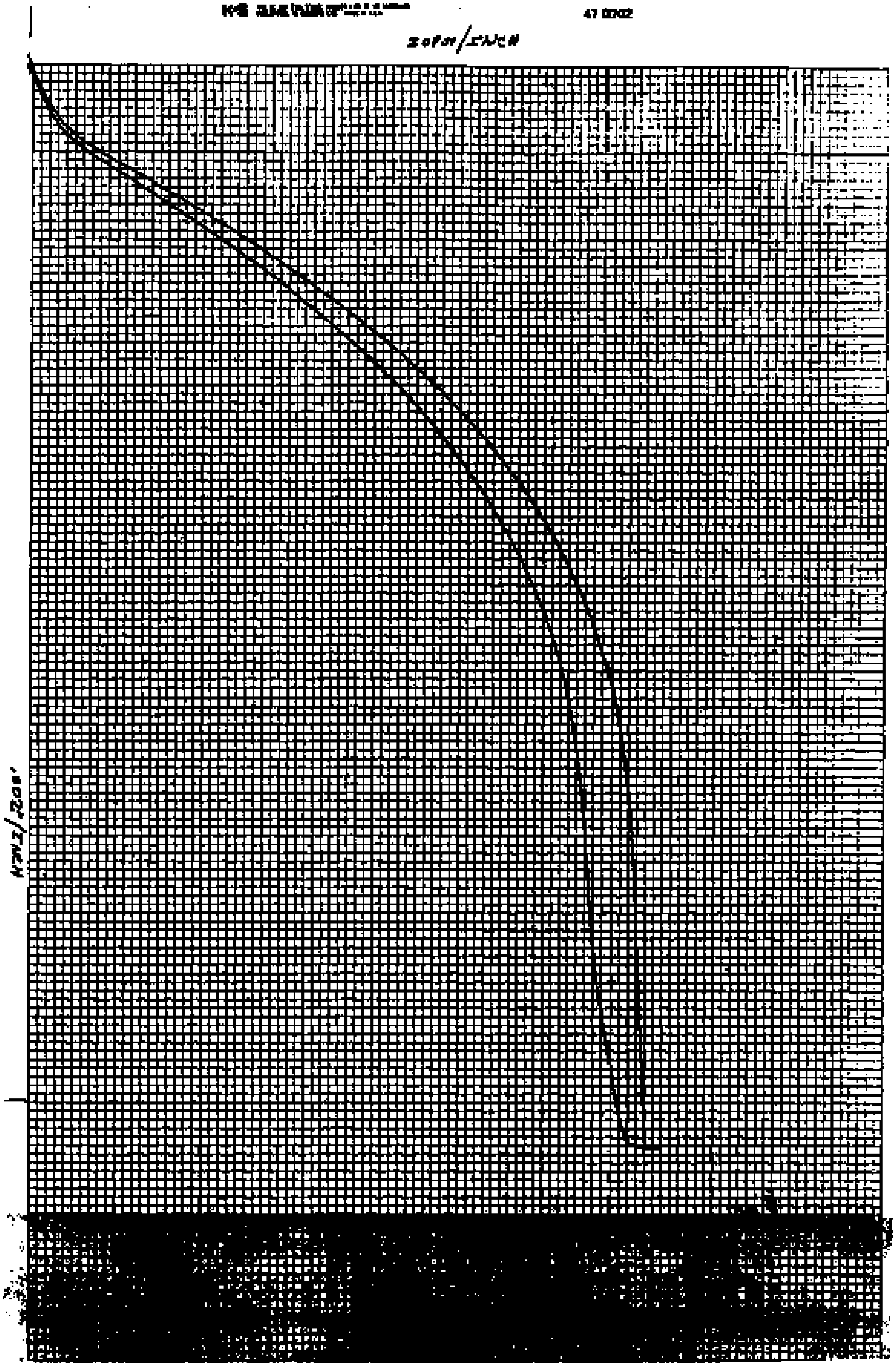
DATE 6/4/96

DISTRIBUTION: WHITE-STAYS WITH MAT'L

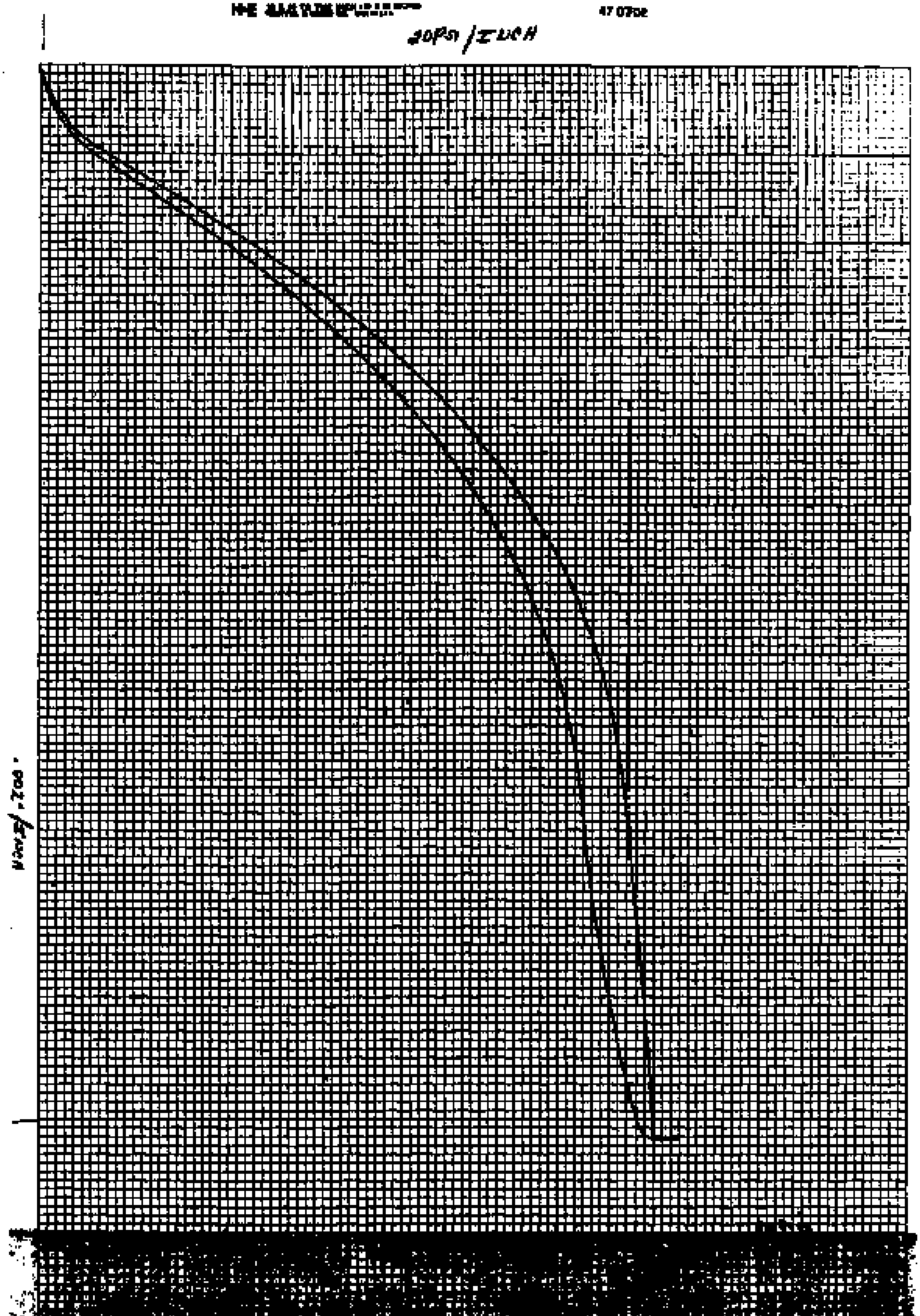


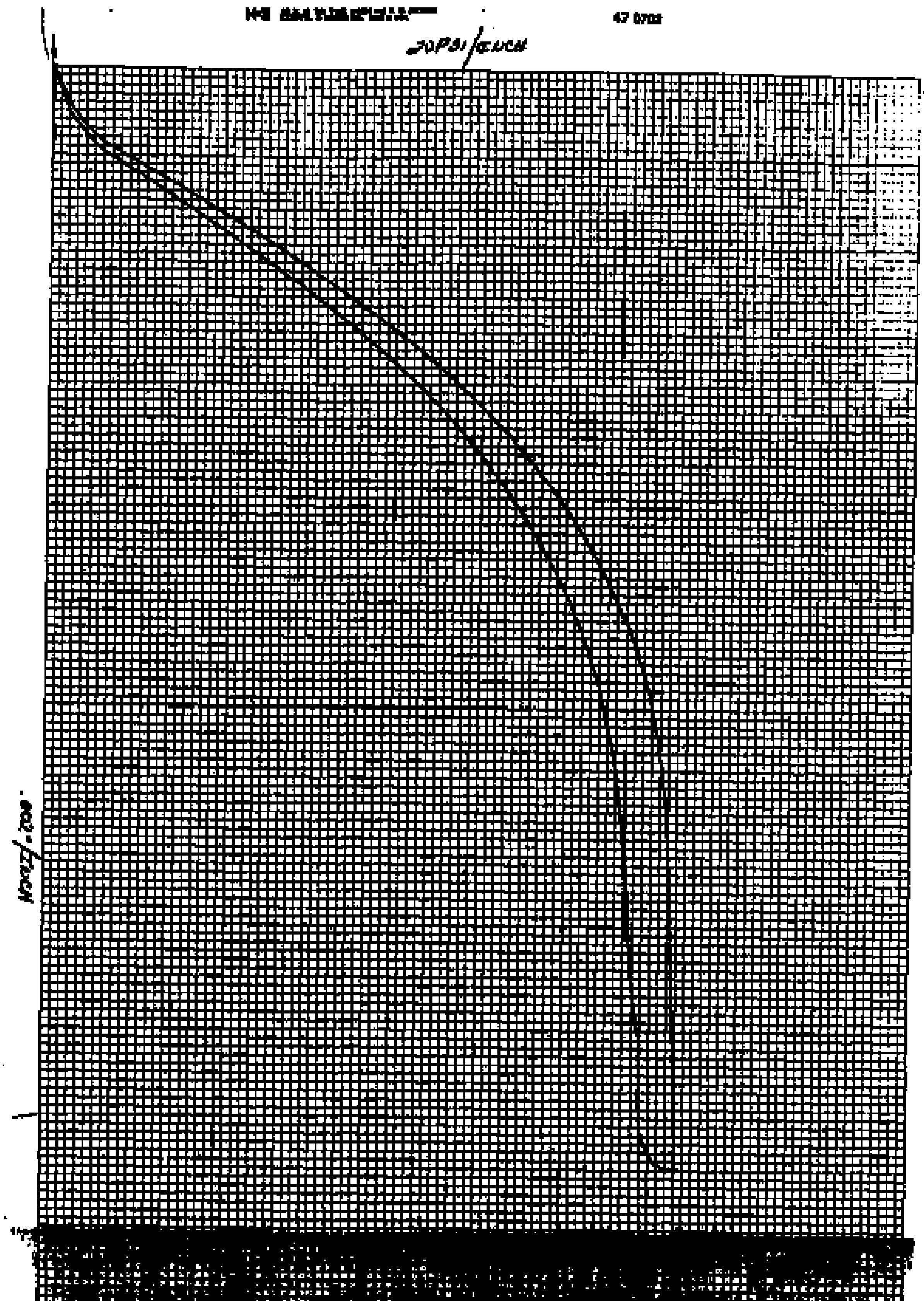
TI-NHTSA 000792


47 0702
20PSI/INCH
.200"/INCH



TI-NHTSA 000794


40PSI/INCH
.200"/INCH



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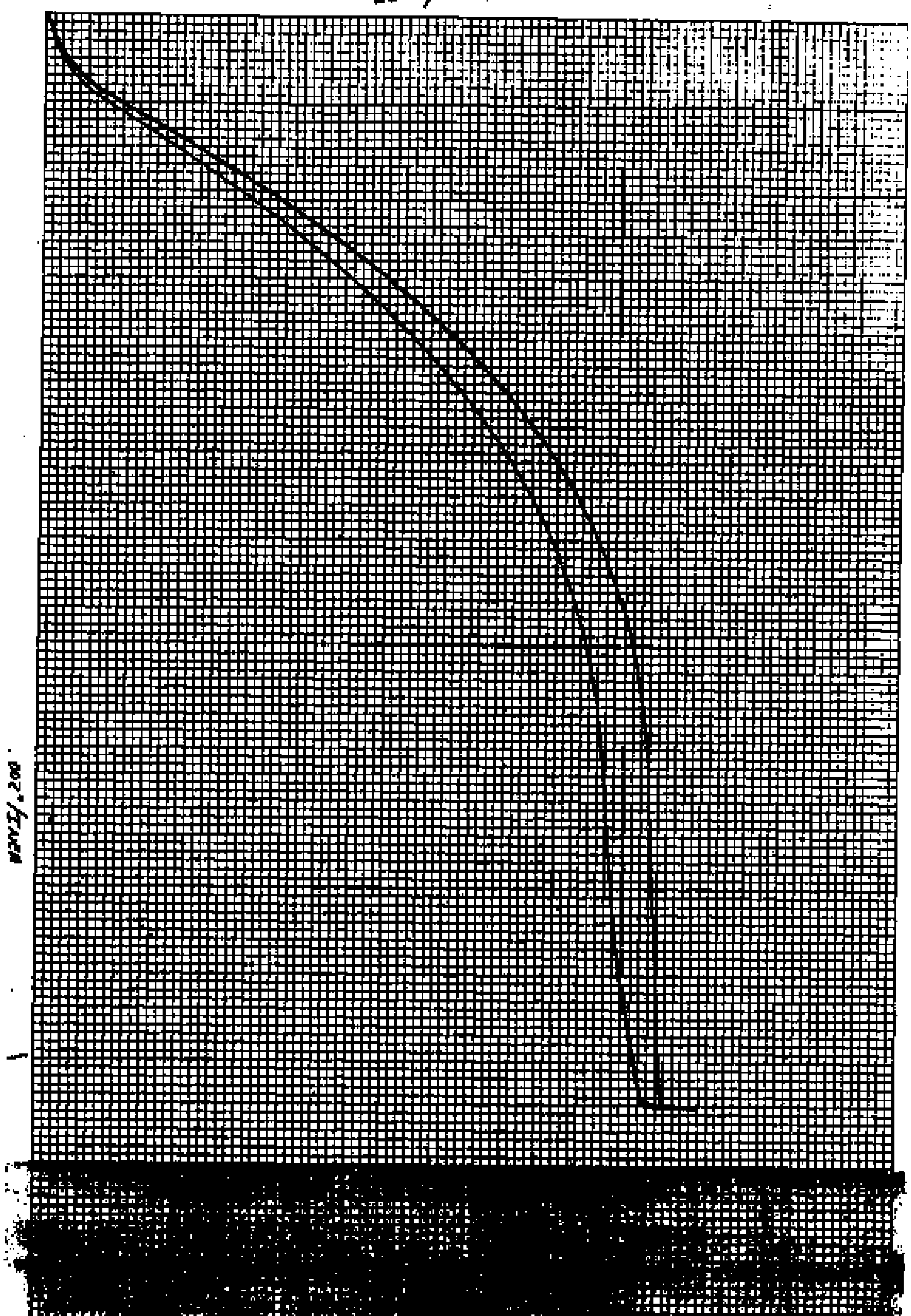

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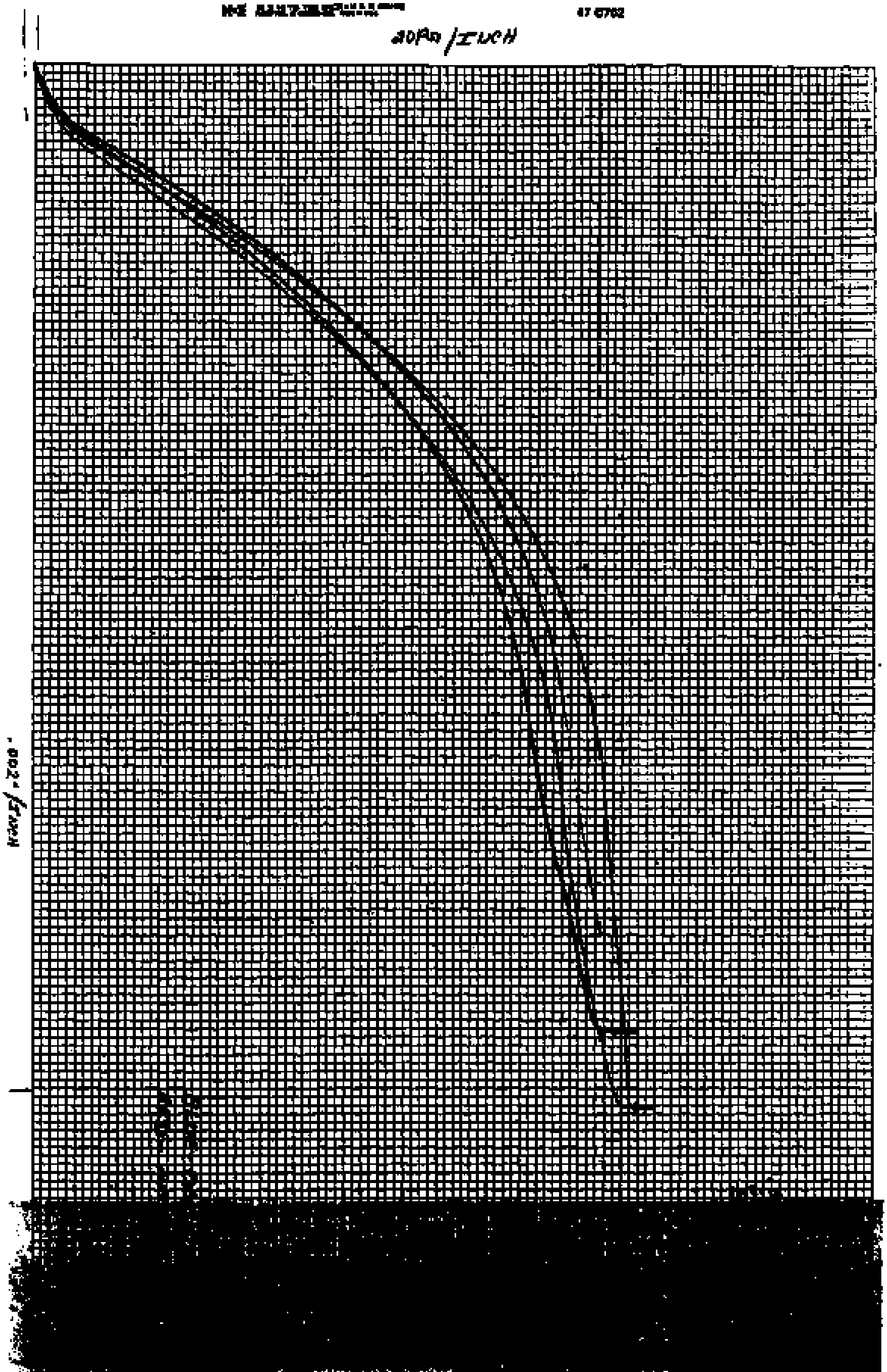
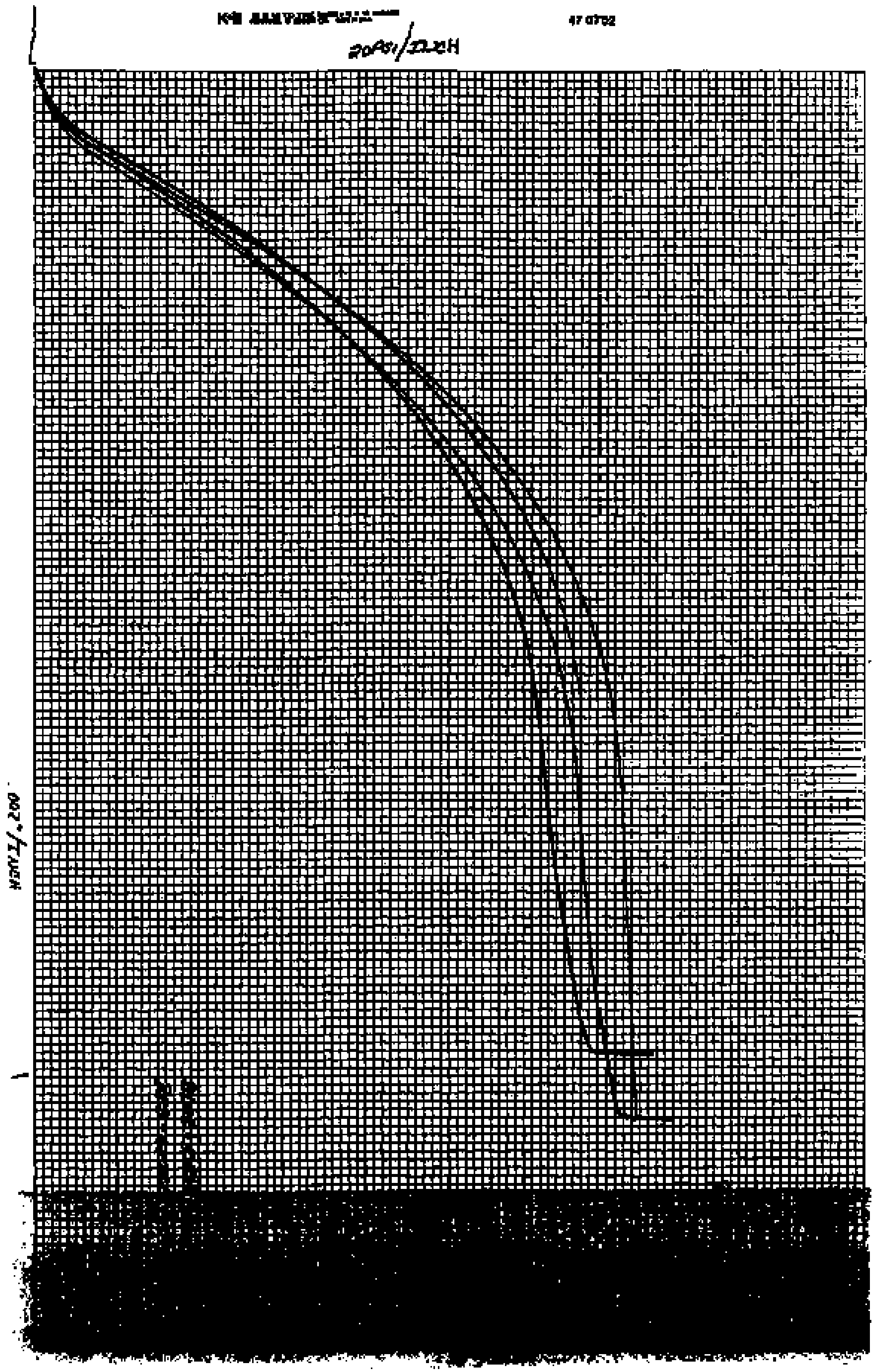
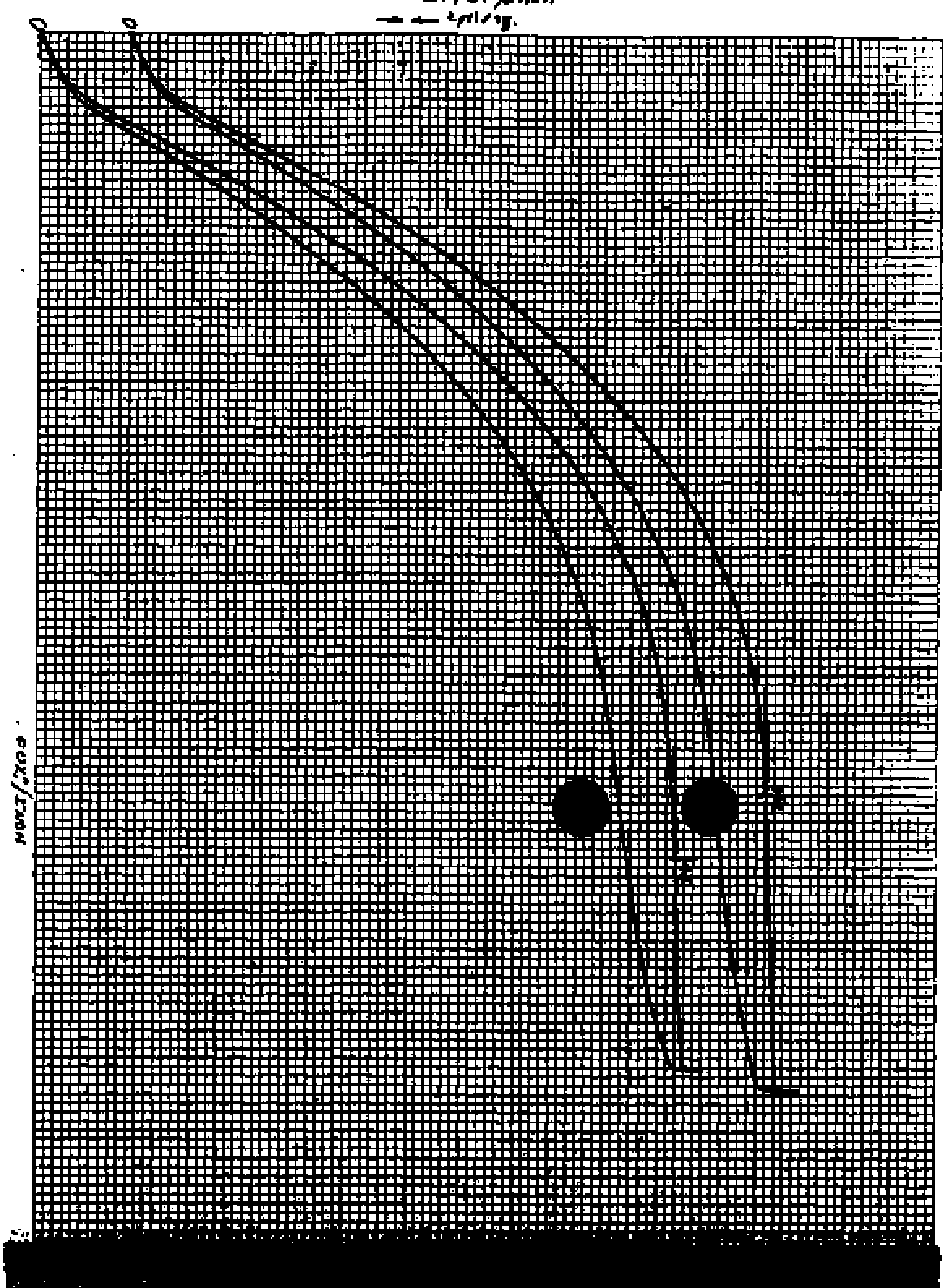


TI-NHTSA 000798

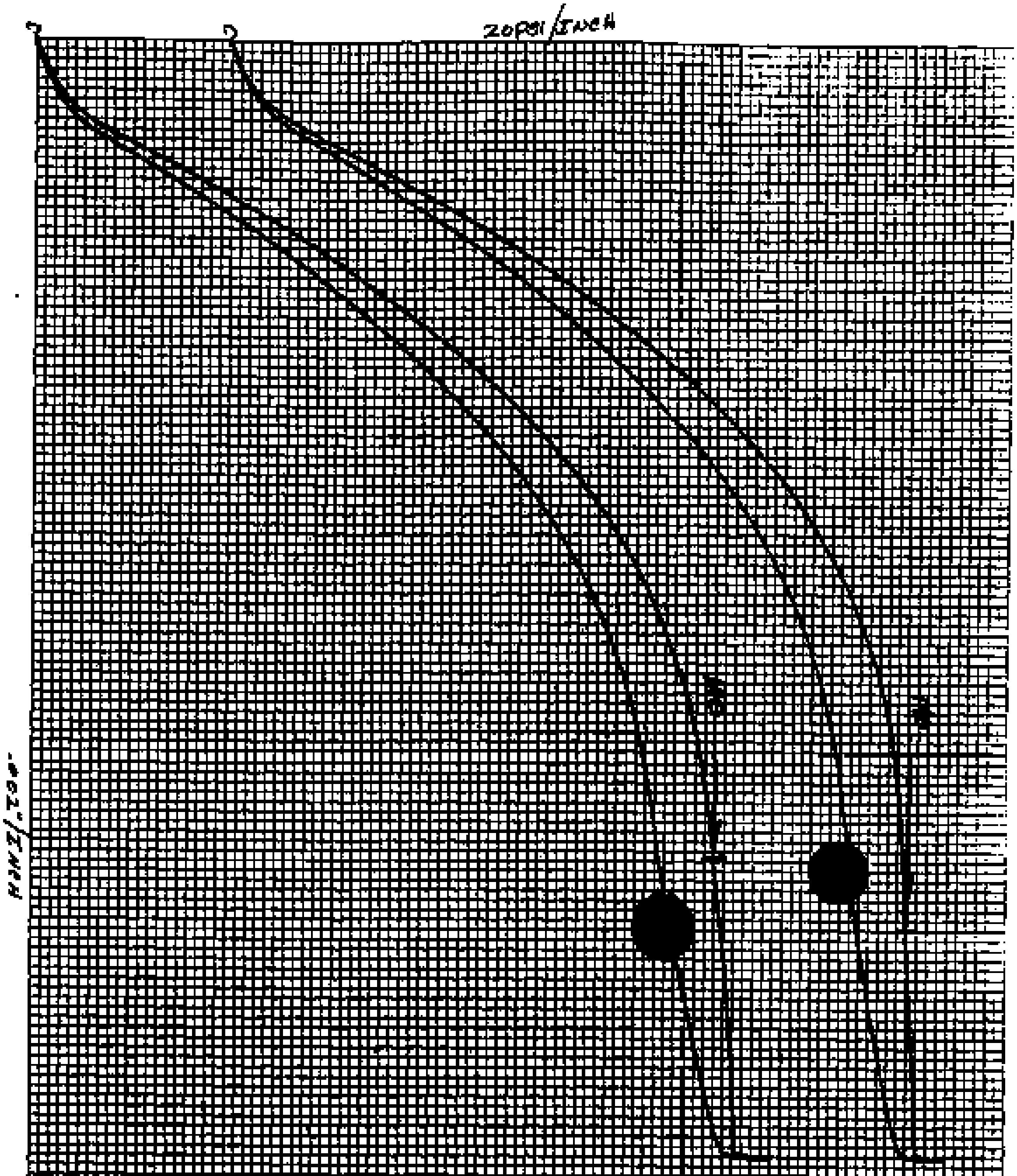


TI-NHTSA 000799



[redacted]

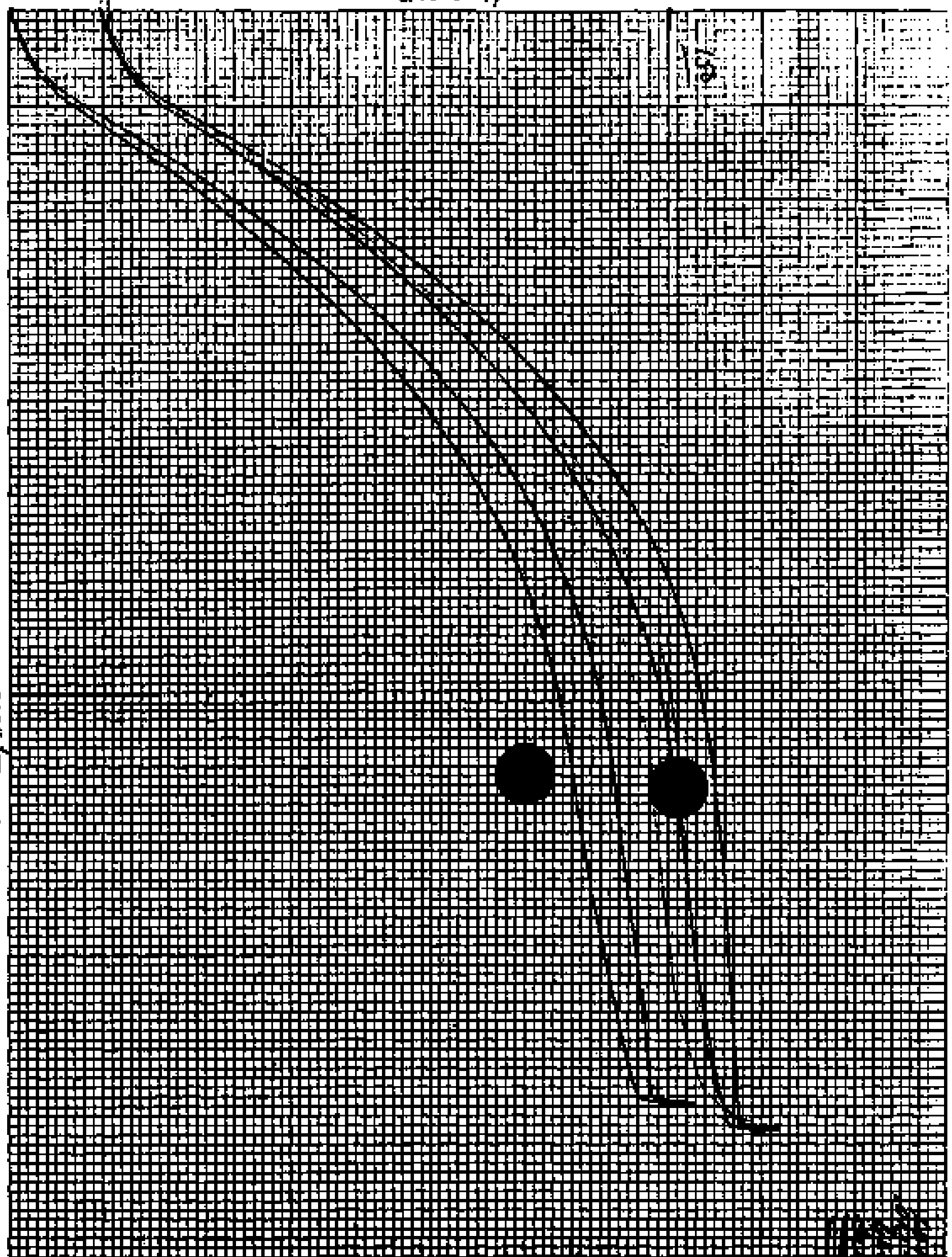
TI-NHTSA 000800



[redacted]

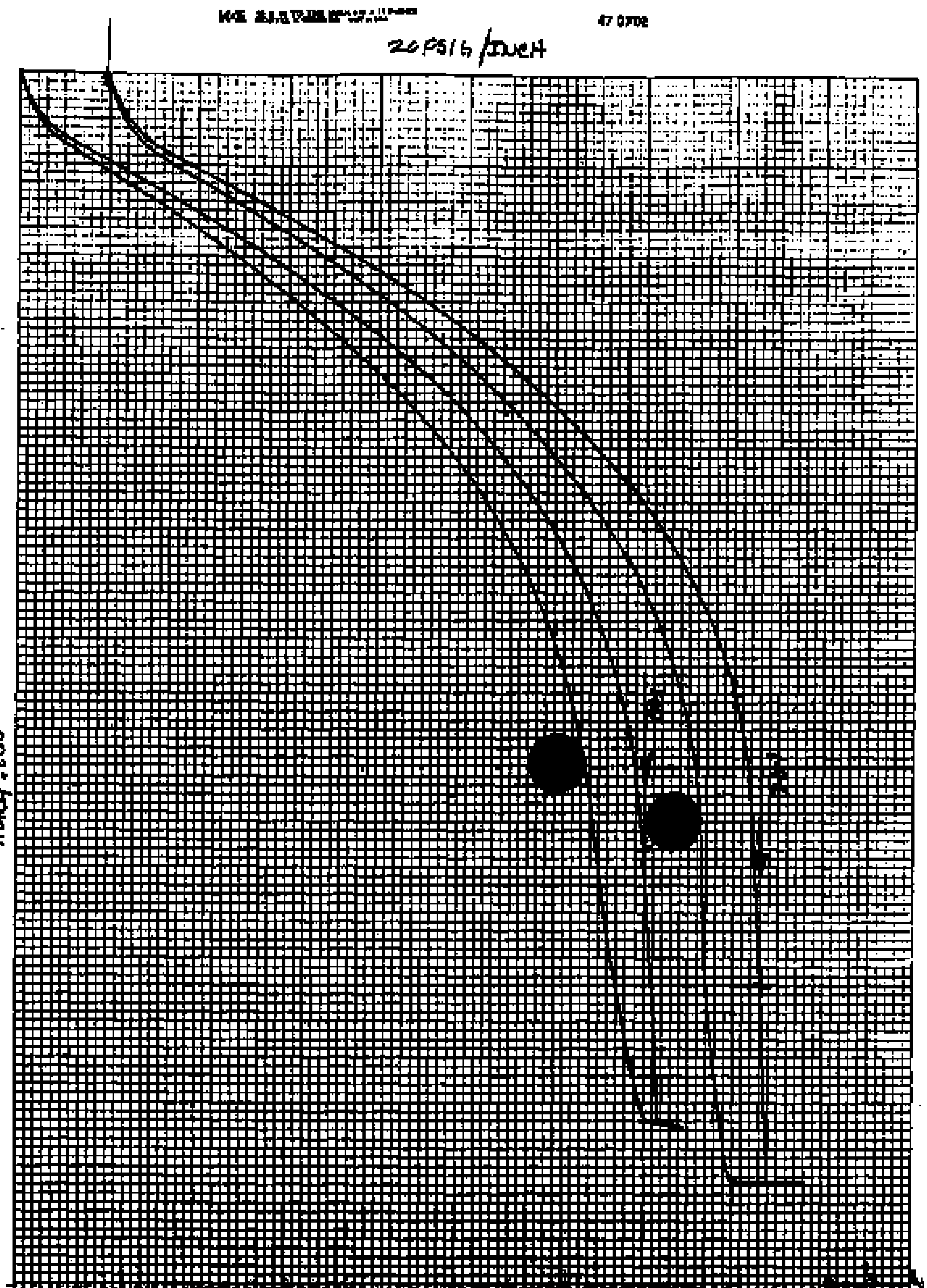
TI-NHTSA 000601

47 0702



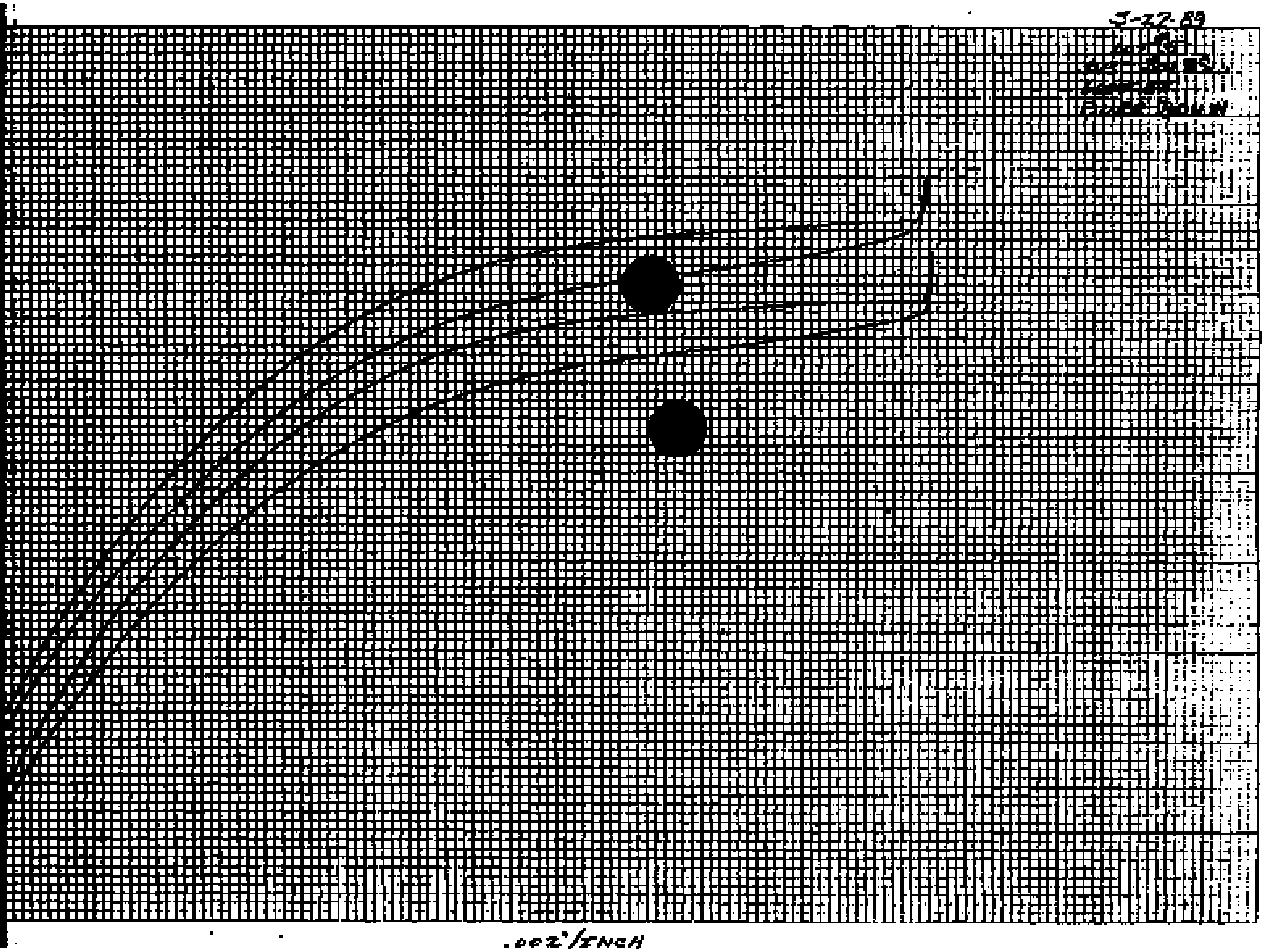
1st
4H ?

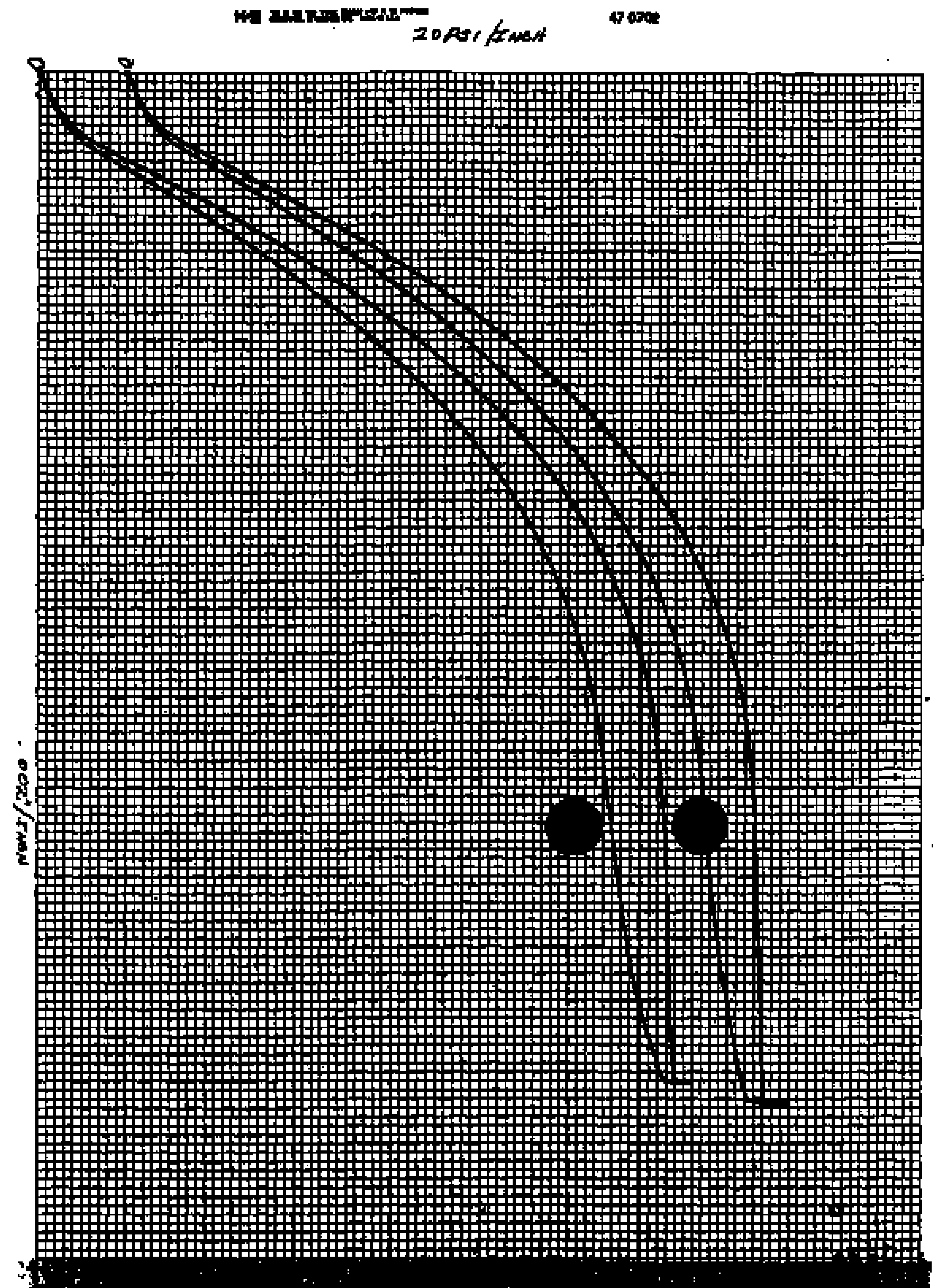
[redacted]



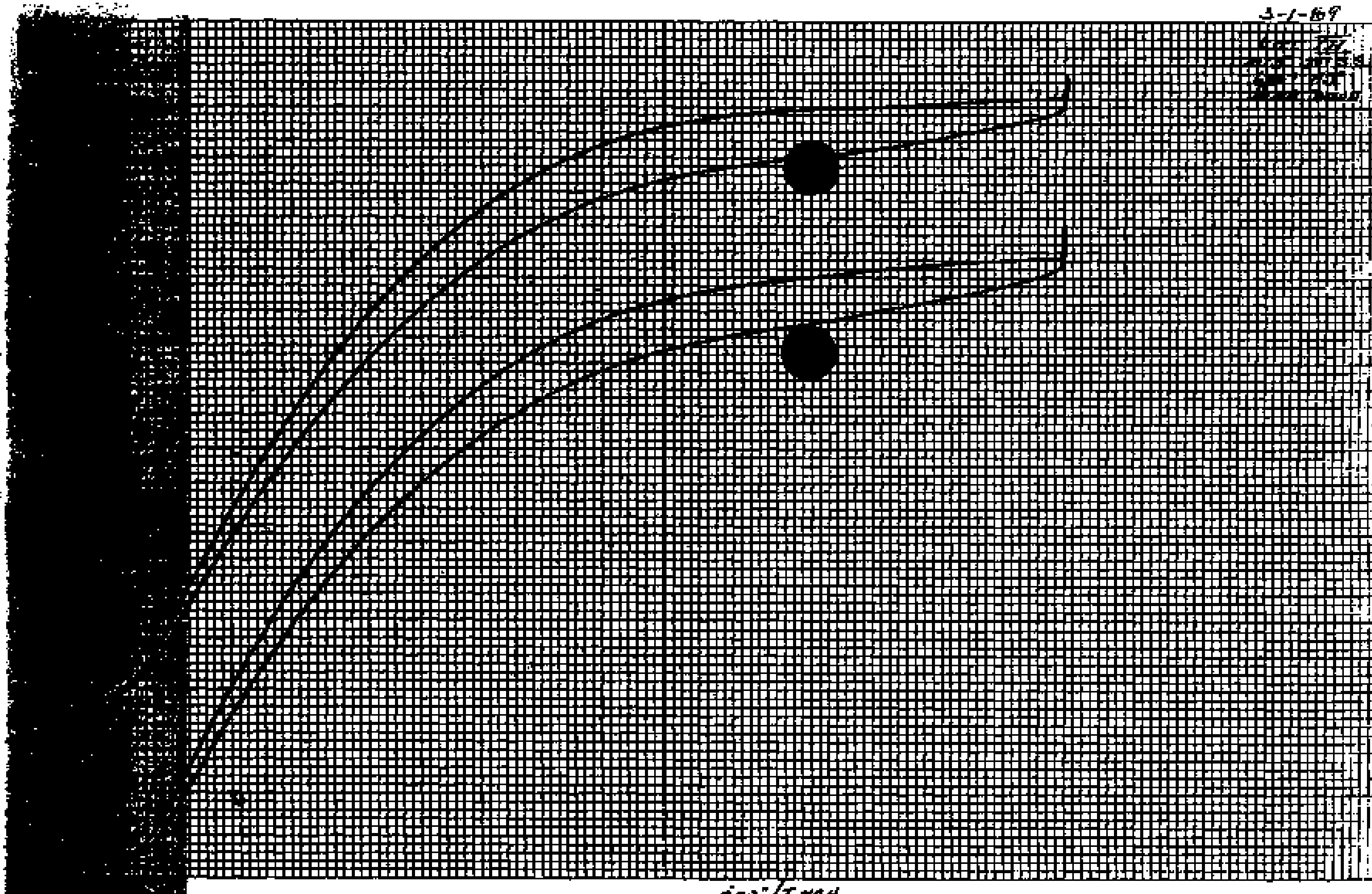
[redacted]

[redacted]



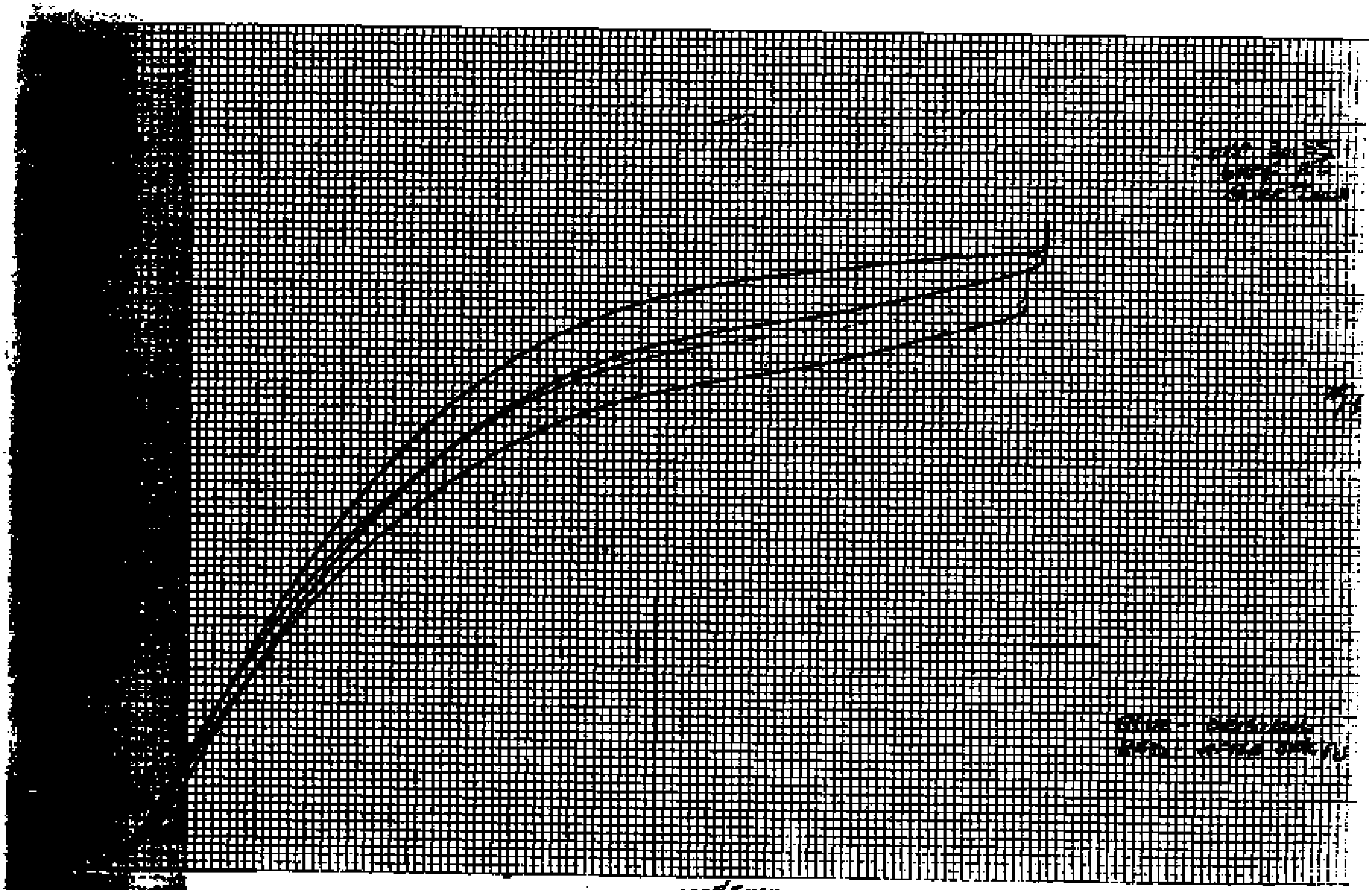


47 0702
20PSI/INCH

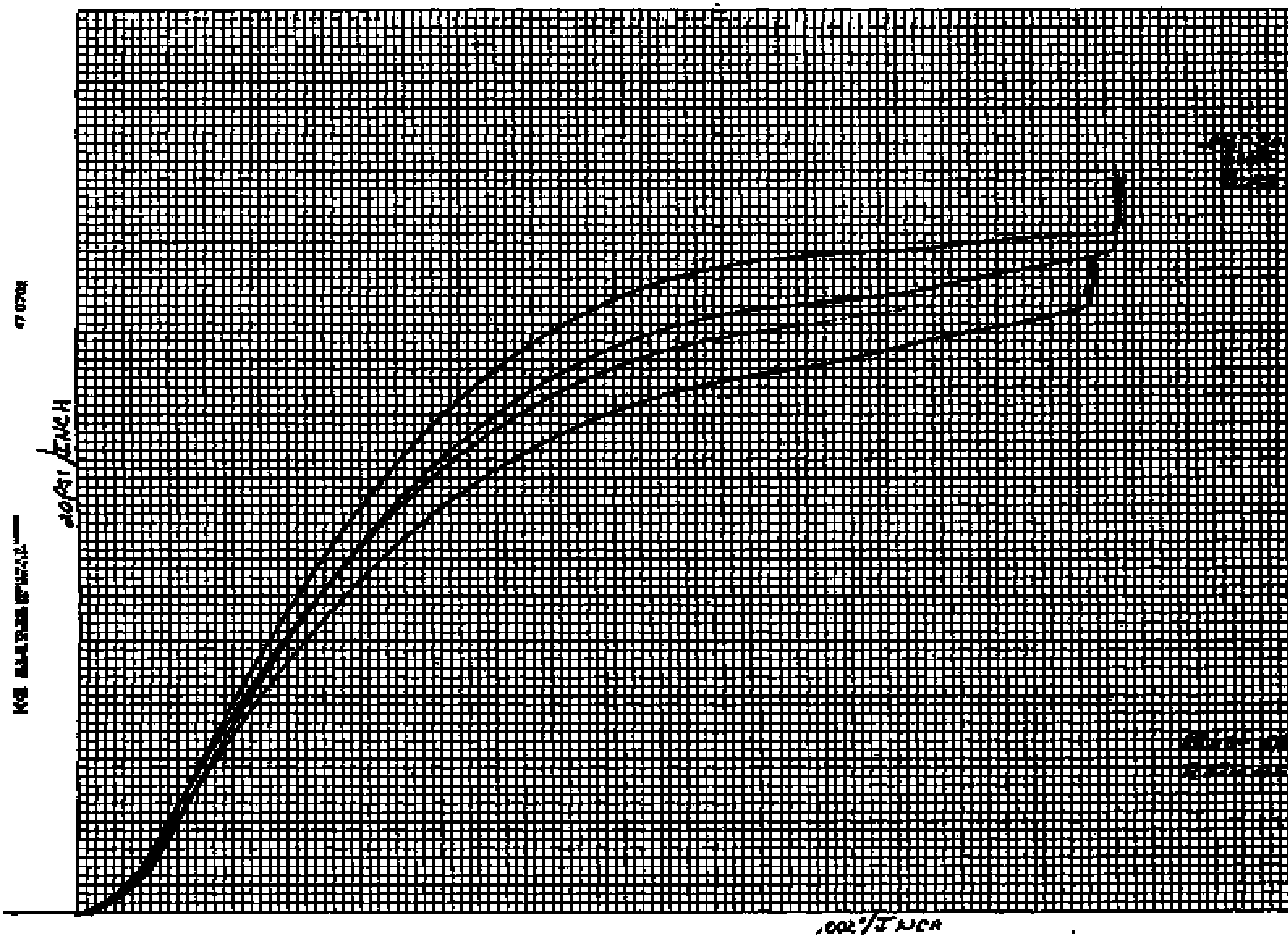


.002"/INCH

14 + 15 from a different lot !!



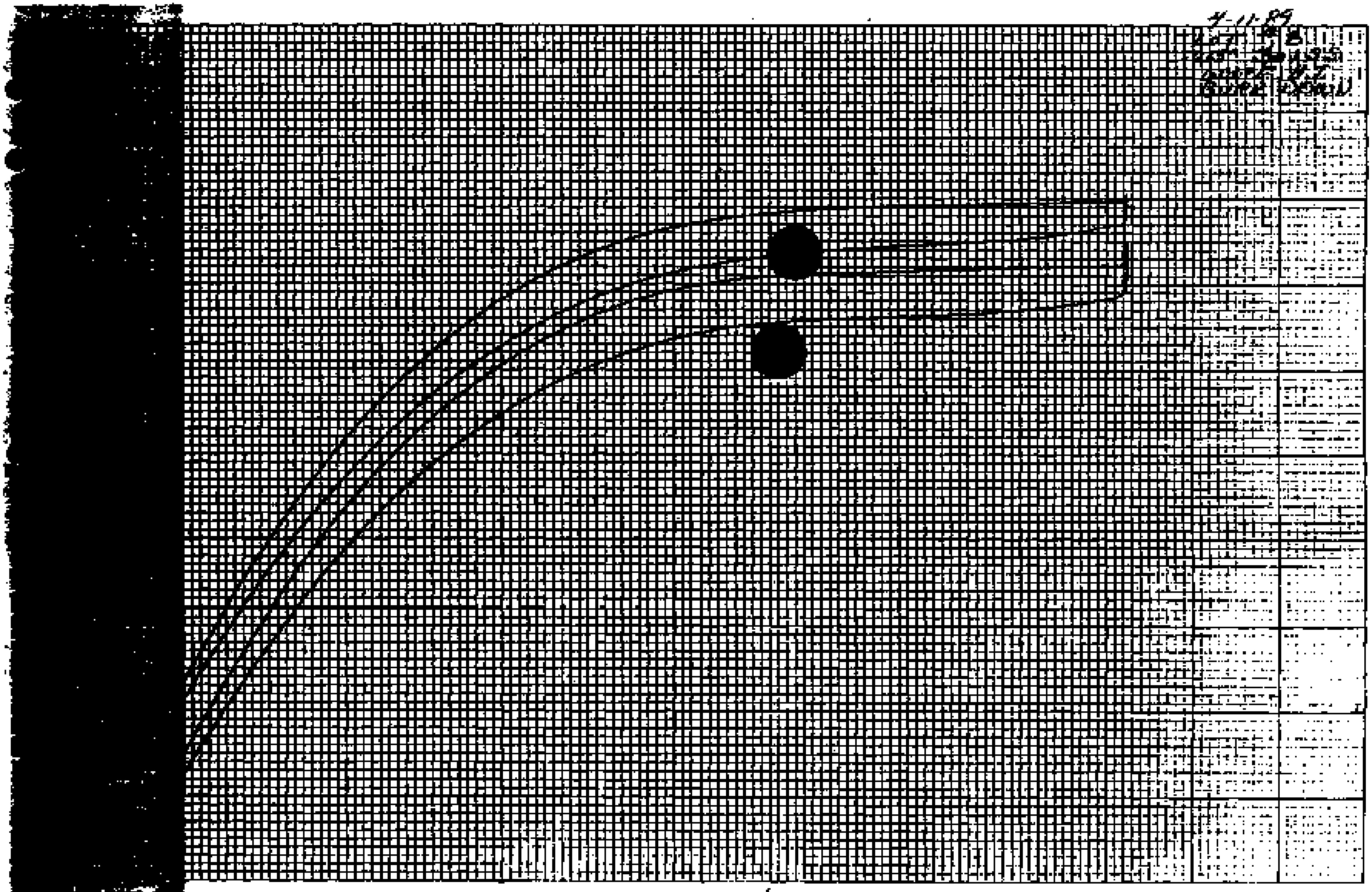
TI-NHTSA 000807



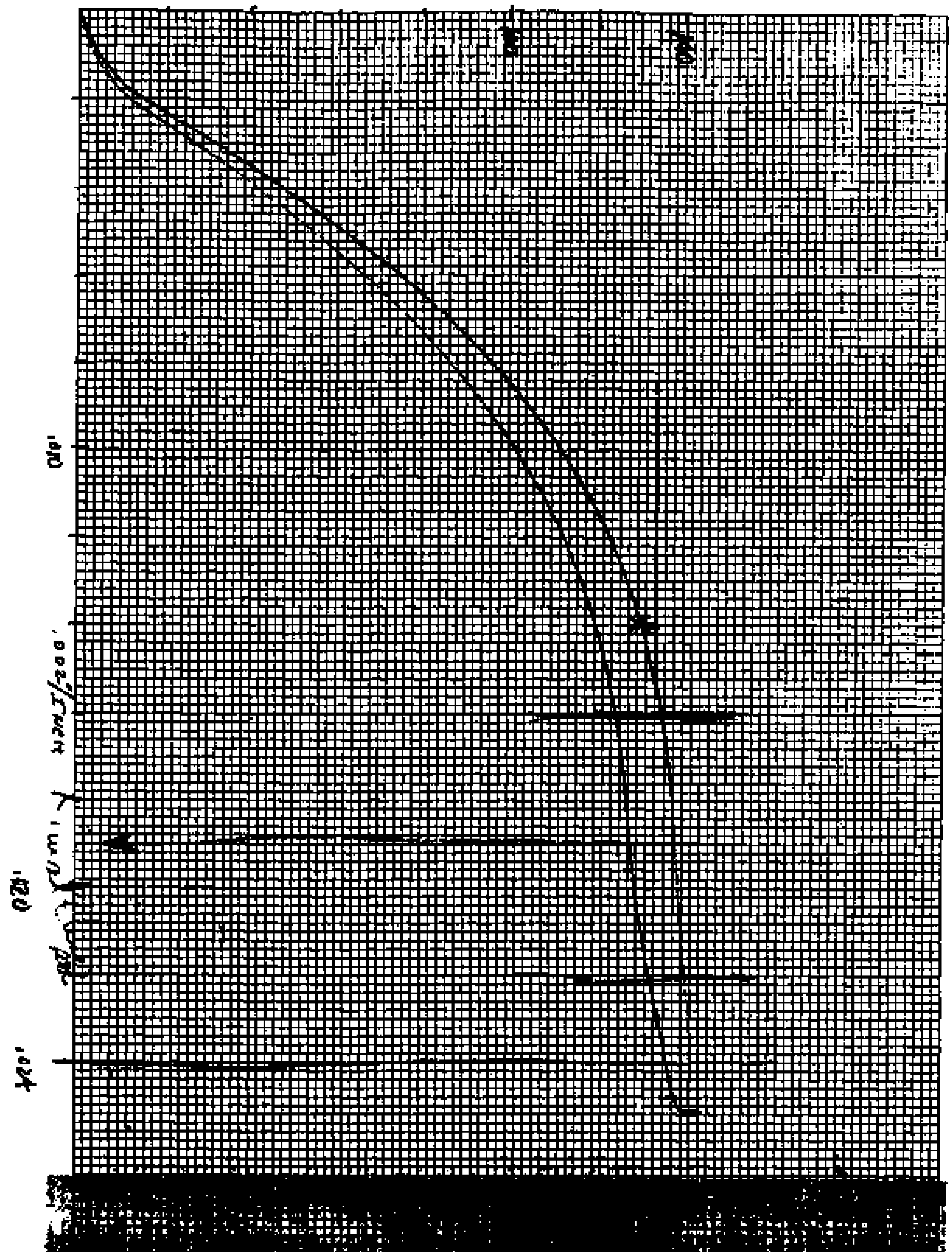
[redacted]

#14 + 15 from a different lot!!

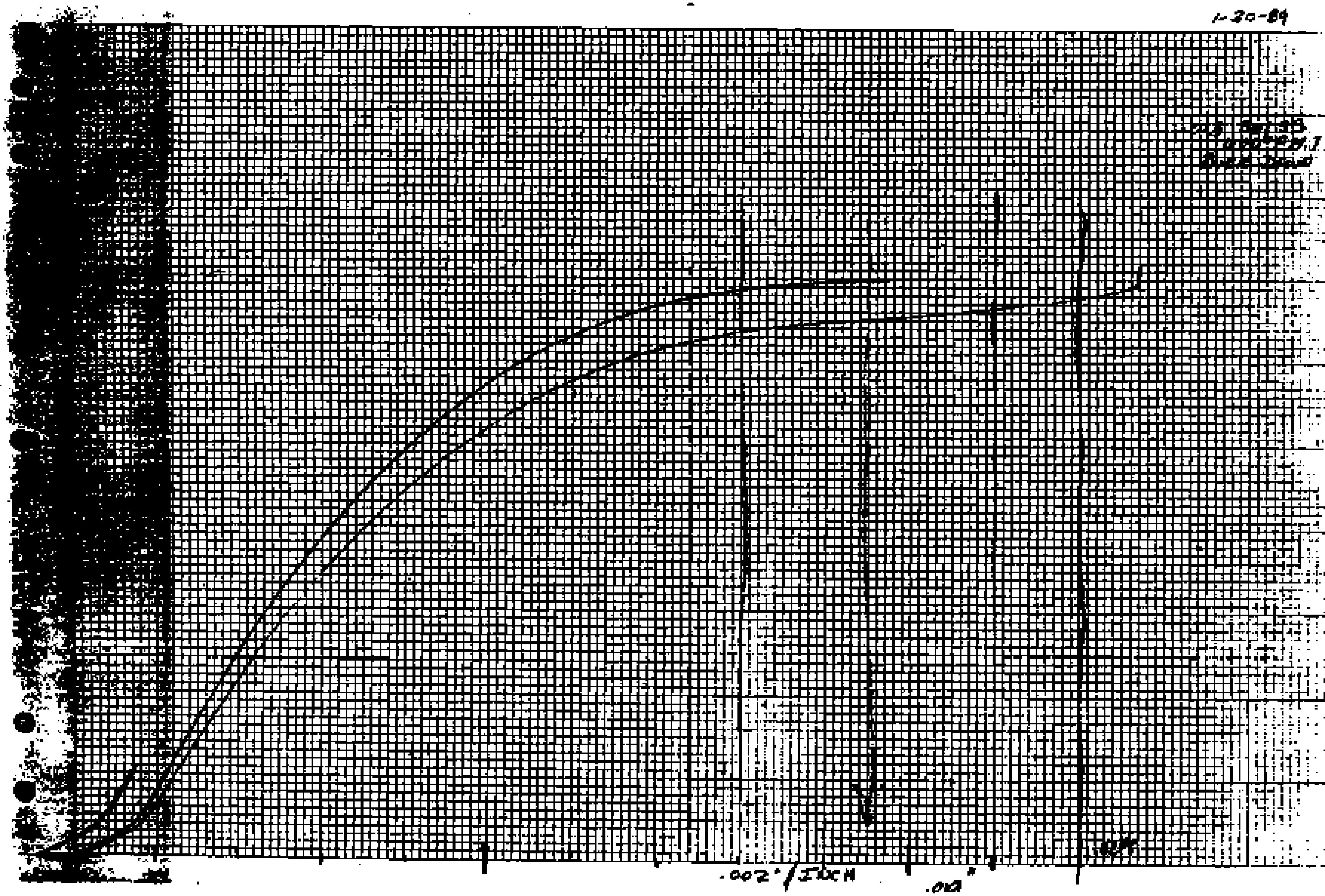
TI-NHTSA 000808



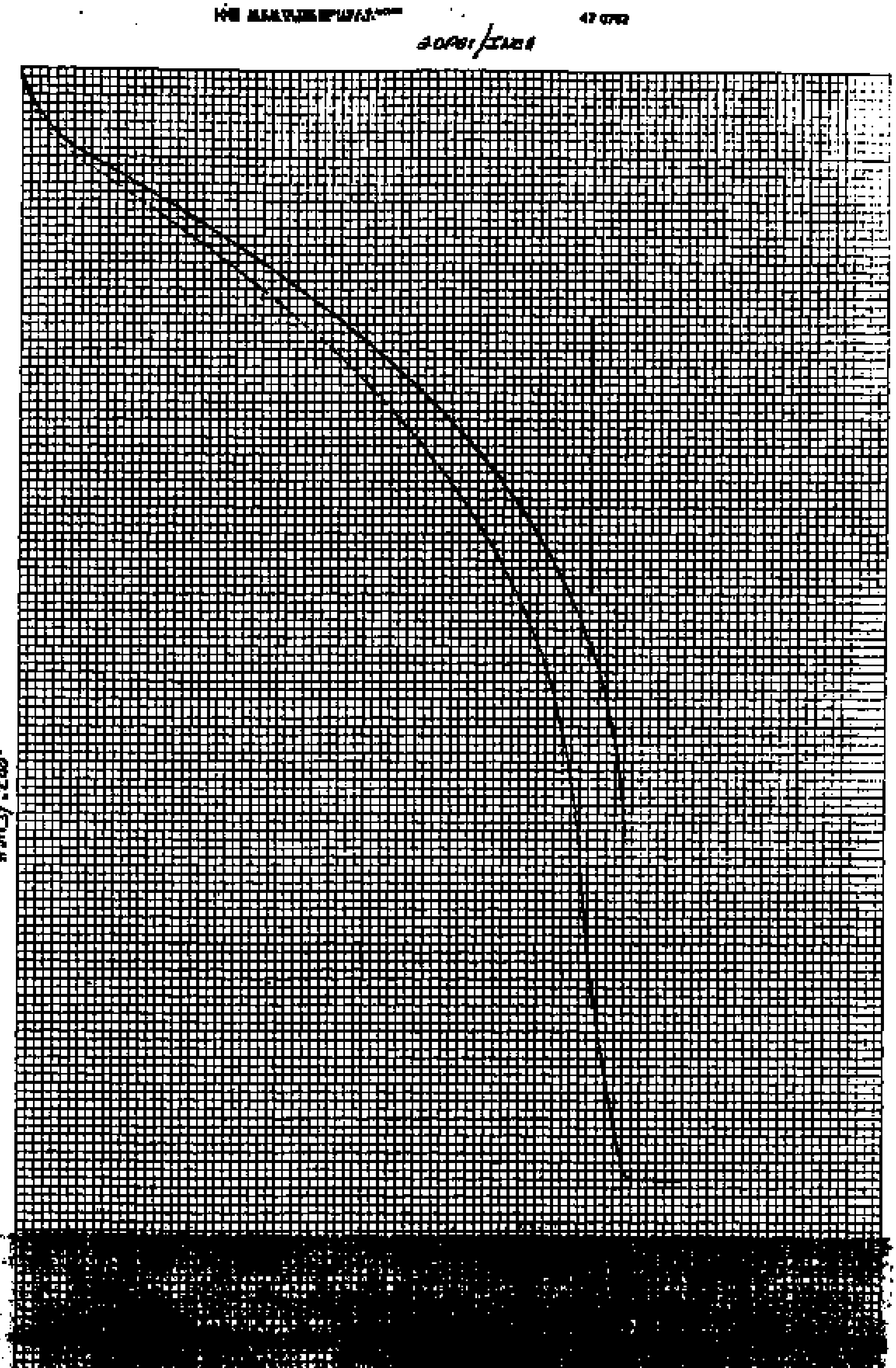
20 PSI/INCH

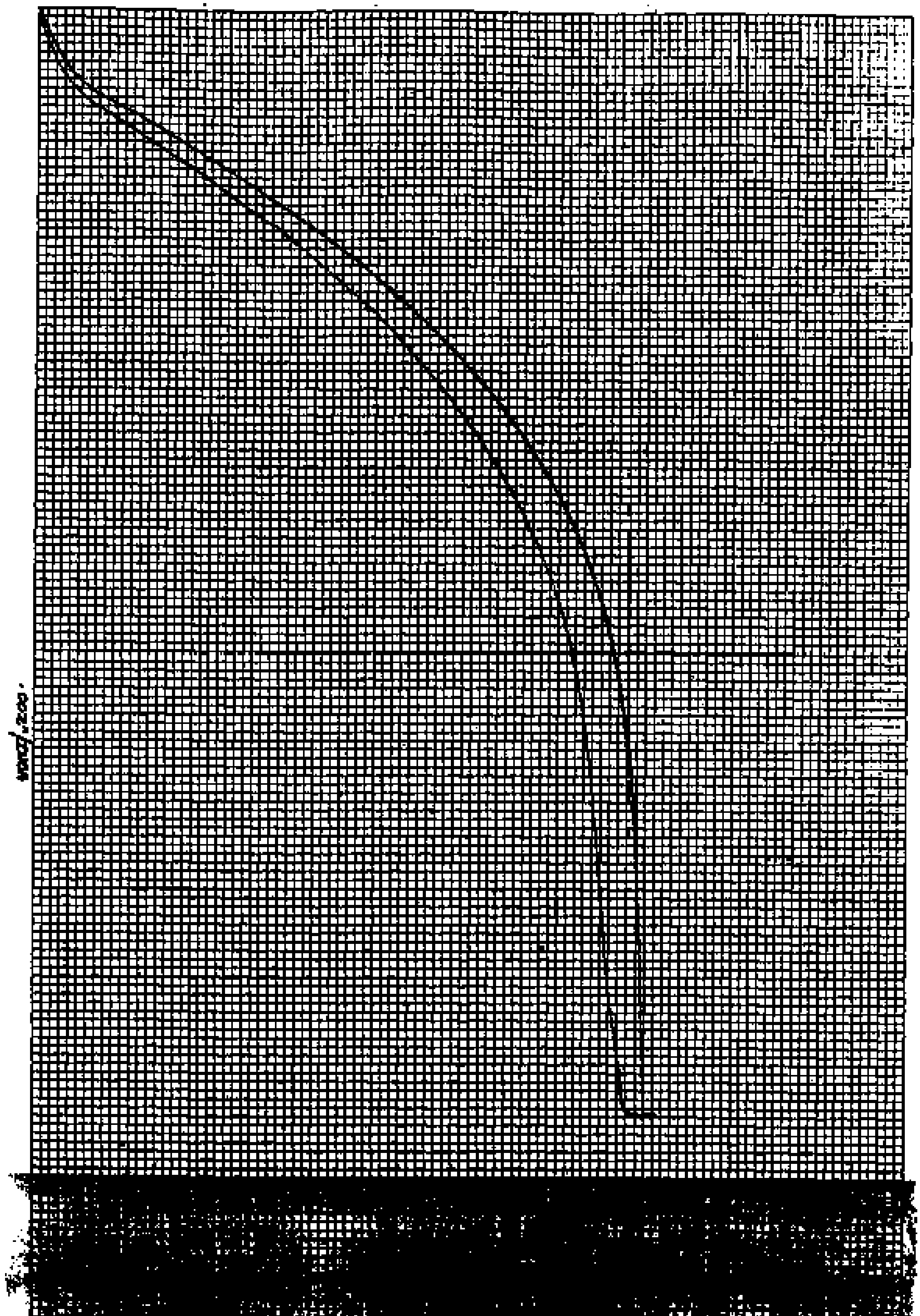


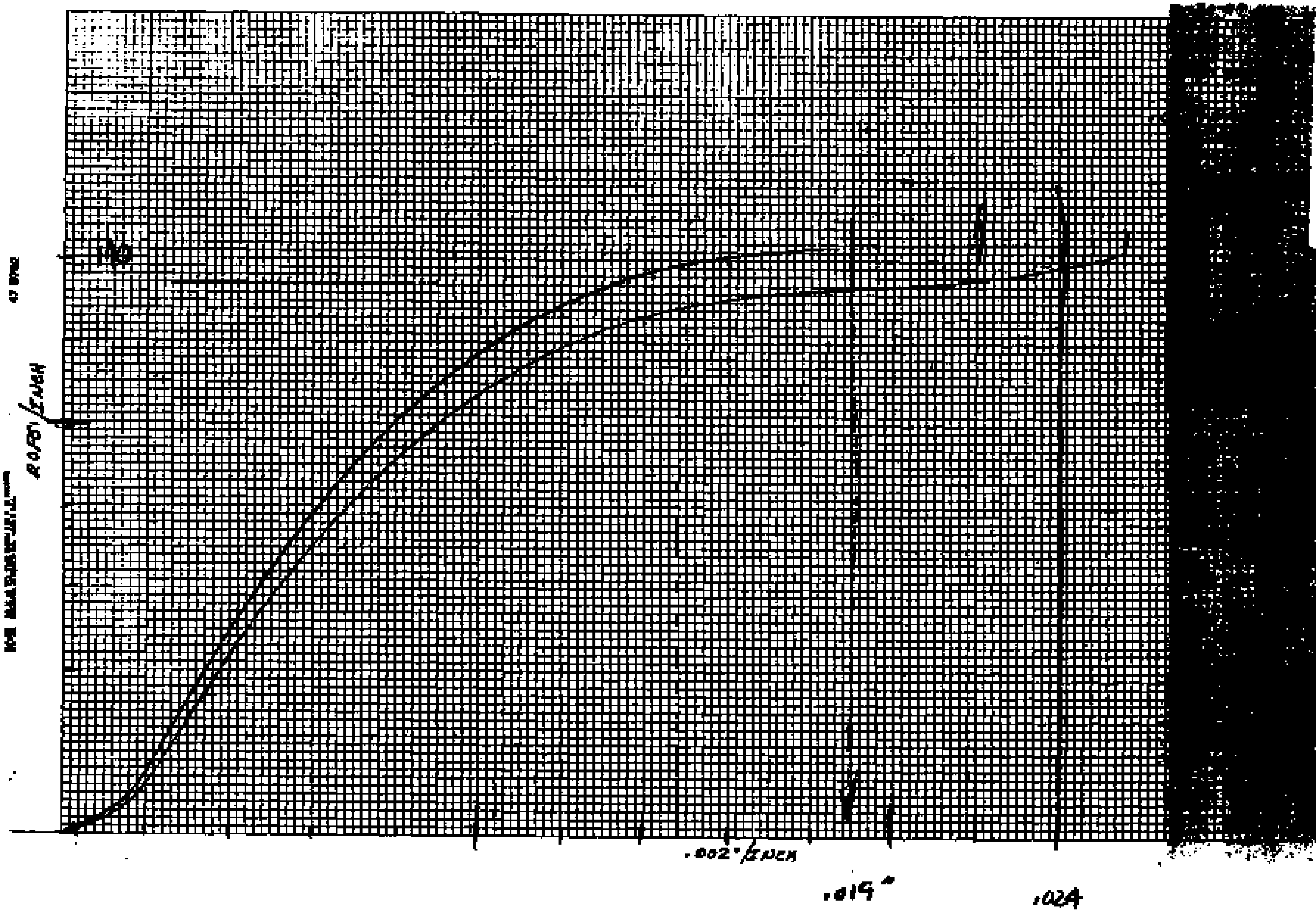
TI-NHTSA 000610



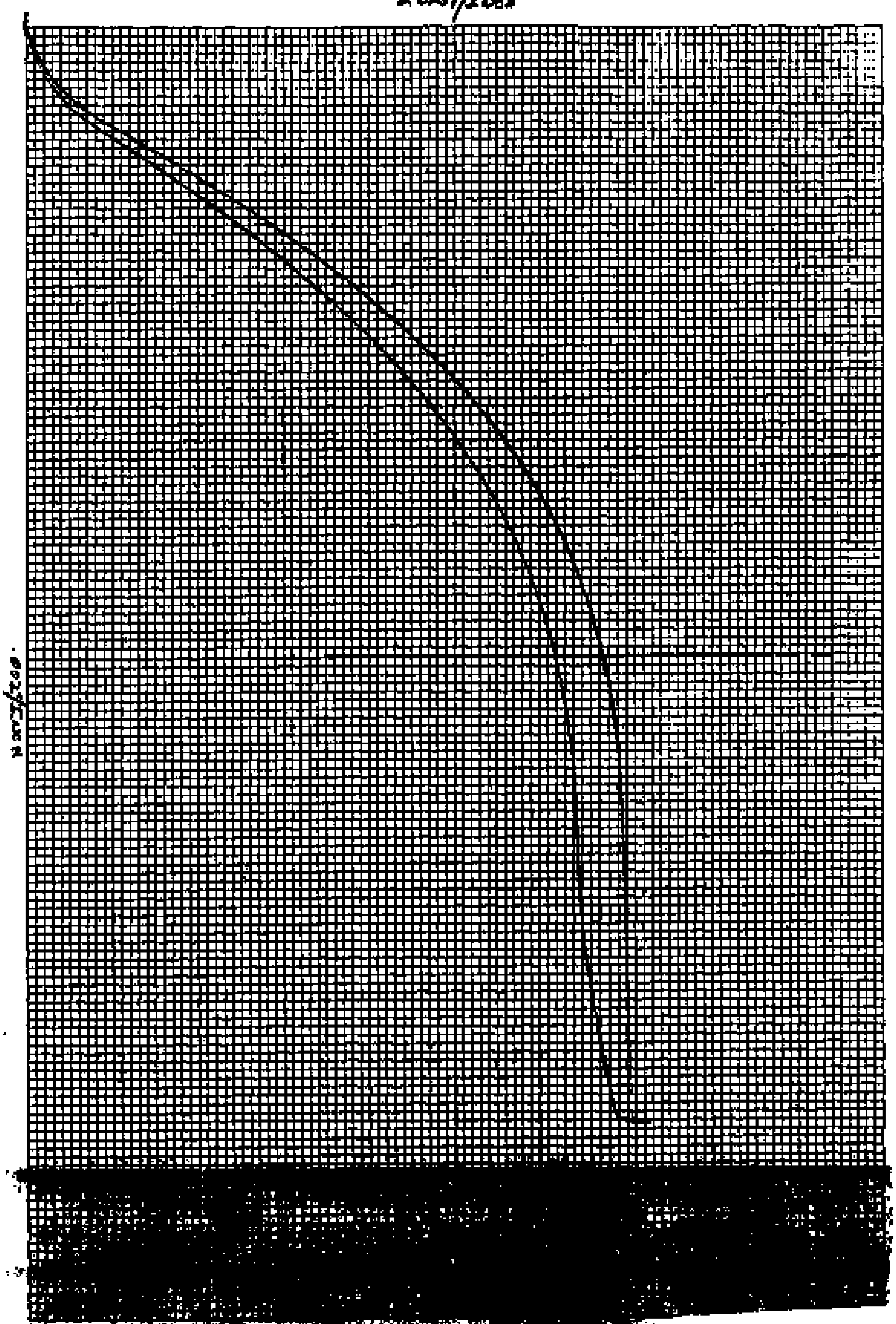
TI-NHTSA 000811







20FB/INCH
.002"/INCH
.019"
.024



HIGHLIGHTS

Stephen B. Offiler
Week Ending 05/25/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER / PROGRAM ISSUES: We've developed a detailed schedule of actions needed in order to finalize the design by the end of June, 5 weeks away. Andy McKenna will be taking over the tasks of finalizing the outstanding details of the base, terminals, and spring; most importantly the development of the burr-less twist design which is presently being prototyped. I am concentrating on LRC sensor and disc development, hexport design, envelope print generation per Ford's requirements, customer-related issues, samples, and testing. The five-week bogey is still very aggressive, allowing limited iteration time.

I spoke with Bruce Pease (Release Engineer at Pass Car Brake Eng) regarding the ISO Flare. I discovered that he developed the sketch we've got from actual measurements of various Teves components and miscellaneous other information. I plan to pursue the actual ISO specification. We managed to clarify the outstanding issues, namely the surface finish spec. and the tolerances. I have enough info to put this hexport design on print (metric) to go out worldwide for quote.

In order to get Pass Car to sign off on the lowered release spec. (40 psi to 20) an argument based on manipulation of Cpk numbers was developed. I was able to show, using assumptions of release sigma's, an improvement from Cpk=1.30 with the 40 psi spec. to Cpk=2.04 with the 20 psi spec.

Dave Brown completed development on schedule of 90 psi and 160 psi discs for use in the old-style direct-disc CCPS. These are ultimately for use in a test vehicle to verify the Pass Car spec of 125 +/- 35. We are assembling devices immediately, to be cycled in order to roughly determine disc life. Since these are one-of-a-kind devices, the 500K life requirement can be relaxed if necessary. These are owed to Ford by the second week of June.

George O'Lear reports that his programmable humidity chamber was up and running as of last week. We will complete the last leg of our Humidity Comparison Test, the results of which are owed to Ford, by June 8.

SENSOR: Three parallel paths are being pursued. The first is use of a standard-ratio converter with "Belville discs". These are .013" 30188 3/4" discs, with a .090" hole in the center. This design is claimed to act like a standard disc made of thinner material. The Disc Dept. has delivered prototypes with 13.2 psi actuation and 7.6 release, with relatively tight sigma's of approx. 0.2. We have built them into 57PS's on the line and will be immediately quantifying proof and cycle life. The second path is use of a cup with the support bump moved radially inward by .050". The model shop is working on making this modification to production cups. This design uses production washers and converters; hence retaining the Kapton-wetting characteristics of production devices. The third path is to further quantify the large-button design, while in parallel working with Ford to gain some relief on the proof spec.

SWITCH: Jeff DiDomenico has made excellent progress in developing a riveting method for the eyelet concept. A two-stage rivet operation seems to be best, using a 45° initial stroke to move material outward, followed by a second stroke with a standard rivet roll. Jeff is designing and building a tool which combines both features.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 59-01-15

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 3423	5/29	RBO	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
	5/29	6/1/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: To provide a device at each end of their actuation spec

PROCEDURE: Build 15 direct acting disc devices. Choose the device with actuation closest to 90PSI and the one closest to 160 PSI. Send to Ford for testing

Device #	Trans Pt T.003	Proof	act	rel	Send
59-01-01	.212	Pass	91	76	✓
02	.210		92	78	
03	.211		91	76	
04	.210		92	77	
05	.210		90	81	
59-01-06	.21[illegible]		158	146	✓
07	.212		153	144	
08	.211		152	144	
09	.212		157	141	
10	.209		157	143	
11	.210		154	146	
12	.210		153	145	
13	.211		156	146	
14	.211		150	143	
15	.211		150	139	

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 60-03-16

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
57PS	—	JAD	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	5/30/90	6/4/90	

PROJECT TITLE: Cruise Control pressure Switch

CUSTOMER:

PURPOSE OF TEST: Iterate test 56-03-12

PROCEDURE: Diaphram: 50% Compression at bump
20% Compression outside bump
-20% Compression inside bump

Discs: $\bar{x}$ 49.5 / 36.47
σ 0.74 / 11.08

Char, heat, char, cycle (500K straight through) char

Sensor #	Initial Act	Initial Rel	Plnt	after Act	Post Rel
60-03-01	558	375		546	389
02	547	378		533	371
03	566	402		556	385
04	582	388		580	401
05	578	398		568	392
06	578	389		557	390
07	580	399	Bent Hex[illegible]		
08	580	385		586	374
09	582	414		573	393
10	539	376		580	374

Hexports bent again after a few K cycles.

TI-NHTSA 000818

HIGHLIGHTS
Stephen B. Offiler
Week Ending 06/01/90

<u>FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423</u>

CUSTOMER / PROGRAM ISSUES: A trip to Ford is planned for next Thursday, 06/07/90. I'm told meetings have been set up with Bruce Pease (Pass-Car Brake Eng.), George Randall (Light Truck NGSC Implementation), and Gary Klingler (Supv. NGSC). Action items include negotiation to obtain relief on the proof spec; negotiation to lower the Pass-Car release from 40 min to 20 min; final spec. outstanding items including humidity testing and in-process spec. non-conformance action plans; updates to the customer schedule (PV, ISIR, Job 1 dates); and details related to finalizing envelope prints.

We have completed a 500K impulse test on the 90 and 160 psi direct-disc test devices for Pass-Car. The 160's were fine. Two lots of 90's were cycled; one lot was 301V (vacuum-melt) and the other was older 301, non-vacuum melt. One non-V device was found cracked at 500K cycles. Samples to ship to Ford have been prepared using the 301V disc lot. I hope to get these into Bruce Pease's hands before my trip, in the hope that he can prepare a car for demo as was done last December with Light Truck.

SENSOR: We received Belville discs from the Disc Dept., very quick turnaround. Jeff Melton indicates that these discs are very easy to "dial-in", requiring a half-hour of setup rather than a half-day as usual. Using standard production converter components, we measured a relatively low ratio on the order of 7.0:1. These were cycled to 500K. One disc was found cracked at the end of 500K, while the rest seem fine. We plan to try a pin-window experiment, as well as opening up the cycled devices and doing a final free-disc characterization. Our next (possibly last) Belville iteration will attempt to hit 125 psi assuming a 7.0:1 ratio, and will decrease differential to obtain better life. These will be cycled to failure and a Weibull will be done.

A sketch of the ISO flare hexport has been developed, using GD&T, and drafting is working on the print. The plan is to send this print to Elco in order to get a feel for the price increase associated with the new flare, and ultimately to send it overseas to suppliers identified in Korea and Japan.

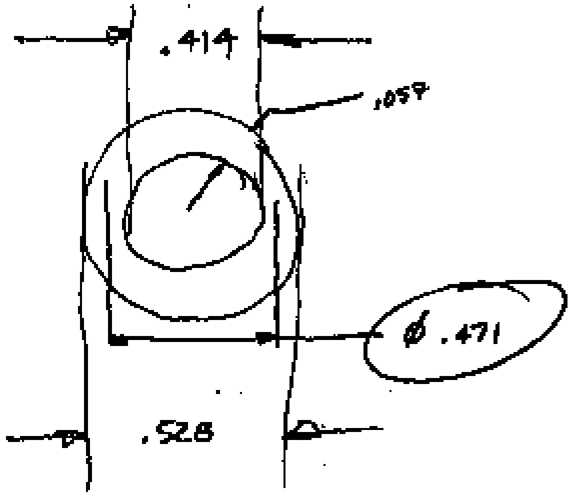
An adapter has been designed which will allow the new ISO flare to be cycled on our present manifolds. This adapter will actually use an O-ring seal rather than sealing on the flare, due to concern over wear on the adapter's sealing surface with repeated use. To do this, the thread-relief dimension on the ISO hexport (spec'ed as optional anyway) was modified slightly to turn it into our standard O-ring gland.

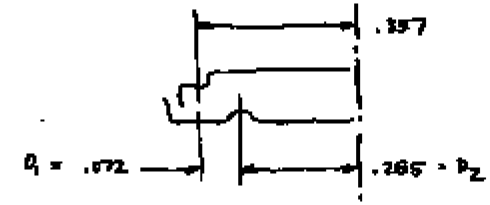
Jeff DiDomenico is continuing efforts on the rubber diaphragm concept on a low-priority basis. The model shop has delivered parts for the next iteration, to be run in parallel with the next planned Impulse test.

MISC: Components for the Impulse Monitor Circuit have been ordered, and expected to arrive mid-next week. The first use for this circuit will be the above failure test of the next lot of Belville discs. The circuit should recognize a cracked disc as an erratic switching characteristic. This will allow collection of accurate failure data for the Weibull.

So 6/4/90

ACTUAL MEASUREMENT





PRODUCTION, NOMINAL

D_2/D_1	RATIO
.300/.057 = 5.26	13.00
.285/.072 = 3.96	9.5
.270/.087 = 3.10	8.6

$y = 2.09x + 1.78$ $\hat{R} = .978$

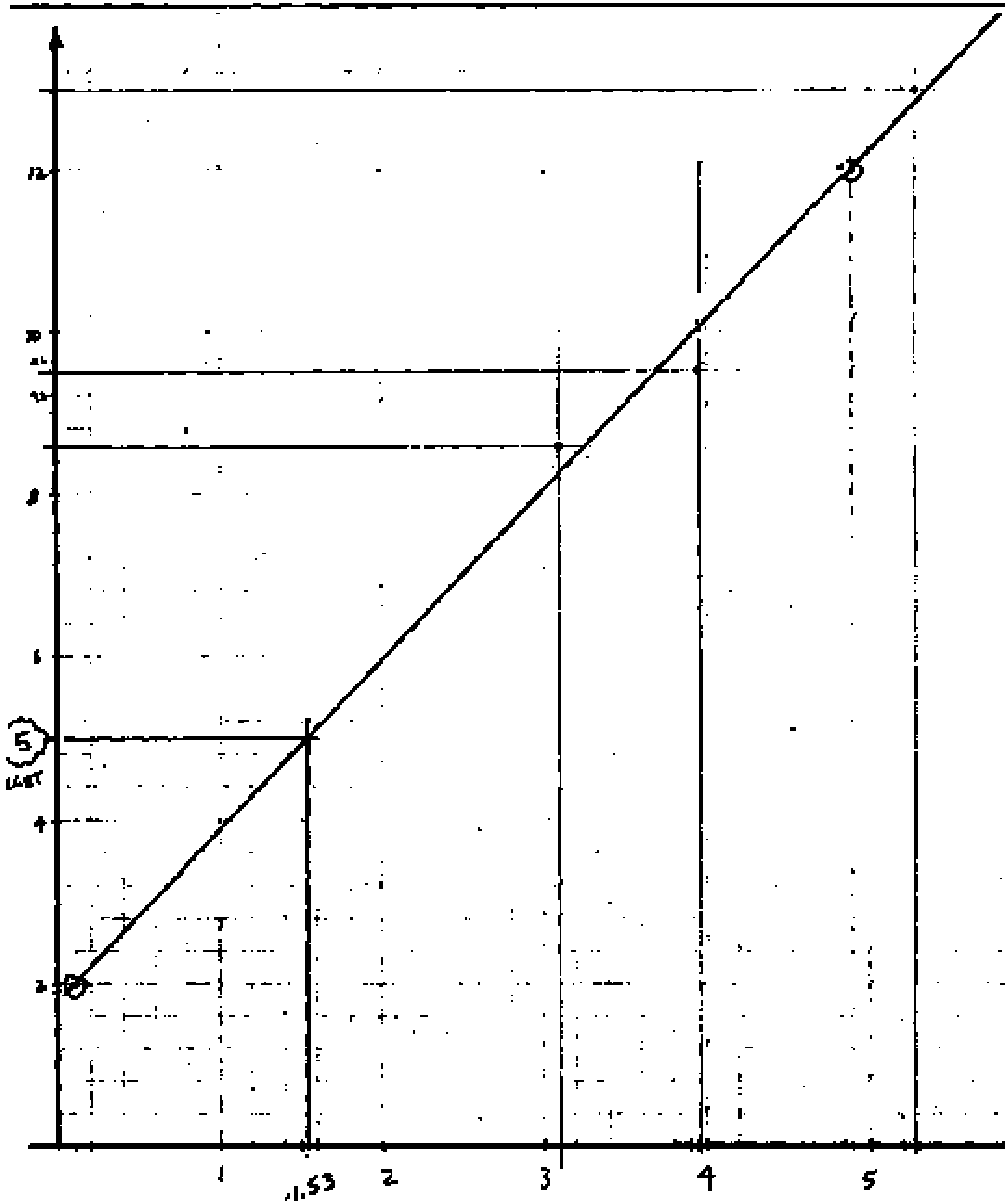
$y = 12, x = 4.89$
$y = 2, x = 0.107$

$D_2/D_1 = 1.53$ $D_1 + D_2 = .357$
$D_2 = (.357 - D_1)$

$.357 - D_1 = 1.53 D_1$
$+D_1 \quad +D_1$
$.357 = 2.53 D_1$

$D_1 = .141$ $D_2 = .216$
→ MOVE BUMP .063"

* FIRST-PASS TRY .050"



TI-NHTSA 000821

HIGHLIGHTS

Stephen B. Offiler
Week Ending 06/06/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH EX3423

CUSTOMER/PROGRAM ISSUES: A very successful meeting was held yesterday with Pass-Car Brake Eng, Next-Generation Speed Control Eng, and Light Truck Speed Control. Please see my trip report for all details, which I have not attempted to present in these highlights.

SENSOR: Further analyis of the first Belville disc experiment shows quite a bit of drift over the 500K cycle life, on the order of 19%. At the same time, the ratio shifts upward from 7.0:1 to 7.8:1 which partially offsets this drift. This does not preclude use of this concept. With an intentional shift upward from nominal, it is still possible to keep the +/- 3 sigma limits within the spec. throughout life. The next Belville disc iteration has been ordered from the disc dept, and takes this shift into account. We have also measured pin window and throw, and found typical numbers of .004" and .017" respectively.

We have received 57PS cups from the model shop which have the bump relocated to a smaller diameter to reduce the lever ratio. Devices are presently being built.

With some relief on the proof spec. forthcoming from Ford, we will begin to develop prints of the original LRC design, which is the large converter bump. A new converter and washer are required.

Steve Offiler 6/6/90

TI-NHTSA 000822

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 61-09-24

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3413	6/1/90	[illegible]	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	6/7/90		

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST: Alternate LRC Design. Relocated cup [illegible].

ACTUAL cup ⌀ .471 MEASURED

PROCEDURE: 12 Model-shop modified cups and 12 standard cups (controls). Do initial Frendise char on 30155 Discs w/ ~ 22PSI actuation, assemble into sensors. Characterize, proof, characterize, measure pin window and disc throw on each, cycle w/ [illegible] @ 10K, 50K, 250K, 500K. Open sensors [illegible] do final disc char.

Sensor #	Cup	Disc Act	Disc Rel	Sensor init Act	Sensor init Rel	After Proof Act	After Proof Rel	Pin Window	Disc Throw
61-09-01	M	21.5	9.0	99	35	100	40	.005	.015
02		23.2	10.0	111	40	116	43	.005	.015
03	0	23.3	9.0	106	29	113	36		
04	d	19.5	7.3	93	27	101	34		
05	.	21.6	10.3	102	35	106	43		
06		24.6	9.6	110	37	119	44		
07	f	20.4	9.4	101	35	105	43		
08		23.5	[illegible]	129	30	140	38		
09		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[redacted]	
WASHER 10	e	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
UPS 100-DOWN 11	d	[illegible]	[illegible]	112	[illegible]	118	45		
FAIL @ 300K 12		23.9	7.7	120	46	125	52		
61-09-13		20.8	10.3	222	[illegible]	223	87	.005	[redacted]
14	S	[illegible]	[illegible]	[illegible]	[redacted]				
15	T	23.4	9.6	230	70	239	93		
16	A	25.7	10.9	255	[illegible]	204	102		
17		23.1	9.6	249	[illegible]	222	75		
18	N	21.9	10.1	210	95	217	101		
19	D	24.9	9.9	235	94	240	100		
20		24.4	9.9	240	91	228	97		
21	A	25.2	10.4	238	97	240	97		
22	R	21.6	7.3	208	63	221	69		
23		24.1	10.1	235	90	237	98		
24	D	20.9	9.9	192	74	198	77		

Tester #	10K cycles Act	Rel
11-09-01	105	49
02	119	57
03	116	48
04	105	43
05	109	57
06	118	50
07	110	49
08	135	42
09	170	74
10	129	61
11	119	53
12	127	57
11-09-13	225	90
14	197	65
15	225	79
16	256	102
17	224	83
18	210	99
19	239	98
20	237	93
21	241	99
22	203	69
23	239	99
24	195	87

TI-NHTSA 000824

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 61-09-24

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 343	5/1/90	SBD	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	6/2/90		

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST: Alternate LRC Design. Relocated cup bump.

PROCEDURE: 12 Model-shop modified cups and 12 standard cups (controls). Do initial Freon disc char on .30155 discs w/ ~22 PSI actuation, assemble into sensors. Characterize, proof, characterize, measure pin window and disc throw on two of each, cycle w/ solar @ 10K, 50K, 250K, 500K. Open sensors and do final disc char.

Sensor #	Cup	Disc Act	Disc Rel	Sensor Init Act	Sensor Init Rel	After Proof Act	After Proof Rel	Pin window	Disc Throw
61-09-01	M	21.5	9.0	99	35	100	46	.005	.015
02		23.2	10.0	111	40	116	48	.005	.015
03	o	24.2	9.0	106	29	113	36		
04	d	19.5	7.3	93	27	101	34		
05	.	21.6	10.3	102	35	106	43		
06	i	24.6	8.8	110	37	117	44		
07	f	20.9	9.4	101	35	109	43	ACT	
DISC ACT 08	.	23.1	6.9	129	30	140	39	x̄ = 116.4	Cpk =
x̄ 23.3 ~~09~~		~~21.9~~	~~10.6~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	σ = 13.1	116.4-90 x
σ 1.75 10	e	25.9	10.9	122	51	136	57	% = 11.3%	3(13.1)
% 7.6% 11	d	21.7	8.9	112	40	118	48		$\boxed{0.67}$
12		22.7	7.7	120	46	125	52		
61-09-13		25.0	10.3	222	84	223	91	.005	.021
14	S	20.3	7.0	196	57	196	65	.006	.020
15	T	25.4	9.6	220	72	224	93		
16	A	25.7	10.4	255	97	254	113		
17		23.1	7.6	219	78	223	83		
DISC ACT 18	N	21.9	10.1	210	93	212	101		
x̄ 23.4 19	D	24.9	9.8	235	94	240	100	ACT	Cpk =
σ 1.82 20		24.4	9.9	240	91	239	97	x̄ 222.7	N/A
% 7.8% 21	A	25.2	10.4	238	99	240	97	σ 21.0	
22	R	21.6	7.3	200	65	201	69	% 9.4%	
23		24.1	10.1	235	90	239	98		
24	D	20.3	9.9	192	78	195	82		

TI-NHTSA 000825

Sensor #	10K cycles Act	10K cycles Rel	60K cycles Act	60K cycles Rel	250K cycles Act	250K cycles Rel	500K cycles Act	500K cycles Rel		
61-09-01	105	49	113	53	108	49	110	53		
02	119	57	127	61	121	57	125	61		
03	116	48	126	52	117	47	119	50		
04	105	43	110	47	102	43	106	47		
05	109	57	113	61	106	56	111	58		
06	118	50	123	54	116	51	121	52		
07	110	49	115	52	108	49	109	50		
08	135	42	140	45	123	43	135	45		
09	170	74	175	97	115	66	leak @	259K		
10	138	61	144	64	140	60	142	63		
11	119	53	122	55	115	52	120	55		
12	127	57	134	60	129	57	131	58		
61-09-13	225	90	230	95	231	86	233	88		
14	187	65	175	67	190	62	191	64		
15	225	78	232	93	230	78	232	91		
16	256	102	257	104	252	98	255	101		
17	224	83	232	84	225	77	227	84		
18	210	99	220	101	219	95	223	97		
19	239	98	250	97	245	92	246	91		
20	237	93	245	97	244	89	244	94		
21	241	99	250	100	245	94	247	97		
22	205	67	211	70	201	64	209	68		
23	239	97	241	96	238	92	243	96		
24	195	82	205	89	198	96	203	87		

TI-NHTSA 000828

—MSG N#= 332282 FR=SKHB TO=AKLB SENT=06/08/90 11:22 AM
R#=004 ST=C DIV=0050 CC=00101 BY=SKHB AT=06/08/90 11:22 AM

TO:	Tom Charboneau	KLB	Stan Homel	KLB
	Dave Czarn	AKLB	Donna Moynihan	PCQA
	Mike DeMattia	PCQA	Keith Roberts	PCME
	Jeff DiDomenico	KLB	Bill Sweet	PCME
	Charlie Douglas	CPPC		
CC:	Joe Schuck	JIB		
FR:	Steve Offiler	KLB		

RE: Trip Report - Cruise Control Pressure Switch - 06/07/90

*** Meeting I - Passenger Car Brake Engineering ***
TI Personnel: Tom Charboneau, Steve Offiler, Joe Schuck
Ford Personnel: Walter Blount, Bruce Pease

PROOF SPECIFICATION: We explained the history behind the move from the direct disc design to the converter design, and our proof difficulty with the low-ratio converter (LRC) design. They said system pressures BARELY got to 2500 psi. They also said proof on other system components is spec'ed at 3000, with a 5000 burst. They see no reason not to lower the proof spec. This does not say they've officially approved a change. Frank Janosi, their supervisor, must still sign off. The final spec wording may include 3000 psi with no change, and 4000 psi with a maximum drift of something like 10%. In order to keep a single ES spec for all applications (truck and car) we will move the actual proof value to the point. (Truck remains at 4000 psi.)

SCHEDULE/QUALITY ITEMS: We discussed our overall program schedule, and discovered some apparent discrepancies. Notably, our plans for ISIR do not line up properly with Ford's requirements. The ISIR is done on fully production-ready assembly equipment, after PV (Production Validation) and IP Phase I (machine/process capability). These two may actually be combined somewhat. Furthermore, a "conditional" ISIR may be done if the assembly equipment is not fully production-ready. More detail will be obtained by Mike DeMattia at his meeting next week with SQA. We also learned Ford assigns SQA individuals by plant, not by product, so SQA for CCPS is the same as 57PS.

Our staggered start-up, beginning with a modified 57PS for the first 90 days, will have to undergo a requalification separate from the above. The ES spec spells out which tests must be run based on which components of the 57 design are changed.

HEXPORT (NOTE: THIS RELATES TO ALL 57F AND CCPS): Until yesterday, Pass Car was favoring an IMO flare fitting based partly on the fact that it has very low potential for air entrapment. However, the ...aling surface of the male component (our hexport) is very critical, and completely exposed. Use of this fitting would definitely result in a cost increase, actual amount was T-B-D.

After our meeting yesterday, it seems that PC has compared notes with Light Truck and decided to go with the fitting favored by LT, the SAE J512 Inverted Flare. Here, the sealing surface on our hex quite a bit from the current ... already designed to protect the lead-in thread, which Elco agreed to produce without any cost penalty.

Also, again due to air entrapment concerns, PC wants the large opening on the backside of the hexport to be filled. We are looking into either building the hexport without the large opening, or filling it.

HUMIDITY TEST: I presented the results of our three-way humidity comparison test. All devices passed all tests functionally. Based on cosmetics, Ford's favored 15-cycle MIL-STD test was obviously the most severe by far, the original Ford spec. was most lenient. and my favored test, the standard 10-cycle MIL-STD fell between the two. Bruce agreed to step back to my test.

RELEASE SPEC: We explained a rationale, based on estimated Cpk numbers, for a reduction in release from 40 to 20. They really don't have a problem with this, as long as they are guaranteed that release will in fact take place. We explained about the speed-control's logic whereby, after a brake-lite failure, if our switch disengages the system then a key-off cycle must take place which indirectly means the brake pressure falls to zero and our device is guaranteed to reset.

ES SPEC ISSUES: The specific wording of several miscellaneous items in the "Notes and Instructions" section is being updated to reflect the real world, based on our internal Quality Assurance Specification document QAS 296 (57PS ... previously approved by Ford SQA). I left a copy of this which Bruce will use to update those areas I hilited.

ENVELOPE PRINTS / SAMPLES: Bruce has asked that we submit a revised envelope print showing the new flare within about 2 weeks. Furthermore, he needs 2 ride-height switch samples (57PSF3-8) with the new flare and filled hexport in about a week.

*** Meeting II - EED NSBC ***
TI Personnel: Steve Offiler, Joe Schuck
Ford Personnel: Gary Klingler

This was an informal progress status/update meeting. Joe obtained the most recent schedule dates for the lead platforms... IBIR's, 4P and 5P MND's, etc. He'll get a copy of these to me for use in updating our overall program schedule.

We delivered test devices at 90 psi and 160 psi for system testing to take place to confirm the PC spec. Also, Gary would like a couple devices which represent roughly the min release for both car and truck. I have 125 psi devices with releases in the 30's and a 201 psi device with 62 psi release ... these will suffice.

Gary is pursuing business at Ford Australia, roughly 40K units per year. He has beat out GM Holden's electronic speed control based on both cost and performance. They want a fully-engineered package which will be a drop-in. No idea how the brake pressure switch will fit into the system, in terms of fluid fitting, etc.

*** Meeting III - Light Truck Speed Control ***
TI Personnel: Steve Offiler, Joe Schuck
Ford Personnel: George Randall

TI-NHTSA 000828

George dropped a couple of bombshells "off the record":

yard. This is based on electronic vs vacuum-based system performance vs. cost. George estimates that electronic system is 10% better performance but 25% more money; this value ratio must improve before F-series will sign up. '94 is a possiblity if Klingler can reduce cost. Ranger-series is a question for the same reason. Econoline is definitely signed up for the new system, and MN88 will run into packaging issues which will force use of the new system as well.

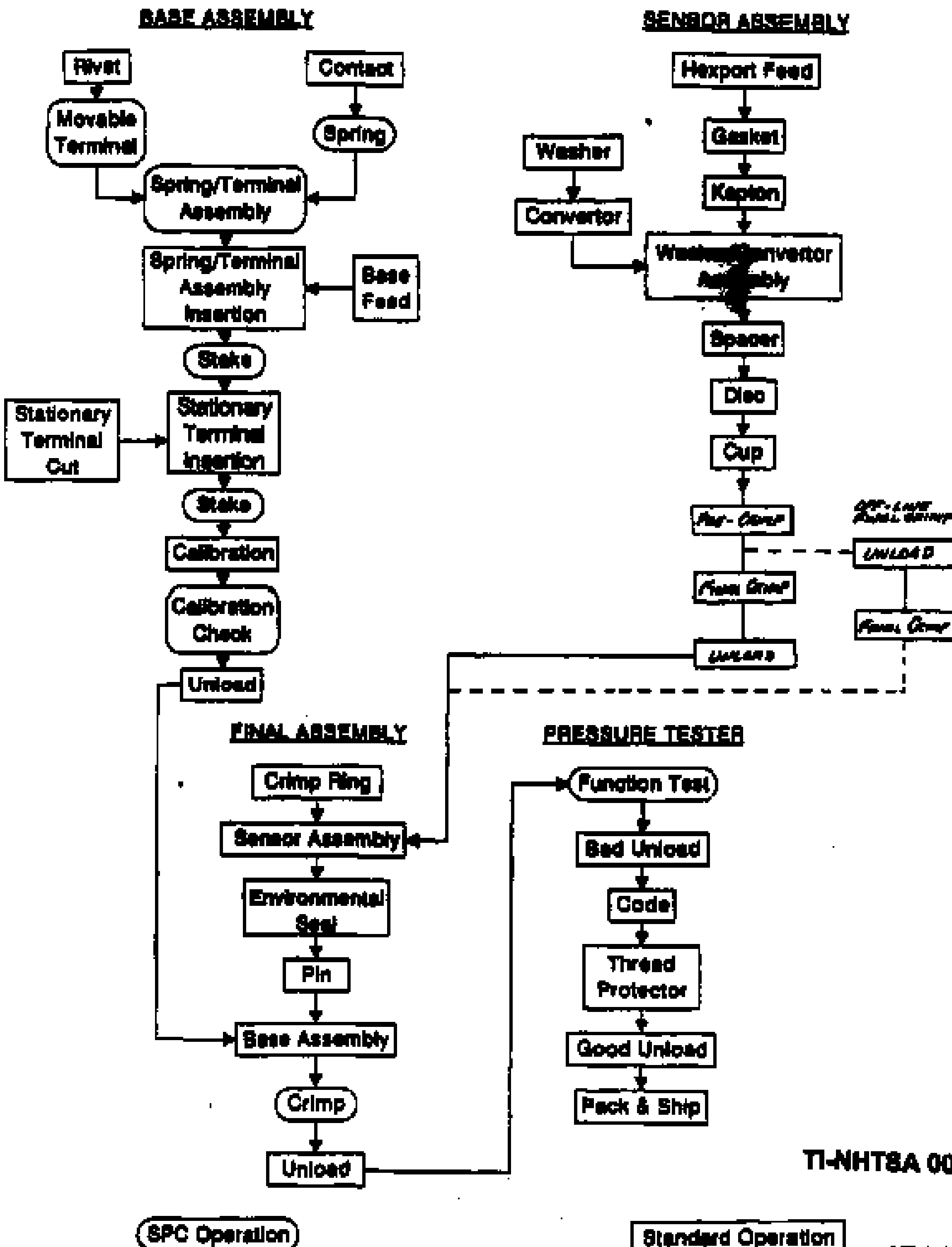
2) LT has no plans at present to move to the CCPS. That is, they plan to continue to pay $2.97 for a modified 57PS indefinitely beyond the 90-day cutoff. This does not mean they will never move to the $2.05 switch, but it will be done "in the future" as a cost reduction action. This is definitely being done to avoid paying a part of the 1.3KK tooling. Reading between the lines, I think LT will move to the CCPS immediately after PC picks up the whole tab for tooling.

George will need an updated envelope soon. He'll accept metric or inch, although he's not under the metrication gun like PC. He doesn't care for "soft" metric (converted inch), preferring true inch or "hard" metric (conceived from scratch as metric, with most dim's in integer mm).

George insists that we stay with 4K proof, but this is no problem. It was his idea to move the proof spec. to the print to keep the SS exactly the same for truck and car. Someone in LT Brake Eng. is playing around with changing the angles on the J512 spec., but George will fight this. He's a real strong believer in established standards. This is also why he didn't bat an eyelash at the latest change from 15 humidity cycles back to 10.

Regards,
Steve O.

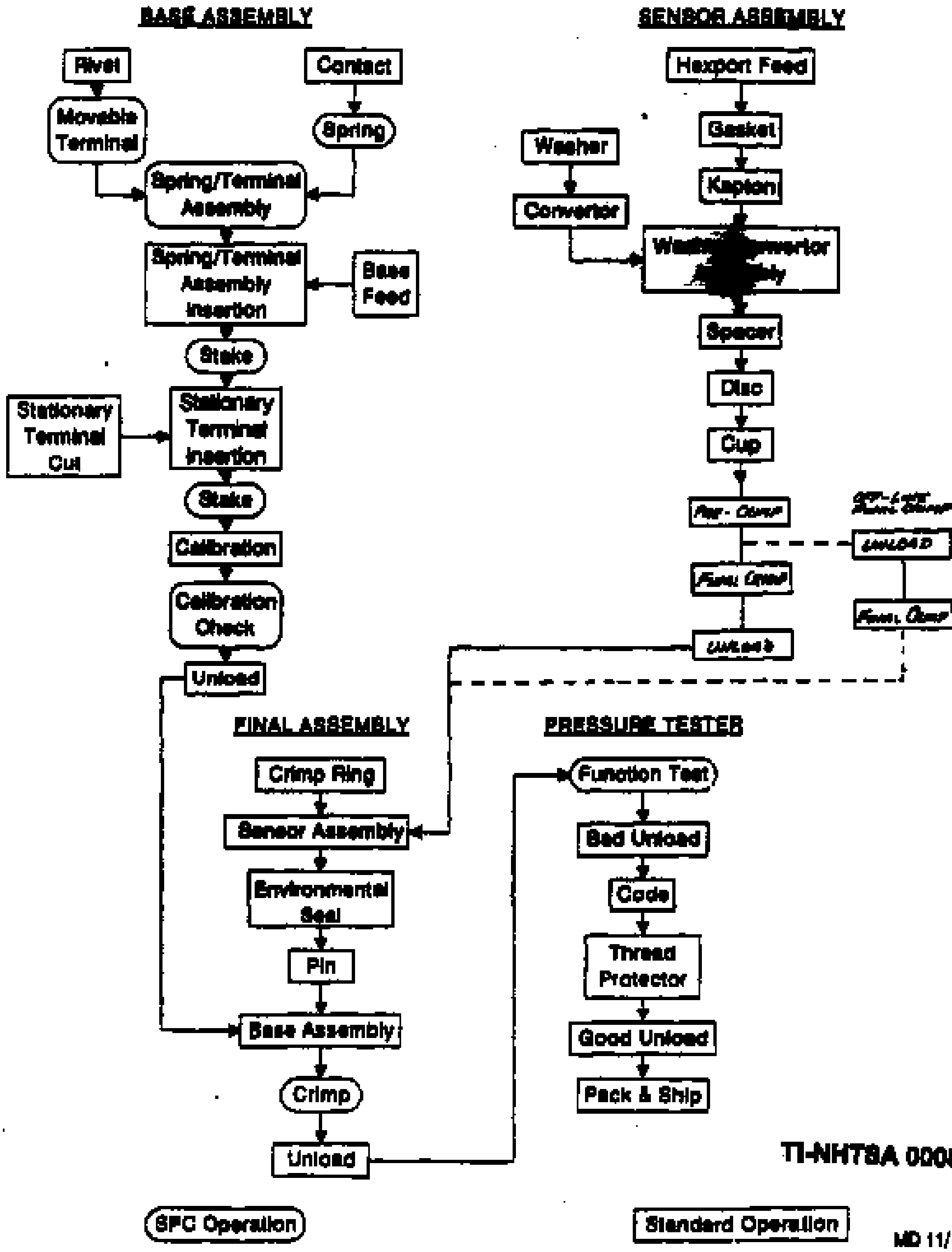
FORD NEXT GENERATION SPEED CONTROL
CCPS (77PS) PROCESS FLOW CHART



TI-NHTSA 000830

MD 11/13/9[illegible]

FORD NEXT GENERATION SPEED CONTROL
CCPS (77PS) PROCESS FLOW CHART



TI-NHTSA 000831

MD 11/13/9

-MSG m#= 1005080 FR=JIB TO=ELB SENT=06/08/90 02:01 PM
R#=042 ST=C DIV=0050 CC=00777 BY=JIB AT=06/08/90 02:01 PM

JUNE 8, 1990

TO: STEVE OFFILER ELB

CC: CHARLIE DOUGLAS CPFC

FM: JOE SCHUCK JIB

RE: CCPS TIMING DATES

	P.C. FN-36	L.T. VN-58	AUSTRAILIA
B&A JOB 1	7/29/91	6/03/91	11/92
* 4P (MRD)	6/03/91	4/15/91	
PH.2 PROD SAMPLE	5/06/91	3/15/91	
PH.1 PROD SAMPLE	2/18/91	12/24/90	
V.P.	7/23/90	5/04/90	

THIS WAS TO FIRST LOT FOR L.T. W/ FIST + FIN.

REGARDS,

JOE SCHUCK

* 4P PARTS MUST BE SUB'ED
PER INFORMAL CONVERSATION
W/ WALT ALBANT & BRUCE PEASE
@ PASS-CAR BRAKE ENG.

POSSIBILITY OF "CONDITIONAL" ISIR?

-MSG no= 362284 FR=SENB TO=AELB SENT=06/11/90 10:45 AM
R#=042 ST=C DIV=0050 CC=00101 ST=SENB AT=06/11/90 10:45 AM

TO:	Tom Charboneau	ELB	Stan Nomol	ELB
	Dave Czarn	AELB	John Kourtesis	MOES
	Mike DeMattia	PCOA	Andy McKenna	ELB
	Charlie Douglas	CPPC	Keith Roberts	PCME
	Bob Hitt	MFPC	Joe Schock	JIB

FR: Steve Offiler ELB

RE: MY 91.75 CCPS Production Numbers

The Ford Cruise Control Pressure Switch will be entering production temporarily as a version of the 57PS, to be replaced as soon as tooling is ready with a device based on the 52/57 sensor and a new, automated switch assembly.

Devices based on the 57 switch assembly have been given the number 57PSL5-x. Devices based on the automated switch assembly have been given the number 77PSLy-z. (Where x,y, and z are T-B-D). Two versions of each switch will exist, one for Pass-Car and one for Light Truck. Differences between the car and truck device include the color of the base, the location of the polarity tab, the disc calibration, and certain element(s) T-B-D of the converter assembly.

We are working to define the schedule, sample quantities, and all other details of revalidation of the 57PS, and Production Validation (PV), In-Process qualification (IP-1 and IP-2), and ISIR of the 77PS.

Regards,
Steve O.

TI-NHTSA 000833

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 62-09-11

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX3427	6/12/90	RBA	
PERFORMED BY JAD	**DATE STARTED** 6/14/90	**DATE COMPLETED**	**APPROVED BY**

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: To see if switch assembly has an effect on the life of a belleville disc (iteration 1B)

PROCEDURE: Build 12 sensors without switches, char, proof, char, cycle 500K (straight through) and final char. Compare w/ results of previous belleville test

Sensor #	Initial Act	Initial Rel	Proof	After Proof Act	After Proof Rel	500K cyc Act	500K cyc Rel		
62-09-01	120	61	Pass	110	66				
02	117	66		119	72				
03	117	60		121	65				
04	110	61		113	65				
05	117	65		116	69				
06	121	69		125	74				
07	115	62		116	66				
08	115	64		110	69				
09	113	60		118	65				
10	121	67		121	71	Hot	@ 153K		
11	120	67		124	75				
12	112	66		118	73				

Dissection on device 62-09-10 revealed that transmission fluid gaskets were used. Since this would undoubtedly cause all of the devices to fail the test was aborted and the devices thrown away.

TI-NHTSA 000834

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 63-09-11

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3423	6/11/90	SBO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	6/14/90	6/14/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: To see the effect of narrower differential on life of Belville discs (iteration 2 C).

PROCEDURE: Heat-treat iteration 2 Belville discs @ 200°F for 1 hour. Characterize free disc, build devices (with chrome crimp ring) char, proof, char, cycle (soak straight + through char, open & characterize discs.

Device #	Free disc Act	Free disc Rel	Initial Act	Initial Rel	Proof	After proof Act	After proof Rel	Final Act	Final Rel
63-09-01	15.1	11.9	129	106	Pass	132	119	141	107
02	15.4	11.7	139	107		142	128	139	105
03	14.2	11.3	109	99		116	99	123	99
04	14.5	11.6	120	101		132	115	130	97
05	15.3	11.9	130	113		148	126	115	97
06	14.7	11.5	118	101		135	113	131	100
07	15.3	11.3	129	109		141	126	149	107
08	15.1	11.9	117	91		128	107	128	95
09	15.6	11.5	134	119		172	153	Leak @	67K
10	14.9	11.9	111	95		180	106	116	99
11	15.3	11.1	123	109		121	116	133	103
12	15.7	11.9	121	102		130	117	137	104

Device #	Final disc char Act	Final disc char Rel	[illegible]
63-09-01	13.5	9.3	9
02	13.1	9.9	9
03	14.3	9.5	10
04	12.7	10.1	11
05	11.0	9.4	11
06	13.3	10.3	11
07	13.2	10.5	9
08	13.4	10.1	11
09	—	—	—
10	12.9	9.9	13
11	13.1	10.3	10
12	13.1	10.1	11

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 6-07-10

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 3423	6/14/90	SBO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
J A D	6/14/90	6/14/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: To see the effect of [illegible] differential on life of Belville discs (Iteration 2 C)

PROCEDURE: Heat-treat iteration 2 Belville discs @ 700°F for 1 hour. Characterize free disc, Build devices (with aluminum crimp rings), char, heat, char, cycle (500K straight + thru), char, open & characterize discs.

NOTE: THIS TEST USED CONTINUITY NOT SNAP FOR DATA & DEVICES PINNED LONG THEREFORE IMPACTING ACCURACY OF ACTUATION DATA WILL BE RE-TESTED, CALLED 2C II

Device #	Free disc Act	Free disc Rel	Initial Act	Initial Rel	Heat	After heat Act	After heat Rel	Final Act	Final Rel
23-09-01	15.1	11.7	129	106	Pass	132	119	141	109
02	15.4	11.7	129	109		142	128	138	105
03	14.2	11.3	109	98		116	99	122	93
04	14.5	11.6	120	101		132	115	130	97
05	15.3	11.9	130	117		148	126	115	98
06	14.7	11.5	113	101		125	112	131	102
07	15.3	12.3	129	109		141	126	149	107
08	15.1	11.9	117	91		128	107	128	95
09	15.6	11.5	134	114		~~[illegible]~~	~~[illegible]~~	~~leak @ life~~	
10	14.9	11.4	111	95		120	106	126	99
11	15.3	12.1	123	104		131	116	133	103
12	15.2	11.9	121	102		132	117	137	104

Device #	Final disc char Act	Final disc char Rel		Total inch/lb	FD Act init	FD Act fin	FA % chg
23-09-01	13.5	9.9		9	$\bar{x}$ 15.05	12.76	
02	13.1	9.9		9	σ .466	.664	
03	12.3	9.5		10	3.1%	5.2%	
04	12.9	10.1		11	Post-heat device Act	Final Actuation	Act % chg
05	11.0	9.4		10	$\bar{x}$ 131.1	131.4	
06	13.3	10.2		11	σ 8.7	9.0	
07	13.2	10.5		9	6.6%	6.9%	
08	13.0	10.1		11			
09							
10	12.9	9.9		12			
11	13.1	10.2		10			
12	13.1	10.1		11			

TI-NHTSA 000836

"EFFICIENCY LINE" 22-210

BELV 1C ACTUATION DATA

SENSORS W/ SWITCHES

GAUGE #	1 F.D.	2 PRE-PROOF	3 POST-PROOF	4 POST-CYCLE	5 F.D.	6 FD% CHG	7 PRE-PROOF RATIO (%)	8 POST CYC RATIO (%)	9 CHANGE (3-4) % CHG	10 PROOF % CHG 2-3	11 PRF + CYC CHANGE % CHG 2-4	12 RATIO % CHG	13
1	15.1	123	132	141	12.6	-12.2	8.15	11.20	+6.8	+7.3	14.6	38.4	
2	15.4	128	142	138	13.1	-14.9	8.31	10.53	-2.8	+10.9	7.8	26.7	
3	14.2	109	116	122	12.2	-14.1	7.68	10.00	+5.2	+6.4	11.9	30.2	
4	14.6	120	132	130	12.9	-11.0	8.20	10.08	-1.5	10.0	8.3	21.7	
(DYING)* 5	15.3	130	143	115*	11.0	-28.1*	8.50	10.45	-19.6*	10.0	-11.5*	22.9	
6	14.7	113	125	131	13.3	-9.5	7.69	9.85	+4.8	10.6	15.9	28.1	
7	15.3	128	141	148	13.2	-13.7	8.37	11.21	+5.0	10.2	15.6	33.9	
8	15.1	117	128	128	13.0	-13.9	7.75	9.85	0.0	9.4	9.4	27.1	
(DEAD) 9	15.6	134	-140-*	DEAD	DEAD	—	8.59	—	—	—	—	—	
10	14.9	111	120	126	12.9	-13.4	7.45	9.77	+5.0	8.1	13.5	31.1	
11	15.3	123	131	133	13.1	-14.4	8.04	10.15	+1.6	6.5	8.1	26.2	
12	15.2	121	132	133	13.1	-13.8	7.96	10.15	+0.8	9.1	9.9	27.5	
13													
$\bar{x}$ 14	15.05	121.4	131.1*	131.4/132.0*	12.75/12.93*	-15.9/-13.6*	8.06	10.30	0.47/2.40*	9.0%	9.4/11.50*	28.6	
σ_{n} 15	.406	7.9	8.7	9.0/7.6	.66/.34	4.8/2.1	0.363	0.52	7.74/3.30	1.6	7.6/3.2	4.8	
$\sigma\%\bar{x}$ 16	2.7%	6.5%	6.6%	6.9/5.7%	5.2/2.6%	32/15.4%	4.5%	5.1%	—/—	—	—/—	—	
17		C_{cc}= 1.32	C_{cc}= 1.41	C_{cc}= 1.46									

18 * ? IS ___ ___ NEEDED AFTER PROOF ?

19 * HOW MUCH OF -13.6% ___ DRIFT IS CAUSED BY CYCLING & HOW MUCH BY INITIAL PROOF BENDING ?

20 * RATIO CAME FROM 8.06 TO 10.30 WHY ?? 28.5%

21 * THE MAJOR DROP IN #5 SEEMS TOTALLY DISC-RELATED, SINCE RATIOS LOOK QUITE AVERAGE.

22 * #9 WAS A MISPLACED-GASKET LEAKER

23 * PROOF IMPACTS ACT. BY + 9.0% ; INCREASED ___ ___ SHOULD LOWER POST-PROOF ;

24 *** NUMBERS RECORDED ABOVE ARE CONTINUITY NOT SNAP SEAL, ___ IS LESS CONSISTENT & REPEATABLE

25

26 * RELATIVE SPREAD, F.D. TO POST-PRF = 2.7 → 6.6 % (2.44 x)

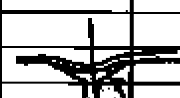
27 * POST-CYCLE, SPREAD HAS WORSENED

28

29

30

31



BEFORE ___ ___ ___ ___ OF HORIZ. TANG.

IT CARRY PART OF LOAD, THE ___ ___ ___ ACTUATION P ___ ___

___ AREA, LOW BUTTON, AREA SMALLER ___ ___ ___ ___

IF PROOF BENT BUTTON DOWNWARD, ACT. WOULD ___ INCREASE (SMALLER A)

TI-NHTSA 000637

BELVILLE DISC TEST 1CII

SCOPE: A total of twenty sensors (without switch assemblies) will be constructed. All twenty will be proofed. At this point 10 will be opened for post-proof free-disc characterization while the other 10 will by cycled.

PROCEDURE:

- Free-disc characterize twenty of the 1C lot re-heat-treated Belville discs.

- Measure the height of the converter button relative to the washer on 10 devices. These are to be used for the proof-only portion of the test.

- Build twenty sensors, keeping track of which discs go into which devices.

- Perform an initial characterization as usual (2 @ 800 psi, 3 more, read 6th).

- Perform a 4000 psi proof test on all 20.

- Perform a post-proof characterization. On the proof-only lot of 10, use the standard method (switch 3, read 4th) while on the lot of 10 to be cycled, use the overpressure cycle method. This is to determine if there are differences in this test method.

- Open up the proof-only lot. Remeasure the button height and the free disc characterization.

- Put the other devices on a standard 500K cycle test, no intermediate characterizations.

- After cycling, do the final characterization. Use either the standard or the overpressure method depending on results above.

- Open up and do the final free-disc char.

900621 SBO filename: BELV1C2.TST

TD 6/11/90

		DISC		POST-PROOF		RATIO		
		1 ACT	2 REL	3 ACT	4 REL	5 ACT	6 REL	7 RATIO STAT'S
RE-BUMP	1	21.5	9.0	100	40	4.65	4.44	REL* $\bar{x}$ 5.00
	2	23.2	10.0	116	40	5.00	4.60	σ_{n} 0.54
	3	23.2	8.0	113	36	4.87	4.50	
	4	19.5	7.3	101	34	5.18	4.66	ACT* $\bar{x}$ 5.21
	5	21.6	10.3	106	43	4.91	4.17	σ_{n} 0.37
	6	21.6	8.6	117	44	5.42	5.12	
	7	20.4	8.4	108	43	5.24	5.12	REL ~~$\bar{x}$ 5.20~~
	8	23.1	6.3	140	38	6.06	6.03	~~σ_{n} 0.08~~
	9	~~27.0~~	~~10.6~~	~~176~~	~~78~~	~~7.25~~ *	~~7.30~~ *	
	10	25.9	10.7	136	57	5.25	5.33	ACT ~~$\bar{x}$ 5.39~~
	11	21.7	9.0	118	48	5.44	5.45	~~σ_{n} 0.41~~
	12	23.7	9.7	125	52	5.27	5.36	
CONTROL'S	13	25.0	10.3	223	91	8.92	8.83	
	14	20.3	7.0	186	65	9.16	9.29	
	15	23.4	8.6	224	83	9.57	9.65	
	16	25.7	10.4	254	103	9.88	9.90	
	17	23.1	9.6	223	83	9.65	8.65	
	18	21.8	10.1	212	101	9.72	10.00	
	19	24.8	9.8	240	100	9.68	10.20	REL $\bar{x}$ 9.47
	20	24.4	9.9	238	97	9.75	9.80	σ_{n} 0.49
	21	25.2	10.4	240	97	9.52	9.33	
	22	21.6	7.3	201	68	9.31	9.32	ACT $\bar{x}$ 9.62
	23	24.1	10.1	238	98	9.88	9.70	σ_{n} 0.30
	24	20.9	9.7	193	87	9.23	8.97	
	25							
	26							
	27							
	28							
	29							
	30							
	31							

DEVICE #9 REMOVED FROM STATISTICS - IMPROPERLY ASSEMBLED, WRONG WASHER TD 6/11/90

EFFICIENCY LINE® 22-205

TI-NHTSA 000839

TD 6/11/90

Serial #	10K cycles Act	Rel	50K cycles Act	Rel	250K cycles Act	Rel	500K cycles Act	Rel		
61-29-01	105	49	113	53	108	49	110	53		
02	119	57	127	61	121	57	125	61		
03	116	49	126	52	117	47	119	50		
04	105	43	110	47	102	43	106	47		
05	109	57	113	61	106	56	111	59		
06	118	50	123	54	116	51	121	52		
07	110	49	115	52	109	49	109	50	ACT	% CHG INC
08	135	42	140	45	133	43	135	45	$\bar{x}$ 120.0	+ 3.8%
09	~~120~~	~~24~~	~~135~~	~~29~~	~~116~~	~~66~~	~~[illegible]~~	~~2.59K~~	σ 11.6	− 11.5%
10	129	61	144	64	140	60	142	63	% 9.6%	− 15.0%
11	119	53	123	55	115	52	120	55		
12	127	57	134	60	129	57	131	59	C_{pk} =	
									(120.0 − 90)	+33%
61-29-13	225	70	230	93	231	86	233	89	3×11.6	
14	187	65	195	67	190	62	191	64	(0.89)	
15	225	79	232	83	230	78	232	81		
16	256	102	257	104	252	98	255	101		
17	224	83	232	84	225	77	227	84		
18	210	79	220	101	219	95	223	77		
19	239	98	250	97	245	92	246	91	ACT	% CHG INC
20	237	93	245	97	244	89	244	94	$\bar{x}$: 228.5	+ 2.6%
21	241	99	250	100	245	94	247	97	σ: 19.9	− 5.2%
22	203	69	211	70	201	64	209	68	%: 8.7%	− 7.5%
23	239	99	241	96	239	92	242	96		
24	195	87	203	82	199	96	205	89		

CONCLUSIONS

THE LRC PARTS DRIFTED UP SLIGHTLY MORE THAN CONTROLS, 3.8% VS 2.6%

THE SIGMA'S BOTH TIGHTENED, THE LRC TO A GREATER EXTENT, BUT LRC'S STILL ENDED UP WITH SLIGHTLY WIDER DISTRIBUTION THAN CONTROLS, 9.6% VS 8.7%

C_{pk} IMPROVED 33% (APPLIES TO LRC ONLY) BUT DISTRIBUTION (σ_{n-1}) IS STILL TOO WIDE

(STILL NEED TO LOOK @ FREE DISCS AND RATIO CHG'S)

Sample #	10K cycles Act	Rel	50K cycles Act	Rel	250K cycles Act	Rel	500K cycles Act	Rel
51-09-01	105	49	113	53	109	49	110	53
02	119	57	127	61	121	57	125	61
03	116	48	126	52	117	49	119	50
04	105	43	110	47	102	43	101	47
05	109	57	113	61	106	56	111	58
06	118	50	123	54	116	51	121	52
07	110	49	115	52	108	48	109	50
08	135	42	140	45	123	43	135	45
09	170	74	125	97	115	66	leak @	259K
10	139	61	144	64	140	60	142	63
11	119	53	127	55	115	52	120	55
12	127	57	134	60	129	57	131	58
51-09-13	225	90	230	93	231	86	233	89
14	187	65	195	67	190	62	191	64
15	225	79	232	83	230	78	232	81
16	256	102	257	104	252	98	255	101
17	224	83	232	84	225	77	227	84
18	216	99	230	101	219	95	223	97
19	239	98	250	97	245	92	246	91
20	237	98	245	97	244	89	244	94
21	241	99	260	100	245	94	247	97
22	203	67	211	70	201	64	209	68
23	239	99	241	96	233	92	243	96
24	195	87	203	89	198	86	205	89

Sample #	Free-Arc End Act	Rel
1-09-01	19.8	9.3
02	22.1	9.5
03	21.2	7.6
04	15.2	6.7
05	19.6	9.4
06	20.3	9.3
07	18.6	7.9
08	21.4	5.9
09		
10	27.7	10.5
11	20.2	9.4
12	22.5	8.5
1-09-13	23.5	10.1
14	19.2	7.0
15	23.1	9.0
16	24.1	10.1
17	21.3	7.7
18	20.3	8.5
19	23.2	9.6
20	23.2	9.6
21	24.5	10.0
22	20.0	6.7
23	22.8	8.9
24	19.6	9.9

EFFICIENCY LINE® 22-210

REBUMP ACTVATION DATA

	F.D.	PRE-PROOF	POST-PROOF	POST-CYCLE	F.D.	FD% CHG	PRE-REF AMPS (?)	POST-CYC AMPS (4/3)	BOOST % CHG (3-4)	PROOF % CHG (2-3)	AF+DE BOOST % CHG 2-4	RATIO % CHG	
	21.5	99	100	110	19.8	-7.51	4.60	5.56	10.00	1.01	11.1%	20.9	
	23.2	111	116	125	22.1	-4.74	4.78	5.66	7.76	4.50	12.6	18.4	
	22.2	106	113	119	21.2	-5.05	4.57	5.61	5.31	6.60	12.3	12.0	
	19.5	93	101	106	18.2	-6.67	4.77	5.02	4.95	8.60	14.0	22.0	
	21.6	102	106	111	19.6	-9.26	4.72	5.66	4.72	3.92	8.8	19.9	
	21.6	110	117	121	20.3	-6.02	5.09	5.96	3.42	6.36	10.0	17.1	
	20.4	101	108	109	19.0	-6.86	4.95	5.74	0.93	6.93	7.9	16.0	
	23.1	129	140	135	21.4	-7.36	5.58	6.31	-3.57	8.53	4.7	13.1	
	23.8 *	228 *	175 *	—	—	—	—	—	—	—	—	—	
	25.9	132	136	142	24.7	-4.63	5.10	5.75	4.41	3.03	7.6	12.7	
	21.7	112	118	120	20.2	-6.91	5.16	5.94	1.69	6.36	7.1	15.1	
	23.7	120	125	131	22.5	-5.06	5.06	5.82	4.80	4.17	9.2	15.0	
		9.4%		7.4%			17.4%						
$\bar{x}$	22.71	110.45	116.36	120.82	20.82	-6.77%	4.94	5.80	4.04%	5.36%	9.6%	17.52%	
σ_{n-1}	1.75	12.32	13.09	11.61	1.83	1.53	0.30	0.21	3.56	2.33	2.8	3.5	
$\sigma\%\bar{x}$	7.8%	11.2%	11.3%	9.6%	8.8%	—	6.0%	3.6%	—	—	27%	20%	

* RELATIVE SPREAD, F.D. TO POST-PROOF = 7.8 → 11.3 45% INCREASE (1.45 x)

* ASSUMING F.D. SPREAD OF 3 σ_{n-1} GIVES POST-REF OF 5.36% → 5/116 = .0045 σ_{proof} = 5 C_{pk} proof = $\frac{116-90}{15}$ = 1.73

* POST-CYCLE, SPREAD HAS TIGHTENED; FD POST TO POSTCYCLE 8.8 → 9.6 (1.09 x)

* ASSUME POST F.D. SPREAD OF 3 (8.8%) = 3.4% GIVES 3.4 x 1.09 = 3.7 5/120 = .037 σ_{pulse} = 4.4 C_{pk} = $\frac{120-90}{4.4 \cdot 3}$ = 2.27

MID-PT FROM 116.4 TO 120.6 IS 118.6 118.6 x = 125 X = 1.054

SO, STARTING w/ 110.5 (1.054) = 116.5 PRE-PROOF $\frac{116.5}{4.94}$ = $\boxed{23.6 \text{ INIT DISC SPEC}}$

110.45 → 118.6 IS 7.4%

$\frac{125}{1.074}$ = $\frac{116.4}{4.94}$ = $\boxed{23.6}$ {REV 12 ...}

AVG w/ 200's → $\bar{x}_{PRE}$ 126.2

$\bar{x}_{...}$ 130.1

PRE-PROOF → POST CYCLE BOOST DRIFT : $\boxed{9.4\%}$

TI-NHTSA 000842

HIGHLIGHTS

Stephen B. Offiler
Week Ending 06/15/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH 77PS

CUSTOMER / PROGRAM ISSUES: We are presently working to flesh-out a detailed program schedule which comprehends the matrix of validation and revalidation testing that will be required. Revalidation applies to the 57PS while the entire battery of Production Validation, In-Process phases 1 & 2, and ISIR applies to the 77PS. This effort is further complicated by the staggered start-up dates for truck and car, and the changeover dates from 57PS to 77PS. New, unofficial information that Light Truck will *not* be switching over to the 77PS means one whole branch of this complex test matrix is eliminated, which has a beneficial effect on the schedule. It is quite important from a test scheduling, financial planning, and capacity planning standpoint to substantiate this information.

I am presently working to update our matrix of envelope prints which both truck and car have requested ASAP. This effort includes conversion to ANSI Y14.5M-1982 (GD&T) and is therefore a substantial task.

We shipped out a set of two 57PSF3-3 samples to Bruce Pease (Pass-Car) which use the SAE J512 inverted flare hexport. He has requested that we supply two more which have the interior cavity filled in a manner T-B-D to address concerns over air entrapment. For samples, we're having the model shop plug this cavity and drill a small hole for fluid passage. J512 hexport prints with and without the cavity are in Drafting's queue. We'll use these to get quotes from Elco which will help determine the cost increase associated with the filled cavity, with will allow us to determine the best design approach. This does not apply to Light Truck.

LRC SENSOR (BELVILLE DISC): A meeting was held with the Disc Dept to discuss results of the first test, where substantial drift was observed. While they develop a second set of discs, we have re-heat-treated the first set to bring actuation up and to decrease differential. Twelve sensors built with these discs are now on test, expected completion next Monday.

LRC SENSOR (RELOCATED CUP BUMP): Twelve test devices and twelve controls have completed a 500K cycle test. By moving the bump from .570" nom. dia. to .470" nom. dia., the average ratio decreased from 9.5:1 to 5.2:1 which is in the right ballpark. Pin window measured on a limited number of devices showed a slight decrease from .0055" to .005". Disc throw decreased from .020" to .015". After cycling, both lots exhibited very slight upward drift, and very similar sigma's.

MISCELLANEOUS: Running piggy-back with the Belville discs, we are testing Stan Hornol's aluminum crimp rings on the standard Ford impulse test (500K cycles at 107°C ambient and 135°C fluid temp). This is to determine if creep at elevated temperatures is an issue.

Jeff DiDomenico has breadboarded and tested the Impulse Monitor circuitry. It functions as intended. He is now in the process of wiring up 24 stations, and interfacing with the cycler's STL. The purpose is to shut down the cycler if the circuit detects any one of 24 devices switching abnormally.

Steph Offiler 6/15/90

TI-NHTSA 000843

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 65-09-10

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3417	6/21/90	SDB	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	6/21/90	7/2/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Impulse test. To see if 19.4/19.10 Discs will meet 200 ± 50 PSI Spec

PROCEDURE: Standard 500 K impulse test. Sensors only

Sensor #	Disc Act	Rel	init act	Char Rel	Blank	Post Act	Post Rel	Post Act	Cycle Rel
65-19-01	20.4	10.0	191	69		197	90	196	81
02	20.5	9.9	201	75		205	97	211	88
03	20.3	10.0	183	77		194	82	173	58
04	20.5	10.4	195	75		197	89	208	82
05	20.6	10.2	188	79		193	89	Leak @ 355k	
06	21.0	10.3	203	79		202	90	186	77
07	20.6	11.0	195	68		193	99	205	89
08	20.2	10.1	190	71		198	82	201	73
09	20.7	9.5	193	68		194	91	206	75
10	20.6	10.2	193	76		197	86	205	71
								10k:1	10k:1

Sensor #	Disc Act	Final Rel
65-09-01	19.1	9.0
02	20.6	9.6
03	11.3	6.9
04	19.4	9.5
05	—	
06	19.1	5.2
07	20.1	9.7
08	19.9	10.1
09	20.1	9.4
10	19.9	9.9

TI-NHTSA 000844

…SSURE SWITCH DATA Form 21605 TEST NO. C4-09-20

…VICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3423	6/21/90	SBB	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAB	6/21/90		

…ROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Belville iteration 3C II

PROCEDURE: Next page

Sensor #	Elec Act	Disc Rel	Washer to [illegible]	Init Act	Clear Rel	Proof	Post Act	Post Rel
C4-09-01	15.1	11.5	.003	140	95	↑	143	104
02	15.2	12.0	.004	138	92		149	107
03	15.4	11.9	.004	145	95		150	[illegible]
04	15.4	11.9	.002	133	99		140	101
05	15.2	11.9	.004	135	92		139	108
06	15.0	11.7	.004	138	95		141	[illegible]
07	15.4	11.9	.004	142	92		142	103
08	15.1	11.8	.005	137	94		143	105
09	15.2	11.7	.009	128	99		141	97
10	15.2	11.9	.004	131	97		146	104
			Dia				OK	OK
11	15.4	11.8	149-151	127	101		130	105
12	15.3	11.1		130	96		127	93
13	15.1	11.9		130	100		122	97
14	15.2	11.7		125	103		125	101
15	15.0	11.9		122	98		127	103
16	15.3	11.3		136	100		118	101
17	15.0	11.8		121	105		122	104
18	15.1	11.0		124	96		129	96
19	15.3	11.9		112	99		117	98
20	14.9	11.9		117	99		118	102

Device #	Test Act	Cycle Rel	Post Use Act P	Final Rel	window to [illegible]
CF-0901			14.2	11.8	.002
02			14.4	11.9	.004
03	No		14.7	12.1	.003
04			14.4	11.8	.003
05		Cycles	14.6	11.9	.004
06			14.7	11.7	.003
07			14.5	11.9	.002
08			14.6	12.3	.002
09			14.8	11.2	.003
10			14.8	12.1	.003
11	172	109	13.0	10.7	
12	106	53	12.3	5.9	cracked; best snap
13	131	95	12.9	10.8	
14	147	112	12.4	10.9	
15	108	77	10.6	8.8	
16	130	97	13.0	10.9	
17	143	108	13.1	10.7	
18	132	95	12.5	10.7	
19	145	85	11.8	10.5	
20	124	90	12.1	11.0	

1C II

		1 RATIO INIT	2 RATIO POST [illegible]	3 RATIO POST CYC	4 RATIO % [illegible]
	1	9.27	10.07		8.6
	2	9.08	10.21		12.4
	3	9.42	10.28		8.3
	4	8.64	9.72		12.5
	5	9.06	9.52		7.2
	6	9.20	9.93		7.9
	7	9.55	10.14		6.2
	8	9.07	9.79		7.9
	9	8.75	9.53		8.9
	10	8.62	9.63		10.6
	11	8.25		10.92	32.4
	12	8.16		——	——
	13	8.61		10.16	18.0
	14	8.42		11.85	40.7
	15	9.03		9.62	19.8
	16	8.89		10.00	12.5
	17	8.29		10.92	31.7
	18	8.21		10.31	25.6
	19	7.39		11.55	53.3
	20	7.85		9.47	20.6
	21				
$\bar{X}$	22	9.05	9.86		9.15%
σ	23	0.32	0.28		2.12
%	24	3.55%	2.87%		——
	25				
$\bar{X}$	26	8.21		10.61	28.3%
σ	27	0.41		0.80	12.8
%	28	5.0%		7.60%	——
	29				
	30				
	31				

* PRESENCE OF SWITCHES BRINGS ACTIVATION DOWN BY ABOUT 9.4% (THIS WOULD BE [illegible] GREATER WITH STIFFER ARMS)

* PROOF BRINGS DISCS DOWN 4.6%, RATIO UP 9% OVERALL SPRINGS END UP 4% HIGHER, AND TIGHTER σ

* PROOF BRINGS BUTTON HT DOWN 23% AVG. THEORY SAYS ACT SHOULD COME UP. THIS IS TRUE.

* AFTER PROOF & CYCLING, DEVICES HAVE COME UP AVG. 7% BUT SIGMAS HAVE DOUBLED DISCS HAVE COME DOWN 16% AND SIGMA'S TRIPLED

* PROOF TEST ONLY ON [illegible] W/O SWITCHES BRINGS RATIO UP BY ~9% AND TIGHTENS SIGMA SLIGHTLY

* PROOF PLUS CYCLING ON DEVICES W/ SWITCHES BRINGS RATIO UP ~28%

* PROOF ONLY BRINGS DEVICES W/O SWITCHES UP BY A GREATER AMOUNT THAN DEVICES W/ SWITCHES (DEVICES W/ SW ARE BASICALLY UNCHANGED BUT SIGMAS ARE TIGHTER)

TI-NHTSA 000847

EFFICIENCY LINE 22-210

BELVILLE DISC TEST LCII ACTUATIONS

DVICE	1 FREE DISC	2 BUTTON	3 CHAR (#1)	4 PROOF	5 CHAR (STD/AP)	6 BUTTON	7 FREE DISC (DIS-ARME)	8 CYCLE	9 CHAR	10 FREE DISC (OUT-CYCLE)	11 F.D % CHG	12 BUT % 5-3	13 CHG % 9-?
1	15.1	3	140		143	2	14.2				-6.0	2.1	
2	15.2	4	138		147	4	14.4				-5.3	6.5	
3	15.4	4	145		150	3	14.7				-4.5	3.4	
4	16.4	3	133		140	3	14.4				-6.5	5.3	
5	15.2	4	135		139	4	14.6				-3.5	3.0	
6	15.0	4	138		141	3	14.2				-5.3	2.2	
7	15.4	4	141		147	2	14.5				-5.8	0	
8	15.1	5	137		143	3	14.6				-3.3	4.4	
9	15.2	4	132		141	3	14.8				-2.6	6.0	
10	15.2	4	121		141	3	14.8				-2.6	7.6	
11	15.4		137		130				142	13.0	-15.6	+2.4	11.8
12	15.9		130		127				106 *	12.3 *	——	-2.7	——
13	15.1		130		122				131	12.9	-14.6	-6.2	0.8
14	14.6		123		125				147	12.4	-15.1	+4.6	19.5
15	15.2		122		127				182 ?	10.6 ?	-30.3 ?	+4.1	-16.4
16	15.3		136		128				130	13.2	-15.0	-4.9	-4.4
17	15.2		126		123				143	13.1	-13.8	-2.4	13.5
18	15.1		124		120				132	12.9	-15.2	+1.2	6.5
19	15.3		113		117				145	12.8	-16.3	+3.5	20.3
20	14.9		117		126				124	13.1	-12.1	+2.7	6.0
21													
X̄ 22	15.22	2.40	132.70		143.2	3.00	14.52				-4.50	+4.05	
σ 23	0.14	0.57	5.19		3.61	0.67	0.22				1.42	2.34	
% 24	0.92%	19.5%	3.77%	-8.4%	2.42%	22.3%	1.52%				——	——	
25													
X̄ 26	15.20		124.80		125.3				132.9 ¥	12.63 ¥	-16.44	+0.57	+7.3
σ 27	0.34		6.65		3.77				14.04	0.79	5.33	4.57	13.2
% 28	2.21%		5.33%		3.01%				10.6%	1.27%	——	——	——
29													
30													
31													

PRESSURE SWITCH DATA FORM 21605 TEST NO. C4-09-20

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3423	6/21/90	SBB	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAB	6/21/90	7/5/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Belville iteration 4C II

PROCEDURE: Next page

Sensor #	Free Disc Act	Free Disc Rel	washer to bottom mg?	Init Act	Clear Rel	Proof	Pos Act	Post Rel	
C4-09-01	15.1	11.5	.005	140	95		142	114	
02	15.2	11.0	.004	138	97		145	109	
03	15.4	11.9	.004	145	96		150	[illegible]	
04	15.4	11.9	.004	133	99		140	101	
05	15.3	11.9	.007	135	98		129	104	
06	15.0	11.7	.004	138	97		141	[illegible]	
07	15.4	11.9	.004	145	92		142	103	
08	15.1	12.0	.005	137	94		143	105	
09	15.3	11.7	.004	128	99		141	99	
10	15.3	11.9	.004	131	99		141	104	
			pin				OK	CL	
11	15.4	11.0	149-151	127	100		130	105	
12	15.9	11.1		130	96		127	99	
13	15.1	11.9		130	100		132	97	
14	14.6	11.7		123	103		125	101	
15	15.0	11.9		122	99		127	102	
16	15.3	11.3		136	100		129	101	
17	15.0	11.0		126	105		132	104	
18	15.1	11.0		124	96		128	96	
19	15.3	11.9		117	99		117	97	
20	14.9	11.9		113	99		126	102	

Device	Test A-F	Cycle Rel	Pre-test Act	Post Final Rel	window to Anther Mid				
64-0901			14.2	11.8	.003				
02	No		14.4	11.9	.004				
03			14.7	12.1	.003				
04	Cycles		14.4	11.8	.003				
05			14.6	11.9	.004				
06			14.4	11.7	.003				
07			14.5	11.9	.002				
08			14.6	12.3	.002				
09			14.8	12.2	.003				
10			14.8	12.1	.003				
11	142	109	13.0	10.7					
12	106	53	12.3	5.4	cracked;	bell	snap		
13	121	95	12.9	10.8					
14	142	112	12.9	10.9					
15	108	77	10.6	9.8					
16	120	97	13.0	10.9					
17	143	103	13.1	10.7					
18	132	95	12.8	10.7					
19	145	95	12.8	10.5					
20	124	90	13.1	11.0					

JEFF

BELVILLE DISC TEST 1CII

SCOPE: A total of twenty sensors (without switch assemblies) will be constructed. All twenty will be proofed. At this point 10 will be opened for post-proof free-disc characterisation while the other 10 will by cycled.

PROCEDURE:

- Free-disc characterize twenty of the 1C lot re-heat-treated Belville discs.

- Measure the height of the converter button relative to the washer on 10 devices. These are to be used for the proof-only portion of the test.

- Build twenty sensors, keeping track of which discs go into which devices.

- Perform an initial characterization as usual (2 @ 800 psi, 3 more, read 6th).

- Perform a 4000 psi proof test on all 20.

- Perform a post-proof characterization. On the proof-only lot of 10, use the standard method (switch 3, read 4th) while on the lot of 10 to be cycled, use the overpressure cycle method. This is to determine if there are differences in this test method.

- Open up the proof-only lot. Remeasure the button height and the free disc characterization.

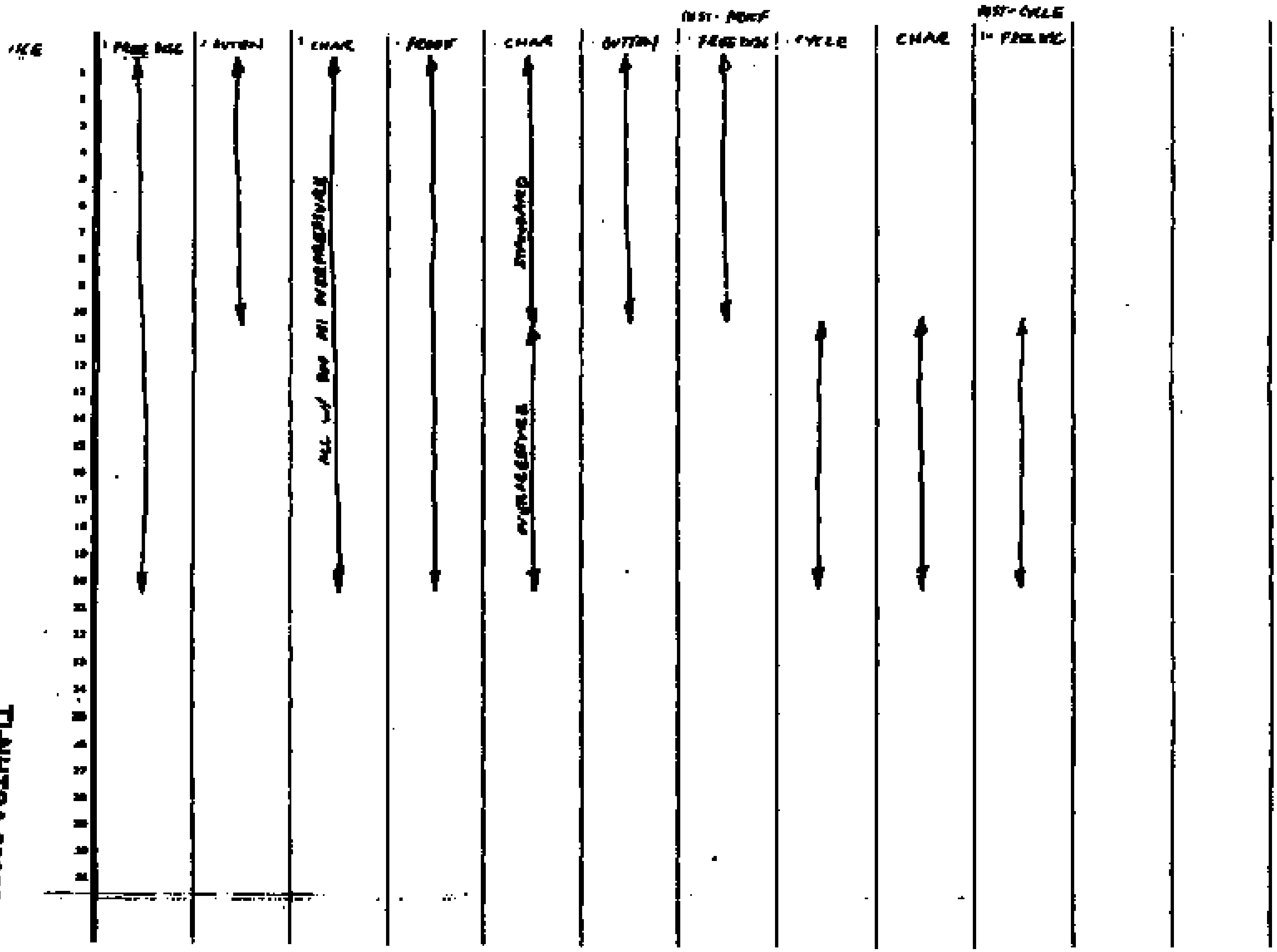
- Put the other devices on a standard 500K cycle test, no intermediate characterizations.

- After cycling, do the final characterization. Use either the standard or the overpressure method depending on results above.

- Open up and do the final free-disc char.

900621 SBO filename: BELV1C2.TST

BELVILLE DISC TEST $\#$ II



TI-NHTSA 000852

BELVILLE DISC TEST (C)!   TEST 64-09-20   JAD 7/5/90

SENSOR #	FREE DISC ACT	FREE DISC REL	BUTTON HEIGHT	SENSOR INIT ACT	SENSOR INIT REL	PROOF	POST PROOF ACT	POST PROOF REL	BOOK CYC ACT	BOOK CYC REL	DISC FINAL ACT	DISC FINAL REL	BUTTON HEIGHT
64-09-01	15.1	11.5	0.003	140	96	!!	143	104			14.2	11.8	0.002
64-09-02	15.2	12.0	0.004	138	97	!!	147	108	N	N	14.4	11.9	0.004
64-09-03	15.4	11.9	0.004	145	95	!!	150	?	O	O	14.7	12.1	0.003
64-09-04	15.4	11.9	0.003	133	99	!!	140	101			14.4	11.8	0.009
64-09-05	15.2	11.8	0.004	135	92	!!	139	106	C	C	14.6	11.9	0.004
64-09-06	15.0	11.7	0.004	130	93	!!	141	?	Y	Y	14.2	11.7	0.003
64-09-07	15.4	11.9	0.004	147	92	!!	147	103	C	C	14.5	11.9	0.002
64-09-08	15.1	12.0	0.005	137	94	!!	143	105	L	L	14.6	12.3	0.003
64-09-09	15.2	11.7	0.004	133	89	!!	141	99	E	E	14.8	11.2	0.003
64-09-10	15.7	11.9	0.004	131	89	!!	141	104	S	S	14.8	12.1	0.003
AVG.	15.2	11.8	0.0039	139	92.9		143	104			14.5	11.8	0.0030
STD.	0.1	0.1	0.0	4.9	3.1		3.4	2.6			0.2	0.3	0.0

DEVICE #	FREE DISC ACT	FREE DISC REL	DEVICE INIT ACT	DEVICE INIT REL	PROOF	POST PROOF ACT	POST PROOF REL	BOOK CYC ACT	BOOK CYC REL	DISC FINAL ACT	DISC FINAL REL	
64-09-11	15.4	12.0	127	100	!!	130	105	142	109	13.0	10.7	
64-09-12	15.9	11.1	130	96	!!	127	93	106	59	12.3	5.4	
64-09-13	15.3	11.9	130	100	!!	122	97	131	95	12.9	10.8	
64-09-14	14.6	11.7	123	103	!!	125	101	147	117	12.4	10.4	
64-09-15	15.2	11.9	172	98	!!	127	102	102	77	10.6	8.6	
64-09-16	15.3	12.2	136	100	!!	128	101	130	97	13.0	10.9	
64-09-17	15.7	12.0	126	105	!!	123	108	143	108	13.1	10.7	
64-09-18	15.1	12.0	124	86	!!	128	96	132	95	12.8	10.7	
64-09-19	15.3	11.9	112	89	!!	117	92	145	85	12.8	10.5	
64-09-20	14.9	11.9	117	89	!!	126	107	124	90	13.1	11.0	
AVG.	15.2	11.9	125	96.6		125	99.7	130	92.6	12.6	9.99	
STD.	0.2	0.3	6.3	5.1		3.6	4.9	14.9	17.9	0.7	1.6	

cracked disc [illegible]

TI-NHTSA 000854

HIGHLIGHTS
Stephen B. Offiler
Week Ending 06/29/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH 77PS

CUSTOMER / PROGRAM ISSUES: Bruce Posie (Pass Car) has indicated that his proportioning-valve supplier, Surfaces Inc., will have trouble machining the mating cone seat for the SAE J512 inverted flare fitting. Their proposed solution is to increase the thread size from 3/8 to 7/16. We are against this change for several reasons related to hexport cost, assembly equipment, and test equipment concerns. Mfg Eng, Marketing, and Design will put our heads together to develop a plan to coerce Bruce away from this. We plan to close with him early next week once Joe Schuck has returned from Europe.

Three separate envelope prints have been marked-up and transferred to Drafting. These cover the 57PS for Light Truck, the 57PS for Pass Car, and the 77PS for Pass Car. They use GD&T and metric dimensions per Ford's requirements. Bruce and George Randall (Light Truck) indicated an immediate need for these prints when I was in Dearborn two weeks ago. A significant backlog exists in Drafting, and I am waiting for them to close with me with an estimated completion date. This information will be transferred to Ford.

We received a request this morning from Lisa Robinson (engr. on WIN88, a new van platform at Ford) for 60 devices with an actuation of 200 psi +/- 50, due 07/23/90. We don't really understand her need, her schedule, or her spec. change at this point, but will follow-up with her early next week. In the meantime, we're building a small lot of devices using discs in stock and standard production converters to get a feel for this spec. range.

BELVILLE DISCS: We're still waiting for the second iteration Belville discs from the Disc Department. In the meantime, we've re-heat-treated the first iteration discs to bring up actuation and decrease differential. Whereas the first devices showed one device out of ten cracked at 500K and an average drift of -25%, the re-HT discs showed no failures and an average drift of -16%. Problems with these include a large increase in sigma from disc to device, and a worsening of the sigma after 500K cycles. The amplification ratio changed quite dramatically (reason unknown) from 8.1:1 to 10.3:1, which served to exactly offset the large disc drift, net result being consistent device readings before and after cycling.

RELOCATED CUP BUMP: Further analysis of data from this test was completed. Discs drifted an average of -6.8% after 500K cycles. The increase in sigma from disc to device was much smaller than the Belville's above, and the sigma actually tightened after cycling. These sensors also drifted upward in amplification ratio as did the Belville's above, but not as dramatically, from 4.9:1 to 5.8:1. At this point, we're leaning heavily towards this design approach for the Low Ratio Converter for Pass Car's 125 +/- 35 spec. Final comparison of the various LRC approaches will be presented at the Program Review next week.

MISCELLANEOUS: While Impulse cycling devices above, we piggy-backed a test of Stan Homol's aluminum crimp rings. Devices were built to a nominal 15 in-lb torque test. After cycling, they tested to an average of 10.2 in-lb. This may be attributed to creep either in the crimp ring, or the plastic base, or both. We need to look at some steel crimp ring parts to get a better handle on these results.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 66-15-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX3413	6/26/90	SBB	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	6/29/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: LRC - Relocated Cup Bump

PROCEDURE: Same as 61-09-24 except 25.52/10.81 Discs
1) No control group
2) No intermediate characterizations.

Sensor #	Pre Cal Act	SC Rel	Sensor Initial Act	Initial Rel	Proof	Post Proof Act	Post Proof Rel	Disc thk	Pin width
66-15.01	27.3	10.2	100	34		100	33	.0135	.008
02	25.2	9.4	113	36		114	42	.0155	.009
03	25.2	11.4	119	37		114	42		
04	26.2	11.2	118	39		112	45		
05	26.2	11.2	128	42		130	48		
06	26.2	11.4	128	37		125	43		
07	26.2	11.4	126	47		125	53		
08	26.3	11.1	120	39		118	44		
09	26.3	11.3	125	40		122	45		
10	26.2	10.9	124	33		116	37		
11	27.2	11.1	120	47		115	51		
12	29.1	9.9	125	22		117	37		
			$\bar{x}$ 120.0			$\bar{x}$ 117.6			
			σ_n 8.32			σ 7.7			
			6.9%			6.5%			

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 66-15-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX3423	6/26/90	SBB	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	6/29/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: LRC - Relocated Cup Band II

PROCEDURE: Same as 61-09-24 except
1) No control group
2) No intermediate characterizations.

Sensor #	Pre-cond 25C Act	Rel	Saturation Act	Rel	Proof	Post Proof Act	Rel	Disc thk	
66-15.01	27.3	10.2	100	34		100	33	.0135	
02	25.2	9.4	113	36		114	42	.0155	
03	25.2	11.9	119	37		114	42		
04	26.1	11.2	118	39		112	43		
05	26.2	11.2	128	47		130	48		
06	26.2	11.4	128	37		125	43		
07	26.2	11.4	126	47		125	43		
08	26.3	11.1	120	39		118	44		
09	26.3	11.3	125	40		122	45		
10	26.3	10.9	124	33		116	37		
11	27.2	11.6	120	47		115	51		
12	29.1	9.9	125	22		118	37		

TI-NHTSA 000857

PRESSURE SWITCH DATA Form 2160S **TEST NO.** 66-15-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX3423	6/20/90	SBB	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	6/22/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: LRC - Relocated Cup Snap

PROCEDURE: Same as 61-09-24 except 25.5°/10.91 Discs
1) No control group
2) ~~no intermediate characterizations~~

∇ = 26.2

Sensor #	Free Air Act	SC Rel	Baseline Act	Initial Rel	Proc F	Post Proof Act	Rel	Disc thk	Pin width
66-15-01	27.9	10.2	100	34		100	33	.0135	.008
02	25.2	9.4	113	36		114	42	.0155	.009
03	25.0	11.9	119	37		116	42		
04	26.2	11.2	118	39		112	43		
05	26.2	11.2	128	47		130	43		
06	26.2	11.4	128	37		125	43		
07	26.7	11.4	126	47		125	43		
08	26.3	11.1	120	39		119	44		
09	26.3	11.3	125	40		122	43		
10	26.2	11.9	124	38		116	39		
11	27.2	11.6	120	43		115	51		
12	29.1	9.9	125	22		117	37		

	[illegible] Act	Rel	[illegible] Act	Rel	Free Disc Act	Rel
66-15-01	95	41	101	47	21.2	8.5
-02	107	44	120	50	22.1	9.2
-03	111	52	120	60	22.2	10.0
-04	104	47	112	54	22.3	9.4
-05	120	55	129	62	23.1	9.2
-06	119	53	125	60	23.0	9.9
-07	119	57	128	69	23.1	10.1
-08	110	50	119	55	23.0	9.6
-09	122	56	125	61	23.4	9.7
-10	108	45	116	54	23.0	9.2
-11	117	53	122	63	23.5	10.1
-12	93	42	101	50	23.2	9.1

PRESSURE SWITCH DATA Form 21605

DEVICE	DATE REQUESTED	REQUESTED BY	TEST NO. 66-15-12
EX3413	6/20/90		
PERFORMED BY: JAD	DATE STARTED: 6/29/90	DATE COMPLETED	APPROVED BY	REQUESTED DATE

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: LRC - Relocated Cup Seal

PROCEDURE: Same as 61-09-24 except
1) No control group

25.50/10.81 [illegible]

Sensor # 66-15-01	Prod [illegible] Act	Rel	Sentry [illegible] Act	Rel	Prog K	Post [illegible] Act	Rel	Disc thw	In width
66-15-01	27.9	10.3	100	34		100	38	.0135	.008
02	25.3	9.4	113	36		114	42	.0165	.009
03	25.0	14.8	119	37		116	43		
04	26.2	11.2	118	39		112	45		
05	26.2	11.3	108	42		120	42		
06	26.2	11.4	108	57		125	43		
07	26.2	11.4	126	47		125	43		
08	26.3	11.1	126	39		118	49		
09	26.3	11.3	125	40		123	45		
10	26.3	11.9	124	33		116	39		
11	27.3	11.1	120	43		115	51		
12	29.1	9.3	125	32		117	52		

	Vac Act	Rel	Vac Act	Rel	Ecu Act	Rel
66-15-01	95	41	101	47	22.2	9.5
.02	103	44	120	50	22.1	9.1
.03	111	52	110	60	22.3	10.6
.04	104	47	112	54	22.3	9.4
.05	120	55	122	62	23.1	9.7
.06	114	53	125	60	23.4	9.2
.07	117	57	128	64	23.1	10.1
.08	110	50	119	55	23.0	9.6
.09	122	56	121	61	23.7	9.7
.10	109	45	116	54	23.0	9.3
.11	112	53	122	63	23.5	10.1
.12	93	42	101	50	23.2	9.1

IAC: RELOCATED CUP BUMP TEST 66-15-12 JAD 7/6/90

	DISC INIT		SENSOR INIT			POST PROOF		DISC	PIN	200K CYC		500K CYC		DISC FINAL	
SENSOR #	ACT	REL	ACT	REL		ACT	REL	THROW	WINDOW	ACT	REL	ACT	REL	ACT	REL
66-15-01	24.8	10.2	100	34		100	33	0.0135	0.000	95	41	101	47	21.2	8.5
66-15-02	25.2	9.4	119	36		114	42	0.0155	0.009	107	44	120	50	22.1	8.2
66-15-03	25.2	11.0	119	37	P	116	42			111	52	120	60	22.2	10.0
66-15-04	26.2	11.2	112	39	R	112	43			104	47	112	54	22.3	9.4
66-15-05	26.2	11.2	120	41	O	130	43			120	55	128	62	23.1	9.7
66-15-06	26.2	11.4	120	37	O	125	43			114	53	125	64	23.0	9.8
66-15-07	26.2	11.4	126	47	F	125	53			110	57	128	64	23.1	11.1
66-15-08	26.3	11.1	120	39		110	44			110	50	117	55	23.0	9.6
66-15-09	26.3	11.3	125	40		122	45			122	56	125	61	23.4	9.7
66-15-10	26.7	10.8	124	33		116	39			108	45	116	54	23.0	9.2
66-15-11	27.2	11.6	120	47		115	51			117	53	122	63	23.5	10.1
66-15-12	28.1	9.9	125	32		110	37			95	42	101	50	23.2	8.1
AVG.	26.2	10.9	120	39		118	43			110	50	118	57	22.7	9.36
STD.	0.85	0.70	7.07	5.16		7.35	5.16			8.52	5.36	8.05	5.49	0.64	0.80

TI-NHTSA 000860

-MSG #= 217713 FR=KA2 TO=ZABH SENT=06/26/90 03:36 PM
R#=004 ST=C DIV=0050 CC=00101 BY=KA2 AT=06/26/90 03:36 PM

TO: Charlie Douglas CPPC
Joe Schuck JIB
Gary Snyder CPPC

CC: Tom Charboneau TC
Dave Cearn ZABH
Mike DeMattia PCQA

FR: Steve Offiler SSOI

SJ: Kelsey-Hayes CCPS Samples (ref MSG #1136659)
==

I spoke with Jim Cousins at K-H today regarding the subject sample request. He is trying to meet an urgent deadline with Ford Pass-Car on 07/09/90. His true need is 20 devices 07/06/90, and another 15 (not 12) on 07/13/90. These particular samples will use our standard O-ring seal. (No SAE J512 inverted flare required YET.) We have in stock all component parts needed to construct 35 samples, including the new low-ratio-converter parts. The only outstanding issue is disc life, which will be determined ASAP. I have discussed the possiblity of limited cycle life (on the order of a couple hundred K cycles minimum) with Jim, which seems to be no problem, and informed him that the devices will meet all other specs. 35 devices will ship on 07/05/90 via Airborne. I will need Marketing to do the necessary paperwork before 07/05/90 in order to ship these in the normal manner.

Regards,
Steve O.

TI-NHTSA 000881

EFFICIENCY LINE® 22-210

REBUMP II ACTIVATION DATA

D.o 1/27/90

	1 F.D.	2 PRE-PEAK	3 POST-PEAK	4 POST-CYC	5 F.D.	6 FD % CHG	7 PEAK-REF RATIO	8 POST-CYC RATIO	9 PEAK % CHG 3-4	10 TROFF % CHG 1-3	11 DEVICE ... 3-4 (REF + CYC)	12 RATIO % CHG	13
1	24.8	100	100	101	21.2	-14.5	4.03	4.76	1.00	0	1.0 %	18.1	
2	25.2	113	114	120	22.1	-12.3	4.48	5.45	5.3	0.88	6.2	21.2	
3	25.2	119	116	120	22.2	-11.9	4.72	5.41	3.4	-2.52	0.8	14.6	
4	26.2	112	112	112	22.3	-14.9	4.27	5.02	0	0	0	17.6	
5	26.2	128	130	128	23.1	-11.8	4.89	5.54	-1.5	1.56	0	13.3	
6	26.2	128	125	125	23.0	-12.2	4.89	5.43	0	-2.34	-2.7	11.0	
7	26.2	126	125	128	23.1	-11.8	4.81	5.54	2.4	-0.79	1.6	15.2	
8	26.3	120	118	117	23.0	-12.5	4.56	5.09	-0.8	-1.67	-2.5	11.6	
9	26.3	125	122	125	23.4	-11.0	4.75	5.34	2.5	-2.40	0	12.4	
10	26.7	124	116	116	23.0	-13.9	4.64	5.04	0	-6.45	-6.5	8.6	
11	27.2	120	115	122	23.5	-13.6	4.41	5.19	6.1	-4.17	1.7	17.7	
12	28.1	125	118	101 *	23.2	-17.4	4.45	4.35	-14.4	-5.60	-19.2 *	-2.2 *	
13													
$\bar{x}$ 14	26.2	120.0	117.6	117.9 / 119.5 *	22.78	-13.15 %	4.58	5.18	0.33 %	-1.96	-1.6 / 0.8 *	13.3 / 14.7 *	
σ_{n-1} 15	0.90	8.22	7.68	32.6 / 7.9 *	0.67	1.80	0.26	0.35	5.21	2.50	6.3 / 3.2 *	6.0 / 3.7 *	
$\sigma \% \bar{x}$ 16	3.42 %	6.85 %	6.53 %	28% / 6.6%	2.95 %	—	5.71 %	6.84 %	—	—	394% / —	45% / 25%	
17													
18													

* RELATIVE SPREAD F.D. → POST-REF 3.42 → 6.53 IS 91% INCREASE (1.91 x) [REBUMP I WAS 1.96 X]

* C_{pk} PRE-REF 120 - 90 / 3(8.22) = 1.22 C_{pk} POST 116.6 - 90 / 3(7.68) = 1.20. C_{pk} POST-CYCLE 117.9 - 90 / 3(...) = 1.0?

* TROFF BROUGHT DEVICES DOWN 1.96% [REBUMP I WAS UP 5.36%]

* RATIO PRE IS 4.6 W/ 6% SPREAD; [REBUMP I WAS 4.9 W/ 6%]

* POST-CYCLE, DISCS HAVE DRIFTED 13% DOWN WHILE RATIO IS UP BY SAME AMT [REBUMP I DRIFTED 6.7%]

TI-NHTSA 000862

—MSG m#= 291699 FR=KA2 TO=IARN SENT=06/29/90 10:44 AM
R#=009 ST=C DIV=0050 CC=00101 BY=KA2 AT=06/29/90 10:44 AM

TO: Joe Schuck JIB

CC: Tom Charboneau TC
Dave Czarn IARN
Charlie Douglas CPPC

FR: Steve Offiler. BB01

SJ: Customer Action Items - CCPS
==

Joe, per the Program Review held yesterday, there are a few customer items that we need to address:

1) Sample requirements, from now to Job 1. Dates and quantities. Could you ask the question to all three groups (PC, LT, ELD) to see if you get consistent answers?

2) 7/16 thread J512 hexport for PC. We have unofficial info from Elco that this change will increase our cost 50%, i.e. from 22 cents each to 33 cents. This will balloon into quite a cost increase to Pass Car. We are working to substantiate this info; however, we should keep Bruce Pease apprised and make sure he is aware of our position.

3) Specification. When I met with Bruce a few weeks ago, we discussed lowering the spec. from 4K to 3K psi. Recall that Walt Blount and Bruce mentioned typical proof spec's on other components around 2K psi. We need to finalize this with them. Also, we plan to move the proof spec to the envelope print in order to keep one spec for all applications.

4) Who exactly is Lisa Robinson, what's she working on, and where is she coming up with this 180 +/- 50 spec ?

Regards,
Steve O.

T1-NHTSA 000863

PRESSURE SWITCH DATA Form 21603 **TEST NO.** 67-01-25

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX3911	6/19/90	880	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	6/19/90	7/5/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: Sample

PROCEDURE: Discs: 25 lip

Bases: Gray "L"

Cap: selected bump (no bumps; not discarded as an issue until 7/1/90.) No

Crimp ring: yellow; no code

Ship 19

Device #	Pressure A.T	Pressure Rel	Pre-Test A.T	Pre-Test Rel	w/O.P. Post A.T	Post Rel	OI Art SA:P		
67-01-01	26.5	13.3	135	50	116	50			
02	26.2	11.9	132	38	119	39	✓		
03	26.9	11.9	109	35	101	34	✓		
04	26.1	10.6	107	37	101	37	✓		
05	27.0	11.9	131	48	120	58			
06	26.7	13.3	120	47	113	52			
07	26.9	11.1	127	40	119	37			
08	26.4	11.4	119	42	115	42			
09	26.3	11.3	114	43	111	43			
10	26.6	11.5	113	36	104	27	✓		
11	26.3	11.5	116	40	117	38	✓		
12	26.8	11.1	111	36	103	37	✓		
13	26.6	11.6	114	45	110	47			
14	26.6	11.3	116	39	109	52	✓		
15	26.5	11.7	119	30	108	37	✓		
16	26.3	11.4	116	29	109	37			
17	26.0	11.5	120	34	116	37			
18	26.3	11.2	121	42	114	49	✓		
19	26.3	11.6	106	39	99	40	✓		
20	26.9	11.3	126	37	115	30			
21	26.1	11.0	115	36	107	38			
22	26.9	11.9	112	43	103	39			
23	26.9	11.0	118	45	104	45			
24	26.6	11.8	114	30	109	36	✓		
25	26.4	11.9	106	37	100	34	✓		
	X̄ 26.4	X̄ 11.6	X̄ 117.2		X̄ 109.9				
	σ 0.37	σ 0.76	σ [illegible]		σ 4.45				

PRESSURE SWITCH DATA FORM 21605 **TEST NO.** 68-01-05

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX3423	6/29/90	SCO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	6/29/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: 5 Samples for Lisa Rebiaser 190PSI ±50

PROCEDURE: Black "L" Bases
yellow Hermetic 9 crimp rings
19/9 discs
Standard Sensor w/ washer
include O-Rings

Device #	Initial Act	Initial Rel	Post Heat Act	Post Heat Rel					
68-01-01	170	86	170	90					
02	172	92	174	93					
03	236	108	228	111					
04	178	67	174	74					
05	177	72	170	77					

TI-NHTSA 000865

HIGHLIGHTS
Stephen B. Offiler
Week Ending 06/29/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH 77PS

CUSTOMER / PROGRAM ISSUES: We received an urgent request for samples from Lisa Robinson at Ford Light Truck. Joe Schuck relayed the information that she needs 5 devices at 180 psi +/- 50, immediately. We are prepared to meet this need. We ran 19/9 discs in standard sensors to 500K cycles last week and obtained sensors with actuations in the 190's, sigma's about 11. Addition of switch assemblies will pull the average actuation down somewhat, allowing us to hit 180 +/- 50 very easily. The requested five devices will go out to Joe today for hand-delivery early next week.

We are preparing to meet Kelsey-Hayes' need for 18 devices at 125 +/- 35 psi by 07/05/90. This urgent request was received late last week. We are now cycling parts built with the relocated-cup-bump, which have past 390K without problem.

Per the Program Review, I'll contact Joe and have him go in to all three groups (Pass-Car, Light Truck, and ELD) to determine future sample needs from now to Job 1. At the same time, we need to close with Pass-Car regarding lowering the proof spec. from 4K to 3K psi and the 7/16 thread issue.

QUALITY: Drafting has begun work on the three envelope prints. Estimated completion date is next Thursday, 07/05/90. The plan is for Design, Mfg. Eng. and Quality to scrutinize these prints together, especially in problem areas such as terminal location, before sign-off. We've closed with Mike DeMaria on this.

Previous information from Ford said that SQA personnel are assigned by plant, not by product, and therefore CCPS SQA is the same as 57PS. This is apparently not the case, however. Mike has uncovered a new SQA through convoluted channels, and will contact this individual ASAP regarding our outstanding questions on ISIR, etc.

HEXPORT: Drafting is finishing up the new J512 GD&T print now. Two versions exist; one with the standard large internal void and one with the 3/32" hole all the way through. These will be used for quotes to determine the best way to fill the void for Pass-Car.

Our inventory of J512 samples has been depleted. Screw Machines' attempt to modify 27372 hexports failed, due to inability to grasp the hexport and maintain concentricity. We need to either help Screw Machines to develop a proper chucking fixture, and/or have our Model Shop build another sample quantity of about 50 parts, and/or go to an outside house.

125 PSI SENSOR: We've laid out a plan with Disc Dept. to continue development work on the Belville disc concept. We'll first try incipient discs with narrow differential; then try different size center holes; then try 455 material. Further development work T-B-D is needed to choose the best low-amplification-ratio design, either Large-Area-Button or Relocated-Cup-Bump.

Scrutiny of the overall schedule shows that the pacing item on finalization of the 125 psi sensor design is 57PS Pass-Car revalidation testing. The only predecessor to this is component tooling. Given typical lead-time of 20 weeks for stamping tools, this means the design must be complete, prints generated, and suppliers chosen by late September.

-MSG no= 291899 FR=KA2 TO=ZABN SENT=06/29/90 10:44 AM
 ES=009 ST=C DIV=0050 CC=00101 BY=KA2 AT=06/29/90 10:44 AM

TO: Joe Schuck JIB

CC: Tom Charboneau TC
 Dave Czarn ZABN
 Charlie Douglas CPFC

FR: Steve Offiler SB01

SJ: Customer Action Items - CCPS

Joe, per the Program Review held yesterday, there are a few customer items that we need to address:

1) Sample requirements, from now to Job 1. Dates and quantities. Could you ask the question to all three groups (PC, LT, ELD) to see if you get consistent answers?

2) 7/16 thread J512 hexport for PC. We have unofficial info from Elco that this change will increase our cost 50%, i.e. from 22 cents each to 33 cents. This will balloon into quite a cost increase to Pass Car. We are working to substantiate this info; however, we should keep Bruce Pease apprised and make sure he is aware of our position.

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4) Who exactly is Lisa Robinson, what's she working on, and where is she coming up with this 180 +/- 50 spec ?

Regards,
Steve O.

JUNE 27, 1990

TO: STEVE OFFILER . SEO:

C: CHARLIE DOUGLAS CPPC

FM: JOE SCHUCK

SU: CCPS 57PSL5-3 ISIR

JIM WILK, PURCHASE SUPERVISOR, CALLED ME TO COMPLETE HIS ISIR RISK ASSESSMENT ON OUR CCPS PROGRAM. I LIMITED THE DIVISION TO THE 57PS AND NOT THE 77PS. BOTH COMPROMISED AT:

10/15/90 LT TRUCK 57PS ISIR
12/12/90 PASS CAR 57PS ISIR

I HOPE YOU FIND THIS AS FAVORABLE AS I DID, WHILE KEEPING IN MIND THE PROBLEMS WE'RE HAVING WITH THE 125 RATING.

REGARDS,

JOE SCHUCK

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 71-11-04

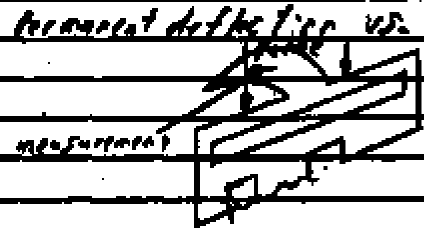
DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3413	6/30/90	[illegible]	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeff [illegible]	7/11/90	7/11/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Establish Springback vs. Permanent Deflection relation during terminal bending method of [illegible] Calibration

PROCEDURE: Stake terminals into old bases. Bend terminal with fork and measure forced and permanent deflection at point of pressure and at center of contact surface as shown. Graph permanent deflection vs. springback at contact surface



Data on following Page

TERMINAL BENDING

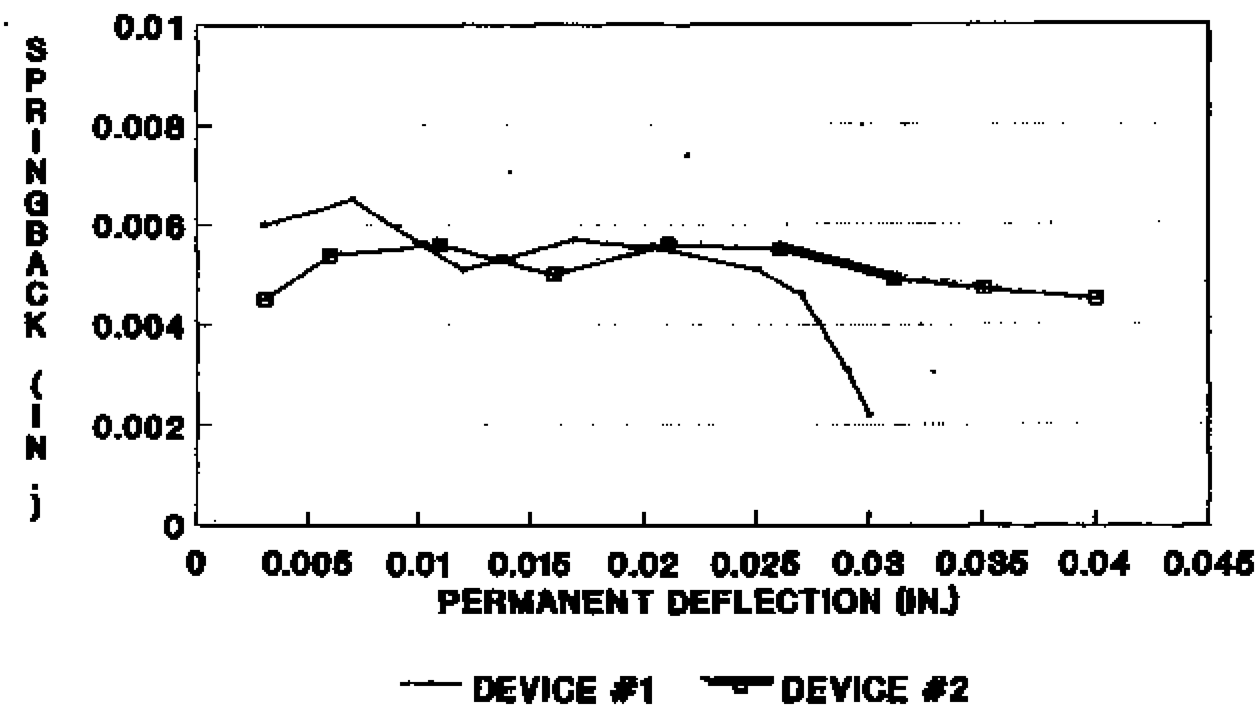
NARROW FORK #1				
AT FORK		CENTER/CONTACT		CENTER/
FORCED	PERM	FORCED	PERM	CONTACT
DEFLECT	DEFLECT	DEFLECT	DEFLECT	SPRINGBK
0.0100	0.0037	0.0092	0.0032	0.0060
0.0150	0.0072	0.0137	0.0072	0.0065
0.0200	0.0121	0.0172	0.0121	0.0051
0.0250	0.0168	0.0225	0.0168	0.0057
0.0300	0.0217	0.0263	0.0208	0.0055
0.0350	0.0273	0.0298	0.0247	0.0051
0.0400	0.0314	0.0315	0.0269	0.0046
0.0450	0.0364	0.0321	0.0290	0.0031
0.0500	0.0415	0.0321	0.0299	0.0022

NARROW FORK #2				
AT FORK		CENTER/CONTACT		CENTER/
FORCED	PERM	FORCED	PERM	CONTACT
DEFLECT	DEFLECT	DEFLECT	DEFLECT	SPRINGBK
0.0100	0.0032	0.0070	0.0025	0.0045
0.0150	0.0075	0.0118	0.0064	0.0054
0.0200	0.0123	0.0166	0.0110	0.0056
0.0250	0.0173	0.0210	0.0160	0.0050
0.0300	0.0222	0.0265	0.0209	0.0056
0.0350	0.0273	0.0315	0.0260	0.0055
0.0400	0.0323	0.0359	0.0310	0.0049
0.0450	0.0366	0.0400	0.0353	0.0047
0.0500	0.0414	0.0441	0.0396	0.0045

WIDE FORK #3				
AT FORK		CENTER/CONTACT		CENTER/
FORCED	PERM	FORCED	PERM	CONTACT
DEFLECT	DEFLECT	DEFLECT	DEFLECT	SPRINGBK
0.0100	0.0022	0.0039	0.0009	0.0030
0.0150	0.0046	0.0068	0.0025	0.0043
0.0200	0.0089	0.0105	0.0054	0.0051
0.0250	0.0140	0.0145	0.0087	0.0058
0.0300	0.0182	0.0192	0.0130	0.0062
0.0350	0.0224	0.0237	0.0174	0.0063
0.0400	0.0261	0.0269	0.0218	0.0051
0.1450	0.0309	0.0311	0.0260	0.0051
0.0500	0.0364	0.0360	0.0303	0.0057

WIDE FORK #4				
AT FORK		CENTER/CONTACT		CENTER/
FORCED	PERM	FORCED	PERM	CONTACT
DEFLECT	DEFLECT	DEFLECT	DEFLECT	SPRINGBK
0.0100	0.0024	0.0034	0.0005	0.0029
0.0150	0.0058	0.0061	0.0017	0.0044
0.0200	0.0091	0.0093	0.0036	0.0057
0.0250	0.0130	0.0134	0.0066	0.0068
0.0300	0.0182	0.0184	0.0109	0.0071
0.0350	0.0222	0.0235	0.0161	0.0074
0.0400	0.0264	0.0296	0.0228	0.0068
0.0450				
0.0500				

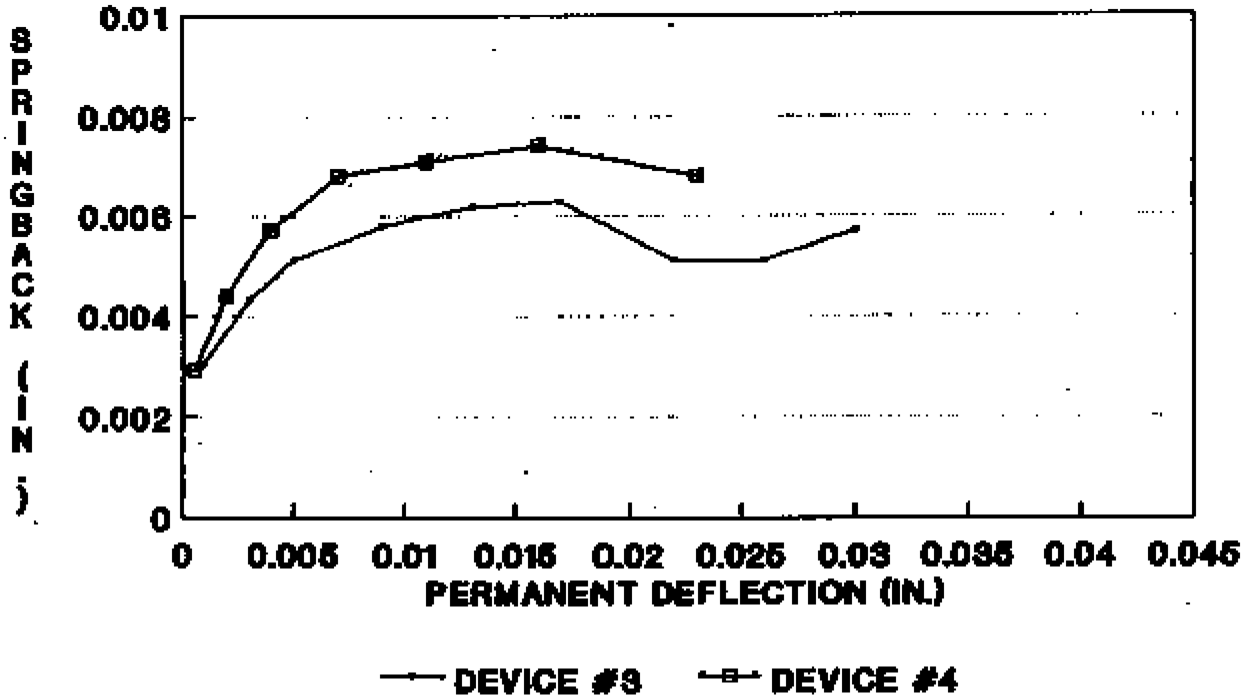
TERMINAL BENDING
NARROW FORK



JAD 7/3/90

TI-NHTSA 000871

TERMINAL BENDING
WIDE FORK



JAD 7/3/90

TI-NHTSA 000872

HIGHLIGHTS

Stephen B. Offiler
Week Ending 07/06/90

<u>FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH 77PS</u>

CUSTOMER / PROGRAM ISSUES: Many outstanding customer-related items are in need of attention. Marketing and Field Sales are aware of these issues and doing whatever possible to address them. However, timely resolution is imperative. Specifically, they are:

1) Sample requirements, including configuration, for all Ford groups and first-tier suppliers

2) Pass-Car's proposed thread change from 3/8-24-UNF to 7/16-24-UNS

3) Finalization of the proof specification with Pass-Car

4) Better understanding of Lisa Robinson, including her role and her true sample needs in light of her recent request for 60 parts by 07/23/90

5) Confirmation that Light Truck will *not* switch over from 57PS to 77PS which has important schedule ramifications (PV, ISIR, IP-1, etc)

Eighteen emergency samples were shipped yesterday to Kelsey-Hayes, on-time. These are 125 psi devices, and used the relocated-cup-bump design with the O-ring seal. Test devices were successfully cycled to 500K to confirm disc life before shipment.

Joe Schuck has met with Ford Purchasing and obtained the true ISIR dates for the introductory 57PS for both Light Truck and Pass-Car. These are 10/15/90 and 12/12/90 respectively. Mike DeMattia has successfully contacted Ford SQA Scott Kusch. They've identified exactly what we owe to Ford in terms of ISIR, etc. Mike plans to forward our overall program schedule to Scott so any discrepancies can be identified.

Envelope prints, owed to just about everybody, are in the final stages of completion. We have 57PSL5-3 for Light Truck, and 57PSL5-2 & 77PSL2-1 for Pass-Car. A 77PS envelope for Light Truck has not yet been developed pending #5 above.

HEXPORT: Drafting has finished the new hexport prints. A last-minute change was needed on the minimum-internal-volume version, however. We realized that the AMI uses the large hole as a location feature. Therefore, a large hole will be retained, but reduced from the present .400 deep to .125, which is deep enough to accommodate present AMI tooling. This print uses the standard 3/8-24UNF thread (see item #2 above).

Since the inventory of J512 hexports has been depleted by sample builds, we'll need to have someone make more. I plan to have the Model Shop do a quantity of about 50 for now. Once we get a better handle on sample needs (item #1 above) we can determine the best way to proceed: AFCC, Model Shop, Elch samples, or an outside machine shop (KMS).

Steve Offiler 7/6/90

TI-NHTSA 000873

PRESSURE SWITCH DATA Form 21505 **TEST NO.** 72-11-09.

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3423	7/9/90	Andy McVernon	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeff D	7/10/90	7/11/90	

PROJECT TITLE: "" Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Terminal bending test in New Bases.

PROCEDURE: Same as 71-11-04 except with slotted bases to guide the bending terminal. The floors of half of the bases are milled so the flat head of the stationary terminal will rest and the edge will bottom. The other half are unmodified.

	Data	on	next	Page					

TI-NHTSA 000874

TERMINAL BENDING IN NEW BASES

BASE #1: WIDE FORK, DRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0036	0.0050	0.0024	0.0034
0.0150	0.0065	0.0094	0.0053	0.0041
0.0200	0.0106	0.0141	0.0095	0.0046
0.0250	0.0146	0.0187	0.0135	0.0052
0.0300	0.0186	0.0234	0.0178	0.0056
0.0350	0.0228	0.0276	0.0225	0.0051
0.0400	0.0273	0.0320	0.0275	0.0045
0.0450	0.0320	0.0366	0.0321	0.0045
0.0500	0.0361	0.0410	0.0362	0.0048

BASE #2: WIDE FORK, DRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0030	0.0060	0.0020	0.0040
0.0150	0.0061	0.0115	0.0062	0.0053
0.0200	0.0099	0.0166	0.0105	0.0061
0.0250	0.0142	0.0216	0.0153	0.0063
0.0300	0.0182	0.0266	0.0201	0.0065
0.0350	0.0223	0.0315	0.0246	0.0069
0.0400	0.0259	0.0360	0.0288	0.0072
0.0450	0.0304	0.0410	0.0340	0.0070
0.0500	0.0389	0.0461	0.0390	0.0071

BASE #3: WIDE FORK, UNDRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0028	0.0092	0.0027	0.0065
0.0150	0.0054	0.0121	0.0061	0.0060
0.0200	0.0090	0.0150	0.0110	0.0040
0.0250	0.0127	0.0197	0.0158	0.0039
0.0300	0.0169	0.0235	0.0195	0.0040
0.0350	0.0219	0.0272	0.0235	0.0037
0.0400	0.0266	0.0300	0.0266	0.0034
0.0450	0.0312	0.0326	0.0294	0.0032
0.0500	0.0360	0.0350	0.0319	0.0031

BASE #4: WIDE FORK, UNDRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0028	0.0083	0.0027	0.0056
0.0150	0.0059	0.0120	0.0065	0.0055
0.0200	0.0096	0.0165	0.0135	0.0050
0.0250	0.0133	0.0205	0.0164	0.0041
0.0300	0.0172	0.0246	0.0209	0.0039
0.0350	0.0216	0.0290	0.0248	0.0042
0.0400	0.0261	0.0330	0.0289	0.0041
0.0450	0.0307	0.0370	0.0331	0.0039
0.0500	0.0356	0.0408	0.0371	0.0037

BASE #5: NARROW FORK: DRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0031	0.0100	0.0032	0.0068
0.0150	0.0063	0.0150	0.0075	0.0075
0.0200	0.0112	0.0202	0.0135	0.0067
0.0250	0.0163	0.0255	0.0190	0.0065
0.0300	0.0214	0.0298	0.0242	0.0056
0.0350	0.0267	0.0336	0.0293	0.0043
0.0400	0.0319	0.0373	0.0335	0.0038
0.0450	0.0367	0.0406	0.0374	0.0032
0.0500	0.0415	0.0430	0.0410	0.0020

BASE #6: NARROW FORK, DRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0044	0.0111	0.0055	0.0056
0.0150	0.0086	0.0163	0.0113	0.0050
0.0200	0.0129	0.0220	0.0170	0.0050
0.0250	0.0177	0.0279	0.0231	0.0048
0.0300	0.0223	0.0334	0.0286	0.0048
0.0350	0.0289	0.0385	0.0339	0.0046
0.0400	0.0310	0.0433	0.0386	0.0047
0.0450	0.0360	0.0481	0.0435	0.0046
0.0500	0.0413	0.0525	0.0481	0.0044

BASE #7: NARROW FORK, UNDRILLED BASE

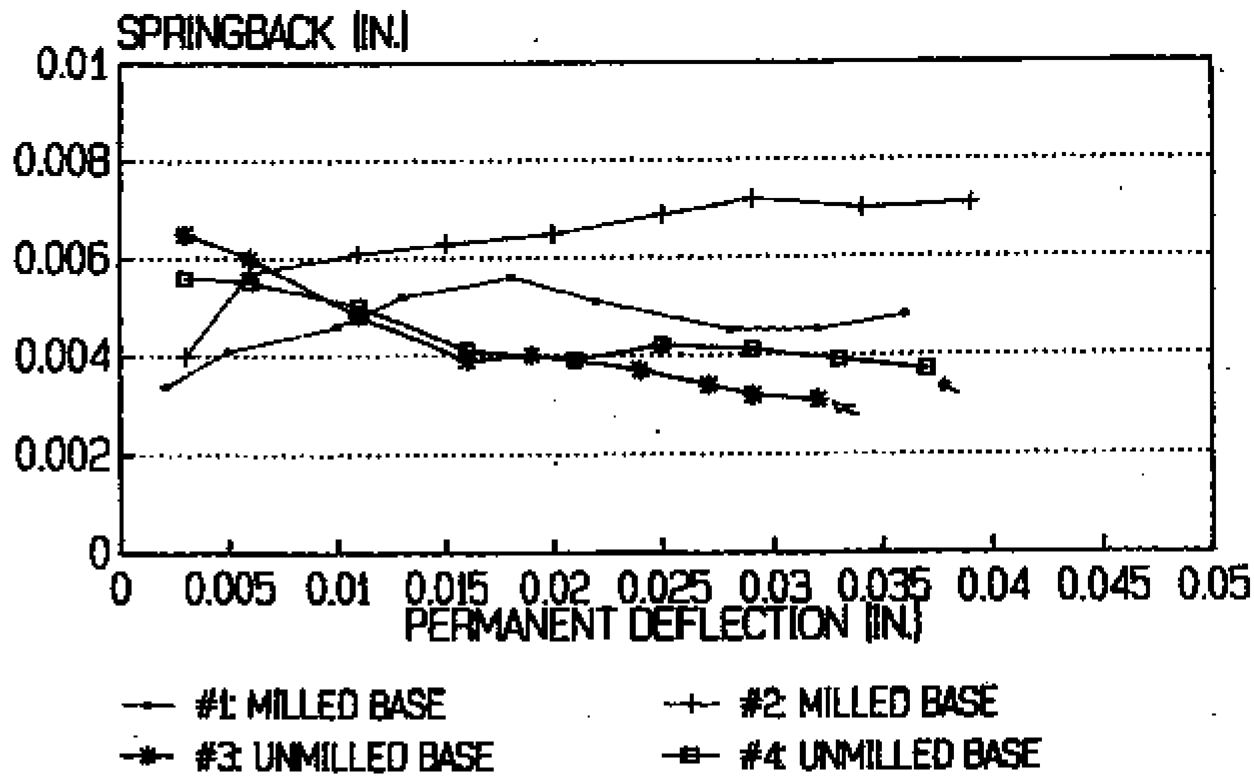
AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0035	0.0050	0.0050	0.0060
0.0150	0.0073	0.0140	0.0079	0.0069
0.0200	0.0122	0.0200	0.0139	0.0061
0.0250	0.0170	0.0249	0.0190	0.0059
0.0300	0.0219	0.0294	0.0241	0.0053
0.0350	0.0271	0.0340	0.0293	0.0047
0.0400	0.0321	0.0385	0.0340	0.0045
0.0450	0.0371	0.0426	0.0382	0.0044
0.0500	0.0419	0.0470	0.0423	0.0047

BASE #8: NARROW FORK, UNDRILLED BASE

AT FORK FORCED DEFLECT	AT FORK PERM DEFLECT	CENTER/CONTACT FORCED DEFLECT	CENTER/CONTACT PERM DEFLECT	CENTER/CONTACT SPRINGBK
0.0100	0.0036	0.0097	0.0030	0.0067
0.0150	0.0073	0.0148	0.0078	0.0070
0.0200	0.0117	0.0199	0.0135	0.0064
0.0250	0.0167	0.0250	0.0191	0.0059
0.0300	0.0214	0.0297	0.0242	0.0055
0.0350	0.0268	0.0340	0.0288	0.0052
0.0400	0.0319	0.0379	0.0334	0.0045
0.0450	0.0379	0.0418	0.0375	0.0043
0.0500	0.0420	0.0454	0.0411	0.0043

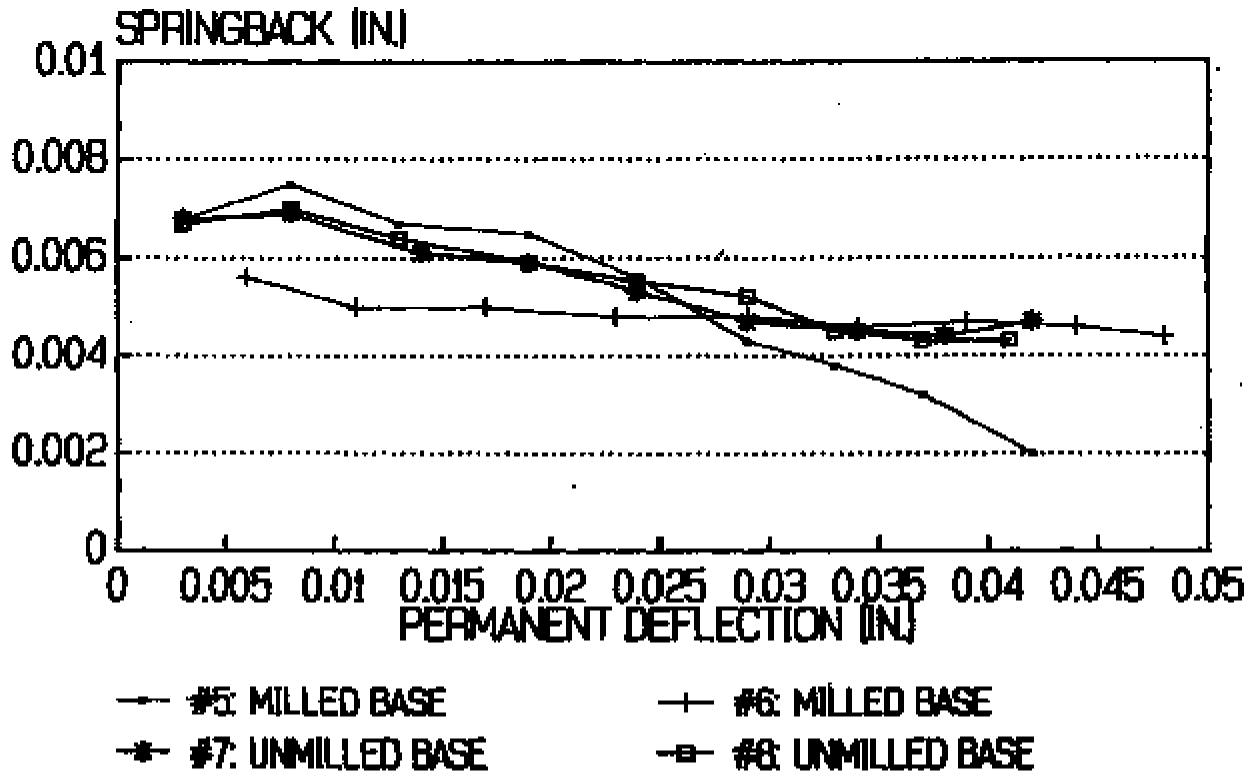
JAD 7/10/90

TERMINAL BENDING IN NEW BASES
WIDE FORK



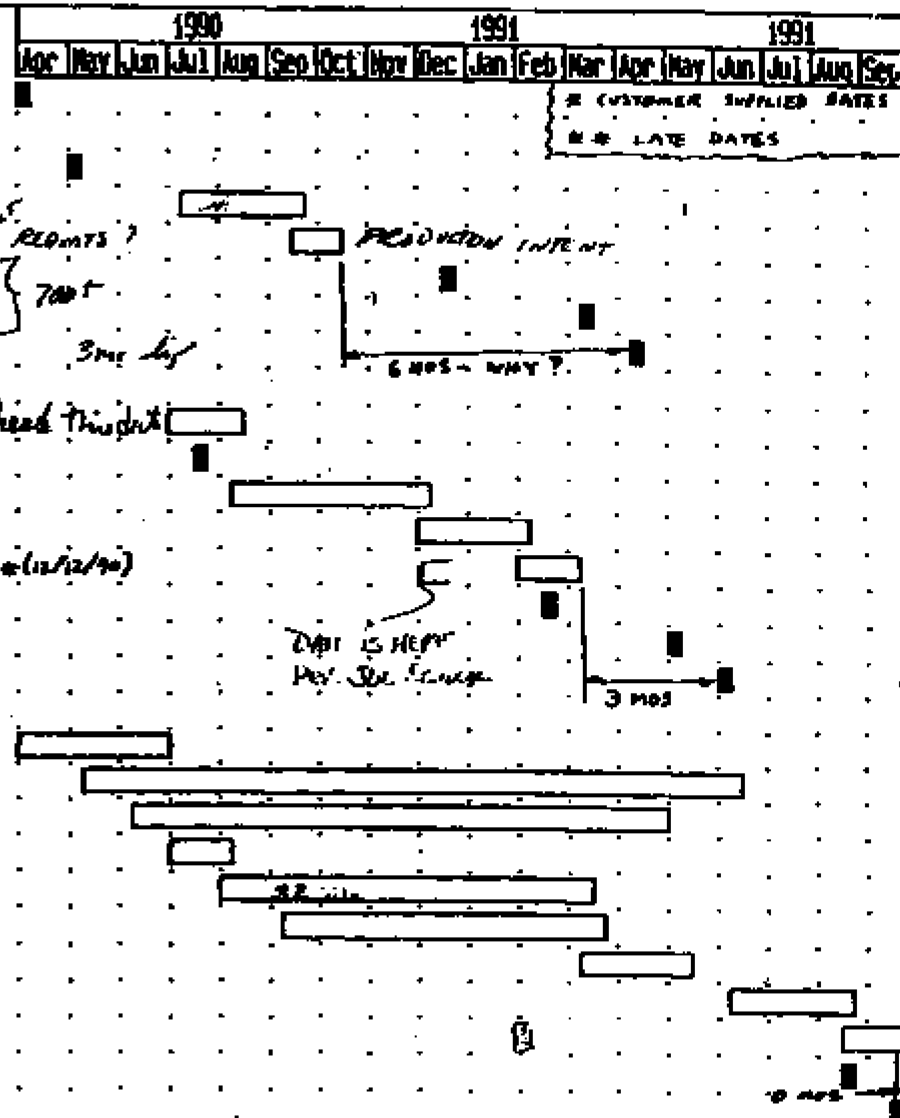
JAD 7/10/90

TERMINAL BENDING IN NEW BASES
NARROW FORK



JAD 7/10/90

		Start Date	Finish Date
1	Contract (PO)	4/ 2/90	4/ 2/90
2	JSC layout		
3	LT Verif. Proto	5/ 4/90	* 5/ 4/90
4	57LT ReValidation	7/ 9/90	9/17/90
5	57LT ISIR 70	9/18/90	* 10/15/90
6	LT Ph.1 Prod Sample	12/21/90	* 12/21/90
7	LT Ph.2 Prod Sample	3/15/91	* 3/15/91
8	57LT Job 0 NRD (4P)	4/15/91	* 4/15/91
9	SOP		
10	57PC Design-Sensor	7/ 6/90	8/10/90
11	PC Verif. Proto	7/20/90	* 7/20/90
12	Tool 57PC compnt's	8/13/90	12/ 5/90
13	57PC RV	12/ 6/90	2/ 5/91
14	57PC ISIR	2/ 6/91	** 3/ 5/91
15	PC Ph.1 Prod Sample	2/18/91	* 2/18/91
16	PC Ph.2 Prod Sample	5/ 6/91	* 5/ 6/91
17	57PC Job 0 NRD (4P)	6/ 3/91	* 6/ 3/91
18			
19	77 Design - Switch	4/ 5/90	6/29/90
20	Switch Ass'y equip	5/16/90	6/10/91
21	Final Ass'y equip	6/13/90	4/23/91
22	77 Proto Switch	7/ 2/90	8/ 6/90
23	Tool 77 compnt's	8/ 7/90	3/13/91
24	Pres Test equip	9/13/90	3/21/91
25	77 PV Prod-validation	3/14/91	5/ 9/91
26	77 IP-1	6/10/91	8/21/91
27	77 ISIR	8/21/91	9/19/91
28	77 IP-2 BEGIN ?	8/21/91	8/21/91
29	77 Job 0 NRD (4P)	9/19/91	9/19/91



Noncritical
Critical
Slack
Milestone
Project: 77 DES04 Date: Jul 9, 1990 7:17 AM

NEXT-GENERATION SPEED CONTROL
DEACTIVATION SWITCH
GENERAL SCHEDULE

TI-NHTSA 000878

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 69-09-10

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
EK 3423	7/10/90	SAO		
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**	
JAD	7/10/90	9/5/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Produce a device with a 150 PSI actuation to build samples

PROCEDURE: Next page

Device #	Pre-Cal Act	Pre-Cal Rel	Initial Cal Act	Initial Cal Rel	Proof	Post Proof Act	Post Proof Rel	Seek Cycle Act	Seek Cycle Rel
69-09-01	35.9	22.7	158	94		137	82	150	102
02	36.7	22.7	165	95		151	89	158	105
03	36.2	22.2	170	92		153	87	164	113
04	35.7	21.4	154	89		138	85	150	103
05	36.3	22.7	Pinned wrong						
06	35.1	21.7	162	94		144	97	156	107
07	35.0	21.7	168	97		149	94	157	109
08	36.1	22.3	143	83		127	80	136	94
09	35.5	21.4	165	98		152	93	160	108
10	35.6	22.1	155	95		138	90	137	106
11	36.3	22.7	172	97		155	95	167	117
12	35.7	22.5	165	95		149	98	161	115
					Cyc: 150	X 145			
						X 84			

	[illegible] Final	
Device #	Act	Rel
69-09-01	30.0	20.3
02	30.4	20.3
03	30.8	19.7
04	30.4	19.4
05		
06	30.2	19.5
07	29.3	19.7
08	29.7	17.9
09	30.4	19.6
10	29.9	19.4
11	30.4	20.6
12	30.1	20.7

7/2

1987 TRI PLANS

- TAKE 12 UNITS FROM 35 PSI BATCH
- INITIAL PRES - NSC CHAR
- BUILD DEVICES W/ SELECTED - OUT - BUMP PARTS
- INITIAL SWING CHAR
- MOVE TO 4K
- RE CHAR.
- CYCLE THERMAL THROUGH TP SOAK
- RECHAR
- OPEN UP, FINAL PRES - NSC CHAR

PRESSURE SWITCH DATA Form 21505 **TEST NO.** 70-15-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex3427	7/11/90	RBO	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
JAD	7/11/90	7/16/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: To find out if discs in rebumped cups are pre-deflected

PROCEDURE: Next page

Sensor #	Cup	Free disc Act	Free disc Rel	Sensor Act	Sensor Rel
70-15-01	R	26.4	11.4	125	43
02	Rc	26.6	11.1	109	39
03	B	26.1	11.6	112	37
04	"	26.4	11.0	125	41
05	"	26.5	11.4	121	44
06	"	26.3	11.9	115	40
70-15-07	C	26.3	11.7	217	83
08	A	26.9	10.9	218	93
09	"	26.6	11.0	226	94
10	"	26.4	11.9	232	83
11	"	26.2	11.1	234	78
12	D	26.4	11.5	225	89

-10 **FIRST ARTICLE REPORT** № 009699

PART	MATERIAL	PRESS	SHIFT
EX 3423-[illegible]	Celanex 1662 Z	12	1st

REASON FOR INSPECTION	NO. PCS IN SHOT
1st PC ENG. Samples	1

SUBMITTED FOR INSPECTION BY	DATE	TIME
[illegible]	7/6/90	12:20

FIRST ARTICLE APPROVED ☐ This is your authority to proceed

FIRST ARTICLE REJECTED ☒ Correct defects & resubmit article

DISCREPANCY

INSPECTED BY: [illegible] DATE: 7/9/90

SPECIFIED	ACTUAL	REASON
1. .209-.215	.189 .1834	New Spec .183/.179 T/slot
2. .027-.031	.0389 .039	T/slot
3. 1.146-1.154	1.155	N/A -10 calls a .930/.922 O.D.
4. .762-.748	.7465	- Locking Tab to TAD
5. .110-.100	.105	- WEB Thickness
6. .500-.499	.498	Cam Depth to Web

RECOMMENDED DISPOSITION/CORRECTIVE ACTION [illegible] as marked in [illegible] & bumps inside ring as marked

Refer to Engr

TI-NHTSA 000882

MFG	DATE	MFG ENG	DATE	QC ENG	DATE
[illegible]	7/9/90				

DISTRIBUTION: WHITE—QC YELLOW—MFG PINK—MFG ENG FORM 20017

M E M O R A N D U M
11 July 1990

TO: Tom Charboneau
Dave Czarn
Mike DeMattia
Charlie Douglas
Keith Roberts
Joe Schuck

TOM + DAVE :

MIKE DEMATTIA IS DISCUSSING THIS W/ FORD SRA; CHARLIE DOUGLAS IS [illegible] THIS TO [illegible] [illegible]. -[illegible]

FR: Steve Offiler

RE: CCPS Schedule Concerns

Attached is the latest revision of the CCPS customer schedule, along with two MSG's from Joe which contain the Ford-requested dates. These dates are marked with asterisks on the schedule. Specific concerns include the following:

- There is a 6 month period between LT ISIR and first production shipment (4P). My understanding is that the ISIR is the last thing to be completed before we obtain approval to ship production parts. Why the 6 months ?

- Probably related to the above, Phase 1 and Phase 2 production samples fall between ISIR and 4P MRD. What are these samples supposed to be for ? How many ? What configuration ?

need final [illegible] point app. before we get official spec (can't [illegible] [illegible] regards)

- LT Revalidation (RV) should have already started in order to meet this schedule. It has not.

- Moving down to FC, the schedule shows we'll miss Ford's requested ISIR date by at least 3 months. I see no way to pull this in. Item #10 is pacing item #12 which must be complete before item #13 begins; all these pace item #14 and the schedule as it stands is very aggressive.

- A quantity of 70 LT Verification Proto's were shipped, on schedule, at the beginning of May '90 (item #3). A similar [redacted]ment for FC is due very soon (item #11). We have [redacted]d no request for these as yet.

[redacted] Scheduling for the new, automated switch (77PS) is [redacted]plete. Note, for instance, that zero time elapses between 77 ISIR and 4P MRD (rather than the above 6 months).

Regards,
Steve O.

SO 7/11/90

TI-NHTSA 000683

```
10 'Stephen B. Offiler          "DISCURVE.BAS"
20 '90/07/12
30 '
40 'This program calculates the amount of room required between
50 'the cup bump and converter bump to accomodate a given disc
60 'geometry.  All calculations are based on the simplifying
70 'assumption that the disc's shape is a simple arc of fixed radius.
80 '
90 KEY OFF:CLS
95 PI=4*ATN(1)
100 INPUT "CROWN HEIGHT OF DISC (TOTAL): ";CR
110 INPUT "DISC MATERIAL THICKNESS: ";TH
120 INPUT "DISC DIAMETER: ";DD
130 INPUT "CUP BUMP DIAMETER: ";BS
140 INPUT "CONVERTER BUMP DIAMETER: ";BL
150 ANGLE=2*ATN((CR-TH)/(DD/2))
160 RN=((DD/2)/(COS((PI/2)-ANGLE)))
170 RO=RN+(TH/2)
180 RI=RN-(TH/2)
190 HO=(RO^2-(BS/2)^2)^.5
200 HI=(RI^2-(BL/2)^2)^.5
210 DELTA=HO-HI
220 PRINT
230 PRINT "Distance between bumps required for this disc is:  ";DELTA
```

25/10 DISC :

CR = .030
TH = .0122
ϕ = .750

49 DISC :

CR = .0345
TH = .0122
ϕ = .750

68 DISC :

CR = .0390
TH = .0122
ϕ = .750

3 DISCS ; 2 CUP. BUMPS ; 2 CAN BUMPS (2 MEAS.)

.030	.470	RE	.707	MIN
.0345	.570	STD	.720	MAX
.0390				

25 ACT DISC, .030 CROWN

RUN

CROWN HEIGHT OF DISC (TOTAL): ? .030
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .750
CUP BUMP DIAMETER: ? .47
CONVERTER BUMP DIAMETER: ? .707

EE:
R: 1 .385"
C: 5-16

REBUMP MIN CONV

Distance between bumps required for this disc is: 2.106786E-02 .0211
Ok

RUN

CROWN HEIGHT OF DISC (TOTAL): ? .030
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .47
CONVERTER BUMP DIAMETER: ? .720

REBUMP MAX CONV

Distance between bumps required for this disc is: 2.165699E-02 .0217
Ok

RUN

CROWN HEIGHT OF DISC (TOTAL): ? .030
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .57
CONVERTER BUMP DIAMETER: ? .707

STANDARD MIN CONV

Distance between bumps required for this disc is: 1.778221E-02 .0179
Ok

RUN

CROWN HEIGHT OF DISC (TOTAL): ? .030
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .57
CONVERTER BUMP DIAMETER: ? .720

STANDARD MAX CONV

Distance between bumps required for this disc is: 1.837134E-02 .0184
Ok

REBUMP w/ NOM CONV .0214

Δ 3.2 MILS

STD w/ NOM CONV .0182

49 ACT DISC, .0345 CROWN

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .0345
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .47
CONVERTER BUMP DIAMETER: ? .707

REBUMP MIN CONV

Distance between bumps required for this disc is: 2.332497E-02 .0233
Ok

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .0345
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .47
CONVERTER BUMP DIAMETER: ? .720

REBUMP MAX CONV

Distance between bumps required for this disc is: 2.406407E-02 .0241
Ok

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .0345
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .57
CONVERTER BUMP DIAMETER: ? .707

STANDARD MIN CONV

Distance between bumps required for this disc is: .0192101 .0192
Ok

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .0345
DISC MATERIAL THICKNESS: ? .570122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .57
CONVERTER BUMP DIAMETER: ? .720

STD MAX CONV

Distance between bumps required for this disc is: .0199492 .0199
Ok

REBUMP w/ NOM CONV .0237

Δ 4.1 MILS

STD w/ NOM CONV .0196

TI-NHTSA 000887

68 ALT DISC, .039 CROWN

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .039
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .47 REBUMP MIN CONV
CONVERTER BUMP DIAMETER: ? .707

Distance between bumps required for this disc is: 2.558247E-02 .0256
Ok

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .039
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .47 REBUMP MAX CONV
CONVERTER BUMP DIAMETER: ? .720

Distance between bumps required for this disc is: 2.647925E-02 .0265
Ok

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .039
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .57 STD MIN CONV
CONVERTER BUMP DIAMETER: ? .707

Distance between bumps required for this disc is: 2.064633E-02 .0206
Ok

RUN
CROWN HEIGHT OF DISC (TOTAL): ? .039
DISC MATERIAL THICKNESS: ? .0122
DISC DIAMETER: ? .75
CUP BUMP DIAMETER: ? .57 STD MAX CONV
CONVERTER BUMP DIAMETER: ? .720

Distance between bumps required for this disc is: 2.153611E-02 .0215
Ok

REBUMP w/ NOM CONV .0261

Δ 5.0 MILS

STD w/ NOM CONV .0211

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 73-15-06

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 3433	7/13/90	SBO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	7/17/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: To eliminate disc pre-deflection in Rebump Cups

PROCEDURE: Rebuild rebump sensors from test # 70-15-12 with .005" spacer between cup and washer. Run pressure vs. deflection curves.

Sensor #	Parts from #	Free Act	Disc Rel	Cup #	Span Act	Span Rel			
73-15-01	70-15-01	36.9	11.4	1	144	58			
02	02	36.1	11.7	3	139	54			
03	03	38.1	11.6	4	136	53			
04	04	36.4	12.8	6	137	59			
05	05	36.5	11.9	7	152	58			
06	06	41.3	11.9	9	125	49			

TI-NHTSA 000889

HIGHLIGHTS
Stephen B. Offiler
Week Ending 07/13/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH 77PS

CUSTOMER / PROGRAM ISSUES: Joe Schuck reports a successful meeting with Bruce Pease at Pass-Car regarding the 7/16 non-standard thread issue and the 3000 psi proof spec. Joe was able to convince Bruce that the non-standard thread would impact device cost, assembly equipment, and testing equipment. Bruce will recontact the proportioning-valve supplier that originally proposed this. On the proof spec., a comparison of proof's of other system components (master cylinder, prop valve, tubing, etc) was used to get Bruce to agree to the lower 3K spec.

Envelope prints for 57PSL5-2 (Light Truck), 57PSL5-3 (Pass-Car) and 77PSL2-1 (Pass-Car) were completed and sent to all parties which had requested them.

The overall program schedule has been revamped, including dates supplied separately by Ford Purchasing and by the platforms. Rolling this all together has exposed some discrepancies. Marketing, Field Sales, and Quality are all involved and working to resolve this issue.

SAMPLES: We've been informed that the 60 devices requested by Lisa Robinson at LT will not actually be needed... Lisa has quit. Her replacement, Phil Gonzales, is requesting a total of 30 devices as follows: 10 @ 125+/-35, 10 @ 150+/-35, and 10 @ 175+/-40. He'd like these ASAP. We can build the lower spec with Low-Ratio-Converter parts and the upper spec with regular parts; discs are available. For the middle spec, we are presently cycling devices built with LRC's and 38 psi discs to confirm disc life. If all goes well, all thirty samples should ship by the end of next week.

I was contacted late Thursday by Jim Cousins at Kelsey-Hayes. He desperately needed 5 125 psi samples, above and beyond the 18 shipped last week. He will ultimately need another thirteen for a grand total of 36. We had originally build 25 devices to meet the first eighteen; 5 of the 7 extra's were shipped via Airborne as no-charge samples. Jim agreed that we will increase the price on the balance of 13 (to be requested via normal purchasing channels) to compensate the no-charge samples and bring the price back to $50/each. *13 @ $ 69.23*

125 PSI SENSOR: Suspecting that the relocated-cup-bumps were causing the discs to be pre-deflected during assembly, an experiment was conceived and executed. Six no-bumps and six controls were constructed, and pressure-deflection curves run. In theory, if the discs were pre-deflected, there would be an initially vertical portion of the P-D curve until enough pressure built up to overcome the preload. The results of the experiment correlated very nicely with the theory. Also, the P-D curves enable a theoretical pin-window to be measured. The controls showed a pin-window averaging around 11 mils while the nobumps showed around 9 mils. Since the pre-deflection is constricting disc movement in the no-bumps, we are rebuilding the test group with shims under the washer which will serve to provide adequate room for the disc. This will allow a more realistic P-D curve and pin window measurement.

Jeff Melton reports that he will be delivering the next Belville die. iteration very soon. We are working to better understand the Belvilles, including their pro's (tighter lot sigma's and easier, quicker press setup) and their con's (about double the drift over life compared with solid discs).

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 75-02-10

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 3423	—	—	
PERFORMED BY JAD	**DATE STARTED** 7/11/90	**DATE COMPLETED** 9/27/90	**APPROVED BY**

PROJECT TITLE: Cruise control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Replace gasket and Kapton seals in 5265 with a single rubber diaphragm

PROCEDURE: Diaphragm: .040" thick
56% compression @ bead
14% compression outside bead
14% compression inside bead

Disc 1, 2 49.5/36.97
σ 0.74/1.08

Char, Proof, Char, cycle, char

Sample #	Free Disc Act	Free Disc Ref	Setting Act	Setting Ref	Proof	Post-Proof Act	Post-Proof Ref	Final Act	Final Ref
75-02-01	51.2	37.1	542	380		522	365		
02	50.7	37.6	537	374		519	369		
03	51.6	34.7	554	388		NO SNAP			
07	50.0	36.9	540	362		527	360		
08	50.4	34.3	533	384		511	372		
10	50.3	36.9	[illegible]	366		502	354		
13	42.9	36.7	[illegible]	362		519	355		
15	43.4	35.6	519	352		499	341		
19	52.1	36.5	519	354		500	341		
16	46.8	36.0	515	355		511	342		
[illegible]	50.5	33.4	526	351		522	356		
11	49.2	34.0	526	362		506	348		

We had failures early on. The gasket was punched between the washer and accidentally cut through [illegible]. We rebuilt these devices with a single .040" piece of Kapton between the diaphragm and converter. These lasted over 200K cycles before the Kapton ruptured and the diaphragm failed eventually. No data was taken after rebuild. Testing of rebuilt devices was aborted after [illegible]

and 3 failures. Thermal cycles were also
run.

DRAWINGS AVAILABLE UPON REQUEST

HIGHLIGHTS
Stephen B. Offiler
Week Ending 07/20/90

FORD MY91.75 CRUISE CONTROL PRESSURE SWITCH 77PS

CUSTOMER ISSUES: I was contacted by Bruce Pease at Pam-Car this week. He informed me that the lead platform for CCPS, MY'92 Town Car, does not want to pay for tooling for the mating connector with the offset polarity key. This offset is really only needed for differentiation on carlines which also use the 57PS (for the electronic shock absorber system) which are Continental and T-Bird; these will use the CCPS in MY'94. Therefore, we don't need to deal with shifting the polarity key in the base mold until then. I have created new Pam-Car envelope prints showing the centered key and sent them to Bruce.

I was contaced by Gary Innocilli at Weatherhead Div. Dana Corp. They are a brake system component supplier, being considered by Ford to supply the junction block which will mount our switch. Gary wanted to know if he could apply installation torque (roughly 15 lb-ft) to the crimp ring in order to automate assembly. I explained that as the switch is presently designed, he cannot. His quote to Ford, therefore, will assume manual assembly. However, this lead to an idea where we key the crimp ring to the hexport via a hex-shaped opening rather than a round opening in the crimp ring. We plan to prototype this idea as soon as feasible, after shutdown. If successful, this may allow us a to charge a slightly higher price for our switch while at the same time allowing an overall cost reduction to Ford because Weatherhead will be able to automate.

SAMPLES: We are presently working to build a total of 30 pairs (10 each at 125, 150 and 175 psi) for Phil Gonzalez at Light Truck. We should be able to ship as early as today. A slight problem arose when the attempt to build 150's came out way too high because a modification to the low-ratio-converter design had the effect of raising the amplification ratio. We plan to build devices without this modification which should produce 150's.

We've received the sample order from Kelsey-Hayes for the final 13 devices. We shipped 5 last week as no-charge samples in an emergency situation. These thirteen devices will go out early next week.

SENSOR: Relocated-cup-bump test devices which showed disc pre-deflection on pressure vs. deflection curves were disassembled and rebuilt with a .005" shim between the washer and cup to provide additional clearance for the disc. P-D curves show that this corrected the pre-deflection, increased total throw from 13.5 to 15.5 mils and increased theoretical pin-window from 6.2 to 6.7 mils. The shim also effectively lowers the height of the button relative to the washer, which reduces Kapton wetted area and increases ratio. We plan to do an actual pin-window test on these and on a set of controls.

We have received the next iteration of Belville discs from the disc dept. We are putting together a test plan for these, as well as a definitive test of Kapton life in the large-area-button low-ratio-converter design.

HUMIDITY: Test devices previously run to compare Ford's humidity spec with MIL-STD-202F were dissected for routine inspection. An interesting phenomenon was discovered. The gaskets were found to be swelled severely (on the order of 25 percent plus). They were confirmed to be EPDM based on the white painted outer surface. The Parker handbook indicates that this material is the best for sealing water/steam. We are looking for other possible causes for the swelling, and are re-running the Humidity test at George O'Lear's suggestion.

Actual 46.5%

DRAWINGS AVAILABLE UPON REQUEST

TO: Bill Sweet

Fm: Matt Sellers

SJ: Highlights W/E 7/29/90

Plastic Cover Program... Manuf. Eng and marketing have completed drafting a presentation for Field Rep's to use when demonstrating the new design to customers. Marketing is projecting completion of customer polling by the end of August, 90.

Optimization yields... The Navy pull-in board has been running exceptionally well lately. The attention to tooling and set-up problems by manufacturing has been having a large impact. However, the disc quality problems we have been experiencing lately are still affecting us. The 9115-15 amp device (GSI) is really giving production some problems. We have been forced to institute a '5' second time window due to the repeatability of the disc. Design is currently evaluating the problem, but is quick to point the finger elsewhere.

No more updates → I was out Tues, Wed. + Thursday.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 75-11-13

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ex 3413	7/12/90	BBO	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAB	7/24/90	8/6/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: Samples 125 PSI ± 35

PROCEDURE: Disc: 25/10
Base: Grey
Cup: Relocated Leap
Crimping: yellow, no code &
use shims .005" — SHIMS

Device #	First Dose Act	Rel	Hi-Temp Act	Rel	Proof	Post-Temp Act	Rel		
75-11-01	26.1	16.9	129	45	11	117	44		
02	25.3	9.8	127	44	11	120	47		
03	25.4	11.9	122	50		113	52		
04	26.9	11.2	135	59	11	139	62		
05	25.1	11.2	121	40		121	41		
~~06~~	~~26.1~~	~~9.3~~	~~77~~	~~32~~		~~99~~	~~37~~		
07	25.2	9.3	122	35	11	113	38		
08	24.8	11.2	120	51		110	58		
09	25.1	11.8	124	49	11	115	50		
10	25.4	11.2	120	42		122	48		
11	25.9	11.2	125	42		126	47		
12	24.7	9.5	121	36	11	109	39		
13	25.7	10.0	125	44		114	46		
~~14~~	~~24.6~~	~~9.0~~	110	34	11	~~99~~	33		
15	26.4	12.5	133	53		121	52		
	$\bar{x}$ = 25.6		123.8			117.5			
	σ = .71		6.15			6.05			
	% = 3.8		4.9%			5.1%			
			(117 w/o			(110 w/o			
			shims)			shims)			
			TT 413			TT 413			

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 26-09-36 [illegible]

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 3413	7/27/90	SAB	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	8/2/90		

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Belville iteration 2B & 2B

PROCEDURE: using discs from lots 2B & 2B, build 18 of each w/ 1/2" switches. Do initial free-disc char; proof to 3K, Rector; cycle 11 of each; after all cycle a final free-disc char.

Device #	Belville iteration	disc Act	init. Rel	Device Act	init Rel	Post Act	Proof Rel	Post Act	Cycle Rel
26-09-01	↑	17.2	14.5	182	79	134	101	127	82
02		17.6	11.1	143	97	144	96	129	95
03		17.1	11.3	136	98	140	78	118	77
04		16.9	11.3	135	102	136	109	124	92
05		17.3	14.5	149	104	146	101	Dead	—
06		12.7	11.2	148	105	145	114	130	85
07		17.3	11.7	154	96	149	97	132	93
08	2B	17.4	11.5	178	97	140	103	127	90
09		16.2	13.0	150	108	149	100	135	95
10		17.3	12.3	135	100	142	109	124	90
11		17.6	13.4	139	106	142	107	129	94
12		17.3	12.9	148	99	145	104	143	77
13		17.7	14.6	138	100	142	102		
14		17.9	12.8	151	95	153	115		
15		17.5	14.1	141	106	142	102		
16		17.1	11.9	131	97	135	105		
17	↓	17.8	11.9	145	97	141	98		
18		17.1	12.2	134	97	132	109		
26-09-19	↑	23.7	20.5	226	179	223	178	Dead	—
20		23.7	20.0	230	193	226	177		
21		22.2	20.3	233	187	227	180		
22		23.7	20.4	218	176	226	178		
23	3B	22.5	20.2	232	190	224	202		
24		22.5	19.9	229	177	221	177		
25		22.3	20.3	221	178	224	177		
26	↓	22.3	20.2	225	179	227	185	↓	

Device #	Belleville iteration	Disc init Act	Disc init Rel	Device init Act	Device init Rel	Post-Pierce Act	Post-Pierce Rel	Post-Cycle Act	Post-Cycle Rel
76-09-18		23.1	19.6	221	198	222	183	Dead	
19		23.3	20.1	219	170	222	175	Dead	
20		23.6	20.3	222	170	226	162	Dead	
21		23.9	20.6	232	190	233	179		
22	5B	23.9	20.6	221	194	227	182		
23		23.3	20.3	221	193	222	183		
24		23.5	20.2	225	195	226	181		
25		23.2	19.9	235	175	235	188		
26		23.9	20.5	226	193	228	194		
	Final disc Act	Final disc Rel							
76-09-01	17.7	10.2							
02	14.9	10.6							
03	14.6	9.3 cracked							
04	14.2	10.0							
05	Dead	—	500K cyc						
06	15.0	8.1 cracked							
07	14.7	10.4							
08	14.3	10.5							
09	15.15	10.7							
10	14.9	9.7							
11	14.9	10.9							
12	14.5	9.4 cracked							
13	16.9	11.3							
14	16.7	11.4							
15	17.1	11.0	Proof only						
16	16.9	11.6							
17	16.2	11.5							
18	16.5	11.7	—						
76-09-19									
20									
21	D								
22	e								
23									
24	a								
25		d							
26									
27									
28									
29									
30									
31	23.7	21.4							
32	23.1	20.5	Proof only						
33	23.3	20.3							
34	23.5	20.0							
35	23.3	19.9							

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INITIAL		
DISC	DEVICE	RATIO
17.2	132	7.67
17.0	142	8.35
17.2	136	7.91
16.8	135	8.04
17.3	147	8.50
17.7	143	8.08
17.5	154	8.80
17.4	138	7.93
18.2	150	8.24
17.3	135	7.80
17.6	139	7.90
17.3	143	8.27
17.7	138	7.80
17.4	151	8.68
17.5	141	8.06
17.1	131	7.66
17.0	145	8.53
17.1	134	7.84
	$\bar{X}$ =	8.11
		0.34
		4.2%

PROOF		
DISC	DEVICE	RATIO
16.8	143	8.51
16.7	153	9.16
17.1	142	8.30
16.4	135	8.23
16.2	141	8.70
16.5	132	8.00
		8.48
		.41
		4.8%

PROOF & CYC		
DISC	DEVICE	RATIO
14.7	127	8.64
14.4	129	8.96
14.2	124	8.73
15.0	130	8.67
14.7	132	8.98
14.5	127	8.76
15.5	135	8.71
14.4	124	8.61
14.8	129	8.72
		8.75
		0.13
		1.5%

$\frac{8.48 - 8.11}{8.11}$ = 4.56% vs, PROOF

$\frac{8.75 - 8.11}{8.11}$: 7.89% vs, PROOF & CYC

BELVILLE ITERATIONS 2B & 3B   TEST 76-09-36   JAD 8/21/90

DEVICE #		DISC INIT ACT	DISC INIT REL	PRE-PROOF ACT	PRE-PROOF REL	POST-PROOF ACT	POST-PROOF REL	POST-CYC ACT	POST-CYC REL	DISC FINAL ACT	DISC FINAL REL	TEST UNDERGONE	DISC CONDITION
76-09-01		17.2	12.5	132	99	134	101	127	89	14.7	10.2	PROOF+CYC	O.K.
76-09-02		17.0	12.7	142	97	146	96	129	95	14.4	10.6	PROOF+CYC	O.K.
76-09-03		17.2	12.3	136	98	140	98	119	77	16.6	9.2	PROOF+CYC	CRACKED
76-09-04	I	16.8	12.3	135	102	136	104	124	92	14.2	10.0	PROOF+CYC	O.K.
76-09-05	T	17.3	12.5	147	104	146	101	DEAD				PROOF+CYC	CRACKED
76-09-06	E	17.7	12.7	143	106	145	114	130	85	15.0	8.1	PROOF+CYC	O.K.
76-09-07	R	17.5	12.7	154	96	149	97	132	93	14.7	10.4	PROOF+CYC	O.K.
76-09-08	A	17.4	12.5	138	97	140	102	127	98	14.5	10.5	PROOF+CYC	O.K.
76-09-09	T	18.2	13.0	150	107	148	100	135	95	15.5	10.7	PROOF+CYC	O.K.
76-09-10	I	17.3	12.3	135	100	142	104	124	90	14.4	9.7	PROOF+CYC	O.K.
76-09-11	O	17.6	13.2	139	106	142	107	129	94	14.0	10.8	PROOF+CYC	O.K.
76-09-12	N	17.3	12.9	143	99	145	104	123	79	14.5	8.4	PROOF+CYC	CRACKED
76-09-13		17.7	12.6	138	100	143	102	NOT CYCLED		16.8	12.3	PROOF ONLY	O.K.
76-09-14	2	17.4	13.0	151	115	153	116	NOT CYCLED		16.7	12.4	PROOF ONLY	O.K.
76-09-15	B	17.3	12.6	141	106	142	100	NOT CYCLED		17.1	12.0	PROOF ONLY	O.K.
76-09-16		17.1	11.9	131	98	135	105	NOT CYCLED		16.4	11.6	PROOF ONLY	O.K.
76-09-17		17.0	11.9	145	93	141	93	NOT CYCLED		16.2	11.5	PROOF ONLY	O.K.
76-09-18		17.1	12.2	134	97	132	102	NOT CYCLED		16.5	11.7	PROOF ONLY	O.K.
AVG.		17.3	12.5	141	101	142	103	127	89	15.3	10.5	16.6	
STD.		0.31	0.34	6.49	5.12	5.20	5.49	4.30	5.90	0.90	1.31	.74 4%	

301

17.3 .28 1.6%

$\bar{X}_i = 17.4$ σ .41 2.4%

140.6 6.60 4.7%

142.1 5.44 3.8%

$\bar{X}_c = 128.6$ 3.67 2.8%

$\bar{X}_f = 14.7$ σ .39 2.6%

$\frac{142.1 - 140.6}{140.6}$ = .09%

PROOF BRINGS DEVICES UP - WOULD DOWN FALL 40%

3K

$\frac{16.6 - 17.3}{17.3}$ = -4.0%

PROOF ONLY

DRIFT $\frac{14.7 - 17.4}{17.4}$

-15.5%

PROOF & CYCLE

DEVICE #		DISC INIT ACT	DISC INIT REL	PRE-PROOF ACT	PRE-PROOF REL	POST-PROOF ACT	POST-PROOF REL	POST-CYC ACT	POST-CYC REL	DISC FINAL ACT	DISC FINAL REL	TEST UNDERGONE	DISC CONDITION
76-09-19		23.7	20.5	226	179	230	182	DEAD				PROOF+CYC	CRACKED
76-09-20		23.7	20.0	230	192	236	199	DEAD				PROOF+CYC	CRACKED
76-09-21		23.2	20.2	223	187	227	190	DEAD				PROOF+CYC	CRACKED
76-09-22	I	23.7	20.4	218	186	226	186	DEAD				PROOF+CYC	CRACKED
76-09-23	T	23.5	20.2	220	190	234	189	DEAD				PROOF+CYC	CRACKED
76-09-24	E	23.5	19.9	224	174	220	177	DEAD				PROOF+CYC	CRACKED
76-09-25	R	23.3	20.2	221	170	224	170	DEAD				PROOF+CYC	CRACKED
76-09-26	A	23.3	20.2	223	179	227	185	DEAD				PROOF+CYC	CRACKED
76-09-27	T	23.6	20.0	230	191	234	197	DEAD				PROOF+CYC	CRACKED
76-09-28	I	23.1	19.6	221	180	222	182	DEAD				PROOF+CYC	CRACKED
76-09-29	O	23.3	20.1	218	170	222	175	DEAD				PROOF+CYC	CRACKED
76-09-30	N	23.6	20.3	222	170	226	182	DEAD				PROOF+CYC	CRACKED
76-09-31		23.8	20.6	232	170	233	179	NOT CYCLED		23.7	20.4	PROOF ONLY	O.K.
76-09-32	3	23.8	20.6	221	184	227	187	NOT CYCLED		23.6	20.5	PROOF ONLY	O.K.
76-09-33	B	23.3	20.3	221	187	228	193	NOT CYCLED		23.3	20.2	PROOF ONLY	O.K.
76-09-34		23.5	20.2	225	185	226	181	NOT CYCLED		23.5	20.0	PROOF ONLY	O.K.
76-09-35		23.2	19.9	235	175	235	180	NOT CYCLED		23.2	19.9	PROOF ONLY	O.K.
76-09-36		23.4	20.5	226	192	228	194	NOT CYCLED		23.5	20.3	PROOF ONLY	O.K.
AVG.		23.4	20.2	225	181	228	185			23.4	20.2		
STD.		0.21	0.25	4.53	7.92	4.15	8.66			0.16	0.21		

455

PROOF DOESN'T CHG 455's

$\bar{X}_i = 23.50$ .25 1.1%

$\bar{X} = 224.6$ $\sigma = 4.67$ 2.1%

$\bar{X} = 228.4$ σ 4.27 1.9%

$\bar{X} = 23.47$ σ .19 0.8%

$\frac{228.4 - 224.6}{224.6}$ = 1.7%

PROOF BRINGS DEVICES UP

TI-NHTSA 000814

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 76-09-36

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
EX 3433	7/14/90	SAB	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
JAD	8/7/90	7/14/90	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER:

PURPOSE OF TEST: Belville iteration 2B & 3B

PROCEDURE: Using discs from lots 2B & 3B, build 12 of each w/ 12" switches. Do initial free-disc build/char., proof to 3K, recharac.; cycle 11 of each; after all adds a final free-disc char.

Device #	Belville Iteration	disc Act	init. Rel	Device Act	init Rel	Post Act	Proof Rel	Post Act	Cycle Rel
76-09-01		17.3	14.5	182	99	134	101	127	87
02		17.0	11.1	142	93	144	96	129	95
03		17.3	11.3	136	98	140	98	119	77
04		16.5	11.3	135	102	136	104	124	92
05		17.3	11.5	149	104	146	101	Dead	—
06		17.1	11.7	143	105	145	114	130	85
07		17.3	11.7	154	96	139	99	133	93
08	2B	17.4	11.5	138	97	140	102	127	90
09		16.3	13.0	150	120	149	100	135	95
10		17.3	12.3	135	100	142	109	124	70
11		17.1	11.4	129	106	142	107	129	94
12		17.1	12.9	148	99	145	104	143	72
13		17.1	11.6	138	100	142	102		
14		17.4	12.6	151	85	153	115		
15		17.5	11.1	141	106	142	109		
16		17.1	11.9	131	97	135	105		
17		17.0	11.9	145	92	141	93		
18		17.1	12.2	134	97	132	103		
76-09-19		23.7	20.5	236	129	223	130	Dead	—
20		23.7	20.0	230	183	226	139		
21		23.3	20.2	232	177	227	130		
22		23.7	20.9	217	126	226	128		
23	3B	23.5	20.2	248	130	224	129		
24		23.5	19.5	224	177	228	127		
25		23.9	20.2	231	120	224	128		
26		23.3	20.2	225	177	227	125		
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

Device #	Belleville iteration	Disc Act	Init Rel	Device Init Act	Init Rel	Post- Act	Post Rel	Post- Act	Cycle Rel
8-09-28		22.1	19.6	221	178	232	193	Dead	
29		22.3	20.1	219	170	232	175	Dead	
30		22.6	20.3	238	176	236	162	Dead	
31		23.8	20.6	232	190	235	179		
32	3B	22.8	20.6	231	184	227	182		
33		22.3	20.3	221	185	228	183		
34		22.5	20.2	225	185	236	191		
35		22.2	19.8	225	175	235	188		
36		22.4	20.5	226	183	227	194		
	Final Act	disc Rel							
16-09-01	14.7	11.2							
02	14.4	10.6							
03	14.6	9.2 cracked							
04	14.2	10.0							
05	Dead	—	Soak cyc						
06	15.0	9.2 cracked							
07	14.7	10.4							
08	14.8	10.5							
09	15.5	10.7							
10	14.4	9.7							
11	14.8	10.9							
12	14.3	6.4 cracked							
13	16.5	11.3							
14	16.7	11.4							
15	17.1	11.0	Proof only						
16	16.4	11.6							
17	16.3	11.5							
18	16.5	11.7							
16-09-19									
20									
21	Dead								
22									
23									
24									
25									
26									
27									
28									
29									
30									
31	22.7	20.4							
32	22.1	20.5	Proof only						
33	23.3	20.2							
34	23.5	20.0							
35	23.3	19.9							
36	23.5	20.[illegible]							

BELVILLE ITERATIONS 2B & 3B   TEST 76-09 36   JAD 8/21/90

DEVICE #		DISC UNIT ACT	DISC UNIT REL	PRE-PROOF ACT	PRE-PROOF REL	POST-PROOF ACT	POST-PROOF REL	POST-CYC ACT	POST-CYC REL	DISC FINAL ACT	DISC FINAL REL	TEST PROCEDURE	DISC CONDITION
76-09-01		17.2	12.5	132	99	134	101	127	89	14.7	10.2	PROOF+CYC	O.K.
76-09-02		17.0	12.7	142	97	144	96	129	95	14.4	10.6	PROOF+CYC	O.K.
76-09-03		17.2	12.3	136	98	140	98	119	77	14.6	0.2	PROOF+CYC	CRACKED
76-09-04	I	16.8	12.3	135	102	136	104	124	92	14.2	10.0	PROOF+CYC	O.K.
76-09-05	T	17.3	12.5	147	104	146	101	DEAD				PROOF+CYC	CRACKED
76-09-06	E	17.7	12.7	143	105	145	114	130	85	15.0	0.1	PROOF+CYC	O.K.
76-09-07	R	17.5	12.7	154	96	149	97	132	93	14.7	10.4	PROOF+CYC	O.K.
76-09-08	A	17.4	12.5	138	97	140	102	127	90	14.5	10.5	PROOF+CYC	O.K.
76-09-09	T	18.2	13.0	158	107	148	100	135	95	15.5	10.7	PROOF+CYC	O.K.
76-09-10	I	17.3	12.3	135	100	142	104	124	90	14.4	9.1	PROOF+CYC	O.K.
76-09-11	O	17.6	13.2	139	106	142	107	129	94	14.0	10.0	PROOF+CYC	O.K.
76-09-12	N	17.3	12.9	143	99	145	104	123	79	14.5	0.4	PROOF+CYC	CRACKED
76-09-13		17.7	12.6	138	100	143	102	NOT CYCLED		16.0	12.3	PROOF ONLY	O.K.
76-09-14	2	17.4	13.0	151	115	153	115	NOT CYCLED		16.7	12.4	PROOF ONLY	O.K.
76-09-15	B	17.5	12.6	141	106	142	100	NOT CYCLED		17.1	12.0	PROOF ONLY	O.K.
76-09-16		17.1	11.9	131	90	135	105	NOT CYCLED		16.4	11.6	PROOF ONLY	O.K.
76-09-17		17.0	11.9	145	93	141	93	NOT CYCLED		16.2	11.5	PROOF ONLY	O.K.
76-09-18		17.1	12.2	134	97	132	102	NOT CYCLED		16.5	11.7	PROOF ONLY	O.K.
AVG.		17.3	12.5	141	101	142	103	127	89	15.3	10.5		
STD.		0.33	0.34	6.49	5.12	5.28	5.49	4.30	5.90	0.90	1.31		

DEVICE #		DISC UNIT ACT	DISC UNIT REL	PRE-PROOF ACT	PRE-PROOF REL	POST-PROOF ACT	POST-PROOF REL	POST-CYC ACT	POST-CYC REL	DISC FINAL ACT	DISC FINAL REL	TEST PROCEDURE	DISC CONDITION
76-09-19		23.7	20.5	226	179	228	182	DEAD				PROOF+CYC	CRACKED
76-09-20		23.7	21.0	230	192	236	199	DEAD				PROOF+CYC	CRACKED
76-09-21		23.2	20.2	223	187	227	190	DEAD				PROOF+CYC	CRACKED
76-09-22	I	23.7	20.4	218	186	226	186	DEAD				PROOF+CYC	CRACKED
76-09-23	T	23.5	20.2	228	190	234	189	DEAD				PROOF+CYC	CRACKED
76-09-24	E	23.5	19.9	224	174	226	177	DEAD				PROOF+CYC	CRACKED
76-09-25	R	23.3	20.2	221	178	224	178	DEAD				PROOF+CYC	CRACKED
76-09-26	A	23.3	20.2	223	179	227	185	DEAD				PROOF+CYC	CRACKED
76-09-27	T	23.6	20.0	228	191	234	197	DEAD				PROOF+CYC	CRACKED
76-09-28	I	23.1	19.6	221	178	222	162	DEAD				PROOF+CYC	CRACKED
76-09-29	O	23.3	20.1	218	178	222	115	DEAD				PROOF+CYC	CRACKED
76-09-30	N	23.6	20.3	222	178	226	162	DEAD				PROOF+CYC	CRACKED
76-09-31		23.8	20.6	232	178	233	179	NOT CYCLED		23.7	20.4	PROOF ONLY	O.K.
76-09-32	3	23.0	20.6	221	184	227	187	NOT CYCLED		23.6	20.5	PROOF ONLY	O.K.
76-09-33	B	23.3	20.3	221	187	220	193	NOT CYCLED		23.3	20.2	PROOF ONLY	O.K.
76-09-34		23.5	20.2	225	185	226	181	NOT CYCLED		23.5	20.0	PROOF ONLY	O.K.
76-09-35		23.2	19.9	235	175	235	180	NOT CYCLED		23.2	19.9	PROOF ONLY	O.K.
76-09-36		23.4	20.5	226	192	220	194	NOT CYCLED		23.5	20.3	PROOF ONLY	O.K.
AVG.		23.4	20.2	225	181	228	185			23.4	20.2		
STD.		0.21	0.25	4.33	7.92	4.15	8.66			0.16	0.21		

HILIGHTS

Stephen B. Offiler
w/e 7/27/90

[illegible] ISSUES: Charlie Douglas & Joe Schenck met with the new light truck engineer, Phil Gonsalves. He seems to be coming up to speed quickly. He has obtained the test-set of 57PS's (originally used by Kingler's group to set LT specs). They also met w/ George Randall. He has gone over our [illegible] envelope print with a fine-tooth comb and has voiced objections to many of the metric conversions. In all cases there are a question of roundoff tunnelling. Also, all groups were asked to define sample needs and schedule. This info is forthcoming.

SAMPLES: 30 devices were shipped to Gonsalves; 10 @ 135 ± 35, 10 @ 120 ± 35; and 10 @ 195 ± 40. These along w/ the test-set will help him determining the spec for any 94 [illegible] which is a Taurus platform mini-van.

13 devices were shipped to Kelsey-Hayes. These, plus 5 emergency samples shipped last week, complete the order for 18.

HUMIDITY: Reported last week, we obtained a 46.5% swelling of the gaskets in Humidity test parts. The humidity test was re-run. No swelling observable. My hypothesis is that some petroleum product found its way into the swelled parts — possibly tubes coming there w/ shop air at the pressure [illegible]?

CCPS Mtg. 3/2/95

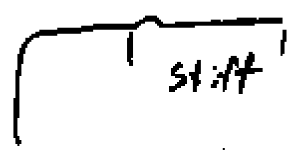
WHO: Tom Charbonneau
Dave Czarn
Andy McKenna

Topic: Spring Development

① Goals:

A. Keep Spring rate low, preferably < 1 #/..

B. Mechanization would like a stiff arm (between bump & contact)



55PS stiffness may be adequate - capability of ± .75 mil

C. Make design as robust as possible, for use on 52/57PS PS & brake(?) switches and also A/C switches;

② what device should we design for?

	Δ	D
- CCPS Truck	250 ± 50	?
- CCPS Pass Car	135 ± 35	?
- 57PSL2-1	450 ± 50	150 Min
- other (best case, ie incipient snap)		

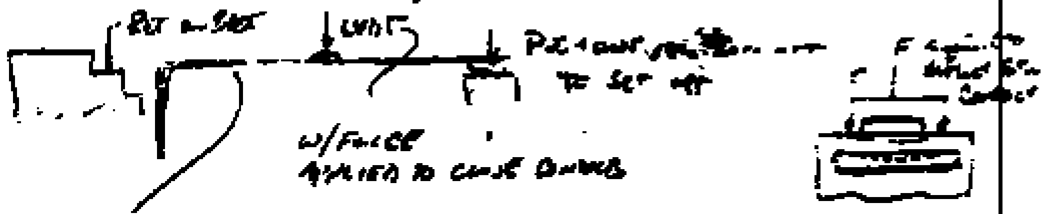
③ Comments

- Watch spring force on disc (cal Δ?)
- can incipient snap disc be used?

CCPS Base   Tom / Andy   3/cc/90

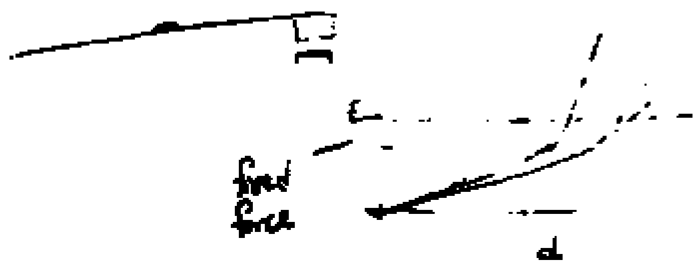
Objectives

- 6 lb/in spring rate or [illegible] ; when [illegible] — get Truck [illegible] Base
  - [illegible] in [illegible]
- [illegible] wants high spring rate ; so [illegible]



WANT THIS TO BE [illegible]

- Physical size being [illegible] ; [illegible]



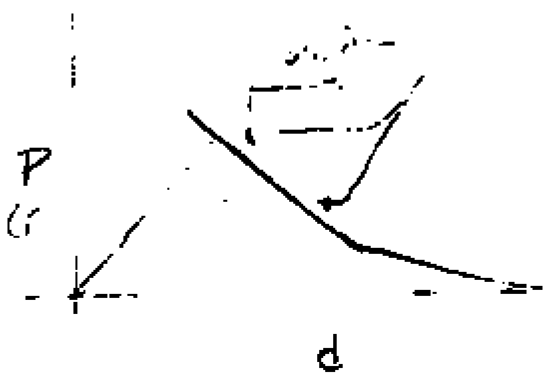
- Actuation / diff / [illegible] ; 3 parameters to [illegible]

CCPS - Ford
Truck   250 ± 50
        125 ± 25   20 [illegible]
500K cycle life.

look at all 52PS/57PS ; ~~[illegible]~~ [illegible]
[illegible]

• 30gm min contact force.

54 mA for 5 ... Squib ...

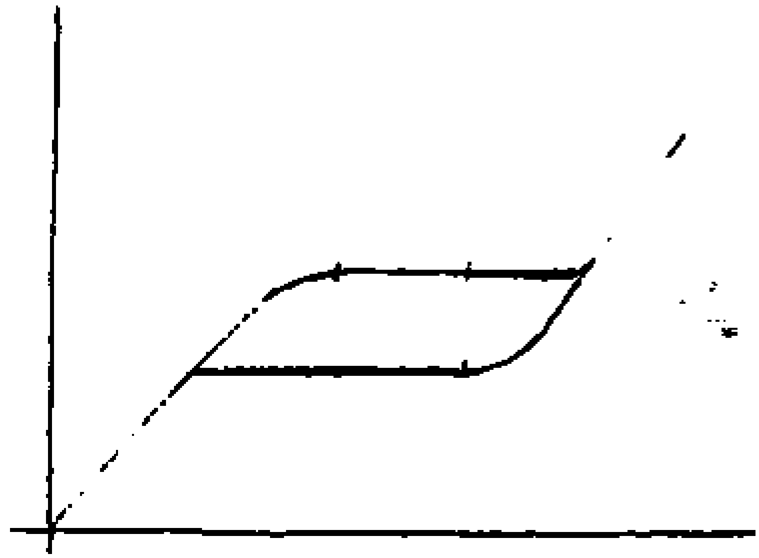


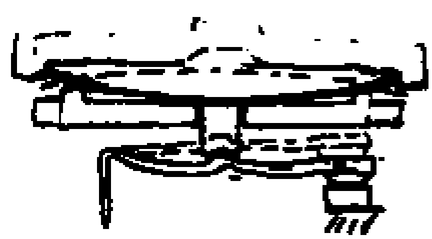
- taper the ... ...

Trach/Cam should be able to work. / any bank, since incipient snap disc can ...

• possibility of using std 9:1 ratio w/ incipient snap disc

Steve - incipient snap vs diz
- ~~calibration~~ timing algorithm
• how did arms fracture on Steve test ?
• look at design pt timing for promising 53/57 w/ CCP's or part CCPS alone





BCr [illegible] #5 [illegible]

57PC [illegible] fan

57CT - 3 de[illegible]

[illegible]

[illegible] crack by the switch [illegible]

- does [illegible]

[illegible] date

Terminal design

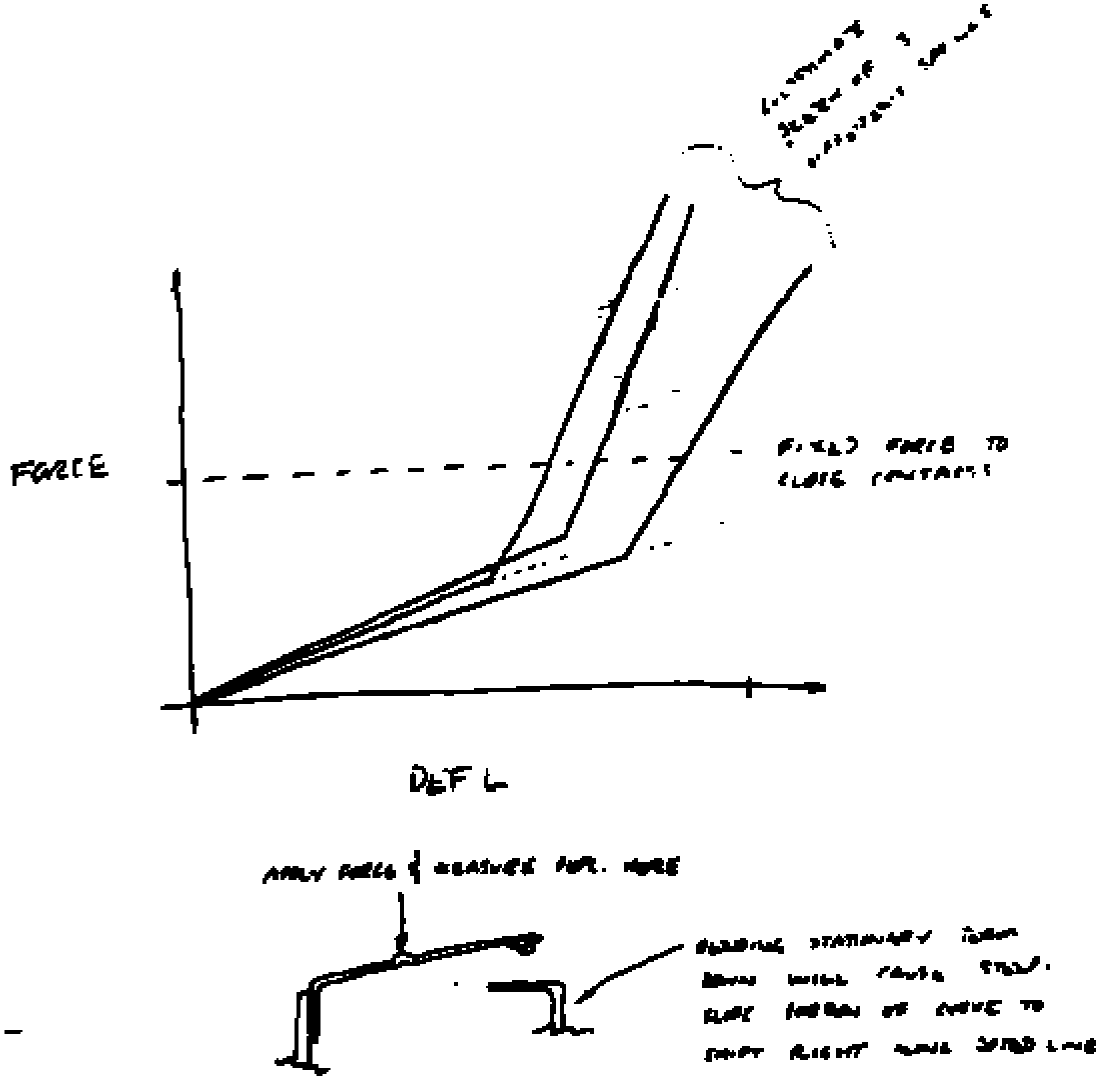
- stationary [illegible]

- attachment of [illegible] MD

[illegible] from Andy

Wel 6 [illegible] mfs

J.O. → What is the crimping [illegible] making →
envelope will change due to thicker [illegible]


FORCE
FIXED FORCE TO CLOSE CONTACTS
DEFL
APPLY FORCE & MEASURE DEFL. HERE