QUIET SWITCH DEVELOPMENT

77 PSL3-1

CRUISE CONTROL PRESSURE SWITCH

FORD MOTOR COMPANY

OPENED APRIL 1992

DALE R. SOGGE

Ford P/N F3TA-9F924-BA (TI P/N 77PSL3-3)
Sound Pulse Evaluation

Scope: Sound Pulse level measurements were made to compare the hydraulic disturbance during switch actuation between standard production switches built with non-quiet discs and prototypes built with quiet discs.

Procedure: A TI-developed sound pulse test stand was used to measure the pressure wave generated in the vicinity of the switch during a pressure ramp of 100-300 psi/second. The pressure was measured by a quartz pressure transducer with a frequency response of 15 kHz.

The pressure wave - or hydraulic disturbance - generated by a standard (non-quiet) switch is characterized by a sudden drop in pressure, followed by a damped wave of decreasing magnitude. The sound pulse value is determined by measuring the vertical distance from the first peak to the first valley in the pressure wave. (See Figure 1)

The pressure wave generated by a quiet switch is characterized by either a very slight drop in pressure (0 - 5 psig is an estimate), or a flat/slightly increasing slope in the actuation region. (See Figure 2)

Results: Twenty switches were randomly sampled from two production lots on August 6, 1992; values are reported in Table A.

Ten switches left over from a sample lot of quiet switches previously sent to John Pelkey, and fifteen additional switches built on 8/6/92 with the same disc lot were tested; values are reported in Table B.

Discussion: The standard switches, as expected, had a relatively large pressure pulse. Values were in the range of -27 to -70.5 psig.

All of the prototype quiet switches had a pulse that was characterized by either a zero slope region or an almost undetectable negative pulse. No values were greater than - 1 psig. It is expected that none of these switches would create an audible noise or tactile feel during operation on the vehicle. While these switches were consistent for sound pulse, the true production capability has not yet been established.

For the Taurus SHO - M/C mount application - a tentative specification of -1.5 psig maximum has been established as the threshold for acceptable noise/feel. This threshold appears to be application-sensitive, as the noise/feel is dependant upon switch location and the way in which the noise is attenuated through the components. A pulse level threshold has not been established for any truck platforms at this time.

D. Ogden 8/10/92

TO: Dave Czarn Circulate as needed. 7-28-92

FR: Dale Sogge

SJ: Ford Silent switch test results

Attached are copies of all the pertinant documents pertaining to the silent switch.

The first document is the results from Ford's Test on parts with a range of sound levels as tested by R.H. Walker. Ford says the only accepatble parts are #64, 01, 16, 74.

The second document describes the details for all of the parts sent to Ford.

#64 was used for the orginal repeatability study so it has been tested several times and it has seen at least one months exposure to brake fluid without any increase in sound level. It uses a disc from the first lot of produ quite switches.

#01 was also used for the repeatability study. It also uses a disc from one of the first four lots of quite production.

#16 uses a disc that I had judged to be slightly noisy based on the disc differential, at the beginning of the project. Apparently it's ok.

#74 is high differential fallout from the production line. This device exceed the 45psi differential test limit onthe flanl tester. Actual value on the final tester was unknow. The differential in the lab was 61.5psi which is probbly 50-55psi on the line. The fact that this was quite allowed me to open the differential spec from 45 to 50psi which has increased our yields. We may want to open it to 55psi. One problem though is we don't know why the differential should ever be that high.

Also attached are the sound curves for these devices. The smoothness of these curves vs others corrleates well to Ford's testing. The only fallback in the test was that it might not have been a blind test at Ford.

The next attachment is the final specification sent to Ford. Ford will make this part of the engineering specification. I selected a sound level of -1.5psi based on the Ford test results. One difficulty with this level for the spec is that we probely won't be 1.33CPK capable due to the device variation and the large R&R (25%). Fortunately we do not need to demonstrate CPK, we must only pass an audit on 12 pieces every 6 months.

The final document is a description of how to interpert the sound curves. Ford requested this for their information.

Actions

1) We need to modify the envelope drawings for quite switches to call out the sound test as specified. We may have to wait until the ES spec is issued. - Charlie, Steve

2) Retest the returned switches and then forward to other groups. - Dale

Regards, Dale

TI-NHTSA 004773

drs92-39, 7-28-92

JULY 15, 1992

TO: B. J. Maeroff

cc: R. H. Walker

Subject: Evaluation of alternate source for 1993 SHO dump switch.

Eleven cruise control dump switches from Texas Instruments were tested on a 1993 SHO to see at which sound level and above could the switches be seen as a viable alternative to the parts currently in use.

Eleven switches with serial numbers listed below were tested. Each was prefilled with brake fluid and the right front brake was bled after installation. A light indicator wired to the switch was used to verify switch actuation. Pedal feel was subjectively evaluated with and without vacuum in the booster. All evaluations were static.

Listed below are the various readings for pedal feel and sound level:

SERIAL NUMBER	FEEL	SOUND LEVEL(psig)
64	9	+1.5
01	9	+0.5
16	9	0.0
74	8	0.0
39	6	-2.5
25	5	-4.25
56	4	-6.6
53	5	-9.5
10	4	-26.2
59	3	-41.4
06	3	-81.0

TI-NHTSA 004774

Conclusion: The switches with a sound level greater than or equal to zero have an acceptable rating for all pedal feel issues.

Sandra Postell

Sandra L. Postell
845-3305

TABLE A - STANDARD PRODUCTION SWITCHES

	DEVICE #	PRESSURE PULSE (psig)
PRODUCTION LOT B		
DISC LOT 106	106-1	-57.8
	106-2	-70.3
	106-3	-64.5
	106-4	-53.8
	106-5	-51.3
	106-6	-27.0
	106-7	-34.3
	106-8	-38.3
	106-9	-49.3
	106-10	-60.0
PRODUCTION LOT B		
DISC LOT 107	107-1	-66.5
	107-2	-70.5
	107-3	-65.3
	107-4	-54.8
	107-5	-60.0
	107-6	-63.5
	107-7	-63.5
	107-8	-63.8
	107-9	-61.3
	107-10	-62.8
QUIET LOT A		
(SAMPLE ORDER	CD92-33-1	0 to -1
CD92-33)	CD92-33-2	"
	CD92-33-3	"
	CD92-33-4	"
	CD92-33-5	"
	CD92-33-6	"
	CD92-33-7	"
	CD92-33-8	"
	CD92-33-9	"
	CD92-33-10	"
QUIET LOT B (SAME DISCS AS CD92-33; SWITCHES BUILT 8/6/92)	15 SWITCHES TESTED	0 to -1

Figure 1

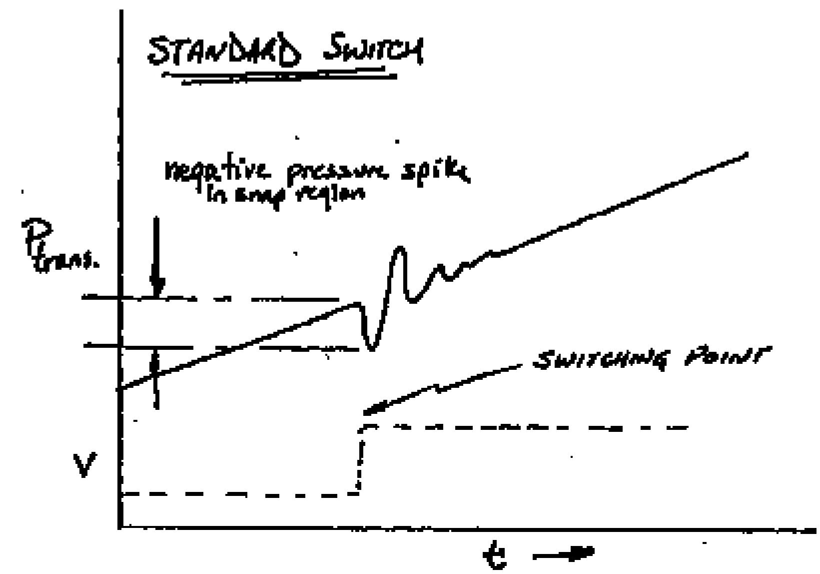
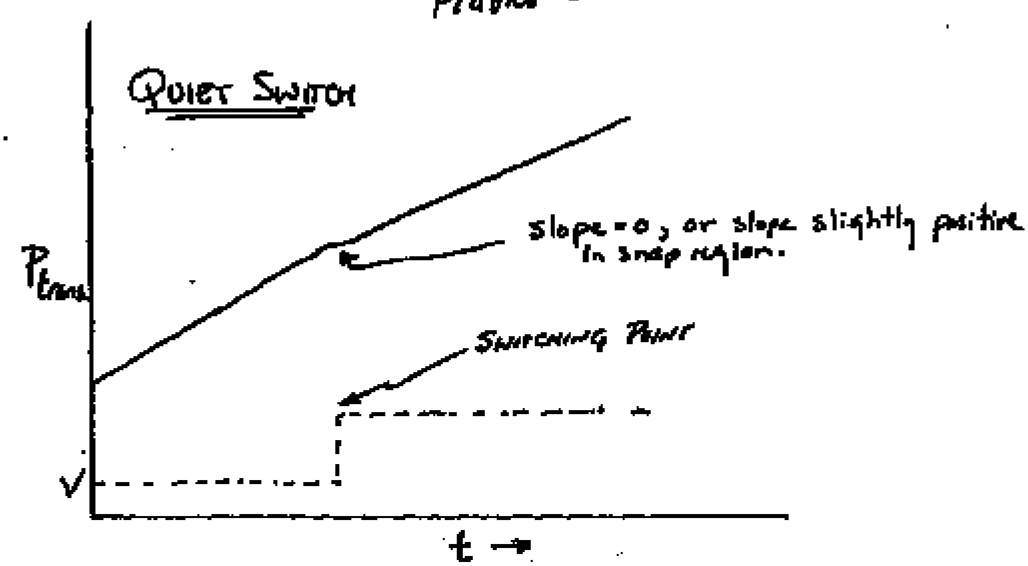


Figure 2



Post-it™ brand fax transmittal memo 7671	# of pages ▸ 6
To KISH BADANI	From DAVE CIARN
Co. FORD MOTOR CO	Co. TI
Dept.	Phone # 508 699-3558
Fax # 313 845-3663	Fax # - -3153

Kish,

The following sheets provide a quick overview of the sound pulse test technique. Included are 2 plots taken on "A" - a quiet P/C switch and "B" - a standard P/C switch. The negative pressure spike of a standard 4/5 switch - such as the 77PSL3-3 (F3FA-9F924-BA) should be at least as great as that shown in "B". In this case, the switch plotted in "B" was noisy on the vehicle. (EN53 without ABS).

Plots of actual 77PSL3-3 prod^n switches are being taken now.

Regards,
Dave Ciarn

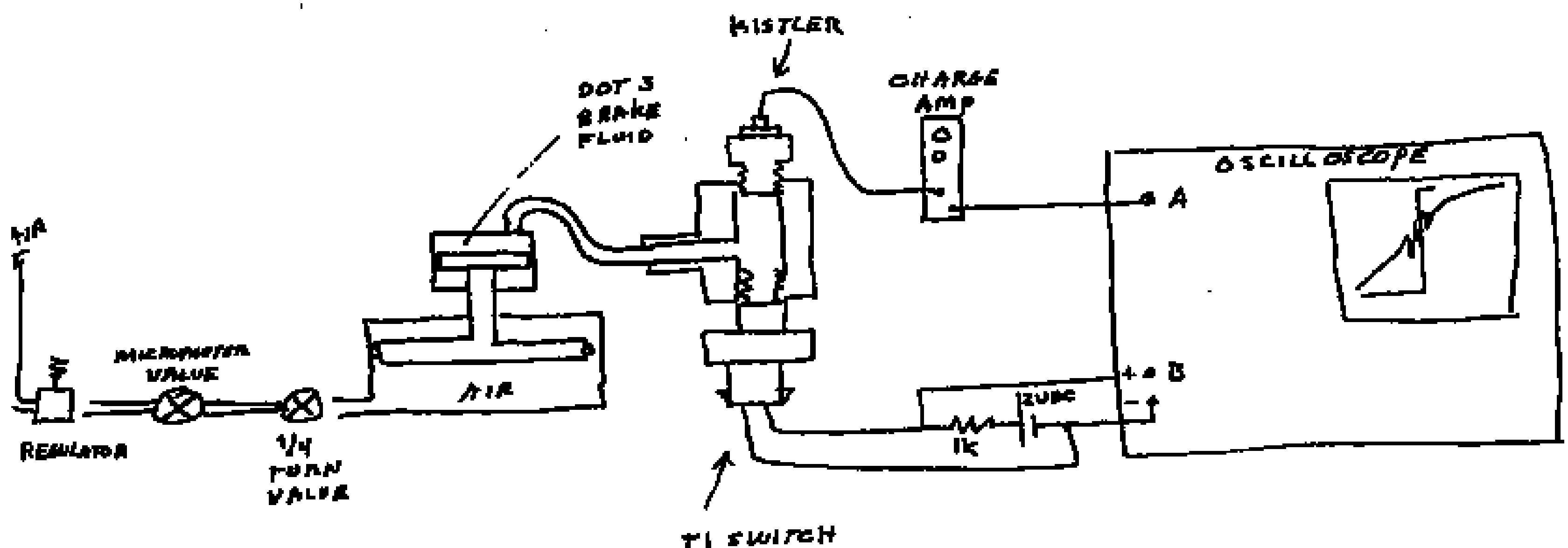
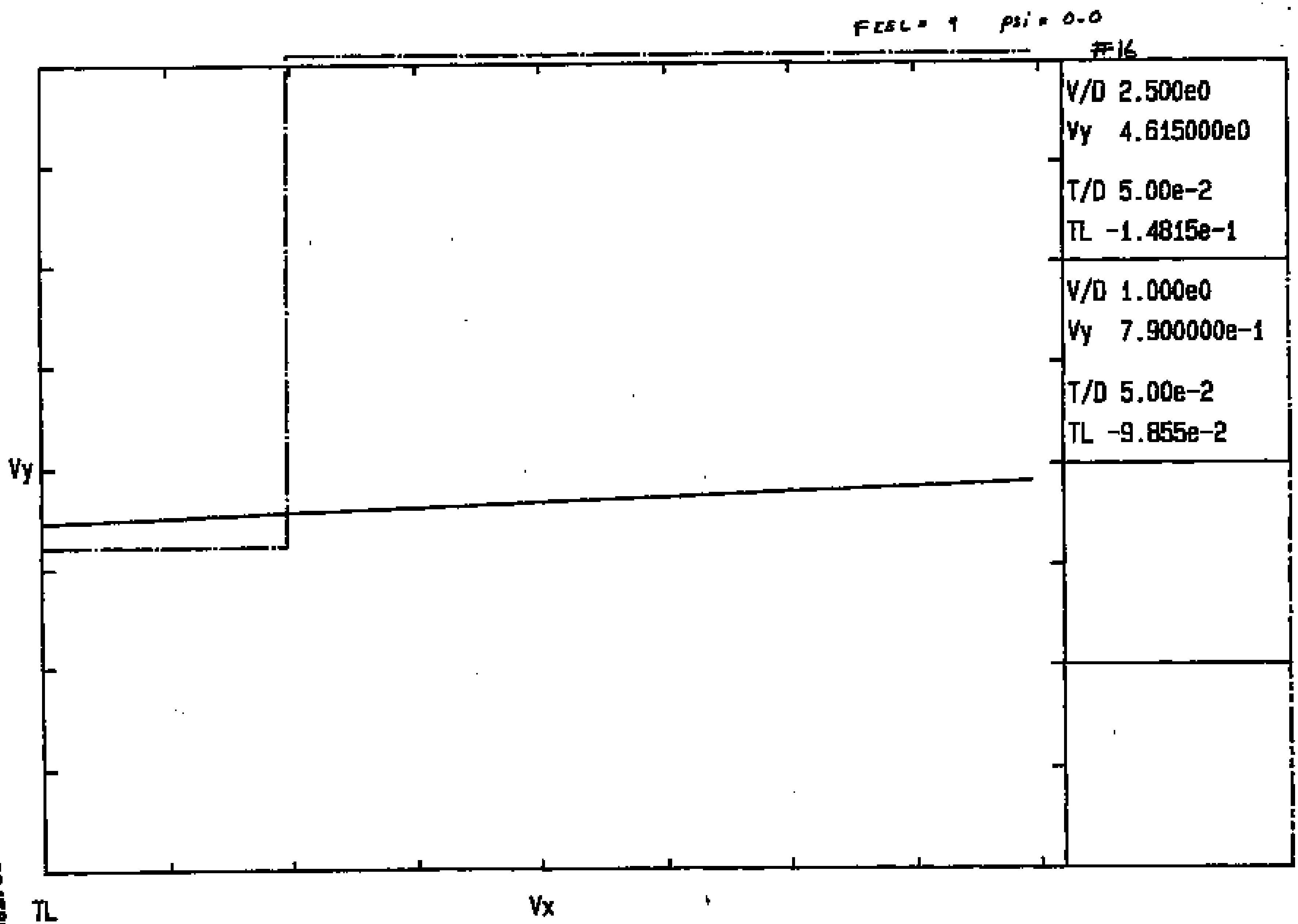
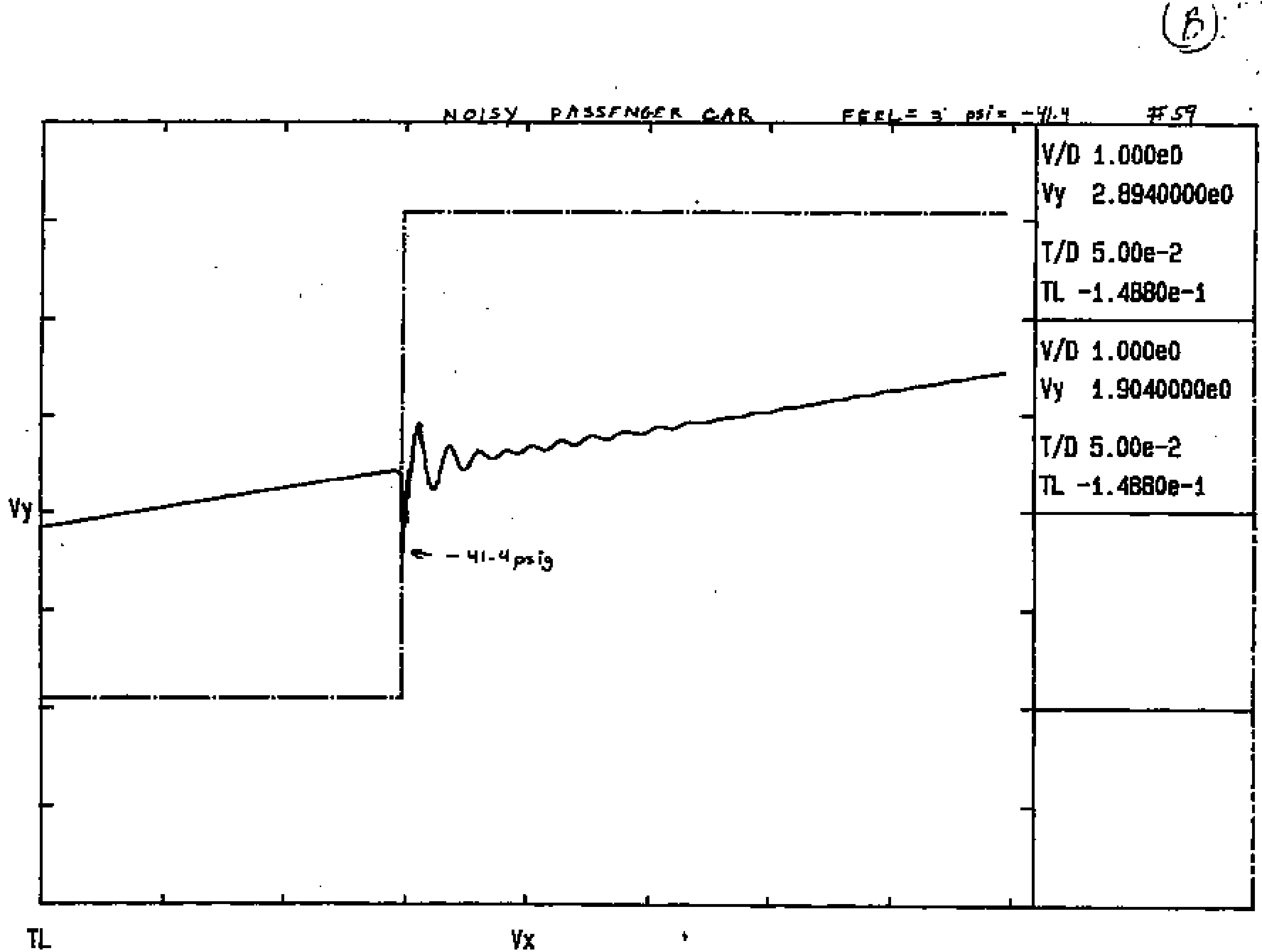

KISTLER
CHARGE AMP
DOT 3 BRAKE FLUID
OSCILLOSCOPE
A
B
AIR
REGULATOR
1/4 TURN VALVE
TI SWITCH
1k

FIGURE 1


#16
V/D 2.500e0
Vy 4.615000e0
T/D 5.00e-2
TL -1.4815e-1
V/D 1.000e0
Vy 7.900000e-1
T/D 5.00e-2
TL -9.855e-2
Vy
Vx
TL



TI-NHTSA 004781

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

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

2) You will see two lines.

A sloped line which is the pressure at the switch (solid line).

This line may be straight and smooth or it may have a ripple. The ripple is the sound pulse

A horizontal and vertical line, (dashed).

This line measures the voltage across the switch. When the switch opens the line jumps vertically from the bottom of the page to the top of the page.

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

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

5) Reset the voltage to zero at that level.

6) Move the curser to the bottom of the first valley and read the voltage.
If the switch is quite use 6A instead.

6A) Move the curser to the next major slope change, usually at the end of a short flat section. This is a visual estimate and as such is subject to interpretation.

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

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

The same technique works on a plotted curve.

A) zoom into the ripple.

B) Plot the curve. Figure 1.

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

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

There are 2cm per division on the y axis

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

There are 2.5 cm per division on the x axis

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

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

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

ps/92/72

CRUISE CONTROL PRESSURE SWITCH SOUND LEVEL SPEC DEVELOPMENT

Background

A 77PSL3-1 cruise control pressure switch has been developed for Ford Motor Co. that generates very little sound when the switch actuates on vehicle. The reduction of the sound was achieved by developing a special low differential snap acting disc. Determination of what was quite vs loud was done by testing a limited number of parts on a Ford Crown Victoria and a Taurus SHO. The quite switch is now in production.

While the switch is in production, further development is needed to specify and control the sound level on an ongoing basis. This report describes the work that has gone into developing a sound standard.

To develop a standard switches were built with a range of disc differentials (differential is the difference between actuation and release pressure). The switches were then tested on a hydraulic system for the sound pulse level.

System Description

To expedite the test a hydraulic system compatible with brake fluid was borrowed from the TI Automotive pressure transducer group. The system consists of an air to hydraulic piston with valves to regulate the air flow (Figure 1). The piston provides a 30:1 amplification so a micrometer needle valve was used to obtain a repeatable air flow into the piston. The system was filled with DOT 3 brake fluid. Oil was inserted into the switch port with a syringe prior to installation on the test fixture. The system was bled by pressurizing and unscrewing the switch until the air bled past the switch threads.

The system was actuated by opening a 1/4 turn valve. Air then flowed through the micrometer needle valve set at fixed point. When the pressure reached approximately 500psi the 1/4 turn valve was closed. This method generated ramp rates in the range of 100-300psi. The variability arises from sticking of the piston seals.

A quartz pressure transducer was used to measure the switch pressure pulse. The transducer can measure to 15KHz. An FFT of the sound levels shows noisy switches resonant at approximately 136Hz with two small spikes at 1.4 and 1.9KHz. Quite switches are 2.44Hz, 73Hz, with small spikes at 1.1KHz and 2.2KHz. In no case was the frequency greater than 8KHz.

The pressure transducer was measured with a digital storage oscilloscope sampling at 20us per point which is good for measuring up to 10Khz.

Results

A total of 75 switches were tested, five in each group. Switches included quite car, noisy car, quite truck, noisy truck plus some made with special discs to achieve an intermediate level of sound. Eleven switches have been selected for vehicle testing because they represent the spectrum of sound levels. They will be sent to Ford, who will test them on vehicle to establish the maximum acceptable sound level. Ford will then return the parts to TI where the sound levels will be reconfirmed.

93 sho

The parts are numbered on the hexport.

Serial Number	Type	Device Differential	Sound level	feel
64	quiet car production	38psi	+1.5psig	4 ✓
01	quiet car production	27psi	+0.5	1 ✓ Good
16	Quiet dev disc "n"	18	0.0	4 ✓
74	Quiet prod fallout	61.5	0.0	5 ✓ feel
39	Truck dev disc	50	-2.5	unacceptable
25	Quiet dev disc "L"	33	-4.25	unacceptable
56	Noisy car prod	79	-6.6	unacceptable
53	truck dev disc	25	-9.5	unacceptable
10	Noisy truck prod	148	-26.2	unacceptable
59	Noisy car prod	86	-41.4	unacceptable
06	Noisy truck prod	176	-81	

Truck parts will actuate at approximately 250-300psi. Car devices actuate at 120-200psi, depending on the type. A positive pressure is where there is minimal leveling of the pressure ramp at the switch point. A negative reading is when the pressure suddenly drops down when the switch operates.

The correlation between differential and sound is not high because its possible to make quite switches with high differentials. This occurs if the disc is a quite disc but the manufacturing tolerances and Kapton effects cause the device to have a nigh differential.

Conclusion

The conclusion depends on what Ford finds during the vehicle tests. The expected result is that Noisy car devices will prove noisy as they have in the past. Also the prod quiet part will be acceptable. The main question lies with parts in the intermediate level of -4 to -15psi.

SOUND LEVEL TESTER

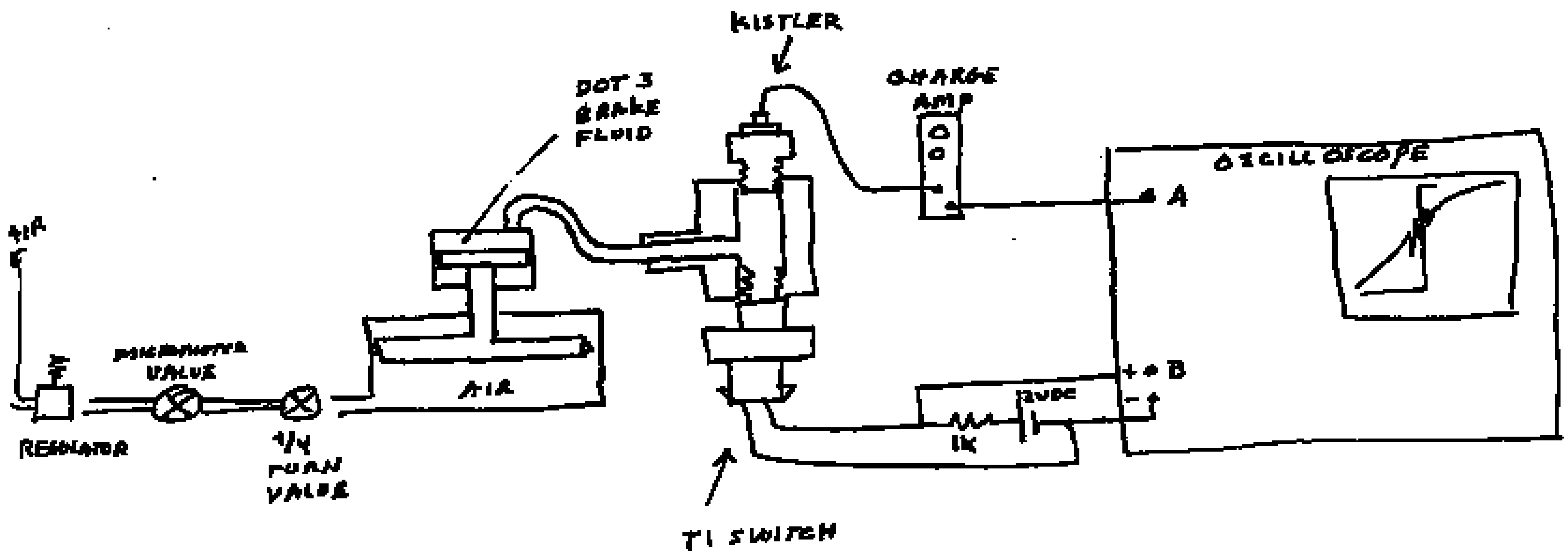
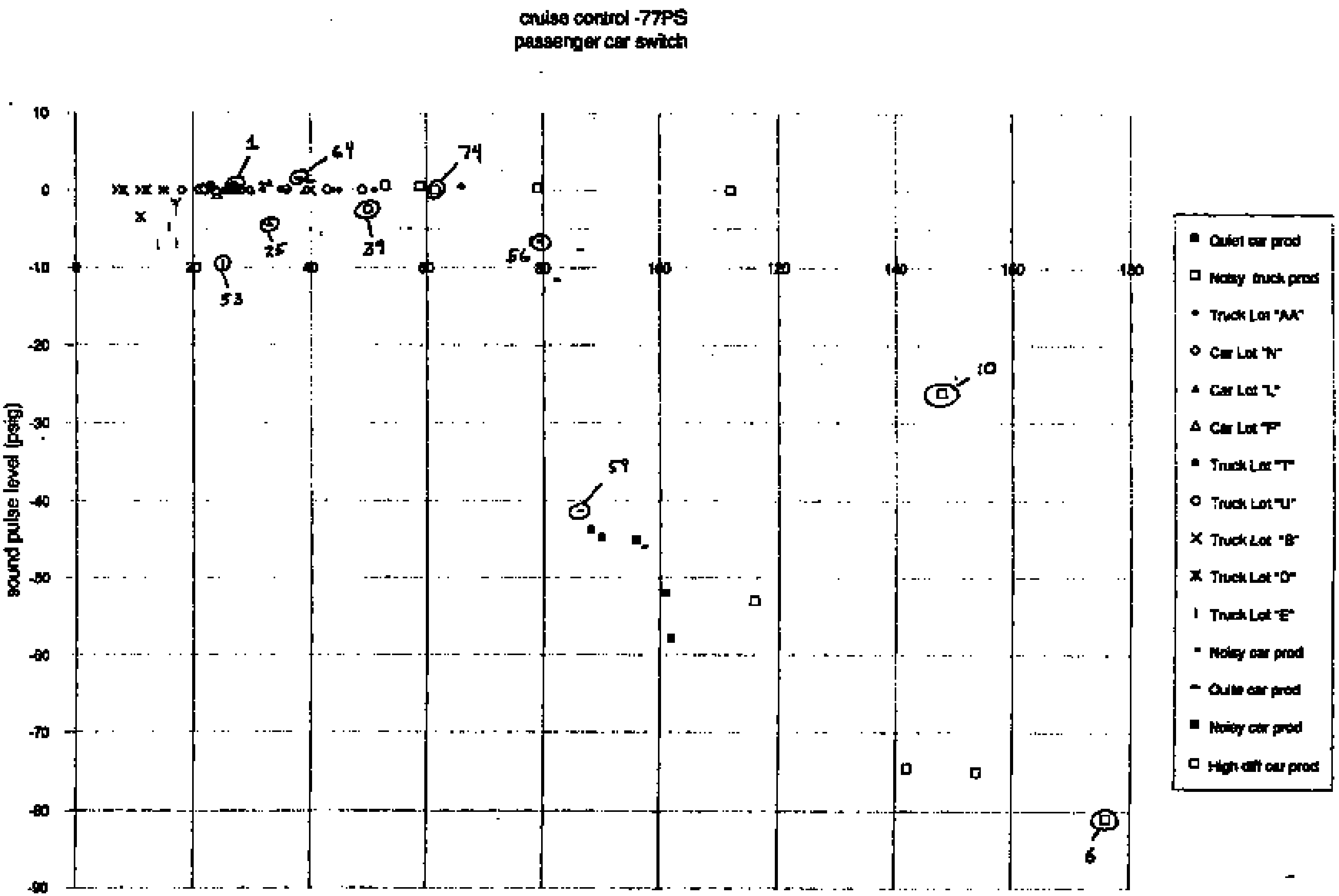


FIGURE 1

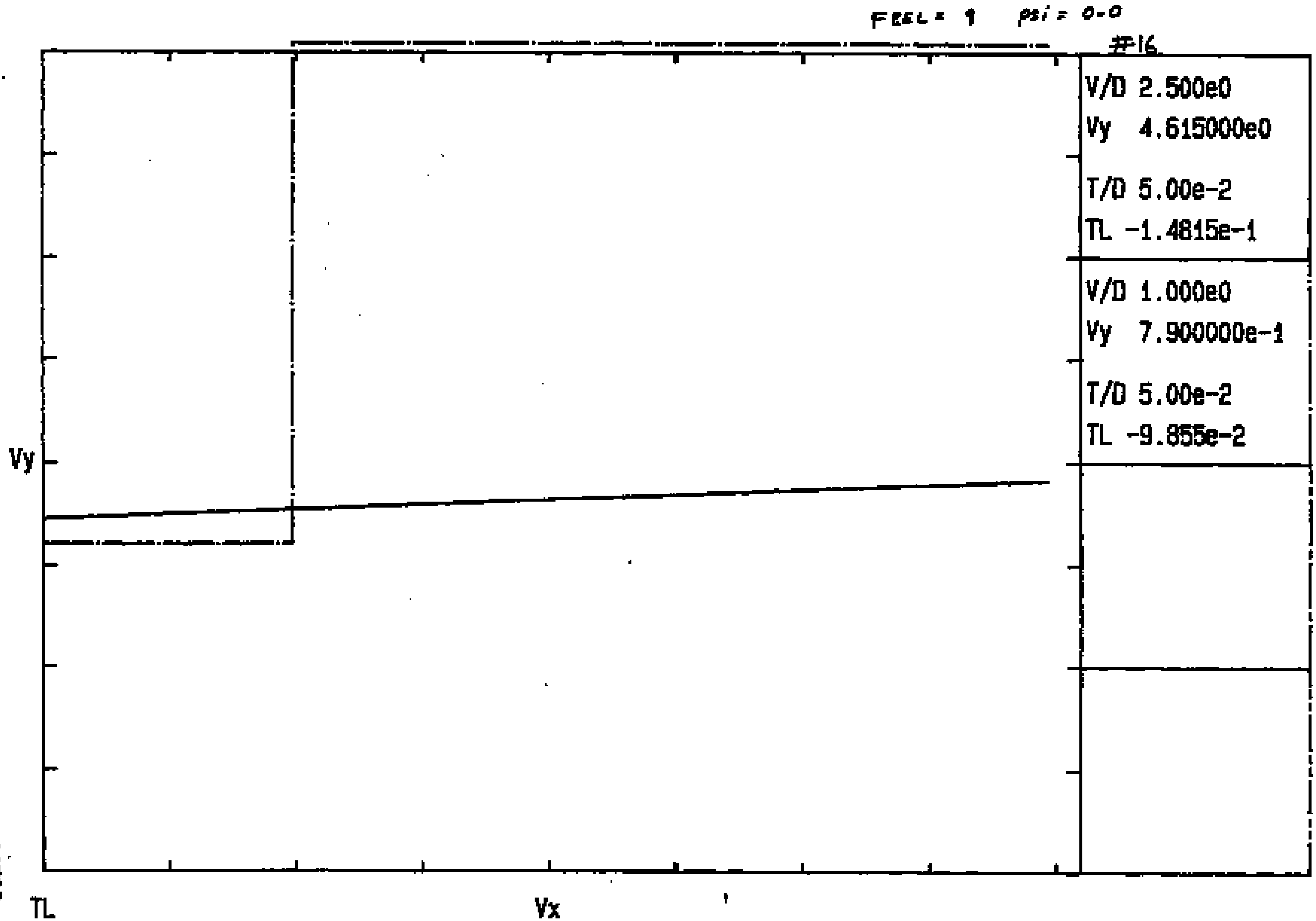


drs, 8/30/92, PULSE4.XLC

TEXAS INSTRUMENTS

MATERIALS & CONTROLS GROUP
ATTLEBORO, MA 02703

(A) #16


FEEL = 1 psi = 0-0
#16
V/D 2.500e0
Vy 4.615000e0
T/D 5.00e-2
TL -1.4815e-1
V/D 1.000e0
Vy 7.900000e-1
T/D 5.00e-2
TL -9.855e-2
Vy
TL
Vx

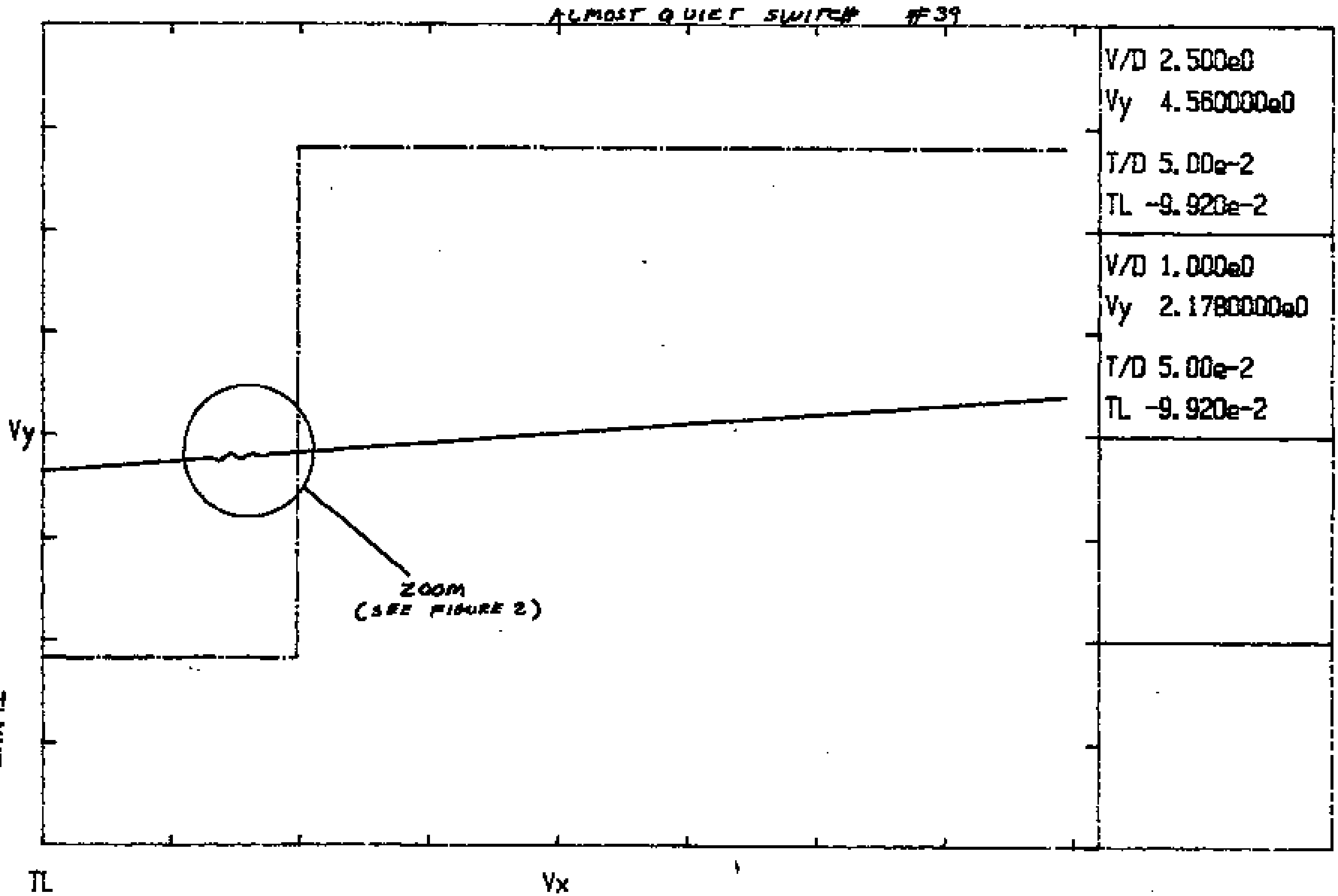

ALMOST QUIET SWITCH #39
V/D 2.500e0
Vy 4.560000e0
T/D 5.00e-2
TL -9.920e-2
V/D 1.000e0
Vy 2.1780000e0
T/D 5.00e-2
TL -9.920e-2
Vy
ZOOM
(SEE FIGURE 2)
TL
Vx

FIGURE 1.

ZOOMED VIEW OF #39

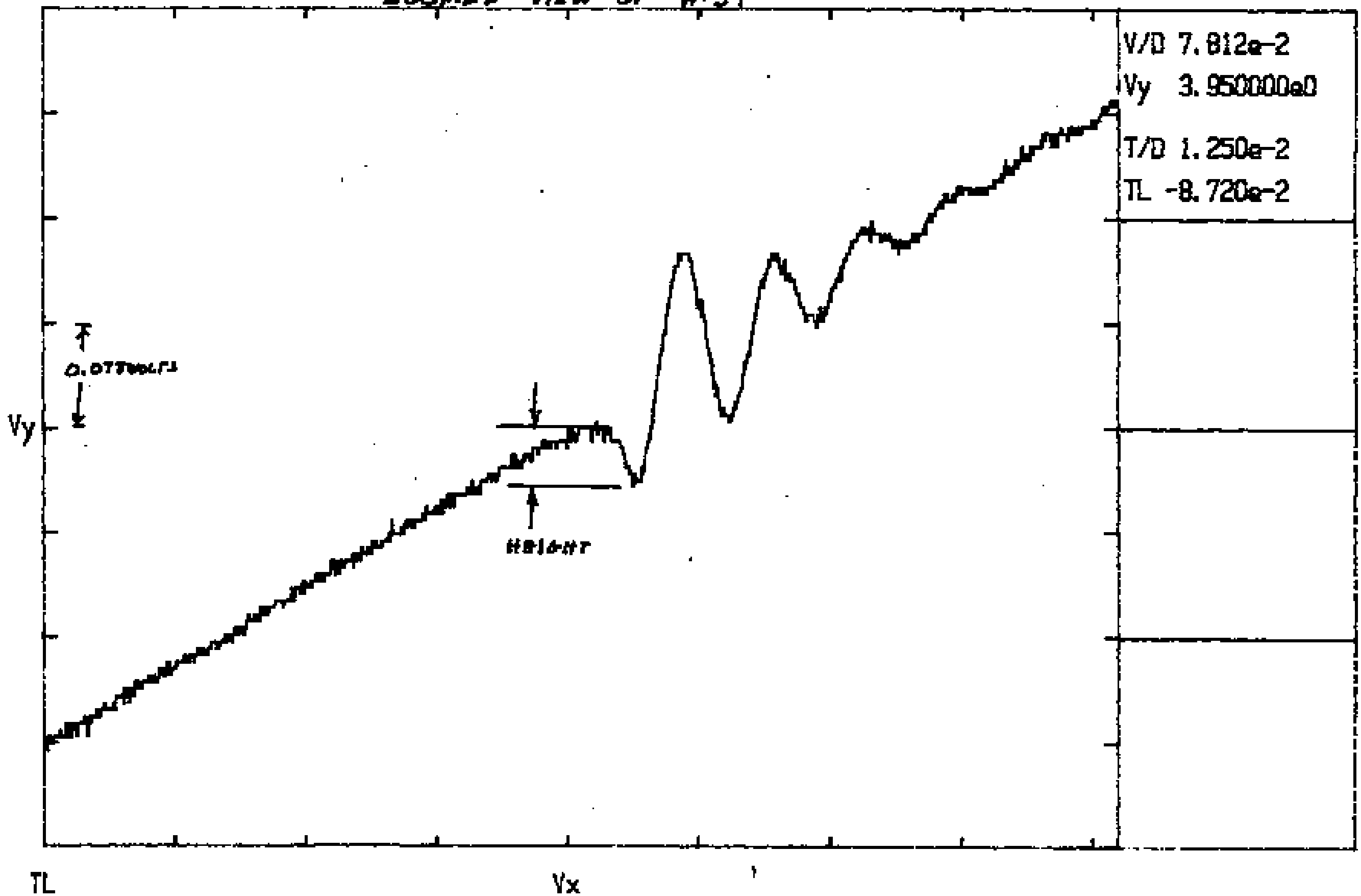


FIGURE 2

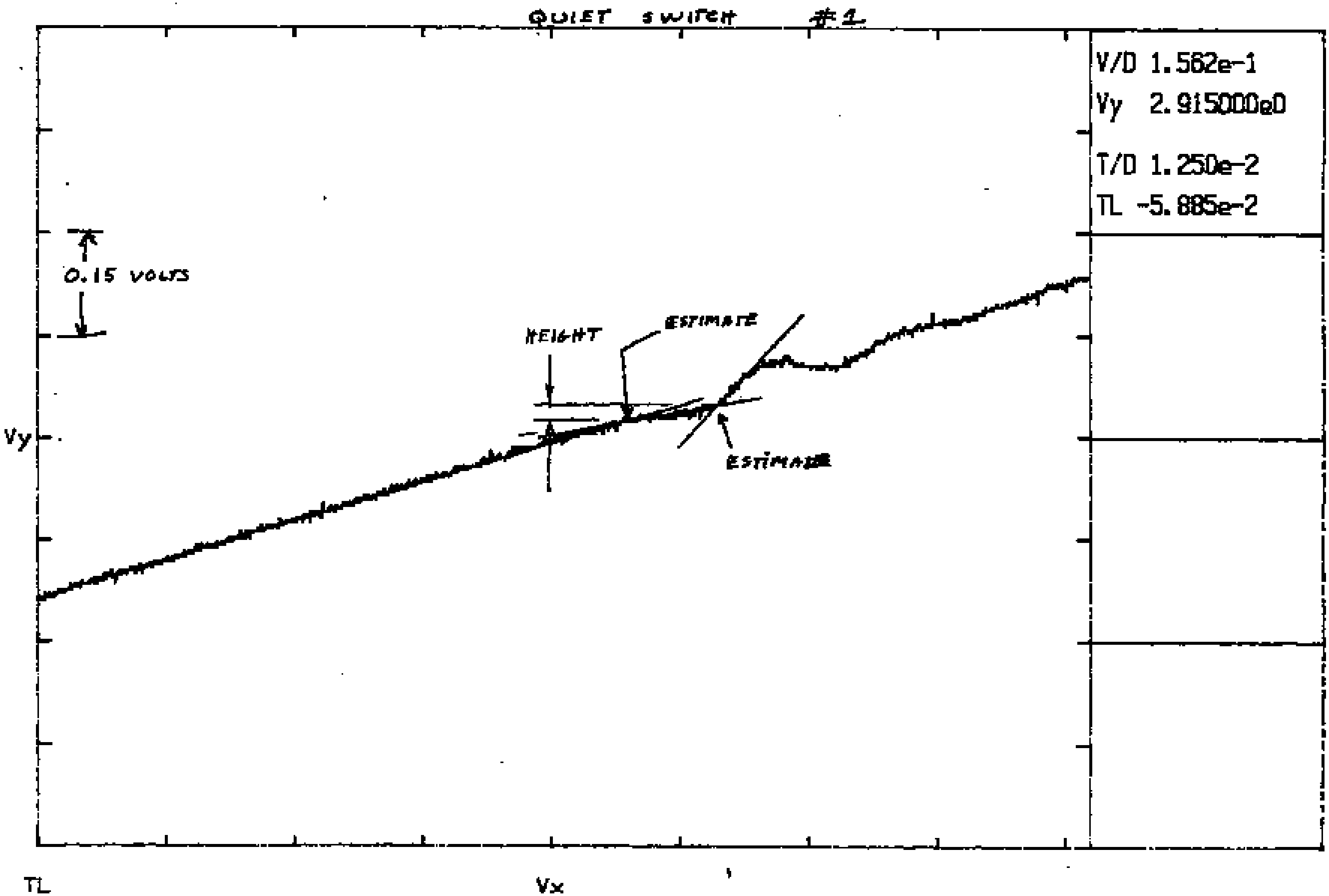
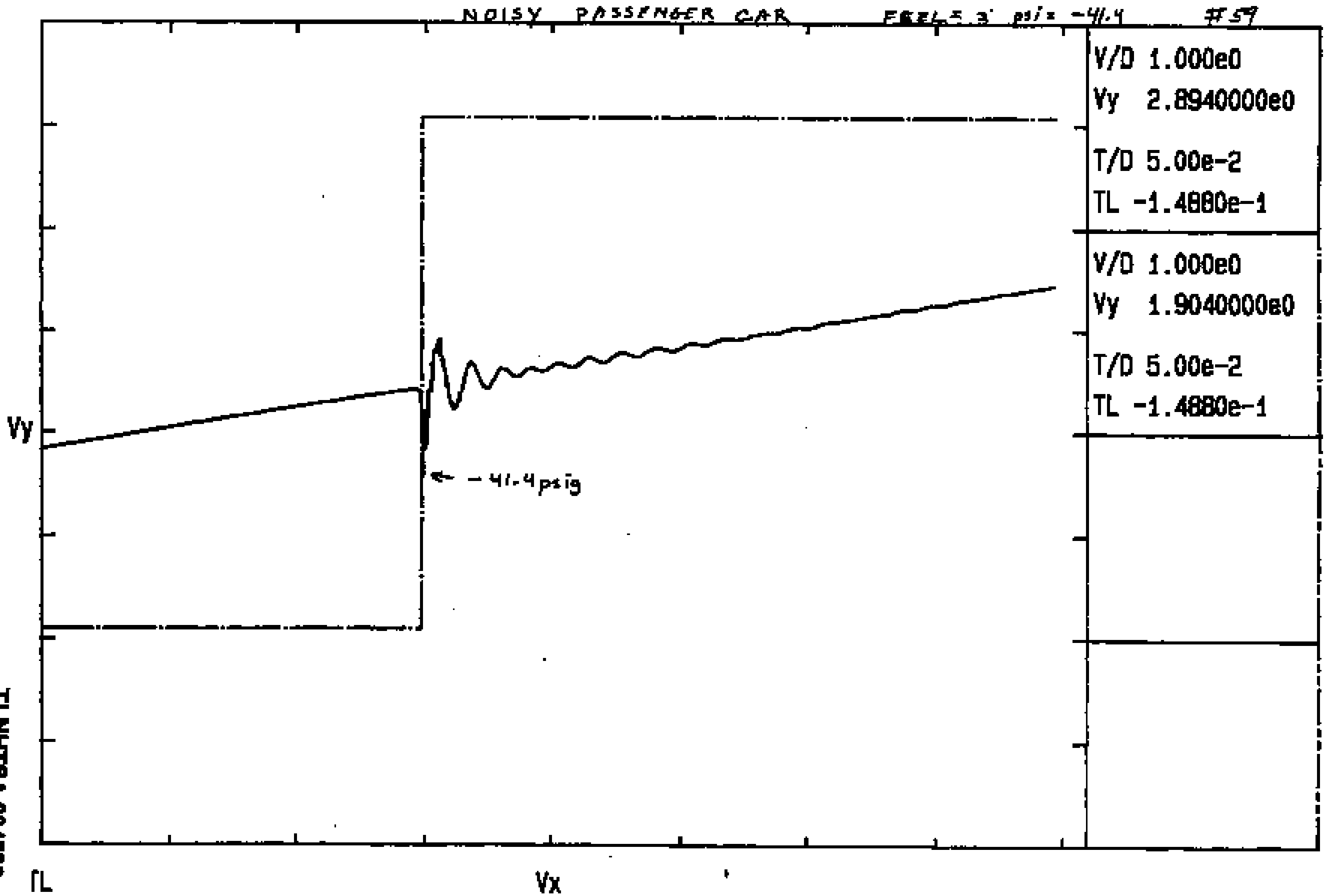


FIGURE 3

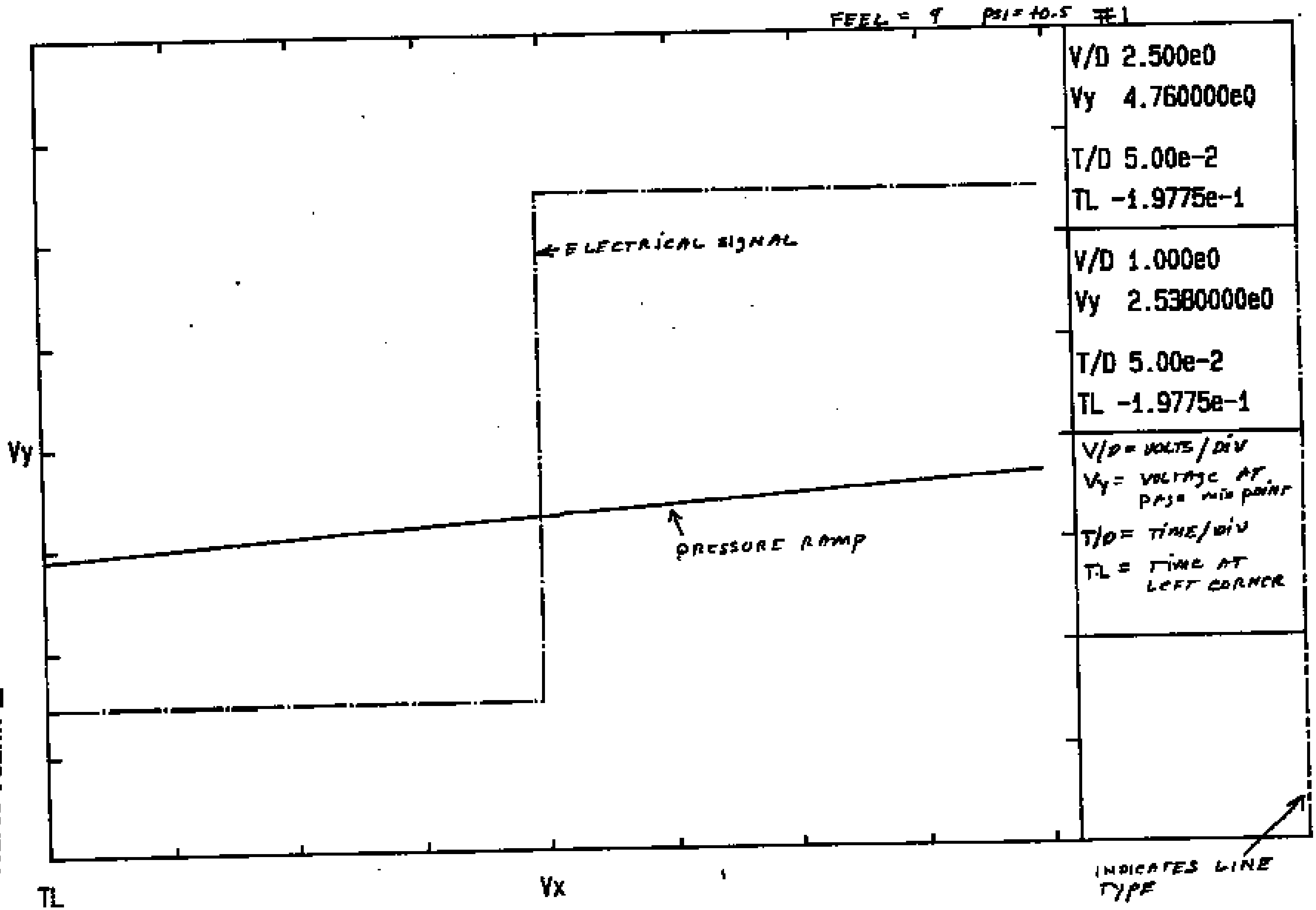
TI-NHTSA 004791

(B) #59

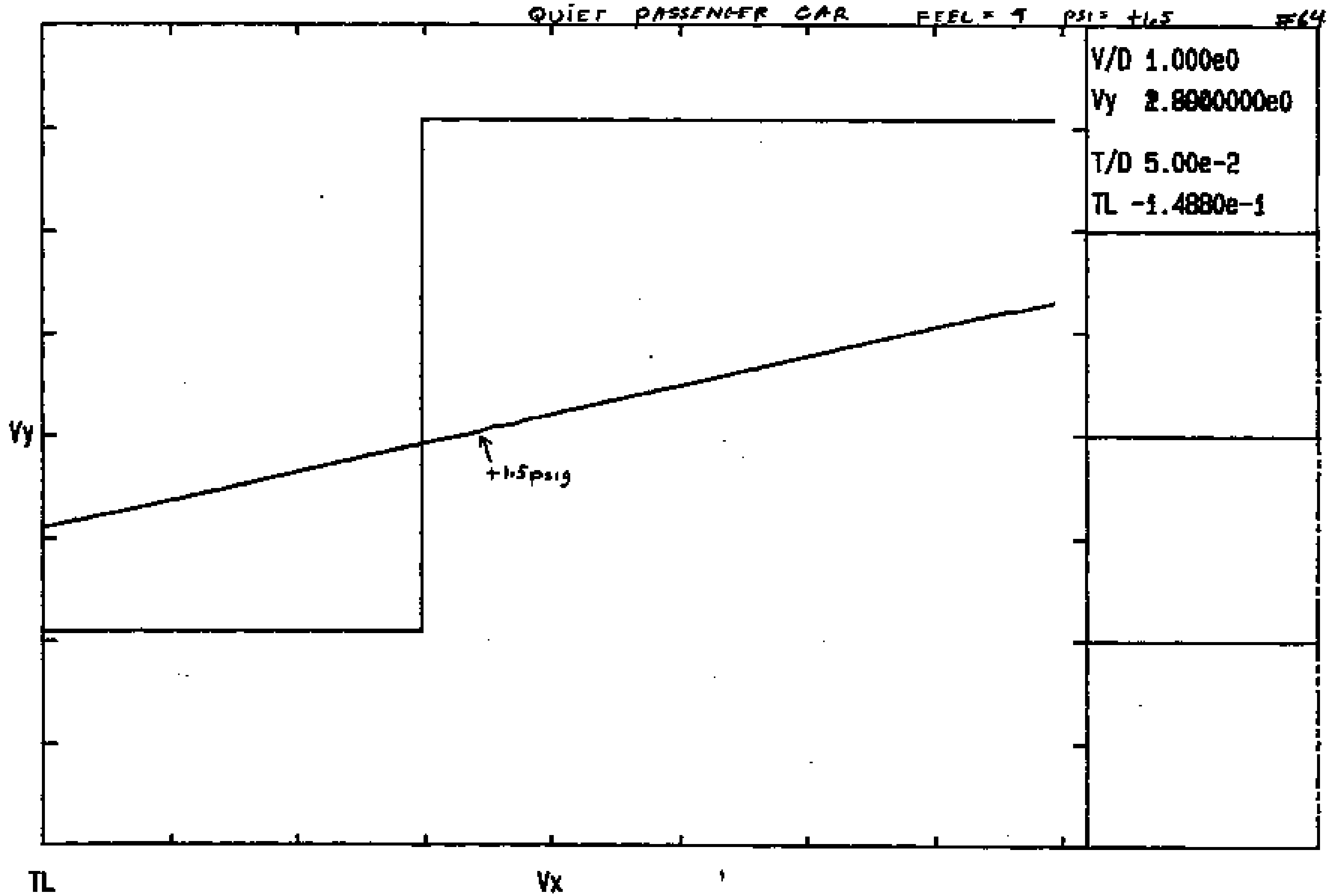


NOISY PASSENGER CAR FEEL = 3' psi = -41.4 #59
V/D 1.000e0
Vy 2.8940000e0
T/D 5.00e-2
TL -1.4880e-1
V/D 1.000e0
Vy 1.9040000e0
T/D 5.00e-2
TL -1.4880e-1
Vy
← -41.4 psig
TL
Vx

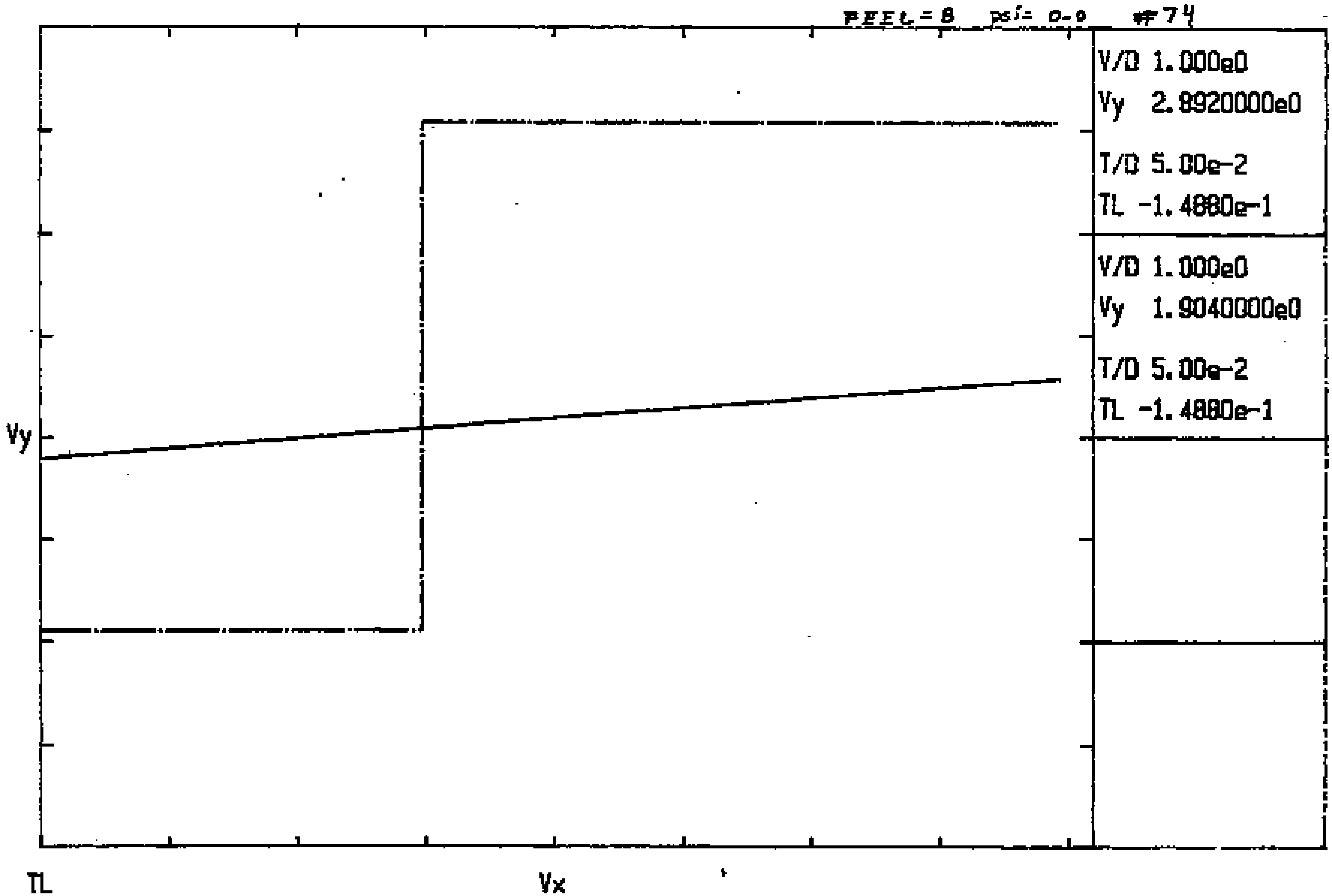
#1


FEEL = 9 PSI = 10.5 #1
V/D 2.500e0
Vy 4.760000e0
T/D 5.00e-2
TL -1.9775e-1
V/D 1.000e0
Vy 2.5380000e0
T/D 5.00e-2
TL -1.9775e-1
V/D = VOLTS/DIV
Vy = VOLTAGE AT PASE MID POINT
T/D = TIME/DIV
TL = TIME AT LEFT CORNER
ELECTRICAL SIGNAL
PRESSURE RAMP
Vy
TL
Vx
INDICATES LINE TYPE

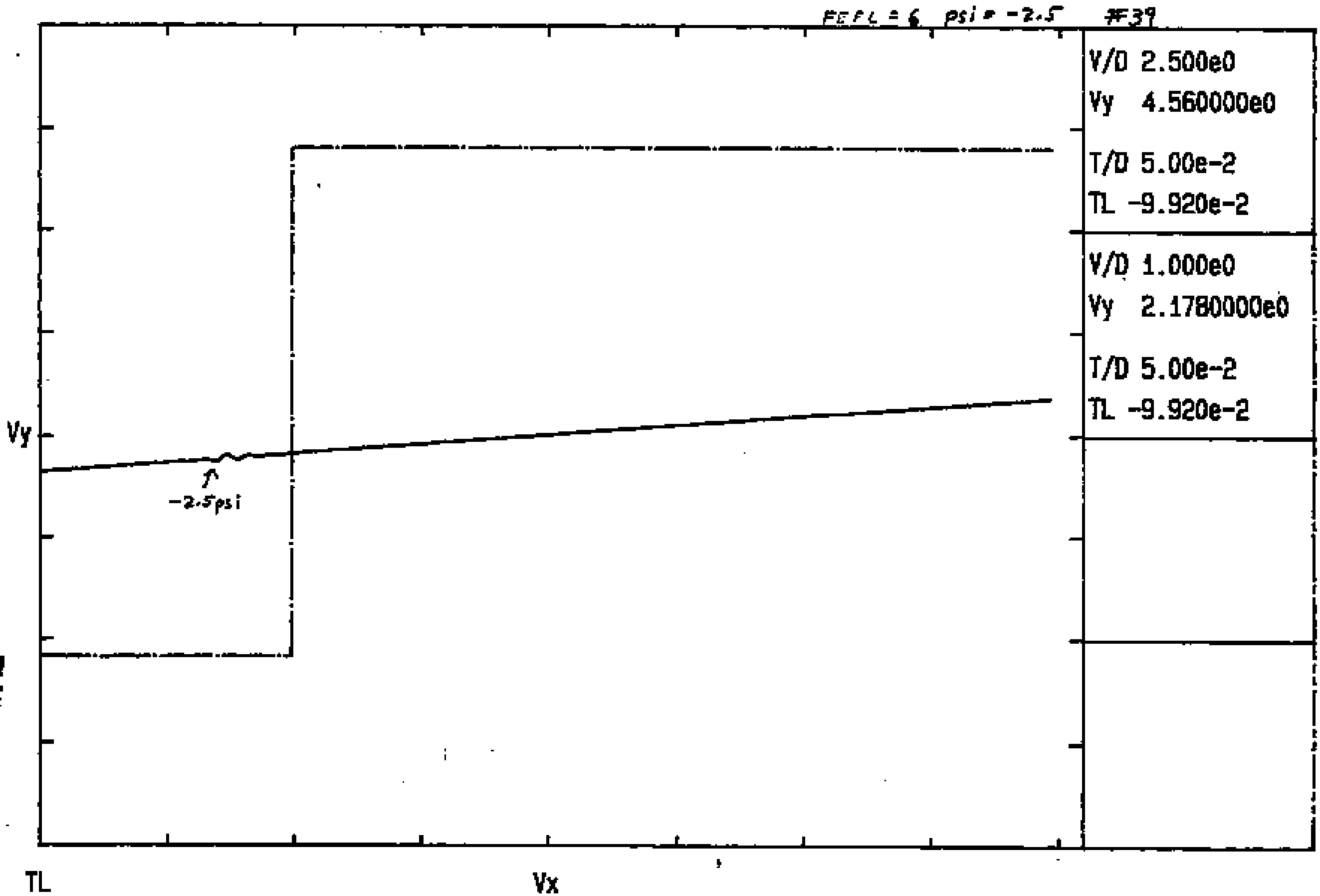
#64



TI-NHTSA 004794


PEEL = 8 psi= 0-0 #74
V/D 1.000e0
Vy 2.8920000e0
T/D 5.00e-2
TL -1.4880e-1
V/D 1.000e0
Vy 1.9040000e0
T/D 5.00e-2
TL -1.4880e-1
Vy
TL
Vx

#39


FEFL = 6 psi = -2.5 #39
V/D 2.500e0
Vy 4.560000e0
T/D 5.00e-2
TL -9.920e-2
V/D 1.000e0
Vy 2.1780000e0
T/D 5.00e-2
TL -9.920e-2
Vy
-2.5psi
TL
Vx

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FOR 77PSL3-1 CRUISE CONTROL SWITCH

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

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

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

[illegible]

[illegible]

[illegible]
DAVID CZARN [illegible]

[illegible]

[illegible]

[illegible] FOR THE INSTALLATION OF A NEW [illegible] IN THE [illegible]
NEED TO COMPLETE THE BASE ASSEMBLIES FOR THIS [illegible] PRIOR TO [illegible]

[illegible] 1, 2, 3, AND [illegible]
[illegible] ADDITIONAL [illegible]
[illegible] IN ORDER TO ACCOMPLISH [illegible]

[illegible] CALL [illegible] PROBLEM.

[illegible]

inventory for Part # 36656 -28.

8/6/92

	Act	Rea	
Lot # 1	25.71	14.19	
2	25.42	13.66	
2-39	25.53	14.83	
3	25.9	12.3	
7-1	26.0	14.81	
4	25.17	13.38	
6-5	25.72	14.54	
5	25.9	12.4	
2-40	25.94	14.87	
6	25.4	14.4	
3-10	25.82	14.88	
2-47	23.5	14.93	— ≈ 8.5 [illegible]
77PS	25.34	12.81	
7	25.3	13.8	
8	25.89	14.08	
9	25.63	14.95	
2-41	25.77	14.77	
6-1	25.35	13.31	
10	24.98	14.52	
11	28.1	14.2	
12	28.2	14.1	
13	28.3	14.0	
7-17-3	27.82	12.55	≈ 14.5 [illegible]
7-17-4	27.47	12.8.	

Quint Smith

TO: Dave Czarn
Matt Sellers
Steve Offiler
Clair Balthazar

drs92-42, 7-31-92

FR: Dale Sogge

sj: 77ps preload

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

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

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

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

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

Loud car	-.0070"
Quiet car	-.0085"
Loud truck	-.0073"
Quiet truck	-.0069"

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

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

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

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

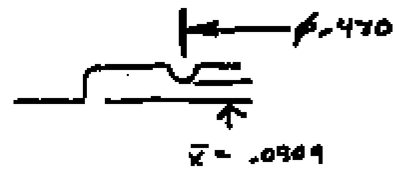
Regards,
Dale

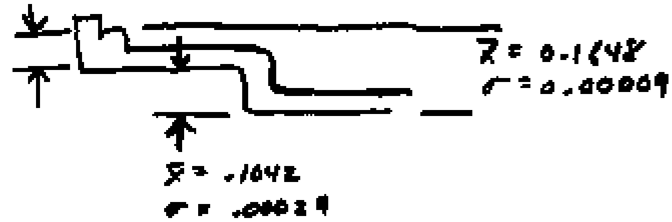
DATE 50990 7-31-92

CAR

DATA FROM SUPPLIER
capability study

CUP
27713





.0606

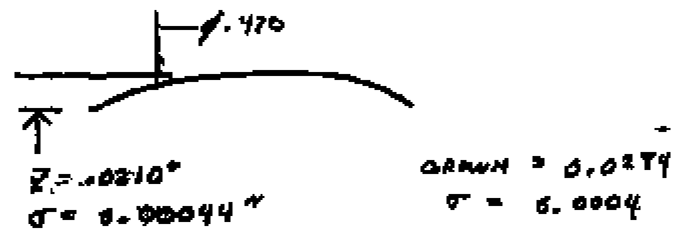
$\sigma = \sqrt{a^2+b^2}$

= .00030

GAP = .0909 - .0606 = .0303

NOISY DISC

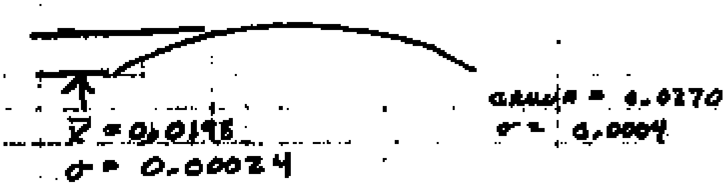
DATA FROM MEASUREMENT
with HAG gage



KAPTON = .002

NOISY CAR PRELOAD .002+.0210-.0303 = -.0073

QUIET DISC



QUIET CAR PRELOAD .002+.0195-.0303 = -.0088

DELTA BETWEEN PRELOAD NOISY - QUIET 0.0015"

DALE JOSIC 7-31-92

TRUCK

ASSUMED CUP CAPABILITY IS IDENTICAL TO 27713 WITH BUMP AT DIFFERENT DIAMETER

CUP $\bar{x}$ = .0880
σ = .00016

CONVERTOR IS THE SAME = .0606

GAP = .0880 - .0606 = .0274

NOISY TRUCK DISC
AT BUMP $\bar{x}$ = .0181
σ = .00035

AT CENTER $\bar{x}$ = .0272
σ = .00034

NOISY TRUCK PRELOAD = .0181 - .0274 = -.0093

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

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

QUIET TRUCK PRELOAD = .0185 - .0274 = -0.0089

✓

TO: DAVE CZARN
MATT SELLERS

7-29-92

FR: DALE SOGGE

SJ: CAP TEST OF PINNING

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

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

2) IF WE WANTED TO CUT ASF AT 9.5 MILS ± 0.5 MILS WE MUST BE ABLE TO RESOLVE TO [redacted] pF. .008 pF

3) THE PROD TESTER COULD ONLY HOLD THE 200 PSI TO [redacted] ± 5-10 psi. ± 10 psi PRODUCES A VARIATION OF .008 pF WHICH IS LARGE THAN 2 ABOVE. 0.008 pF = 0.5 mils

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

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

WE MUST FIND ANOTHER METHOD TO CHECK DEVICES. THIS BECOMES MORE IMPORTANT BECAUSE OF OUR DISCOVERY OF A 2.5 MIL & 10.6 MIL PRELOAD WITHIN THE 40 PIECE RANDOM SAMPLE. THESE WOULD NOT BE CAUGHT BY HYPOT.

AT THIS POINT I HAVE NO ALTERNATIVE SUGGESTION

REGARDS
DALE

TI-NHTSA 004805

[illegible]

To: Dave [illegible]
Matt [illegible]
[illegible]

From: Dale [illegible]

Sub: This note on [illegible] preload target.

Question: When rework is sent back through the line new discs [illegible] to the target preload of [illegible]. The line currently [illegible] in [illegible].

Answer: Rework can take place if the target for the [illegible] ±0.5 mils. ie [illegible] to 7.0.

All production can also be built to this spec.

Justification: At 6.5 mils the conservatively assumed high temp shift of [illegible] produces actuations as low as [illegible]psi at 150C. At low temps the assumed [illegible] produces actuation at 175psi. This indicates that there is more room to [illegible] target towards 7.0 mils which would produce 180psi actuation which is just [illegible] the spec of 200psi.

At high temps we are well below the spec of [illegible]psi. If we assume a [illegible] shift of [illegible] mils for high temp shift then we get [illegible] at 150C, just meeting the spec. This indicates that we cannot target anything below [illegible]mils.

These calculations work so long as the sensor assembly switches in the [illegible] 140psi range. If the disc drops it down to 120psi we would fall below the [illegible] spec again. Then the preload target should shift upwards to match the changing disc. Tying the target and the act and rel specs to the disc at this point is not recommended because of the complexity it adds. It may need to be consider in the future so that production is not always running in and asking for a test modification because of a change in the lots.

Note: We recently have a lot running low. For this lot we reduced the lower spec limit on act from [illegible] to [illegible]psi, without making any change in the target preload. These parts maybe a problem at high temps.

Regards,
Dale

- Add Kapton spacer btwn disc & cup

- Modify cup – ~~decrease~~ envelope dia 

  & affects seal gland dia

- modify converter – reduce envelope

- modify washer – add step

TI-NHTSA 004607

DAVE CZARN

[illegible]

DAVE CZARN

[illegible]

-MSG M#= 328840 FR=SB01 TO=ZARN SENT=09/15/92 07:11 AM
R#=113 ST=C DIV=0050 CC=00101 BY=SB01 AT=09/15/92 07:11 AM

TO: Dave Czarn ZARN
Matt Sellers MJS2

FR: Steve Offiler SB01

SJ: Disc Dim. Meas. for Cup Modifications
===

As a quick check on Dale's previous work, we measured the assembled height of a dozen each, quiet and snap, discs. The disc measurement was taken with a dial indicator, as-assembled, using an actual 27713 cup and converter, measuring to the converter bump. Each test lot of 12 represents 3 discs taken from 4 different lots. Each disc measurement was repeated 3 times and averaged to obtain the numbers used in the statistics.

The results track Dale's extremely well. The difference observed was 0.0011" greater for the snap disc, versus 0.0012" in Dale's study. Standard Deviations also compared well with Dale's, at 0.00030"/0.00032" (snap/quiet) versus 0.00044/0.00024 in Dale's study.

Regards, Steve O.

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

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

III TEST PROCEDURES AND REQUIREMENTS

N. SOUND LEVEL

1. Test Requirements

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

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

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

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

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

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

2. Acceptance Requirements

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

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

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

Proposed Validation Requirements.

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

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

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

[illegible]

[illegible]

[illegible]	DAVE CIARN	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	

[illegible]

[illegible]

[illegible]

[illegible]

JCG:TMJ MSGID# [illegible] [illegible] EXT# 3679

[illegible]

[illegible]

DAVID LZAKN

[illegible]

[illegible]

I HAVE [illegible] RECEIVED [illegible] ... THIS MEANS, IN ESSENCE, THAT [illegible] BE APPLIED [illegible]

[illegible] THE FALCON [illegible] ... APPROVED TO [illegible] ALL THE [illegible] AND [illegible] THAT AND THE [illegible] STRAIGHT TO YOU

[illegible] THAT YOU [illegible] WITH SOME OF EUROPE ON THE [illegible] ... THE SAME LEVEL OF [illegible]

[illegible]

MATT SELLERS [illegible] JIM MATT [illegible]

[illegible] [illegible] [illegible]
CARL [illegible]
[illegible]
[illegible]

[illegible]

· 36400 mat'l spec

[illegible]
[illegible]
[illegible]
[illegible]

[illegible]

[illegible]	SELLERS	7/17	
[illegible]	MATT	7/14	
[illegible]	SELLERS	7/20	[illegible]
[illegible]		0/21	REV
[illegible]	[illegible]	7/20	[illegible]
Plan is in place.			
[illegible] (Kelley)	[illegible]	7/17	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	7/7	

[illegible] TOWN CAR & [illegible] / Fites
[illegible] standard [illegible]

[illegible]

[illegible] (champion: [illegible])
[illegible] SELLERS
[illegible] CLARK [illegible]
[illegible]
[illegible] (champion: [illegible])

[illegible]

[illegible] (champion: [illegible])
TERMINAL POSITION (champion: Sellers)

PROGRAM/CUSTOMER: ECONOLINE / Ford [illegible]
DESCRIPTION: [illegible] standard [illegible] 30K

[illegible] 100% AMORTIZ[illegible]

PROGRAM/CUSTOMER: [illegible] AXS / [illegible]
DESCRIPTION: [illegible] 100%
[illegible] 7/14/92

[illegible]

[illegible]
[illegible]

TI-NHTSA 004816

. [illegible] VEHICLE EVAL'N [illegible]
[illegible] [illegible] [illegible]
[illegible] [illegible] [illegible]
[illegible] [illegible] on [illegible] (Saturn/[illegible])

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

[illegible] (items not covered above):

[illegible] (Champion: Gagge)
. [illegible] IMPACT [illegible] REPORT [illegible] 7/22 ORIG
[illegible] REV
[illegible] [illegible] 7/23 ORIG
[illegible] REV
. [illegible] ASSUMPTION [illegible] 7/[illegible]
W/ [illegible] & [illegible]

[illegible] [illegible] / Ford direct
[illegible] [illegible] standard disc [illegible]
[illegible] in August/[illegible]

[illegible] (items not covered above):

[illegible] THERMAL TEST [illegible] 7/21 ORIG
[illegible] REV
[illegible] CONF
[illegible] THERMAL TEST [illegible] [illegible]
[illegible] [illegible] 7/21 ORIG
[illegible] REV

[illegible] / Taves
[illegible] quiet/snubber [illegible]
[illegible]

[illegible]

. COMPLETE [illegible] TESTING AND REPORT OTTILER 9/14
. SUBMIT ISW WATT 9/14

[illegible] (items not covered above):

[illegible] (Champion: Watt)
Taves to supply reusable totes, timing for the totes is TBD but [illegible] as
[illegible] are on schedule for this month[illegible] plan is needed ASAP.
. [illegible] Taves' packaging [illegible] WATT 8/20
[illegible] for [illegible]
. [illegible] WATT

[illegible]

[illegible] Capri (Australia) / [illegible]
[illegible]
[illegible]

[illegible]

[illegible]

[illegible]

Falcon (Australia) / Ford - direct
[illegible] quiet/metric [illegible]
[illegible] est. 12/13/93

[illegible]	Resp.	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1094	TBD

Ranger/Explorer / Domestic
[illegible] - quiet diesel [illegible] - 1000
[illegible] est. [illegible]

[illegible] above:

[illegible] CAD DATA TRANSFER [illegible] 7/17 [illegible]
7/30 [illegible]

[illegible]

Elec call → 36900/mo lube ~3K ~~[illegible]~~

- P-tester: need control of sound level pick-up

- Ultem - $12K for heaters
  - no div'l guarantee

- Smaller height

-MSG M#= 203646 FR=SBO1 TO=ZARN SENT=09/10/92 08:26 AM
R#=090 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/10/92 08:26 AM

TO: Matt Sellers MJS2

CC: Dave Czarn ZARN John Kourtesis JKOU
Charlie Douglas CMP1 Steve McCooey COOO
Dick Garimpy RWG3 Danny O'Driscoll DOD
Mike Gioia MGIO Bill Sweet WS4

FR: Steve Offiler SBO1

SJ: 77PSL6-1 Sample Needs
==

We have upcoming needs for samples for both a pre-production car build in Australia, as well as a battery of validation tests. The schedule for this may conflict with the planned Mechanization upgrades to the movable terminal riveter and die set; as such, we should comprehend it in the inventory build-up plans. Per the meeting w/ Mechanization held on Wed. (92-09-09) several ideas were discusses. These include:

* completion of req'd L6-1 base assemblies prior to the upgrade

* pre-build of several feet of mv. term. strip prior to the upgrade, allowing the base asm. AMI to be run without mv. term machine

* build validation parts using the upgraded equip. as soon as possible (in jog mode ?); using val. testing to also prove-out the upgrades

My short-term needs/plans are as follows:

* Qty xx (to-be-determined by Danny/Charlie) for PPB build due to ship no later than Oct 2; build Sept 29 or prior

* Qty 100 for validation work; build Oct 09 or prior

Any other unanticipated needs (within reason) should be covered by the prebuild of strip mentioned above.

Regards, Steve O.

TI-NHTSA 004820

Dave: FYI / Comments
Matt

9-9-92

Mini - FMEA For:

1. * Spring hole geometry change From → 
To → 

2. * Rivet redesign From → 
To → 

Note: Some Controls Allready Are in place while others will need to be Added / modified.

Process Desc	potential Fail mode	pot effect	Cause	Controls
- Stamp And Form spring	- Notch For rivet hole improperly positioned relative to end of spring.	- premature spring breakage during mechanical Cycling	- Set-up error - Tool Fabric. error.	- SPC visual inspect. - Visual Standar... -
	- Notch ommission. Reverting to original round punch design.	- Reduction in spring torque withstand After riveting.	- Set-up error - Tool Fabric. error	- SPC visual inspection. - Visual Standard

- [Also retain All other modes, effects, etc.

Process Desc	potential Fail mode	pot effect	Cause	Controls
- Rivet spring to Terminal strip	- Insufficient riveting	- Loose spring	- worn or Broken Driver tool - Tool Fab error. - Incorrect Stroke Adj... - Insufficient rivet pressure - Insufficient pick-up suction.	- Set-up Instr - P.M. - Torque spec - Riv HT spec
	Excessive rivet pressure	loose or damaged spring.	excessive head pressure	- Set-up Instr - P.M. - Torque spec - Riv HT spec - Visual Instr At SPC.
	Rivet missing	No spring Device will not operate	- Rivet mis-feed - pick-up error	- P.M. - 100% pre ... - 100% function test.

TI-NHTSA 004821

-MSG M#= 207135 FR=VAGS TO=ZARN SENT=09/10/92 07:55 AM
R#=089 ST=C DIV=0050 CC=00134 BY=VAGS AT=09/10/92 07:55 AM

TO: GEORGE HOLMAN B512 9/10/92

CC: BILL SWEET PCME
STEVE OFFILER SBO1
DAVE CZARN ZARN
ED O'NEILL EJON
RUSTY STRUBLE RCS2

FR: MATT SELLERS MJS2

RE: K.F.BASSLER TERMINAL CAPABILITY ISSUES

Get back to Matt

GEORGE,

K.F.BASSLER HAS NOTIFIED US THAT THEY CONTINUE TO HAVE DIMENSIONAL CAPABILITY ISSUES ON THE 36888-1 STATIONARY TERMINAL USED ON ALL 77/67PS BASED PRODUCTS. AS A RESULT, K.F.BASSLER IS REQUESTING NUMEROUS DIMENSIONAL SPECIFICATION CHANGES AND/OR SHIFTS. AFTER LENGTHY CONSIDERATION, I FEEL THAT THE MOST EFFICIENT METHOD OF EVALUATING THE POTENTIAL IMPACT OF THESE REQUESTS ON OUR INTERNAL PROCESSES, AS WELL AS OUR CUSTOMERS PROCESSES, IS TO HAVE K.F.BASSLER TAKE THE FOLLOWING STEPS:

1.0 MAKE A WHOLE PRINT CAPABILITY ASSESSMENT OF BOTH THE 36888-1 AND 36887-1 TERMINALS.

2.0 DETERMINE THROUGH SELF ASSESSMENT EXACT STEPS THAT HAVE BEEN TAKEN, AND ALSO PROJECTED STEPS THAT WILL BE TAKEN TO IMPROVE THE CAPABILITY OF THESE TERMINALS TO ACCEPTABLE LEVELS. DEVELOP A CHRONOLOGICAL LIST FOR REVIEW BY T.I.

3.0 SUPPLY BUDGETARY INFORMATION ON ADDITIONAL MEASURES THAT COULD BE TAKEN, BUT WILL NOT BE TAKEN, BY K.F.BASSLER THAT COULD IMPROVE CAPABILITY ON THESE TERMINALS. REGARDLESS OF COST.

4.0 DEVELOP A CASE FILE OF EACH DIMENSION THAT K.F.BASSLER IS EXPERIENCING DIFFICULTY WITH. EACH FILE MUST CONTAIN A PROCESS STUDY AVERAGE, SIGMA, AND TEST FOR NORMALITY. SUPPLY FOR REVIEW BY T.I.

AFTER RECEIVING THIS COMPLETED PACKAGE FROM K.F.BASSLER I WILL INITIATE THE FOLLOWING STEPS:

1.0 DETERMINE EACH REQUESTS IMPACT ON T.I. MANUFACTURING PROCESSES AND FORD PROCESSES. MAKE CONCESSIONS WHERE POSSIBLE.

2.0 DETERMINE WHAT PROCESS MODIFICATIONS/PRINT CHANGES T.I. CAN, AND IS WILLING TO, MAKE TO COMPENSATE FOR PROCESS SHIFTS BY K.F.BASSLER.

3.0 PURSUE FROM OUR CUSTOMER IF ANY RELIEF CAN BE NEGOTIATED ON ANY OF THE DIMENSIONS THAT CAN NOT BE TAKEN CARE OF THROUGH STEPS 1 AND 2 ABOVE.

4.0 REPORT COMPLETED FINDINGS BACK TO K.F.BASSLER FOR REVIEW AND COMMENT.

I BELIEVE WE WOULD ALL AGREE THAT THERE IS MUCH TO BE SAID OF FACE TO FACE CONVEYANCE OF THESE TYPES OF ISSUES. CERTAINLY THERE ARE

PERMITTED. HOWEVER, DUE TO EXTENUATING CIRCUMSTANCES RELATED TO THIS SPECIFIC ISSUE OTHER METHODS ARE DICTATED (AS OUTLINED ABOVE). PLEASE HAVE APPROPRIATE PRIORITY PLACED BY ALL PARTIES INVOLVED SO THAT RAPID RESOLUTION OF THESE ISSUES WILL BE POSSIBLE.

I AWAIT A RESPONSE FROM K.F.BASSLER . . .

REGARDS . . . MATT
X1245

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 4
To J. Pelkey	From D. Cearn
Co.	Co.
Dept.	Phone #
Fax # 313 845-3063	Fax #

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 2
To KISH BADANI	From DAVE GEARN
Co. FORD MOTOR Co	Co. TI
Dept.	Phone #
Fax # 313 845 3063	Fax #

KISH,

The following shows the pressure peak levels of 20 switches taken at random from 2 production lots that were in-process today.

In Lot A, the values ranged from -27.0 to -70.3 p. The values were less consistent - as you can see - than Lot B which ranged from -54.8 to -70.5. The general grouping seems to be in the -50 and below range, which is consistent with my expectations of a standard L/F switch.

We can discuss our next step tomorrow.

Regards,

Dave G

TI-NHTSA 004825

Aug. 6, 1992

TI P/N 77PS13-3 FORD P/N F3TA-9F924-BA
F-SERIES / BRONCO SWITCH WITH STANDARD DISC

SOUND PULSE TEST SUMMARY - RANDOM SAMPLING OF 2 PRODUCTION LOTS

PRODUCTION LOT A	DEVICE #	PRESSURE PULSE (PSIG)		
(DISC LOT 106)	106-1	-57.8	106-6	-27.0
	-2	-70.3	-7	-34.3
$n = 10$	-3	-64.5	-8	-38.3
$\bar{X}_A = -50.7$ psig	-4	-53.8	-9	-49.3
$\sigma_A = -13.8$ psig	-5	-51.3	-10	-60.0

PRODUCTION LOT B	DEVICE #	PRESSURE PULSE (PSIG)		
(DISC LOT 107)	107-1	-66.5	107-6	-63.5
	-2	-70.5	-7	-63.5
$n_B = 10$	-3	-65.3	-8	-63.8
$\bar{X}_B = -63.2$ psig	-4	-54.8	-9	-61.3
$\sigma_B = -7.9$ psig	-5	-60.0	-10	-62.8

D. [signature] 8/6/92

DA1 72-48

Test Report
314-15-10

TEST PURPOSE: Determine if quiet sensors with noryl bases pinned at low pin lengths would fail open at high temps because of the base dimensional change from room to 180C.

METHOD: 10 were made at contact preloads from 0.4 to 5.3 mils. The act values were recorded at temp increments from room to 180C.

RESULTS: The results were somewhat inconclusive, there is some variation in the act shift in the 4-5mil range that was not expected (see Plot). In general going from 125 to 150 to 180 the behavior was as expected with the lowest pins failing open at the lowest temps.

By 180C essentially all lengths up to just less than 5mils failed open. This concurs with with steve o's measured shift of 5mils.

Our mfg lower spec limit is 8.0mils so I don't expect any device to fail open.

For quiet passenger car the lower spec limit is 4.0mils so it would fail open at 180C.

CONCLUSION:

1) NORYL BASES ARE OK FOR 180C OPERATION ON QUIET TRUCK PARTS.

2) NORYL BASES ARE NOT ACCEPTABLE FOR 180C OPERATION ON QUIET PASS CAR.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 314 - 15 - 10

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
77PS63-1	8-11-92	DALE SOGGE		8-14-92
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**	
DAVID O TRICE	8-12/92	8/13/92		

PROJECT TITLE: High temp creep study - production line

CUSTOMER: FORD TRUCK (77PS65-1)

PURPOSE OF TEST: DETERMINE AT WHAT PRELOAD DEVICES WILL FAIL OPEN AT THE HIGH TRUCK TEMPS (180°C). THIS WILL BE USED TO DETERMINE IF THE DISC MATERIAL MUST BE CHANGED TO ACCOUNT FOR THIS HIGH TEMP RANGE.

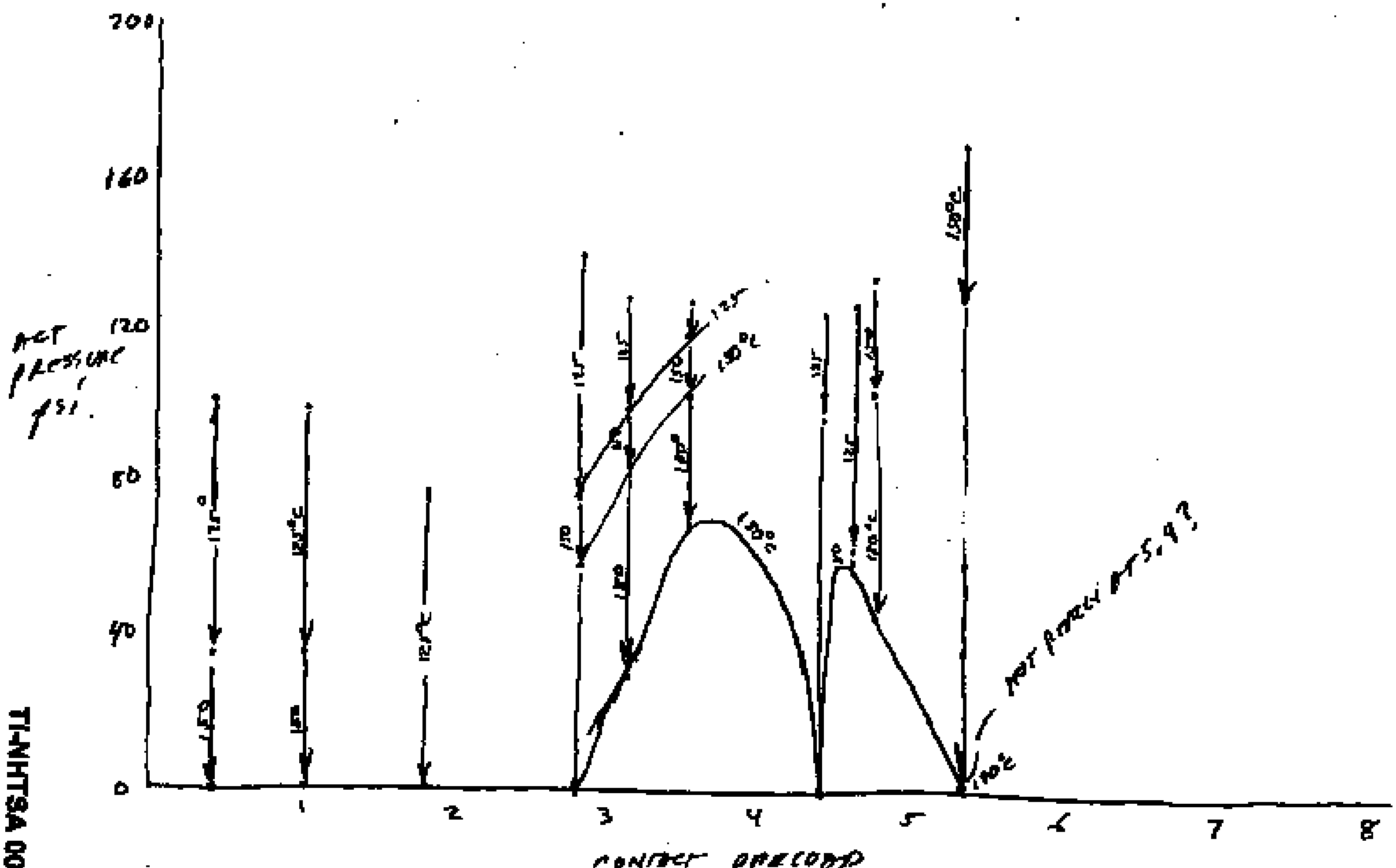
PROCEDURE: USE THE 10 SENSORS SUPPLIED BY PRODUCTION PINNED AT VARIOUS LOW PRELOADS. MEASURE ACT VALUES AT RM, 125, 150, 160, 170 & 180°C. It took 4-7 tries to get a consistant act. 1

1,3 * I could not get the contact to stay on/be making w/device. Contact works fine still

at 65psi closed

				preload	RM	125°C	150°C	160°C	170°C
1	.143	.0952	.0468	1.0	99	35	* 16.5 *	Either cont. some are not making.	not making
2	143	0952	.0474	.4	105	37	50		" "
3	144	095	0477	1.8	76	Stuck open	*		" "
4	140	090	0472	2.8	162	78	67	51	only 1 reading
5	140	0892	0477	3.1	130	100	93	86	66.5
6	141	090	0475	3.5	127	121	118	107	95
7	140	.0889	0470	4.6	136	106	101	92	78
8	140	.0886	0470	4.4	184	65	62	51	26
9	140	.0873	0474	5.3	169	Stays open	134	62.5	32
10	140	.0887	0466	4.7	at 137psi	114	95	97.5	77

TEST NO 314-15-10
77PSL3-1 SHIFT IN ACT VALUES
AT LOW PINS AT HIGH TEMPS



DATE 5052C 8/14/72

TI-NHTSA 004829

TO: Dave Czarn
Matt Sellers

drs92-47

FR: Dale Sogge

SJ: Target Preload

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

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

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

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

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

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

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

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

For rework purposes we can use the following tolerances:

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

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

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

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

Regards
Dale

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

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

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

2. Assemble a range of discs into sensor assemblies.

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

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

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

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

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

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

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

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

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

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

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

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

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

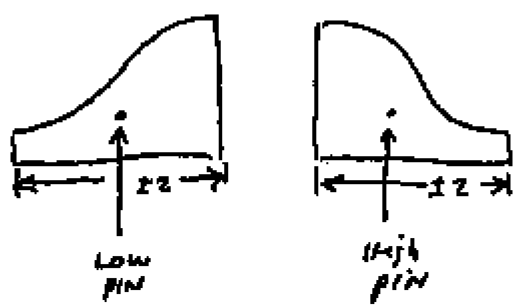
12. Decide if the tolerance is okay or if the target valve should be shifted one way or another to avoid failures. For example, shift the preload 0.5 mils higher (to the right) to reduce the risk of high temperature open circuits.

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

For quiet truck the same steps except this device is know to operate at 182°C.
The customer has melted connectors.
Use 200 psi min act
300 psi max act
40 psi min release

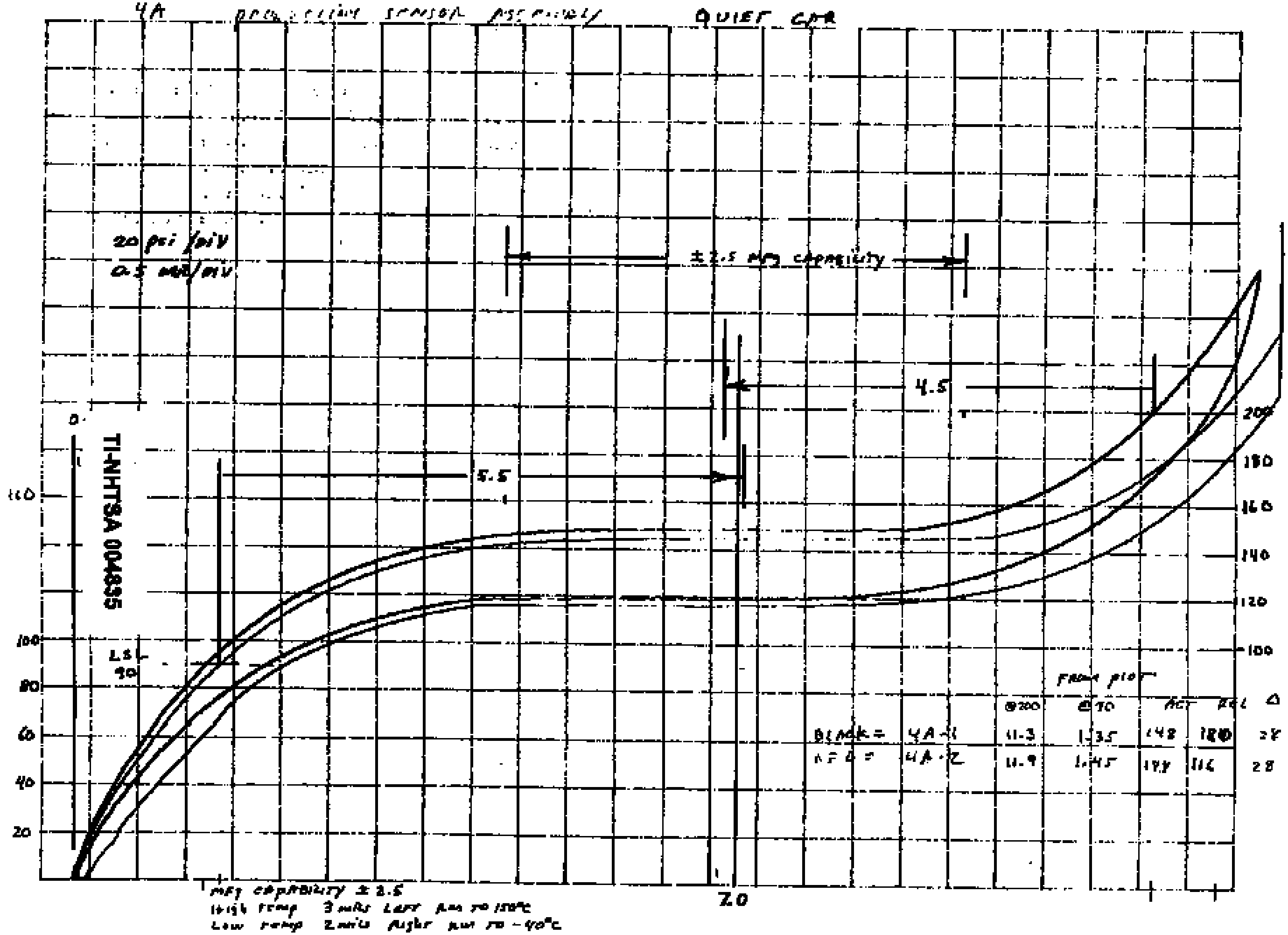
5 mil high temp movement 25°-182°C
plus 2.5 mil manufacturing cap (test 302-15)

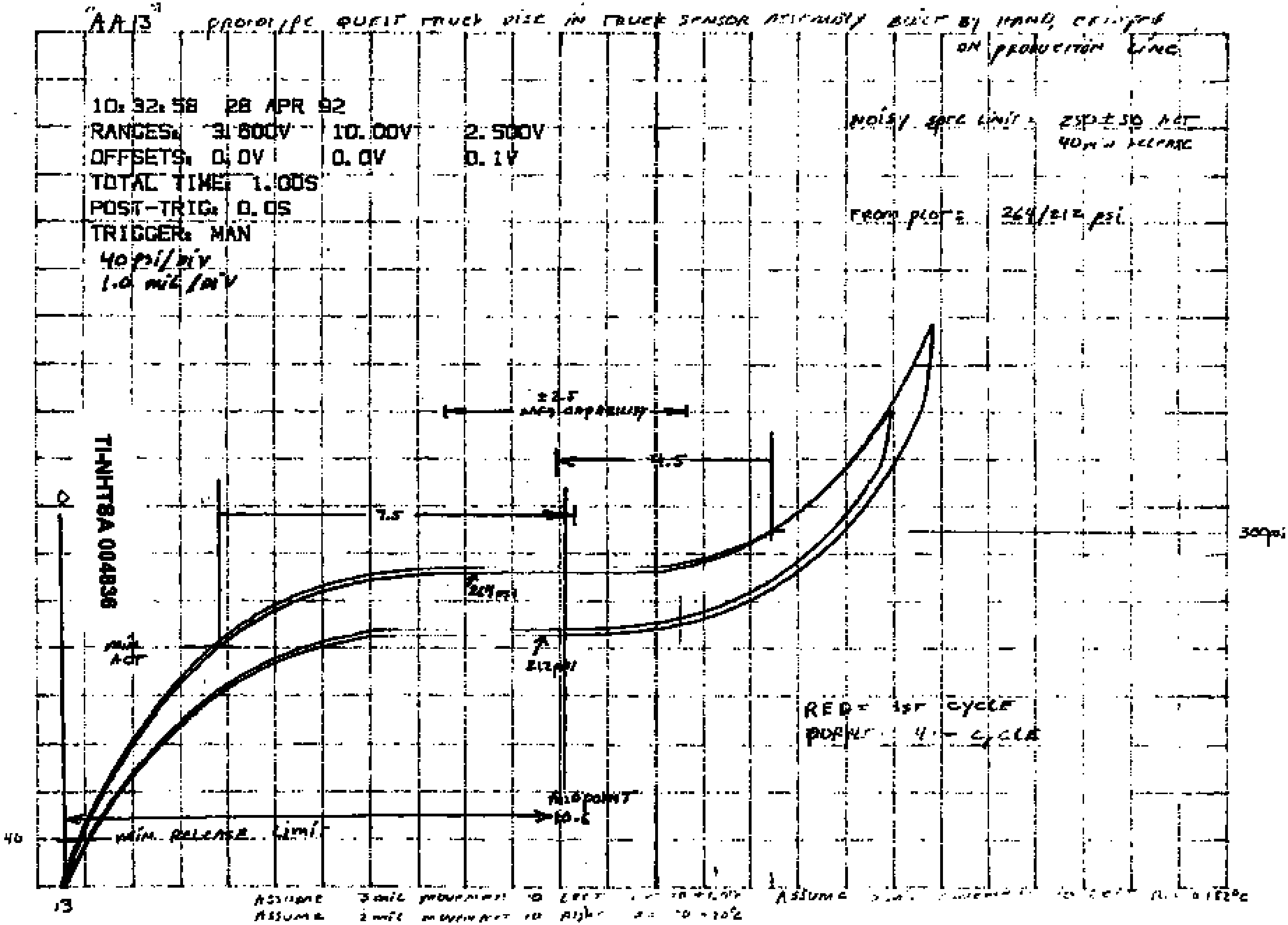
NOTES: 1. Bases are calibrated, resulting in a truncated spread of ± 4 mils, normally distributed. The lot is split in half at the mean. The low half of the lot is used with a pin 1 mil less than calculated based on the mean of the entire base population. The upper half of the lot is pinned with a pin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



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

Dale 8-12-92


4A PRODUCTION SENSOR ASSEMBLY
QUIET CAR
20 psi /div
0.5 mils/div
± 2.5 mfg capability
4.5
5.5
LSL 90
200
180
160
140
120
100
80
60
40
20
7.0
FROM PLOT
@200
@70
BLACK = 4A-1
11.3
1.35
148
180
28
4A-2
11.9
1.45
28
MFG capability ± 2.5
High temp 3 mils left run to 150°C
Low temp 2 mils right run to -40°C



"AA13"
10: 32: 58 28 APR 92
RANGES: 31.600V 10.00V 2.500V
OFFSETS: 0.0V 0.0V 0.1V
TOTAL TIME: 1.00S
POST-TRIG: 0.0S
TRIGGER: MAN
40 psi/div
1.0 mil/div
on production line
from plot: 264/212 psi
±2.5
7.5
4.5
264 psi
212 psi
min. release limit
10.6
300psi
40
13
TI-NHT8A 004836
RED = 1st cycle

TO: Dave Czarn
Matt Sellers
Steve Offiker
Bill Sweet

drs92-46

CC: Tom Charboneau

FR: Dale Sogge

sj: 77ps3-1 preload capability: VSA

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

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

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

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

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

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

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

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

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

ACTUAL CAPABILITY

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

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

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

VSA with shear bumps added to the convertor to increase preload by 4.5 mils gives a mean of -.0014" and 3-sigma range of .0054". (figures 7-8).

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

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

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

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

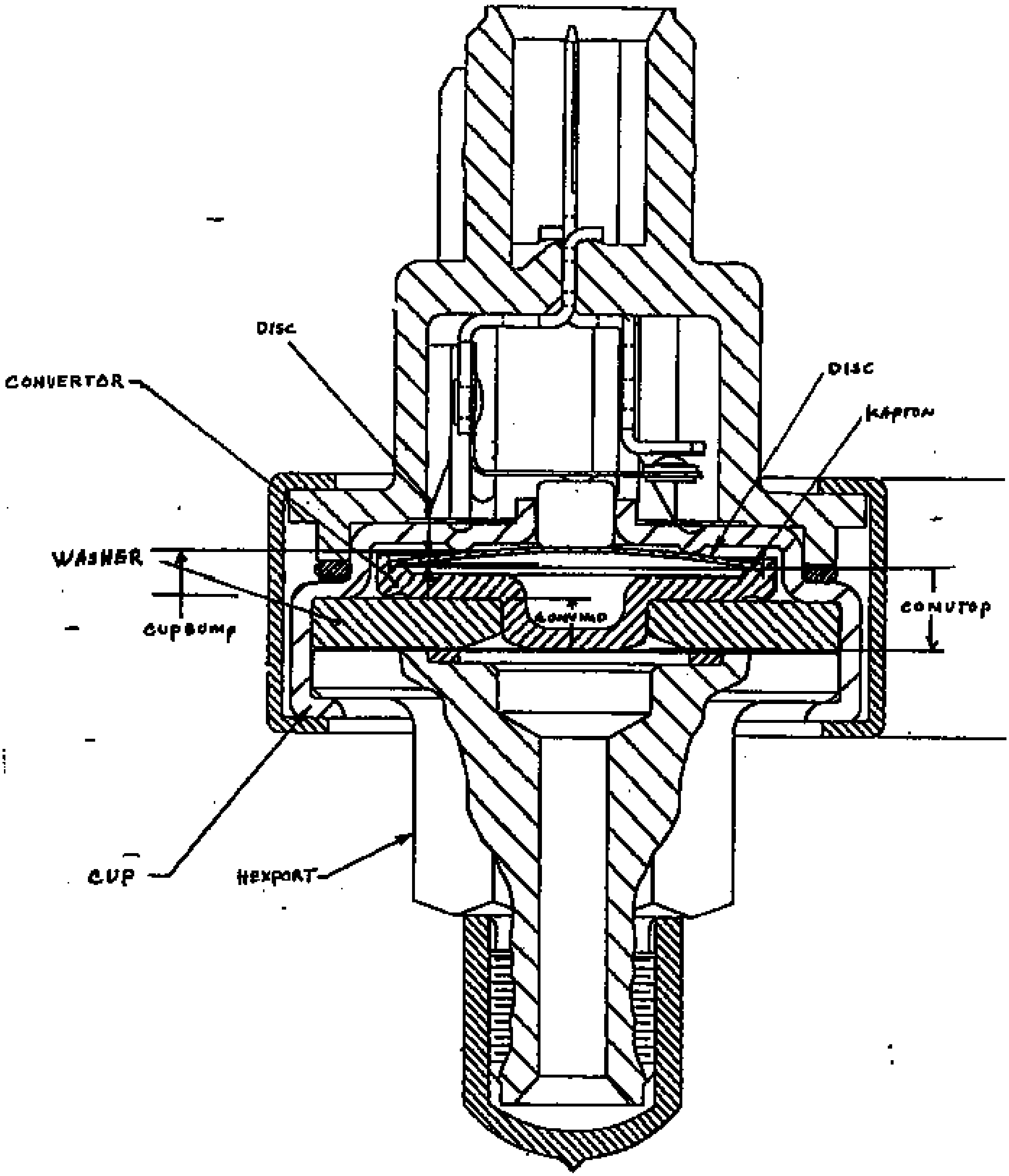
CONCLUSION

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

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

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

Dale



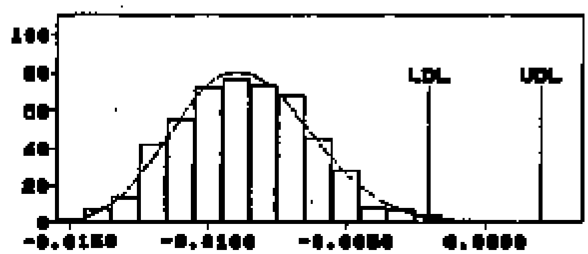
LABELS USED
FIGURE 1

TI-NHTSA 004839

Session: [illegible]

PRELOADR / GAP BETWEEN DISC AND BUMP ON TTF[illegible]-1 — [illegible] samples

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



	Actual	Est		Actual	Est*
% < Low Limit	[illegible]	[illegible]	Low	-0.0140	-0.0140
% > High Limit	0.0000	0.[illegible]	High	-0.[illegible]	-0.[illegible]
% Out of Spec	[illegible]	[illegible]	Range	0.0140	0.0130

[illegible]% C.I. for % Out of Spec : [illegible] to [illegible]   * Est Range : [illegible]

NO CRIMP SHIFT

FIGURE 2

TI-NHTSA 004840

Session: [illegible]

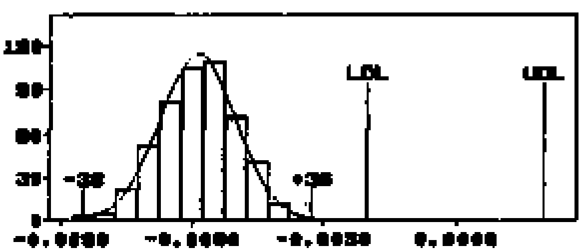
```
PRELOAD2 / GAP BETWEEN DISC AND SUMP ON TTFSLJ-1

 Nominal at Median : -[illegible]                    High-Low-Median Study
       HLM Variance : [illegible]

Tolerance                                                       Effect

DISC1    LINEAR Pearson XYWRKPLN at [illegible]                    97.26%
CON/MID1 LINEAR Normal [illegible] XYWRKPLN at [illegible]         1.86%
                                                                ------
                                                                99.12%
  3 additional contributor(s) <1.0% each                         0.88%
```

FIGURE 3

Session: [illegible]

PRELOAD1 / DISC PRELOAD WITH CRIMP SHIFT AVG=.[illegible] STD=.[illegible] [illegible] samples

Nominal :	-[illegible]
Mean :	-[illegible]
Standard Deviation :	[illegible]
Lower Design Limit :	-[illegible]
Upper Design Limit :	[illegible]
Cp :	[illegible]
Cpk :	N/A
Distribution :	Tested Normal



	Actual	Est		Actual	Est*
% < Low Limit	[illegible]	[illegible]	Low	-[illegible]	-[illegible]
% > High Limit	[illegible]	[illegible]	High	-[illegible]	-[illegible]
% Out of Spec	[illegible]	[illegible]	Range	[illegible]	[illegible]

[illegible]% C.I. for % Out of Spec : [illegible] to [illegible] * Est Range : [illegible]

WITH CRIMP SHIFT
FIGURE 4

Session: [illegible]

PRELOAD1 / DISC PRELOAD WITH CRIMP SHIFT AVG=.[illegible] STD=.[illegible]

Nominal at Median : -0.[illegible] — High-Low-Median Study

HLM Variance : 0.7511E-[illegible]

Tolerance		Effect
CRIMP	LINEAR Normal [illegible] XYWRKPLN at 0.0000	[illegible]%
CONVMID	LINEAR Normal [illegible] XYWRKPLN at 100.0000	11.[illegible]%
DISC	LINEAR Pearson XYWRKPLN at 0.0000	6.27%
CUPBUMP	LINEAR Pearson XYWRKPLN at 100.0000	0.21%
KAPTON	LINEAR Normal 0.[illegible] XYWRKPLN at 0.0000	1.33%
CONVTOP	LINEAR Normal 0.[illegible] XYWRKPLN at 0.0000	1.[illegible]%
		100.00%

with crimp shift

FIGURE 5

TI-NHTSA 004843

Session: [illegible]

Tolerance Summary

Name	Distrib	Nominal	Tolerance	Sig	Source
CONVMID	Normal	[illegible]	[illegible]	3	Manf
CONVMID1	Normal	[illegible]	[illegible]	3	Manf
CONVTOP	Normal	[illegible]	[illegible]	3	Manf
CONVTOP1	Normal	[illegible]	[illegible]	3	Manf
CRIMP	Normal	[illegible]	[illegible]	3	Manf
CUPBUMP	Pearson	[illegible]	NA	NA	Manf
CUPBUMP1	Pearson	[illegible]	NA	NA	Manf
DISC	Pearson	[illegible]	NA	NA	Manf
DISC1	Pearson	[illegible]	NA	NA	Manf
KAPTON	Normal	[illegible]	[illegible]	3	Dsgn
KAPTON1	Normal	[illegible]	[illegible]	3	Dsgn

DISC $\bar{X}$ = .0198 σ = .06239 skew = -.06 kurt = -.32

cupbump $\bar{X}$ = .090127 σ = .00015 skew = -1.71 kurt = 12.38

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

with #'s used for figure 4, 5, with crimp

with crimp shift

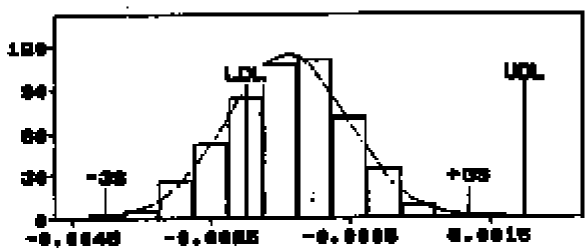
FIGURE 6

TI-NHTSA 004844

DISC PRELOAD WITH CONVERTOR HEIGHT INCREASED BY
4.5MILS ASSUMINGTOLERANCE REMAINS SAME AS CONV/MID
Session: SD-020907-164716

PRELOAD1 / DISC PRELOAD WITH CRIMP SHIFT AVG=.0020 STD=.0007 500 samples

Nominal :	-0.0014
Mean :	-0.0014
Standard Deviation :	0.0008
Lower Design Limit :	-0.0020
Upper Design Limit :	0.0020
Cp :	0.7870
Cpk :	0.2203
Distribution :	Tested Normal



	Actual	Est		Actual	Est*
% < Low Limit	25.4000	24.6631	Low	-0.0041	-0.0040
% > High Limit	0.0000	0.0000	High	0.0013	0.0012
% Out of Spec	25.4000	24.6631	Range	0.0054	0.0052

95% C.I. for % Out of Spec : 22.1973 to 28.6627 * Est Range : 99.7300

with shear bumps 4.5 mils high

FIGURE 7

TI-NHTSA 004845

DISC PRELOAD WITH CONVERTOR HEIGHT INCREASED BY
4.5MILS ASSUMINGTOLERANCE REMAINS SAME AS CONVMID
Session: 2D-020807-164716

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

 Nominal at Median : -0.0014                                  High-Low-Median Study
      HLM Variance : 0.7011E-06

Tolerance                                                            Effect

CRIMP     LINEAR Normal [illegible] XYWRKPLN at 0.0000             76.31%
CONVMID   LINEAR Normal [illegible] XYWRKPLN at 100.0000           11.20%
DISC      LINEAR Pearson XYWRKPLN at 0.0000                         6.27%
CUPBUMP   LINEAR Pearson XYWRKPLN at 100.0000                       3.21%
KAPTON    LINEAR Normal [illegible] XYWRKPLN at 0.0000              1.33%
CONVTOP   LINEAR Normal [illegible] XYWRKPLN at 0.0000              1.00%
                                                                   -------
                                                                   100.00%
```

with shear bumps
Figure 8

TI-NHTSA 004846

DISC PRELOAD WITH CONVERTOR HEIGHT INCREASED BY
4.8MILS ASSUMINGTOLERANCE REMAINS SAME AS CONVMID
Session: SD-[illegible]-164710

Tolerance Summary

Name	Distrib	Nominal	Tolerance	Sig	Source
CONVMID	Normal	[illegible]	[illegible]	3	Manf
CONVMID1	Normal	0.1042	[illegible]	3	Manf
CONVTOP	Normal	0.1046	[illegible]	3	Manf
CONVTOP1	Normal	0.1046	[illegible]	3	Manf
CRIMP	Normal	[illegible]	[illegible]	3	Manf
CUPBUMP	Pearson	[illegible]	NA	NA	Manf
CUPBUMP1	Pearson	[illegible]	NA	NA	Manf
DISC	Pearson	[illegible]	NA	NA	Manf
DISC1	Pearson	[illegible]	NA	NA	Manf
KAPTON	Normal	[illegible]	[illegible]	3	Dsgn
KAPTON1	Normal	[illegible]	[illegible]	3	Dsgn

Reflect reduced value from shear bumps.

with shear bumps

Figure 9

RAW [illegible] - 2 [illegible]

88K

TI-NHTSA 004848

Send cc:

TI-NHTSA 004849

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[illegible]

TO: [illegible] [illegible]

CC: **Dave Czarn** [illegible]
[illegible] [illegible]
[illegible] [illegible]

[illegible] [illegible] [illegible]

RE: Kapton Films (ref. [illegible])

John, thanks for your update. I'd like to add a couple bits of factual detail to the chemical attack/mechanical stress theories.

We use basically the same Kapton diaphragm design in both power-steering pressure switches and brake pressure switches. The only difference is the PS uses two layers, and the brake uses three. However, we typically don't see any problems with the PS diaphragm life, even out to over a million cycles. Brake devices built with only two layers generally start to fail prior to 200K (based on a limited amount of testing), at similar test temperatures and pressures. This, I'm told, is the reason for addition of the third layer back during development of the brake device in the early [illegible].

As far as mechanical stress, we actually have two slightly different pressure/sensor designs for the brake device. One yields converter displacement identical to the PS, while the other produces somewhat larger displacement, on the order of about 30% (roughly .017" vs .022"). We have shown, (again based on somewhat limited testing), that the higher converter travel = greater diaphragm strain does indeed reduce diaphragm life.

In order to schedule a day/time to meet, please consider I'll be taking vacation days 08/24, 25, 26 and 09/04. Thursdays late AM and Fridays early AM I'm generally tied up. The afternoon of the 27th would be the first foreseeable timeslot for me.

Regards, Steve O.

[illegible]

[illegible]

[illegible] [illegible] [illegible]
Dave Czarn [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible]

I want to update you about what's happening here on Kapton film.

We have exposed Apical & Kapton films to DOT 3 brake fluid at 105 C. To date we have not observed cracking or delamination of the films. The film may be becoming more brittle, we need to check on this.

[illegible] Gumm of DuPont received the films I sent him. His conclusion is that the film is failing because of mechanical overstress, not chemical attack. His observations that led to this conclusion are:

- the damaged area goes straight down through all three layers
- the size of the crack
- the damaged area occurs in the same location in all parts he examined

The non-randomness of the failure indicates to him that there is a mechanical factor involved. Pure chemical attack should be randomly located. Gumm discussed these issues with our regional Kapton sales manager. They may set up a meeting between us and DuPont to analyze our part. We should make certain that this meeting occurs.

We have also seen evidence of mechanical overstress in Advanced Development. The most damaged surfaces in the films that we've examined are the top surface of the top film and the bottom surface of the bottom film. These two surfaces are in direct contact with metal parts. The bottom film has severe ripping of the Teflon coating. The top film has circle of Teflon drawn up like a wall at the outer diameter of the gasket. It has apparently been drawn up between the gasket and the metal part. The upper piece also has Teflon sticking out past the perimeter of the polyimide layer in certain locations. These forces alone on Teflon might cause delamination.

I'm not as certain as Gumm that chemical attack can be completely ruled out. I believe that mechanical stressing is the prime culprit, and chemical attack may aggravate the situation and accelerate the failure.

I finally caught Chuck Olsen of Dow (the brake fluid contact) when he wasn't on vacation. Unfortunately, he was in a meeting. He is supposed to call me back tomorrow.

I'd like for us to get together so I can show you the things we're seeing and so we can talk more about the problem. What would be a good day/time for you?

Take Care,

John

TI-NHTSA 004853

DAVE CZARN

CRUISE CONTROL PRESSURE SWITCH
SOUND PULSE LEVEL TEST

Background

The 77PSL2-1 cruise control pressure switch for Ford Motor Co. has been noted to cause a sound in the passenger compartment of some vehicles. The sound is heard during the switch actuation and release when the switch is mounted on the master cylinder. Testing has shown that the sound intensity decreased with decreasing switch differentials. It was theorized that the sound was caused by the sudden increase in the hydraulic volume of the system when the switch actuates. On actuation the pressure disc snaps and travels a small distance (<.020") causing an increase in the fluid volume.

A "noisy" switch can be heard in the lab by applying air pressure and listening for the sound with a common microphone. Nearly "quiet" switches could not be heard with this method. They could be heard when mounted on the brake system. Therefore a more sensitive method of listening for & quantifying the sound level was needed. A new method was developed which actuates a switch hydraulically and listens for the sound with a hydrophone.

System description

The prototype system consist of a hydraulic hand pump which is used to supply pressure to a "t"- fitting. The switch is mounted on the fitting along with a sensitive pressure transducer. The pressure transducer is a quartz dynamic pressure transducer capable of resolving to .001psi. The quartz transducer can measure to 15Khz frequencies. A system overview is shown in Figure 1.

The pressure is increased rapidly from 0- 200psi or greater while the switch and the pressure transducer output is monitored with an oscilloscope. With the scope it is possible to observe any sudden change in pressure (including turbulence) which is equivalent to sound in an air system.

Results

Tests were run on both 77PSL2-1 "noisy" switches and 77PSL3-1 low differential "quiet" switch. The results are shown in figures 2 & 3.

The pressure trace shows that the "noisy" switch does have a significant sudden change in pressure associated with a sudden increase in volume. The pressure drop is an average of 55psi, sigma = 4psi for ten pieces. The plot shows that the sudden drop excites the system to resonate.

The low differential switch shows little corresponding pressure drop. A slight leveling of the pressure curve can be see in Figure 3. The volume change is reduced with the lower differential disc and there is less energy in the disc to excite the system. Because of manufacturing variability the quiet switch sometimes shows a small pressure drop (Figure 4) and sometimes shows a zero to slightly positive pressure increase (Figure 5). A positive resonant spike was never observed. This indicates that any volume change is immediately dampened out. For a ten piece sample the average pulse level was a positive plus 2.2psi, with a sigma 0.30psi.

TI-NHTSA 004854

TEST LOT NO.	TEST	DEVICE
TESTED BY		77PS
APPROVED BY D. SOGGE	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC. PS92-66
DATE 5-20-92		PAGE 1 of 13

FORM 5295

It was noted during repeatability & reproducibility testing that sound levels on noisy switches changed during the test. This is shown by the difference between column one and column two under operator Howard in Figure 6. This data is consistently below the other three sets of readings on the same part. It was discovered that the low readings were taken two days before all other readings. This increasing sound level with time has been noted by Ford on test vehicles. An investigation is planned to understand the cause. The investigation may indicate that preconditioning of the parts is required before auditing sound levels.

The time shift affect was not noted on the quiet parts because they were all tested within hours of each other. The R&R for the quiet switches is shown in figure 7.

Conclusion

The test clearly shows a significant difference between noisy and quiet switches. The test achieved it purpose of being able to measure the level of noise in a quiet switch. Based on these results the test will be used on a quarterly basis to audit the production quiet switches. It will also be used check the impact of any design changes that may be required in the future.

Further testing is planned to develop a correlation between the pressure pulse and the device differential for devices that are between noisy and quiet. This correlation will then be used to establish a more precise cut-off point for differential on the production line.

A proposed spec limit for the quiet switch is minus 10psi until a limit can be developed with Ford based on actual vehicle tests.

The test has been run on a production lot date coded 2127 for May 6th, 1992. The test will be rerun in August 1992 as the first quarterly audit.

PROTOTYPE PULSE TESTER

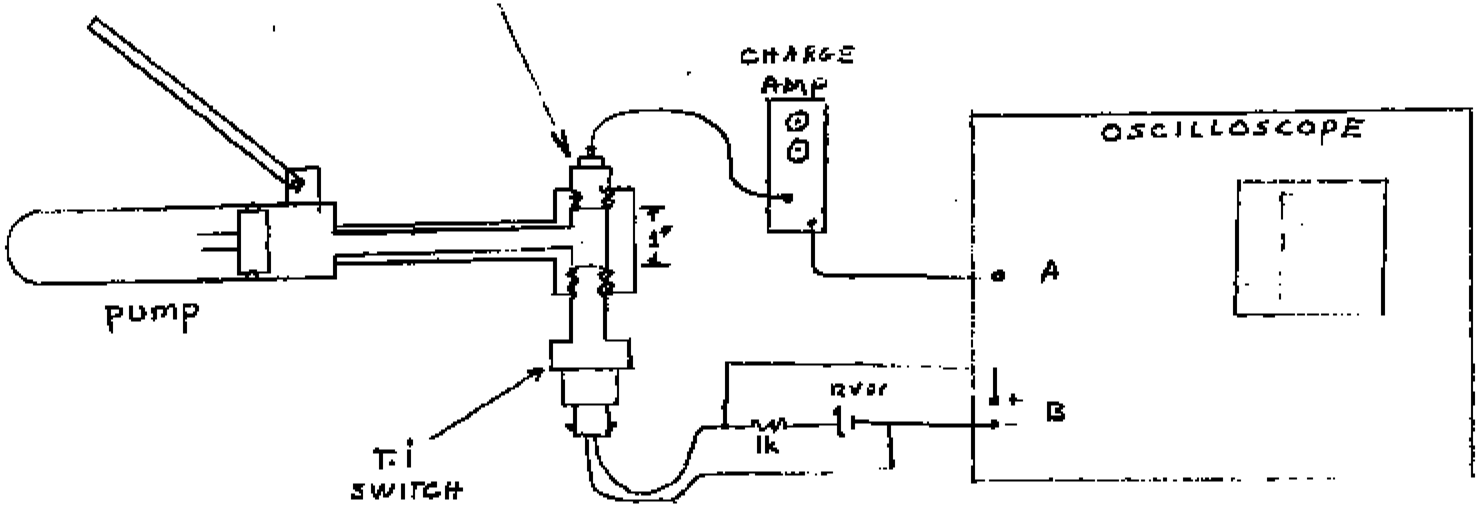
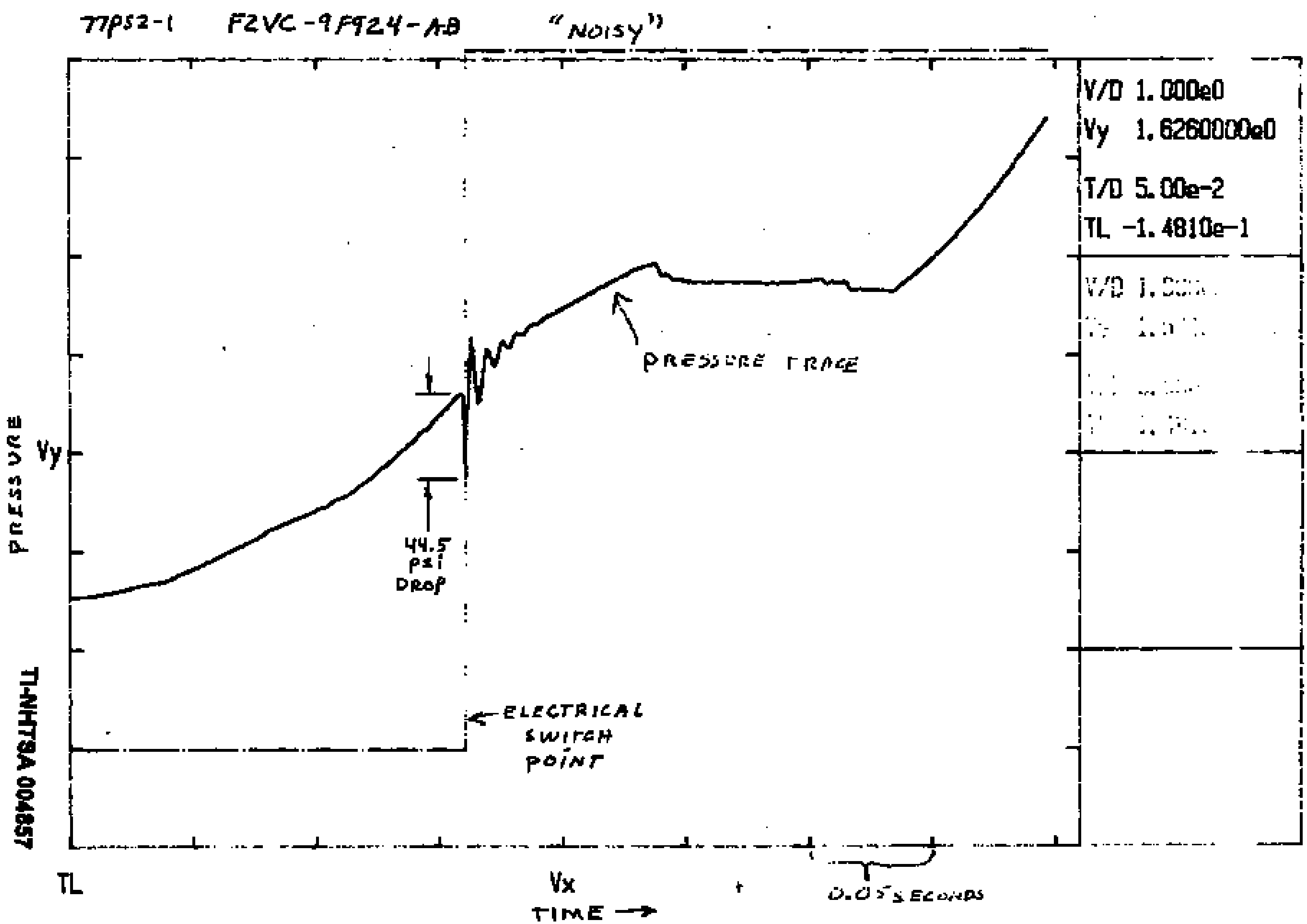


FIGURE 1

DRE, 5-18-72



77PS2-1
F2VC-9F924-AB
"NOISY"
V/D 1.000e0
Vy 1.6260000e0
T/D 5.00e-2
TL -1.4810e-1
PRESSURE TRACE
44.5 psi DROP
ELECTRICAL SWITCH POINT
PRESSURE
Vy
TL
Vx
TIME →
0.05 SECONDS

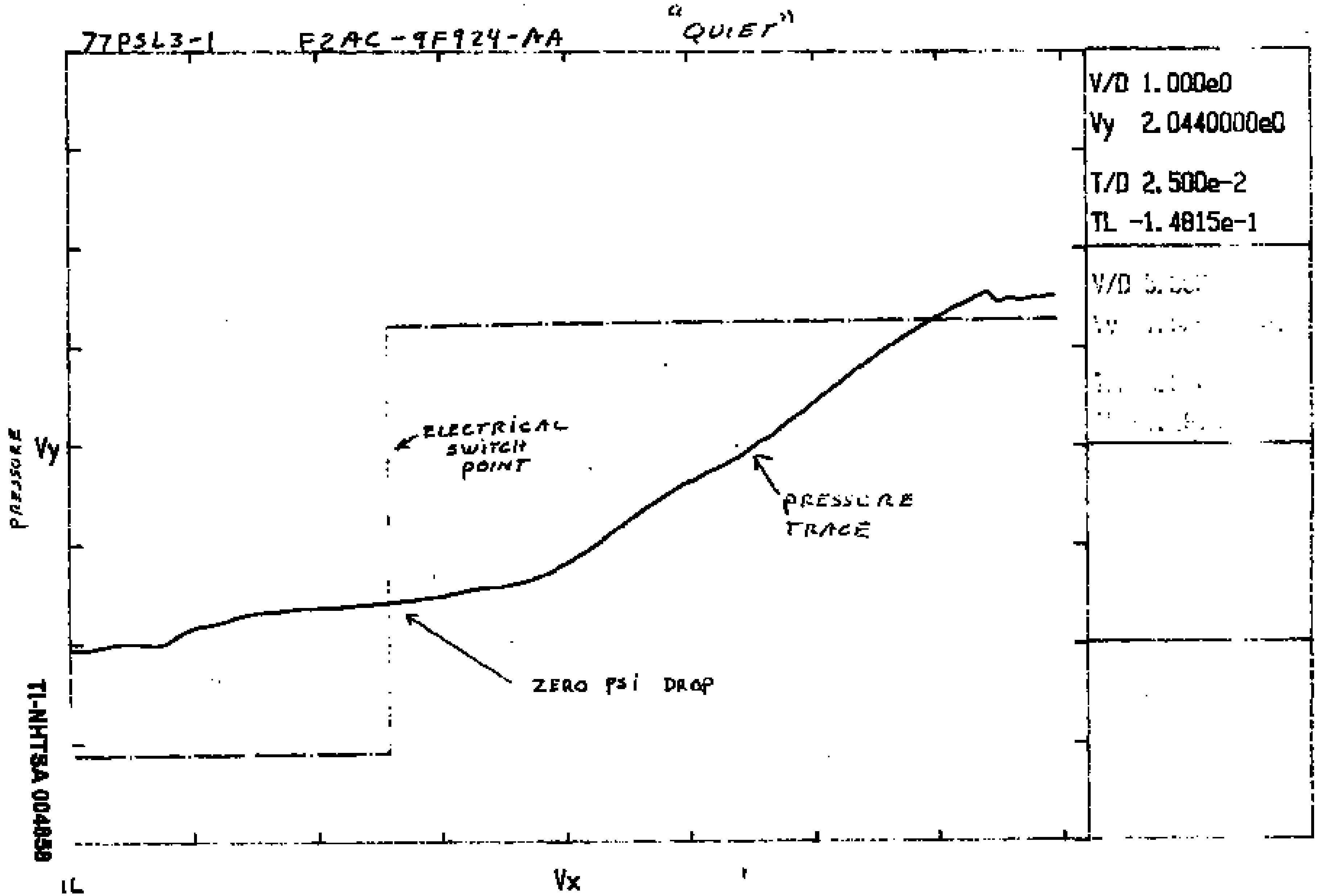

77PSL3-1
F2AC-9F924-AA
"QUIET"
V/D 1.000e0
Vy 2.0440000e0
T/D 2.500e-2
TL -1.4815e-1
PRESSURE
Vy
ELECTRICAL SWITCH POINT
PRESSURE TRACE
ZERO PSI DROP
TL
Vx

FIGURE 3

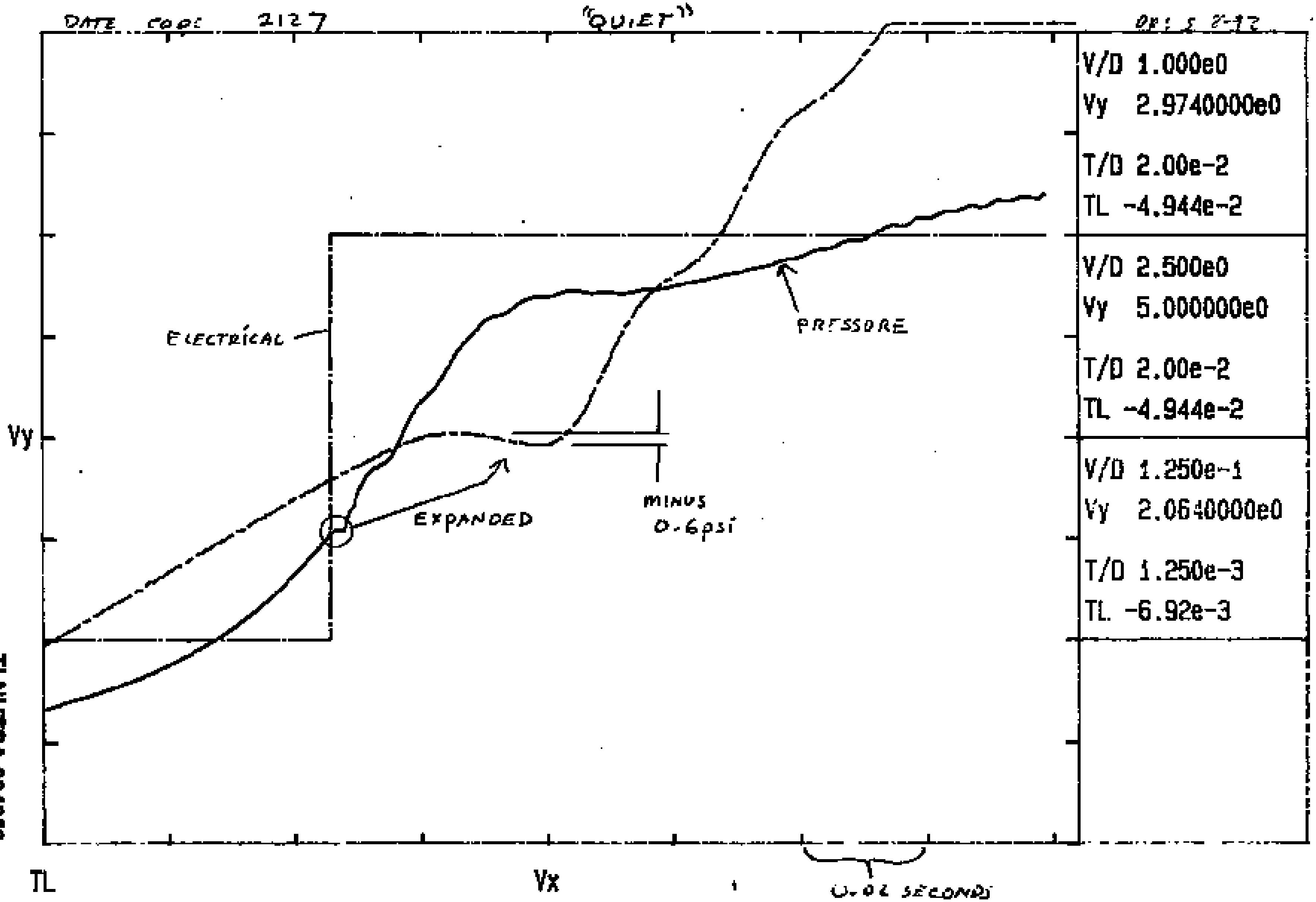
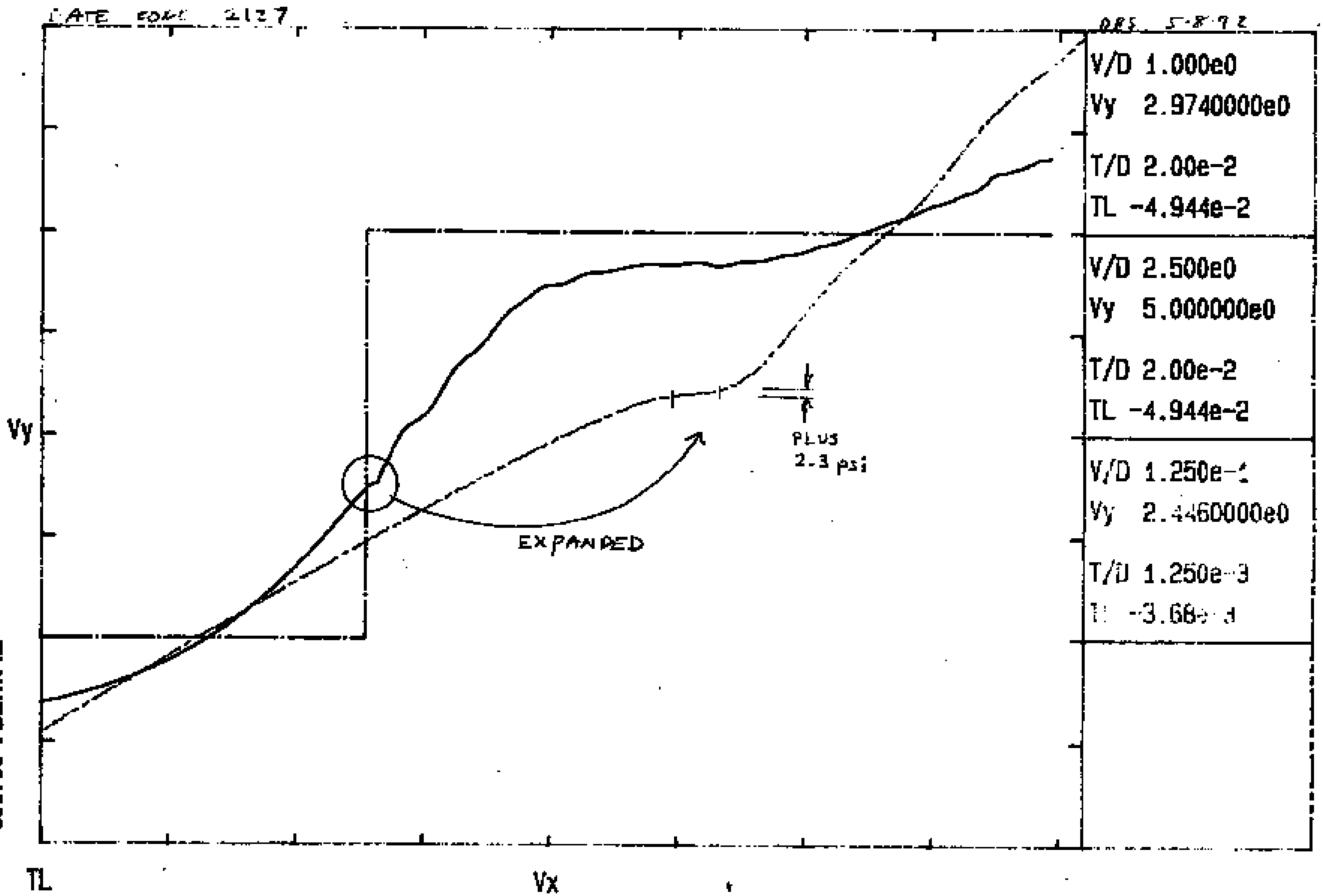

DATE CODE 2127
"QUIET"
V/D 1.000e0
Vy 2.9740000e0
T/D 2.00e-2
TL -4.944e-2
V/D 2.500e0
Vy 5.000000e0
T/D 2.00e-2
TL -4.944e-2
V/D 1.250e-1
Vy 2.0640000e0
T/D 1.250e-3
TL -6.92e-3
ELECTRICAL
PRESSURE
EXPANDED
MINUS
0.6psi
Vy
TL
Vx
0.02 SECONDS

FIGURE [illegible]



TI-NHTSA 004860

FIGURE 6.

[illegible] STUDY FOR REPEATABILITY AND REPRODUCIBILITY [illegible]

18-MAY-92

[illegible]

NUMBER OF OPERATORS	[illegible]		[illegible]	[illegible] psi
NUMBER OF TRIALS	[illegible]		[illegible]	[illegible]
NUMBER OF PARTS	[illegible]		[illegible] RANGE	[illegible]

DATA SUMMARY

OPERATOR	AVERAGE	RANGE
JEFF	[illegible]	[illegible]
[illegible]	55.0275	[illegible]
[illegible]	NA	NA
	NA	NA
[illegible]	NA	NA
	NA	NA
[illegible]	NA	NA
	NA	NA
	NA	NA
[illegible]	NA	NA
AVERAGE	[illegible]	[illegible]

MIN XBAR	19.9049
MAX XBAR	55.0275
XBARDIFF	[illegible]

	MEASUREMENT UNIT ANALYSIS	% TOLERANCE
REPEATABILITY	70.14195	37.07%
REPRODUCIBILITY	34.71500	27.36%
RPT & RPR (R&R)	39.95685	44.46%

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

TI-NHTSA 004661

[illegible]

[illegible]

[illegible]	[illegible]00
[illegible]	[illegible]00
[illegible]	[illegible]00

DATA FOR OPERATOR JEFF

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	33.55	50				41.775	16.45
2	34.7	54.55				44.625	19.85
3	32.85	50.25				41.55	17.4
4	[illegible]	46.05				37.45	17.2
5	[illegible]	[illegible]				46.925	[illegible]
6	[illegible]	[illegible]				[illegible]	[illegible]
7	[illegible]	[illegible]				[illegible]	[illegible]
8	[illegible]	[illegible]				[illegible]	17.45
9	[illegible]	[illegible]				[illegible]	[illegible]
10	[illegible]	[illegible]				47.275	[illegible]
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

SIGNIFICANTLY LOWER THAN OTHER THREE TRIALS

GRND AVG: 39.9443 AVG RNGE: 26.341
UCL FOR INDIVIDUAL RANGES 50.19092

DATA FOR OPERATOR HOWARD

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	44.[illegible]	54.[illegible]				50.[illegible]75	7.25
2	56.5	59.[illegible]				[illegible]3.1	[illegible]
3	48	50				49	2
4	65.5	67.5				66.5	2
5	44	44.5				44.25	0.5
6	46	[illegible]				50	[illegible]
7	41.25	56.15				48.7	14.9
8	61	64				62.5	3
9	57.5	57				57.25	0.5
10	52	54.8				53.4	2.8
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	[illegible]
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 55.5275 AVG RANGE: 4.585
UCL FOR INDIVIDUAL RANGES 50.[illegible]9092

TI-NHTSA 004663

FIGURE 7

GAGE STUDY FOR REPEATABILITY AND REPRODUCIBILITY (LONG METHOD)

[illegible]

[illegible]

NUMBER OF OPERATORS	[illegible]		MIN SPEC	[illegible] psi
NUMBER OF PARTS	10		MAX SPEC	[illegible]0
NUMBER OF TRIALS	[illegible]		TOLERANCE	50

DATA SUMMARY

OPERATOR	AVERAGE	RANGE
[illegible]	1.9452	0.8304
[illegible]	2.245	1.39
3	NA	NA
4	NA	NA
5	NA	NA
[illegible]	NA	NA
[illegible]	NA	NA
[illegible]	NA	NA
[illegible]	NA	NA
10	NA	NA
AVERAGE	2.0951	1.1052

MIN XBAR	1.9452
MAX XBAR	2.245
XBARDIFF	0.2998

	MEASUREMENT UNIT ANALYSIS	%TOLERANCE
REPEATABILITY	5.045904	10.09%
REPRODUCIBILITY	0	0.00%
RPT & REPR (R&R)	5.045904	10.09%

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

ENTER TRIAL VALUES IN CELLS AA AS [illegible] MIN/MAX SPEC IN [illegible]
[illegible] SWITCH PULSE LEVEL

MIN SPEC -10
MAX SPEC 30
TOLERANCE 50

DATA FOR OPERATOR JEFF

	TRIAL						
PART	1	2	3	4	5	AVG	RANGE
1	1.85	2.6				2.225	0.75
2	-0.6	-0.356				-0.478	0.244
3	1.65	0				0.825	1.65
4	[illegible]	-0.67				-0.877	0.46
5	1.95	0.5				1.225	1.45
6	-0.25	[illegible]				-0.49	0.56
7	-0.85	[illegible]				-0.625	0.45
8	0	1.5				0.75	1.5
9	2.95	2.65				2.8	0.3
10	2.45	3				2.725	0.55
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 1.9452 AVG RNGE: 0.8204
UCL FOR INDIVIDUAL RANGES 3.610688

[illegible] FOR OPERATOR [illegible]

PART	TRIAL 1	2	3	4	5	AVG	RANGE
[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
[illegible]	[illegible]	[illegible]				[illegible].65	[illegible]
[illegible]	[illegible]	2.[illegible]				[illegible].925	[illegible]
[illegible]	[illegible]	-0.[illegible]				[illegible]	[illegible]
[illegible]	0.85	0.45				0.65	[illegible].4
[illegible]	[illegible].05	7.75				3.4	[illegible].5
[illegible]	-[illegible]	[illegible]				0.33	[illegible]
[illegible]	0	1.65				0.825	1.65
[illegible]	3.5	0.95				2.225	[illegible].55
10	4.05	[illegible].4				[illegible].725	0.65
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
[illegible]						NA	0
24						NA	0
25						NA	0

GRND AVG: 2.245 AVG RNGE: 1.39
[illegible] FOR INDIVIDUAL RANGES 3.610628

Voltage Set up for Plotter System.
For Disc X - 2.25V Range 1

For Sensor X = 1-800 V Range 1

2.25 V
2.5 PSI/Div

1.8V
20 PSI/Div

Y = 3.75V Range 3/0-100 Psig Sensotec

Y = 1.25V Range 3/0-1000 PSIG Sensotec

3.75 V
1-5 mils/Div

1.25V
0-5 mils/Div

MEMORANDUM

July 22, 1992

To: Charlie Douglas
Dick Gariepy
Paul Kotch
Steve Offiler
Matt Sellers
Dale Sogge
Rusty Struble
Bill Sweet
Jim Watt

Copy: Mike Downey
Norm Freda
Danny O'Driscoll
Gary Snyder

From: Dave Czarn

Re: CCPS Cross-reference list

July 21, 1992 update is attached.

Regards,
Dave Czarn
/dt

Attachments

CCPS X-REFERENCE LIST - Rev. July 21, 1992

Program	Town Car EN53 - ABS	Econoline	EN53 non - ABS	F-Ser./Bronco	Taurus SHO	WIN 88	Capri (Austr)	Falcon (Austr)	Rang./Explor.
TI p/n	77PSL2-1	77PSL2-3	77PSL3-1	77PSL3-3	77PSL5-2	77PSL3-2	77PSL6-1	77PSL4-1	t-b-d
Ford p/n	F2VC-9F924-AB	F3TA-9F924-AA	F2AC-9F924-AA	F3TA-9F924-BA	F3DC-9F924-AA	F58A-9F924-AA	94JA-9F924-AB	94DA-9F924-AA	t-b-d
Switch type	standard	standard	quiet	standard	quiet	quiet	quiet	quiet	quiet
Mounting loc'n	Prop. valve	T-fitting M/C NY94	Prop. valve	T-fitting M/C NY94	M/C	M/C	T-fitting	M/C	M/C
Miscellaneous				high temp			high temp		
Calibration									
Actuation	90-160	200-300	90-160	200-300	90-160	90-160	90-160	90-160	200-300
Release	20 min	40 min	20 min	40 min	20 min	20 min	20 min	20 min	40 min
Base									
Color	brown	black	natural	red	natural	dk grey	dk grey	natural	red
Key	offset	centered	offset	centered	offset	centered	centered	offset	centered
Material	PBT	PBT	Noryl	Noryl	Noryl	Noryl	Noryl	Noryl	Noryl
part no.	46515-2	46515-1	46515-3	46515-7	46515-3	46515-10	46515-10	46515-3	46515-7
Hexport									
type	J512	J512	J512	J512	J512/snubber	J512/snubber	O-ring	O-ring	open
thread	3/8-24 M	3/8-24 M	3/8-24 M	3/8-24 M	3/8-24 M	3/8-24 M	3/8-24 M	M10x1.0 M	3/8-24 M
hex size	9/16	9/16	9/16	9/16	9/16	9/16	9/16	14mm	9/16
finish	Zn/yellow	Zn/yellow	Zn/yellow	Zn/yellow	Zn/clear	Zn/clear	Zn/yellow	Zn/clear	tbd
part no.	36900-1	36900-1	36900-1	36900-1	36997-1	36997-1	36917-1	tbd	tbd
Ford									
Purchasing	Colleen Weiss	Fred Hendershot	Colleen Weiss	Fred Hendershot	Colleen Weiss	Rich Freitag			Rich Freitag
Engineering	Bruce Pease	John Pelkey	Bruce Pease	John Pelkey	Tim Andresen	Ted Commons	John Peck	Tony Gage	
SQA	Mark Scholler	Mark Scholler	Mark Scholler	Mark Scholler	Mark Scholler	Mark Scholler	Bob Taylor	Bob Taylor	Mark Scholler
Tier 1	Pitts	n/a	Dana	n/a	Teves	Tokico	BCIA	n/a	Bendix
Purchasing	Joe Jorda		Mike Rogers		Cathy Kyd		Ron Douthie		Sue Snyder
Engineering	Jack Hutchison		Gary Ianucilli						
SQA	George Comiskey		Lynn Johnson		Kathy Hamborg	Tim Ishimaki	Rod Stone		

TI-NHTSA 004869

TI-NHTSA 004870

CCPS X-REFERENCE LIST - Rev. July 21, 1992

Program	Town Car EN53 - ABS	Econoline	EN53 non - ABS	F-Ser./Bronco	Taurus SHO	WIN 88	Capri (Austr)	Falcon (Austr)	Rang./Explor.
MY start-up	MY92.5	MY92.5	MY93	MY93	MY95+	MY95	MY94	MY95	MY95
Annual volume	150k	90k	250k	360k	30k	MY95 - 100k MY96 - 250k	23.4k	30k	100k
Ford JOB 1				3-Aug-92	1-Sep-92	1-Jul-94	1-Jul-93	1-Jul-94	1-Jul-94
Tier 1 SOP									
TI SOP			1-Apr-92	12-Jun-92	1-Aug-92	1-May-94	1-May-92	1-May-94	1-May-94
TI ISR date	comp	comp	14-Aug-92	comp	14-Aug-92	10-Dec-93	10-Dec-92	10-Dec-93	10-Dec-93

-MSG M#= 439184 FR=SBO1 TO=FFUN SENT=04/15/92 10:52 AM
R#=176 ST=C DIV=0050 CC=00101 BY=SBO1 AT=04/15/92 10:53 AM

TO:	Ted Ballard	ETB	Norm Freda	WHLZ
	Dave Czarn	ZARN	Matt Sellers	PCME
	Charlie Douglas	CMP1	Dale Sogge	FFUN
CC:	Tom Charboneau	TC	Gary Snyder	GJS1
	Steve Major	SMFH	Bill Sweet	WS4
FR:	Steve Offiler	SBO1		

SJ: NOTES FROM MTG W/ BRUCE MAEROFF, APRIL 13 & 14

===

GENERAL

We need to quickly develop some kind of benchtop test to determine sound levels in a fluid system. Dale will work on a system with a high frequency transducer (hydrophone) to "listen" for the pressure waves associated with the sound/feel. We may begin with a Kistler piezo transducer for expediency. We owe a status report on this development to Bruce on 920424. The general methodology will be to compare the present quiet devices F3DC and F2AC with standard snap devices until we are satisfied that we have identified the correct parameters to measure. Then, using this knowledge, work to further control and minimize the phenomenon will commence. Ford indicates that they can provide only very limited development assistance, because they are swamped with larger issues including new platform development and a couple of recalls. They can help by providing hardware as needed for test stand (master cylinders, boosters, pedal assemblies, etc). We should not bother [illegible]m until our internal testing indicates we've made significant progress, then submit these for evaluation.

TI will propose modifications to the verbage of the ES to include checks for sound using whatever equipment is ultimately developed and concurred by Ford, and include sound on In-Process tests quarterly. Snap devices will be exempted from this testing using a note on the print.

Mounting downstream of HCU (Hydraulic Control Unit) on ABS vehicles seems to quiet the switch action. One hypothesis is that the solenoid valves in the HCU include rubber diaphragms which may help dampen pressure/sound wave transmission.

Still need to perform First Cycle Syndrome evaluations; a key concern is whether the "reset" occurs within 6 hours (= 1 tank of gas)

TI-NHTSA 004671

Temperature concern: . The fact that the spec says 121C (=250F) is inconsequential, since typically the spec's are written or evolved before actual testing is conducted or without knowledge of same. 150C (=302F) is an internal Ford bogey based on the boiling point of DOT3 fluid at 3% moisture absorption.

We supplied the following samples which were hand-carried back to Detroit: (5) modified 57PSF3-3's with actuation around 700 psi for evaluation of system performance (not related to CCPS); (20) 77PSL5-2 of which 2 will go [illegible] Tim Andresen to complete a need for 10, 10 to Mike Spears, Taurus Chassis [illegible]g Mgr (to carry to Atlanta? to replace the pressed-in snubber proto's ?), and the remaining 8 for use by the brake department for evaluations; and 1 box of 77PSL3-1 for Bruce to FedEx to dealerships as needed when they call responding to a recently released service bulliten for EN53.

Need a couple of switches at 300 psi, out of "normal" operating range - this requires Ted's silent LT discs on order DATE?

***** EN53 *****

We should include in our partial ISR package documentation of all testing conducted to date on Noryl, whether internal lab tests, Ford spec tests, or whatever. I have a copy of Steve Butler's report comparing several plastics; addition we'll need quick writeups of thermal evaluations conducted by ...le and I.

We need to update our envelope drawing for parts destined for Dana to include 125 psi +75/-35 in order to comprehend First Cycle Syndrome. Dana makes the junction block for EN53 which will be getting the silent/no snub 77PSL3-1. We also discussed the same update for 77PSL5-2, silent/snub for SHO - however, I'm unsure of our rationale for this... has Teves indicated a FCS issue? How about Pitts (77PSL2-1)? Also, Bruce indicates a strong preference for mylar prints, not vellum as we've been supplying.

***** SHO TAURUS *****

The current SHO device (lot F w/ snubber, 77PSL5-2, F3DC9F924AA) is NOT ACCEPTABLE long-term, however, they're going to have to build with these for now. ONE device of the 9 with pressed-in snubbers has been evaluated in Dearborn on a SHO automatic and found to be 9 on sound but only 7 on feel. Therefore, our thrust should be to improve on the feel issue - again, these comments based on eval of a single prototype.

Bruce's personal opinion is that the switch should be removed from the Master Cylinder. HOWEVER, he indicates this will be a major battle with B&A. One issue seems to be that if mounted on a prop valve, service will require engine removal (!)

) SHO 2PP build (NOT SALABLE) is now scheduled for 4/21 (program timing chart dated 920331 shows 4/13; Into Plant Date is 7 calendar days prior; giving updated 2PP IPD of 4/14). We assume the 8 pressed-in snubber parts we produced made their way to Teves, and Teves intercepted the 4/14 IPD date. So, as of now, these pressed-in snubber parts are on M/C's in Atlanta to be build 4/21.

The IPD for FEU build (SALABLE) is 5/4, meaning we'll need to get production (representative) parts to Teves by 4/27. Ideally these snubber hexports will be Elco produced; fallbacks include 1) Elco blanks finished here or 2) parts produced here on CNC equipment.

We should speak with Cathy Hamborg at Teves to see about including our switch in their HCU life testing; get a copy of whatever spec they test to (not necessarily a Ford ES, since Teves markets a black box system and accepts warranty responsibility.)

TI-NHTSA 004872

***** ATLANTA PREPARATION *****

We will be potentially meeting with plant management, the launch team, the plant engineer, the launch leader, etc. Their concern is whether the problem is solved. They don't care about how, or the development required, etc. Technical details should be presented in layman's terms. They will want:

- explanation of how the problem got all the way to the assembly plant.
  proof that the problem is fixed.
- proof that a plan is in place to ensure it stays fixed, which will probably encompass the test fixture Dale is proposing.
- discussion of partial ISR and plans for full ISR including combination of EN53 and SHO per the rough plan I've already laid out, also including a weibull requested by M. Spears.
- take-aparts for showandtell, keying on the snap disc versus the silent

It seems important to close ASAP with Tim Andresen and Mike Spears to ensure that we're adequately prepared.

Regards,
' ove O.

SOUND VALUE

	B.H.T			A.H.T			DALE'S P-D ON DISC				DALE'S SIMULATED SENSOR				ACTUAL SENSOR ASSEMBLY				SLOPE
													ΔD	90-200psi			ΔD	90-200psi	MIL/PSI
	ACT	REL	ΔP	ACT	REL	ΔP	ACT	REL	ΔP	ΔD	ACT	REL	ΔP	ΔD	ACT	REL	ΔP	ΔP	
'P' PRODUCTION							24.6 / 25.7	13.1 / 10.7	11.5 / 15	13.8 MIL	150	80	— / 70	13.7 MIL	134	75	— / 59	13.4	0
'F' QUIET PASS CAR	21.3	11.7					— / 24.5	— / 20	4.5	6.5	148	120	28	10.0	146	120	3.1 / 26	10.8	0
'Q' 1ST LOT PROD F DISC 1ST RUN F DISC							22	18.5	4.5	7.5	146	122	2.5 / 24	10.2					0.77
'R' 2ND LOT PROD F DISC 1ST RUN F DISC																			
'S' 3RD LOT PROD F DISC 1ST RUN F DISC							22	18.5	4.5	6.5	140	122	2.25 / 22	9.4					2.2