EA02-025

TEXAS INSTRUMENTS, INC.'S

9/10/03

REQUEST NO. 7

BOX 9

PART A – R

PART M

TEXAS INSTRUMENTS INCORPORATED, AUTOMOTIVE SENSORS & CONTROLS		
DOC.TYPE: QUALITY ASSURANCE SPECIFICATION	DOC. NO. QAS 208	REVISION: R
TITLE: ACCEPTANCE TEST PROCEDURE 77PS PRESSURE SWITCH	FOR REFERENCE ONLY Always check the latest revision before use.	SHEET 1 OF 10 DOC. 508130 DATE: 02/03/00
PREPARED BY: B. Gilden	APPROVED: J. Watt	

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

1.0 PURPOSE:

To document procedures for TI's 77PS pressure switches that meet requirements set forth by customer purchase orders and engineering standards.

2.0 SCOPE:

This specification establishes the inspection criteria, methods, standards and reaction plans for the inspection of the 77PS pressure switch.

3.0 REFERENCES:

3.1 QA 05 2 01 -- QAS Preparation & Control Procedure

3.2 TI/Customer P/N's -- See Para. 5.1

4.0 RESPONSIBILITIES:

4.1 The Quality Assurance Manager, or that individual having delegated responsibility for this product or program, shall assure that this document is reviewed in accordance with the requirements of QAS Preparation & Control Procedure (QA 05 2 01).

4.2 The designated Quality Assurance Inspection Supervisor is responsible for assuring the requirements and procedures set forth in this document are complied with.

5.0 GENERAL PROCEDURE:

5.1 This specification is applicable to all production units listed below:

TI P/N	*CUSTOMER P/N*	*CUSTOMER*
77PSL2-1	F2VC-9F924-AB	Ford
77PSL2-2		Ford
77PSL2-3	F6LC-9F924-AA	
77PSL3-1	F2AC-9F924-AA	Ford
77PSL5-2	F3DC-9F924-AA	Ford
77PSL3-2	F58A-9F924-AA	
77PSL3-3	F3TA-9F924-CA	To Kioo
77PSL3-4	MSK 100050	Land Rover Defender
77PSL4-1	94DA-9F924-AA	Australia
77PSL6-1	94JA-9F924-AB	Australia

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5.2 Unless otherwise noted all sampling plans allow zero defects (reject on one defect)

TI-NHTSA 014444

5.3 Every effort shall be made to employ statistical methods (X & R Chart, pre-control, etc.) to assure ongoing process control after capability has been demonstrated.

5.4 A route card shall accompany each sub-lot of material, after it obtains identity.

- The route card shall indicate the part number, job description, date, and operator number.

5.5 A lot is defined as that quantity of devices which is homogeneous. A lot shall not exceed 8 hours of production or 4000 devices. If one day's production exceeds 4000 devices, sub-lot numbers may be used. A sub-lot of the same shift's production will be noted with a letter and will not exceed 4000 devices.

5.6 Unless otherwise specified, all tests will be conducted at room ambient conditions.

5.7 Final inspection will be accomplished in accordance with Section 6.0 of this QAS. A Reject Notice (Form Number 5341) shall be initiated and the applicable reaction plan will be initiated.

5.8 Special Inspections and Requirements will be accomplished in accordance with Section 7.0 of this QAS.

5.9 Reliability testing will be accomplished per Section 8.0 of this QAS.

6.0 FINAL INSPECTION TEST

The following inspections will be accomplished on completed devices. When a discrepancy is encountered, Quality Engineering will be notified by a Reject Notice (Form 5341). Tear down analysis or other means will be employed to ascertain the cause of the discrepancy and to define what corrective actions will be initiated.

6.1 Post Pressure Tester Inspection

Five (5) devices per box selected at random, will be visually checked for:

- Code - Legibility and correctness of code.
- Crimp ring and hexport - free of dents, nicks, scratches, surface contamination and other deformities.
- Sensors to be free of metallic flakes and slivers.
- Check base for cracks, bent or deformed terminals and large surface dents.
- Record results on "Inspection Log Sheet"
- Terminal location with connectors or go no go gage.
- Polarity key - correctness of location.
- Check threads.

6.1.1 For 77PSL3-2 only: Measure 10 pieces per lot of dimension .620" min (point to point on hex). Using the thin end of the vernier jaws, the dimension must not be less than .617" at the lowest underfill point and not less than .620" measured at the highest cross-corner point. (See visual aid)

6.2 Packing

Check all shipping labels for current Engineering Revision number and ensure correct customer part number is on label and device. Ensure labels on box are in correct position and legible. Auditing frequency of packed devices to be set by Quality Engineer.

7.0 SPECIAL INSPECTIONS AND REQUIREMENTS

The following chart is to be used as a guide for special testing of pilots prior to packing. Results will be used as the final inspection for these attributes.

Note: Those specific tests which require a hydraulic seal to the hexport must have an O-ring fitted to the hexport; e.g., impulse testing; proof/burst testing.

Use appropriate thread adapters where and if appropriate.

7.1 Special Inspections and Requirements

5 DEVICES	4 DEVICES
Calibration 7.1.1	Calibration 7.1.1
Impulse 7.1.3	Dimensional 7.1.6
Proof 7.1.4	Term. Strength Push-out 7.1.7
Calibration 7.1.1	Current Leakage 7.1.2
Current Leakage 7.1.2	Proof 7.1.4
Scrap	Calibration 7.1.1
	Burst 7.1.5
	Scrap

7.1.1 Calibration/Voltage Drop (Automatic)

Nine (9) devices from each disc lot will be 100% tested for actuation, release, and voltage drop using TI automatic test equipment.

All tests will be accomplished after the third cycle with the switch conducting 700-800 mA at 12.0 - 14.0 VDC.

The actuation and release pressure will meet the customer requirements as indicated on envelope drawing.

The rate of pressure change (ramp-up, ramp down) will be 50 psi/sec.

The voltage drop across the contact area is automatically checked by the test equipment.

The voltage drop will not exceed 200 mV with a 700 to 800 mA current flow through the switch.

Devices which fail must be segregated from acceptable units and appropriately identified by category.

Results of the calibration and voltage drop test shall be maintained by Inspection for 2 years.

NOTE: The automatic pressure tester provides screen indications for actuation, release, differential plus voltage drop so discrepancies can be categorized.

7.1.2 Current Leakage

Four (4) devices per sample of nine (9) will be measured for current leakage. The current leakage is to be measured with 500 volts, 60 Hz alternating current applied. The current leakage is to be checked as follows: NOTE: TI automated test equipment is used to accomplish this test.

- Between the switch leads with contacts open.
- Between the lead and switch housing with contacts closed.
- Between either lead and switch housing with contacts open.

For lot acceptance, the measured leakage current shall not exceed 0.1 milliampere. Record results on inspection characteristic data sheet.

7.1.3 Impulse Test

The pressure medium shall be currently released brake fluid. The switches will be cycled to 500,000 cycles.

NOTE: Upon completion of impulse testing, the switches are to be tested per Para. 7.1.1, 7.1.2, 7.1.4, 7.1.5. Record results on inspection characteristic data sheet.

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7.1.4 Proof Test

The test is to be conducted using power steering fluid or equivalent as pressure medium. Test pressure is to be isolated from pressure source and held for not less than 30 seconds. For lot acceptance, the switches shall not show any evidence of oil leakage, seepage or drop in pressure greater than 62.0 psig. Record results on inspection log.

Test per following chart or part number envelope drawing

P/C 3000psig	L/T 4000psig
77PSL2-1	77PSL2-3
77PSL3-1	77PSL3-3
77PSL3-2	
77PSL3-4	
77PSL4-1	
77PSL5-2	
77PSL6-1	

NOTE: Upon completion of testing, every lot with new converters and/or new washers are to be decrimped and given to Design Engineering. With this exception, all other test samples shall be scrapped after testing.

7.1.5 Burst Test

The burst pressure medium shall be power steering fluid or equivalent. The switch is to be pressurized to 7000 psig and held for 30 seconds minimum. For acceptance all switches will not show evidence of oil leakage or seepage from the switch or threads. Record data on inspection characteristics data sheets.

Note: Samples used for this test must be scrapped after testing is completed.

7.1.6 Dimensional Checks

Four (4) devices from each disc lot, pilot will be checked for dimensions as follows:

- Length (see Envelope Drawing)
- Crimp Ring Dia. (see Envelope Drawing)
- Hex (see Envelope Drawing)

Thread (torque wrench go-no go) per envelope drawing
4.5 in. pounds max.

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Connector and dimensions (per print)
Terminal location and dimensions (go gages)
Note: Record results on inspection log

7.1.7 Terminal Strength

The same four devices used in 7.1.6 will be measured for terminal strength.

The switch shall be mounted in a special force test gage.

A pendulum shall apply a 10.0 lb (.415 lb at 1.0 ft) impact force to the switch housing at the connector end, perpendicular to the center line axis of the switch.

7.1.8 Push Out Test

The same four (4) devices used in 7.1.7 will be tested for push out force. The switches will be mounted in test stand with a force gage.

For acceptance, the terminals will withstand a 20.0 lb axial push force.

Upon completion of the test, the switches shall be tested for calibration, current leakage, and proof test.

For lot acceptance, all switches shall not have any terminal or housing fracture, and must pass test defined above. Record results on inspection log.

7.2 Inspection of Salvaged/Reworked Material

All salvage material will be inspected prior to use. Ten percent (10%) of the salvage parts or subassemblies will be inspected to determine that they conform to print specification or engineering standard. A defect requires notification of the supervisor or group leader by a rejection notice (Form #5341) and a resample after corrective action.

8.0 RELIABILITY

8.1 Reliability testing will be accomplished per the following schedule:

TYPE TEST	*SAMPLE SIZE*	*FREQUENCY**	*MIN. REQ.*
Humidity	6	2/Yr	P90=.72
Salt Spray	6	2/Yr	P90=.72
Vibration	6	2/Yr	P90=.72
Vacuum	6	2/Yr	P90=.72
Temperature Cycle	6	2/Yr	P90=.72

NOTE: Additional reliability testing may be accomplished to assure product conformance.

* 2/yr., where the reliability testing will be accomplished during the first and second halves of the year.

Reliability testing may be accomplished with switches that are similar in construction and function; e.g., 87PS/57PS/77PS/52PS, whereby reliability testing of switches in these families may be used to fulfill this requirement. Switch samples, where possible, will include representative samples from the 87PS/57PS/77PS/52PS series.

8.2 Test Procedures:

8.2.1 Humidity

8.2.1.1 Mount the switch in the test port in a humidity chamber. Currently released mating electrical connector must be installed before start of test.

8.2.1.2 Subject the switch to ten (10) continuous humidity cycles as follows:

- Raise temperature to 65 + 10/-2°C over 2.5 hours; at 90 - 98% relative humidity.
- Hold 3 hours at 65 +10/-2°C at 90-98% relative humidity.
- Lower temperature to 25 + 10/-2°C over 2.5 hours; at 80 - 98% relative humidity.

8.2.1.3 Acceptance Requirements

Within 15 minutes after completion of the tenth humidity cycle, check the switch to 7.1.1, 7.1.2 and 7.1.4.

8.2.1.4 Nonconformance is defined as any switch not meeting the criteria in Section 7.0, Para. 7.1.1, 7.1.2, and 7.1.4.

8.2.2 Salt Spray

8.2.2.1 Mount the switch horizontal in the test port in a salt spray chamber. The currently released mating electrical connector and wiring must be installed prior to start of test.

8.2.2.2 Expose the switch assembly to 72 hours of salt spray per ASTM B-117.

8.2.2.3 After exposure, check the switch to 7.1.1, 7.1.2, and 7.1.4, using the procedure established in each section.

8.2.2.4 Nonconformance is defined as any switch not meeting the criteria in 7.1.1, 7.1.2, and 7.1.4. Samples used for this test must be destroyed after all testing is completed.

8.2.3 Vibration

8.2.3.1 Mount the switch in the test port and attach the currently released mating electrical connector before the start of test.

8.2.3.2 Switches are to be vibrated in all 3 planes with electrical continuity being monitored during the entire test. Vibration tests are to be conducted at room temperature using brake fluid, ambient air, or equivalent as the pressure medium.

8.2.3.3 Internal pressure shall be maintained at zero kPa when the switch is in the closed position and 1.1 times max actuation pressure shown on print when the switch is in the open position.

8.2.3.4 Vibrate the switch 1.5 mm displacement (peak to peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

8.2.3.5 Vibrate the switch in alternate one-hour periods in the open and closed positions for a total of 8 hours in each plane. (Total test time is 24 hours.)

8.2.3.6 After the entire vibration sequence, check the switches to Section 7.0, Para. 7.1.1, 7.1.2, and 7.1.4 using the procedures established in each section.

8.2.3.7 Nonconformance is defined as any evidence of leakage or any change in electrical continuity/ discontinuity during the vibration cycles, or any switch not meeting the criteria in Section 7.0, Para. 7.1.1, 7.1.2, and 7.1.4. Samples used for this test must be destroyed after all testing is complete.

8.2.4 <u>Vacuum</u>

8.2.4.1 Mount the switch in the test port. Vacuum tests are to be conducted at room temperature using ambient air as the pressure medium.

8.2.4.2 Subject the switch to 5 cycles of vacuum from atmospheric pressure (760 mmHg) to an absolute pressure of 3-6 mmHg. Maintain the vacuum for a minimum of 60 seconds.

8.2.4.3 Check the switch to Section 7.0, Para. 7.1.1, 7.1.2 and 7.1.4 using the procedure established in each section.

8.2.4.4 Nonconformance is defined as any switch not meeting the criteria in Section 7.0, Para. 7.1.1, 7.1.2, and 7.1.4.

- Note: 3 mmHg = 0.058 psi = 0.400 kPa
  6 mmHg = 0.116 psi = 0.800 kPa

8.2.5 Temperature Cycle

8.2.5.1 Mount switches in test ports; test to be run using currently released brake fluid.

Repeat the following procedure 25 times.

8.2.5.2 Lower the switch and fluid temperature to at least -40°C.

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8.2.5.3 Cycle the switches ten times at 10 seconds/cycle. One cycle consists of a pressure variation from 0 - 276 kPa G (0-40 psi) to 9,655 - 10,345 kPa G (1400 - 1500 psi).

NOTE: Switch must open and close each cycle.

8.2.5.4 Raise switch fluid temperature to 38°C minimum.

8.2.5.5 Repeat step 8.2.5.3.

8.2.5.6 At completion, check switches per Section 7.0, Para. 7.1.1, 7.1.2 and 7.1.4.

8.2.5.7 Nonconformance is defined as any evidence of switch fluid leakage, seepage, or not meeting the criteria of Sections 7.0, Para. 7.1.1, 7.1.2 and 7.1.4.

9.0 AUDITING

9.1 To provide uniform and systematic procedures for conducting an audit for a single operation or an entire product line. Audits will be conducted to ensure all operations are in control and being performed to the latest manufacturing standards and procedures and comply to both internal and customer drawings and specifications.

9.2 The instructions for conducting an audit will be found in QA-17-2-1.

9.3 Areas to be Audited

A. Process Specifications (Operations)
B. SPC Process Specifications
C. Route Slips
D. Preventive Maintenance
E. Blueprints
F. Tools
G. Quality (Produce/Operation)
H. Statistical Process Control (SPC)
I. Housekeeping and Material Identification
J. Safety

10.0 RECORD RETENTION

Route Cards, control charts, inspection characteristics, data sheets, test forms, laboratory test results, gage repeatability studies, and engineering specification test methods must be retained through the current model year and for one year thereafter. All records will be available for review by customers and copies of individual records will be furnished upon request. All records should be properly organized, filed, and separated by month.

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TEXAS INSTRUMENTS INCORPORATED, AUTOMOTIVE SENSORS & CONTROLS		
TITLE: ACCEPTANCE TEST PROCEDURE 77PS PRESSURE SWITCH	DOC. NO. QAS 208	
	SHEET 10 OF 10	REV. R

REV	ECN	DESCRIPTION OF CHANGE	DATE	BY
A		Para. 4.0 Special Instructions – Reformatted	04/11/92	Rose
B		Correlated Sample Sizes to Spec.; Added new part numbers to cover sheet	09/23/92	Rose
C		Added Para. 1.0, 3.0 and 4.0. Reformatted and renumbered the remaining paragraphs to comply with ISO 9001 requirements	06/09/94	Rose
D		Para. 5.0 – Change customer P/N to F6LC-9F924-AA	12/02/94	Rose
E		Para. 10.0 -- Added "All records should be ..."	12/06/94	Watt
F		Para. 7.0 – Added "Thread Adaptors"; Para 8.0 – Added note on frequency	02/23/95	Rose
G		Para 7.1.3 -- Added # of cycles	03/08/95	Rose
H		Para 7.1.4 – Added test chart	04/26/95	Rose
J		Added 6.1.1; Replaced thread size specific in 7.1.6 with 'see env. dwg.'	06/09/95	Rose
K		Changed 'Precision Controls Department' to 'Precision Controls Business'; Rearranged Test Format under 7.1; Replaced 'build' with 'packing' under 7.0	11/20/95	Rose
L		General editing	10/02/96	Watt
M		Changed 'Precision Controls Business' to 'Automotive Sensors & Controls'	03/14/97	RA
N		7.1.6 Removed actual dimensions; Replace with reference "See Envelope Dwg."	03/09/98	Rose
O		Added P/N 77PSL3-4 Para 5.1	05/18/98	Rose
P		Sect. 5.1 changed customer p/n of TI p/n 77PSL3-4 to MSK 100050; Added TI p/n 77PSL3-4 to sect. 7.1.4; changed distribution	10/15/98	DH
R		General Update	02/03/00	J. Watt

1992 CROWN VICTORIA NORTH AMERICAN POWERTRAIN CUSTOMER CORRELATION PROGRAM

1992 CROWN VICTORIA 4.6L, AODE PARAMETERS	BASED ON 150,000 MILES OF NORTH AMERICAN CUSTOMER USAGE			
	NORTH AMERICAN CUSTOMER		Michigan Proving Ground	
	50%	95%	R-319 Procedure	
	VALUES	VALUES	VALUES	PERCENTILE
BRAKING RELATED PARAMETERS				
Number of brake applications	715331	1764993	1240[illegible]	[illegible]
Total time braking (h)	13[illegible]	3[illegible]	241	[illegible]
Time mild braking ([illegible] 6 fpss) (h)	12[illegible]	2[illegible]44	157	7
Time med. braking ([illegible]) (h)	[illegible]	144	76	51
Time heavy braking ([illegible] 15 fpss) (h)	0	1	7	100
Brake energy (ft-lb/mile)	21[illegible]	405371.67	47[illegible]	9[illegible]
Brake energy (ft-lb/brake-application)	37715	72[illegible]	1[illegible]	100
Brake Power (hp/min)	79.04	1[illegible]	1[illegible]	87
Brake Power (hp/brake-application)	14.[illegible]	34.47	54	100

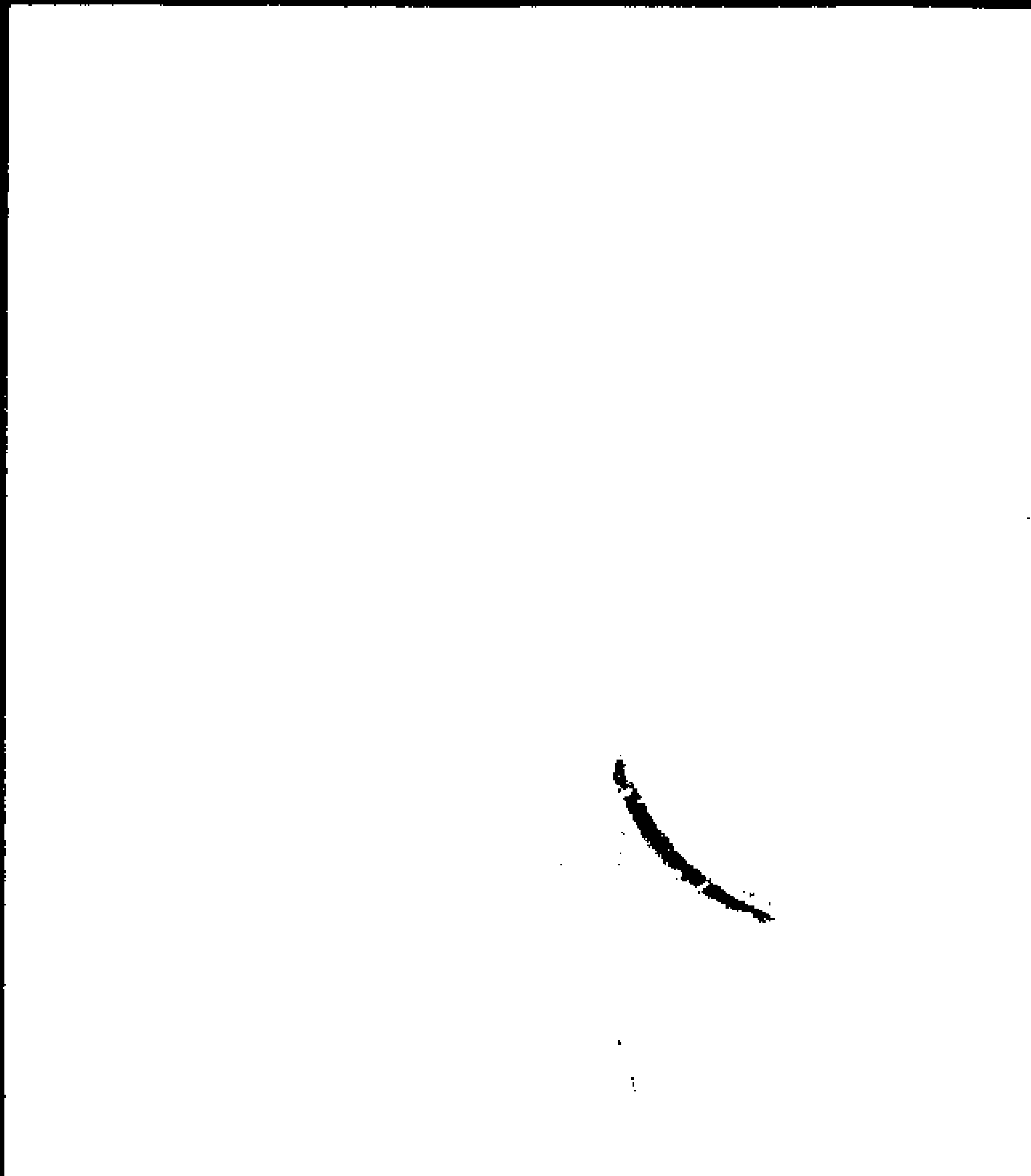
$\frac{715,331}{150,000} = 4.77 \text{ appl mi}^{-1}$ $\frac{1,764,993}{150,000} = 11.70 \text{ appl mi}^{-1}$

Customer Sample: 4[illegible] Crown Victoria/Grand Marquis

1992 Crown Victoria North American Powertrain Customer Correlation
[illegible] : Customer Correlation [illegible]
[illegible]

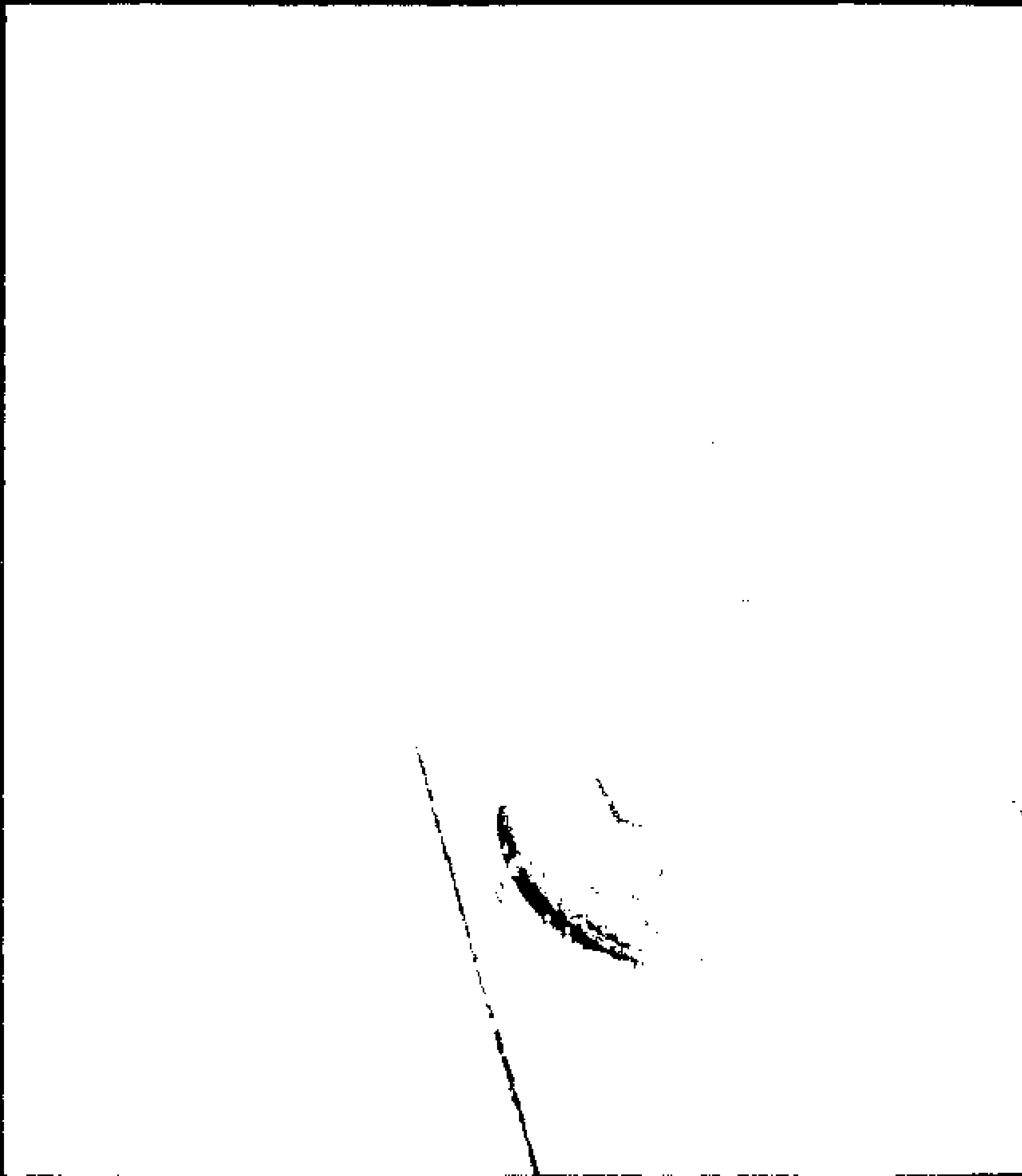
TI-NHTSA 014454

[illegible]
Ford
[illegible]



TI-NHTSA 014456

TI-NHTSA 014458



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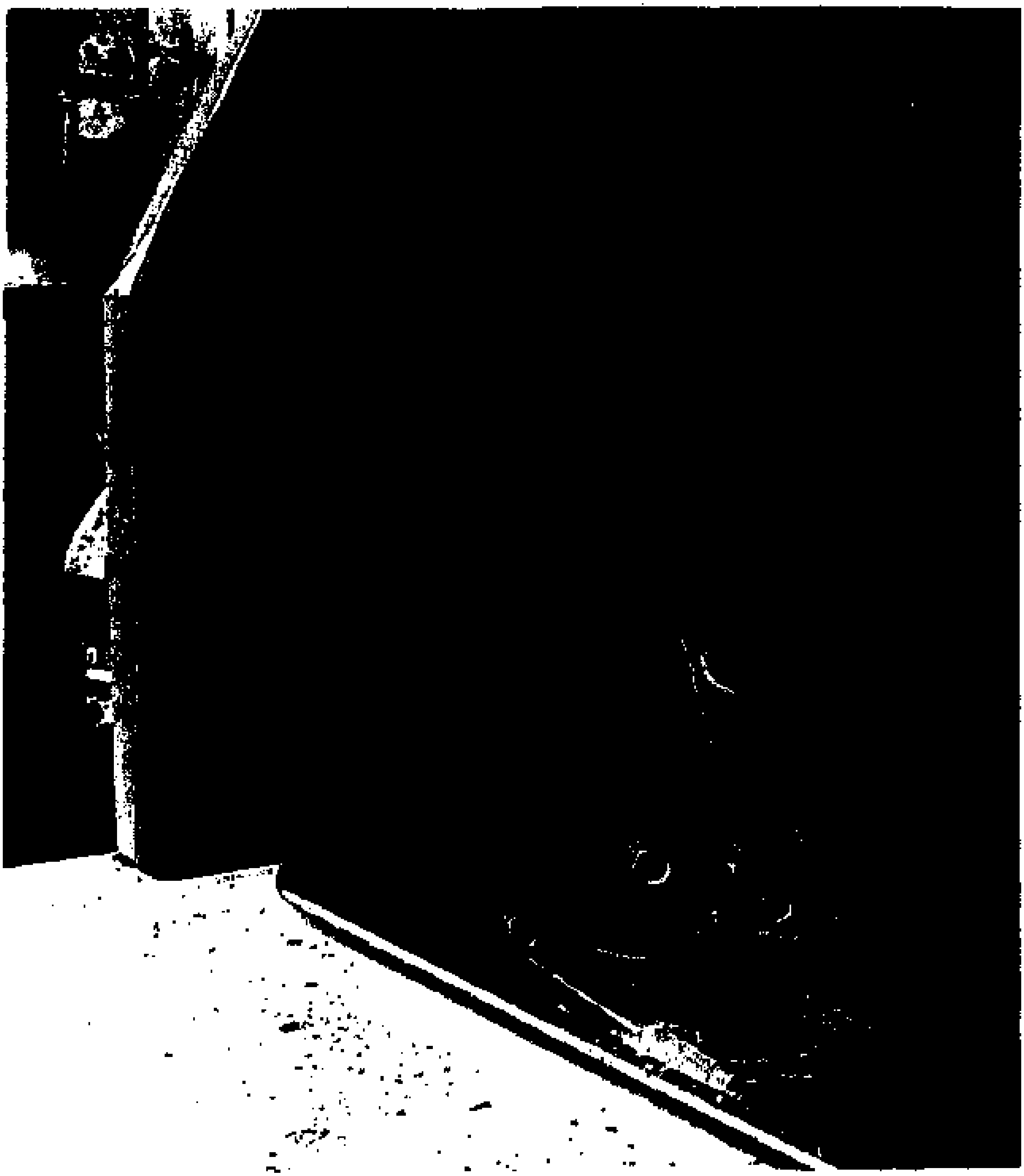
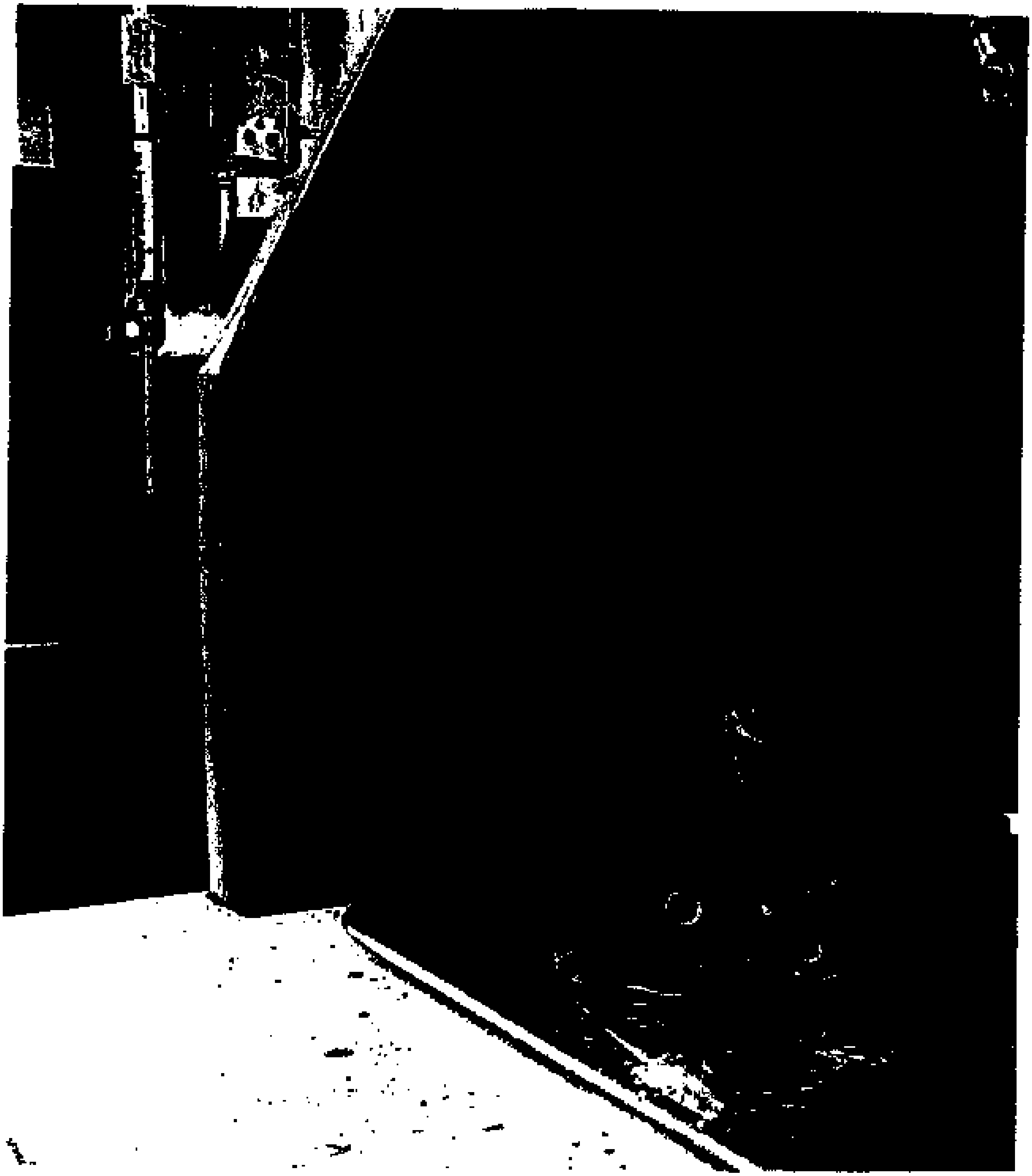


TI-NHTSA 014458



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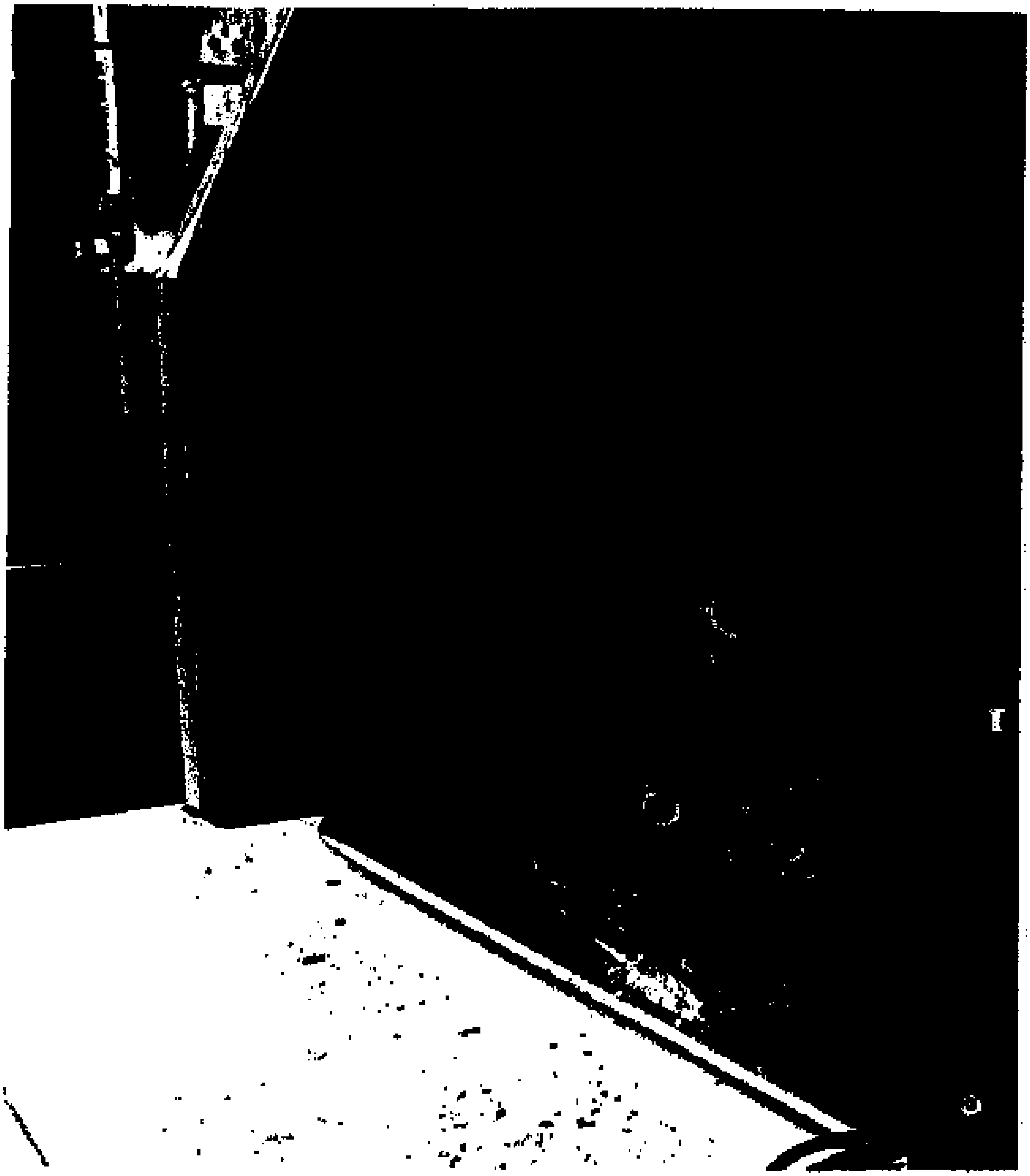
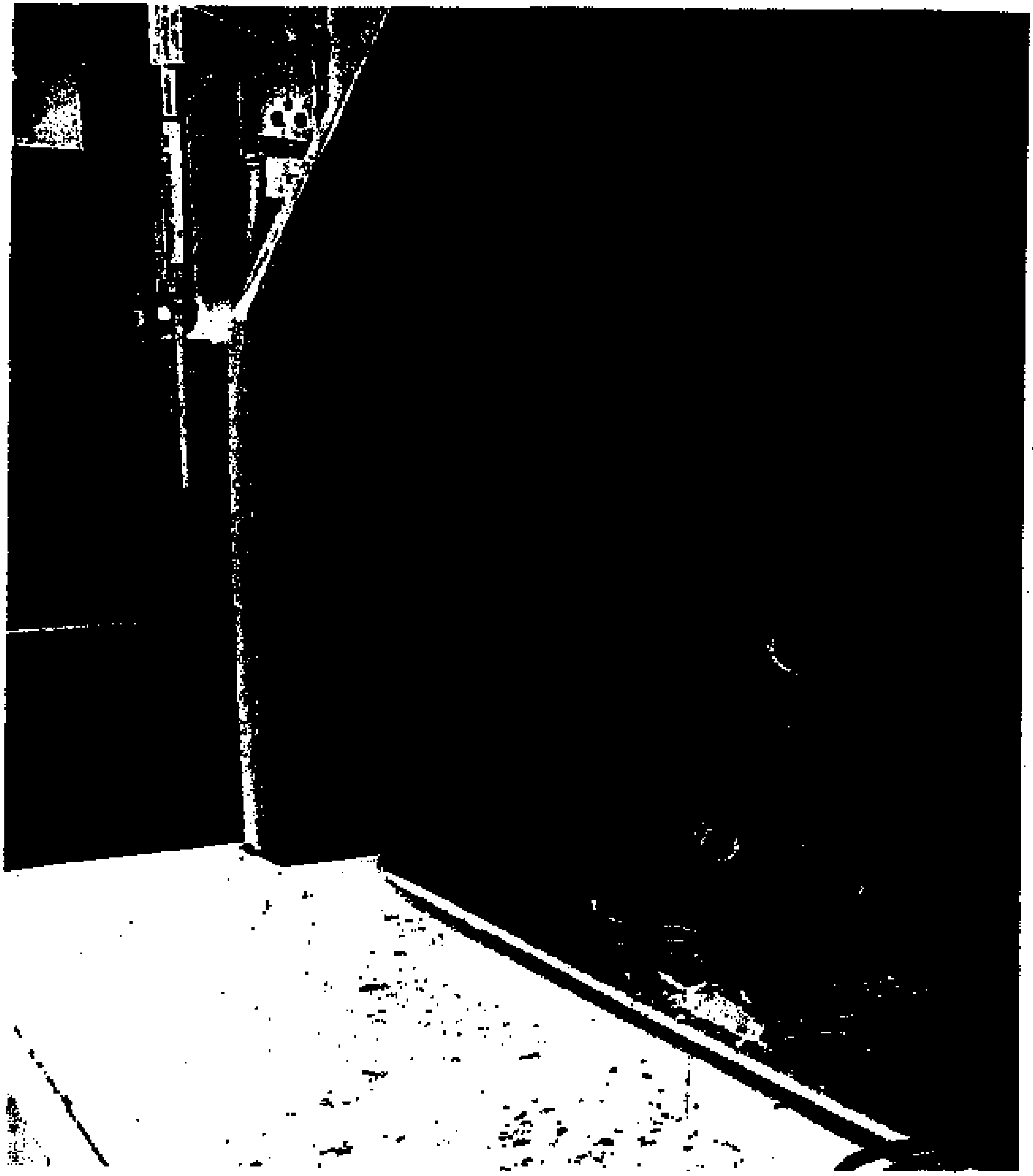


TI-NHTSA 014460



Leonard, Kevin

From:	Douglas, Charles
Sent:	Thursday, May 18, 2000 11:22 AM
To:	Leonard, Kevin
Cc:	Gildea, Robert
Subject:	FW: 77PSL3-3 performance

Kevin,

Based on the attached and given that we ship roughly 2MU per year of the 77PSL3-3, actual field quality ppm performance has been sub 10 consistently on an annual basis over the timeframe CY97 - CY00.

For your reference, the CY98 contamination issue refereed to is contamination that occurred at our customers' plant (one specific Bosch assembly plant). The issue was a discoloration of one of the terminals. Upon detailed analysis, there was a determination that chlorine was somehow present. Given that we ship the part to more than half a dozen different assembly plants and given that we ship to multiple Bosch assembly plants and the issue only showed itself at one specific Bosch plant, our determination was that the cause of the problem occurred at Bosch (which is probably the reason we did not get dinged on ppm for this one).

Relative to CY00, as you will note, the out of round condition on the hexport orifice was for the most part contained to our facility.

Also of note, for your reference, the issue with that led to Ford recalling vehicles to replace switches was isolated to passcars which utilized the 77PSL2-1 and not the L3-3. However, it is as a result of this incident that we will no longer take on new applications which result in constant power being applied to our device even when the vehicle is not running.

Hopefully, the above combined with the attached provides enough information for you to share with C-T. If we had waited for formal QC input, they wanted another 2 weeks to provide any inputs. As a result, Bob and I did the best we could to piece together some pertinent information.

Regards,

Charlie

Charles L Douglas
c-douglas3@ti.com
(508) 236-3857 (P)
(508) 236-1598 (F)

From:	Gildea, Robert
Sent:	Thursday, May 18, 2000 10:53 AM
To:	Douglas, Charles
Subject:	77PSL3-3 performance

Charlie,

The following is the data dating back to 1997.

1997: 1 device from Tokico for no continuity.

TI-NHTSA 014462

1998: Bosch contamination issue, don't believe we took any parts back.

1999: 2 devices from Bosch. 1 for no continuity and 1 for exposed Kapton. The exposed Kapton was debris from the table, nothing to do with the device.

2000: Out of round metal to metal seal. We rejected 942 parts through our own sort. We only had 4 parts returned from the customer.

Regards,

Bob

-MSG M#= 00189261 FR=ZIZ TO=ZIZ SENT=00/00/00 12:00 AM
S#=116 ST=U DIV=0050 CC=00101 BY=ZIZ AT=06/06/94 02:10 PM

To: BELINDA YARNELL BSYB

Copy: MATT SELLERS MJS2
CHRIS D. WAGNER CDW3

From: AZIZ RAHMAN ZIZ

Subj: 77PS/87PS OPEN ITEMS

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1. 100% IMPULSE TESTING OF 77PSL3-3:

THIS TEST WAS INSTITUTED AS A RESULT OF OUR 8-D INVESTIGATION INTO WASHER/CONVERTOR BINDING SEEN IN FIELD RETURNS DURING 3-4Q'93. THE 8-D CORRECTIVE ACTIONS CALLED FOR A DUAL PATH APPROACH TO RESOLVE THE ISSUE. THE FIRST STAGE, TIGHTER CONVERTOR BUTTON DIAMETER CONTROL HAS BEEN IMPLEMENTED. THE SECOND STAGE, CHANGING WASHER GEOMETRY IS ON HOLD PENDING RESOLUTION OF TOOLING ISSUES. THE IMPULSE TEST WAS "AN INTERIM" CONTAINMENT ACTION, UNTIL THIS TOOL CHANGE WAS COMPLETE. SO IN EFFECT, WE STILL NEED TO CONTINUE DOING THIS TEST. THERE MAY BE SOME WAYS IN WHICH WE CAN ALLEVIATE THE LINE-LOAD WHILE STILL MAINTAINING THE CONTAINMENT INTENT IN PLACE. I HAD TALKED WITH CHRIS REGARDING THE POSSIBILITY OF CHANGING THE IMPULSE REQUIREMENT FROM "EVERY LOT" TO "EVERY WASHER LOT". CONCEPTUALLY, THIS SHOULD REDUCE THE NUMBER OF LOTS SENT FOR IMPULSE. PLEASE CLOSE WITH CHRIS & MATT TO FORMALLY IMPLEMENT THIS CHANGE.

2. 100% VACUUM TESTING OF 77PSL4-1, 5-2 & 6-1.

THIS TEST WAS MANDATED BASED ON RESULTS OF INVESTIGATION INTO FIELD FAILURES OF THE 5-2. 5-2s, 4-1s AND 6-1s ARE UNDER HIGHER LEVELS OF VACUUM IN THE FIELD THAN OTHER CCPS SWITCHES. IN ORDER TO PRECLUDE OPEN CIRCUIT CONDITION AT A HIGH VACUUM, THE CUP DESIGN WAS CHANGED TO PREVENT EXCESSIVE SLOP IN THE SENSOR PACKAGE. THE ADDITIONAL BURDEN OF BEING "QUIET" SWITCHES DOES NOT HELP THIS CONDITION. THE VACUUM TEST ON LINE IS SOMEWHAT OF A BELTS AND SUSPENDERS APPROACH. THE CUP DESIGN CHANGE DID REDUCE SLOP IN THE PACKAGE, BUT THERE ARE OTHER PROCESS VARIABLES (E.G. CRIMPING) WHICH CAN CONTRIBUTE TO THIS FAILURE MODE. IN LIGHT OF THE RECENT "RATTLING" ISSUES ON THE L3-3 , A CLASSIC SIGN OF EXESSIVE CLEARANCE IN THE SENSOR PACKAGE, I DO NOT RECOMMEND REMOVAL OF THIS TEST. WE NEED FURTHER STUDIES TO FULLY COMPREHEND THIS RECENT RESURGENCE OF RATTLERS. ON THE OTHER HAND, IN VIEW OF INCREASED CUSTOMER DEMAND FOR THESE PART NUMBERS, WE NEED TO FIND AN ERGONOMICALLY SENSIBLE METHOD TO PERFORM THIS OPERATION. USE OF AN AIR ASSISTED DRIVER WILL REDUCE OPERATOR FATIGUE. WE SHOULD ALSO LOOK AT POSSIBLE INCORPORATION OF THIS TEST IN THE FINAL TESTER. PLEASE CLOSE WITH MATT, R&M AND MECHANIZATION TO DETERMINE IF WE CAN INDEED DO THIS.

3. 52/77PS CRIMP DIE INTERCHANGEABILITY:

THE ONLY HISTORY I HAVE HERE, IS THAT DURING INITIAL VALIDATION TESTING OF THE 77PS PROGRAM, SENSORS CRIMPED WITH THE 52PS DIES EXHIBITED EARLY LIFE FAILURES WHEREAS SENSORS CRIMPED ON 77PS DIES REACHED ACCEPTABLE CYCLE LIFE. THAT IS HOW THE SWITCH WAS APPROVED BY THE CUSTOMER, AND THE DIES STAYED. AT THIS STAGE OF THE GAME, IN LIGHT OF SERIOUS CAPACITY CONCERNS ON THE AMI, WE SHOULD REVISIT OUR ORIGINAL ASSUMPTIONS. I WILL CLOSE WITH CHRIS TO PUT TOGETHER A GAME PLAN TO ADDRESS THIS ISSUE AND COPY YOU ON OUR TEST PLAN/SCHEDULE.

I HOPE THE ABOVE HAS GIVEN YOU SOME INSIGHT INTO WHY WE ARE DOING THESE

REGARDS
AZIZ.

PS/00/32

"Tear Drop" Impulse Test (Section 3.1.0)
December 23, 2000

Purpose:
The objective of this test is to compare the life of "tear drop" diaphragms to "non tear drop" diaphragms when pressure cycled per the Ford specification.

Procedure:
1) 150 77PS pressure switches were built. Since it is not possible to determine which switches have "tear drops" and which ones do not have "tear drops" without cutting the switch open at the hex, the mix would be determined later. See Step 5.

2) Switches were exposed to pressure cycles in brake fluid and temperatures as defined in Ford Engineering Specification ES-F2VC-9F24-AA. Since the cycling equipment is only capable of cycling about 50 switches at once, 3 groups of 50 where run.

3) Switches were to be run to failure or 1.5 million cycles whatever occurs first. The Ford Specification requires 0.5 million full-scale pressure cycles.

4) Failure is defined as a switch that leaks brake fluid.

5) Upon failure or reaching 1.5 million cycles the switches were removed and the and the hex was cut off in a manner that made it possible to view the diaphragm. While the diaphragm was still compressed, it was now possible to determine if the diaphragm had formed a tear drop during assembly. The number of switches with "tear drops" were determined.

Results:
Group #1:

Switch failed:
1 at 1.23 million cycles no "tear drop".

49 were suspended at 1.5 million cycles. 6 with "tear drops". 43 without "tear drops".

Group #2:

Switch failed:
1 at 1.12 million cycles "tear drop".
1 at 1.37 million cycles no "tear drop"
1 at 1.41 million cycles no "tear drop"
1 at 1.42 million cycles no "tear drop"
2 at 1.5 million cycles no "tear drop"

44 were suspended at 1.5 million cycles. 12 with "tear drops". 32 without "tear drops".

CUSTOMER: Ford	TEST:	PAGE 1 OF 2
TESTED BY: L. Cambra	TEXAS INSTRUMENTS INCORPORATED	DEVICE: 77PSL3-2
APPROVED BY: B. Dague	MATERIALS & CONTROLS GROUP	DOC.: PS/00/32
DATE: 12/23/00	ATTLEBORO, MASSACHUSETTS 02703	FILE NAME:

Group #3:
Switch failed:

Zero failed before suspension.

50 were suspended at 1.5 million cycles. 12 with "tear drops". 38 without "tear drops".

Total for all 3 groups:
150 switches run in total(100%).
143 were suspended at 1.5 million (95%).
31 with "tear drops" (21%) of the 150.
119 without "tear drops (79%) of the 150.

7 failures before 1.5 million, 2 with "tear drops" and 5 without "tear drops".

Of the 150 switches, 31 were found to have "tear drops", and 119 were found to have no "tear drops".

Conclusions:
No significant differences in time to failure or end of life could be seen between the switches with "tear drops" and switches without "tear drops" when exposed to the Ford specification. The population consisted of 21% "tear drops" and the failures consisted of 28% "tear drops". Given the sample sizes, there appears to be no significant difference.

CUSTOMER: Ford	TEST:	PAGE 2 OF 2
TESTED BY: L. Cambra	TEXAS INSTRUMENTS INCORPORATED	DEVICE: 77PSL3-2
APPROVED BY: B. Dague	MATERIALS & CONTROLS GROUP	DOC. : PS/00/32
DATE: 12/23/00	ATTLEBORO, MASSACHUSETTS 02703	FILE NAME:

1/2/01
52930

run	F lb	P psi	-A G	$\frac{P}{F}$	$-\frac{A}{F}$	$\frac{P_T}{P_4}$
2-5	13	370	0.306			
2-3	13	380	0.299			
1-4	14	370	0.319			
1-5	14	380	0.323			
2-2	14	400	0.295			
2-4	14	410	0.313			
1-3	15	360	0.313			
1-2	15	380	0.324			
2-1	16	440	0.328			
1-1	17	420	0.317			
3-6	25	600				
3-5	29	550				
ave $_{12}$	14.50		0.3197		2.163×10^{-2}	
ave x	16.58	421.7		25.43		1.000
	23.89	600.0	0.5103			

TI-NHTSA 014468

1/2/01
52930

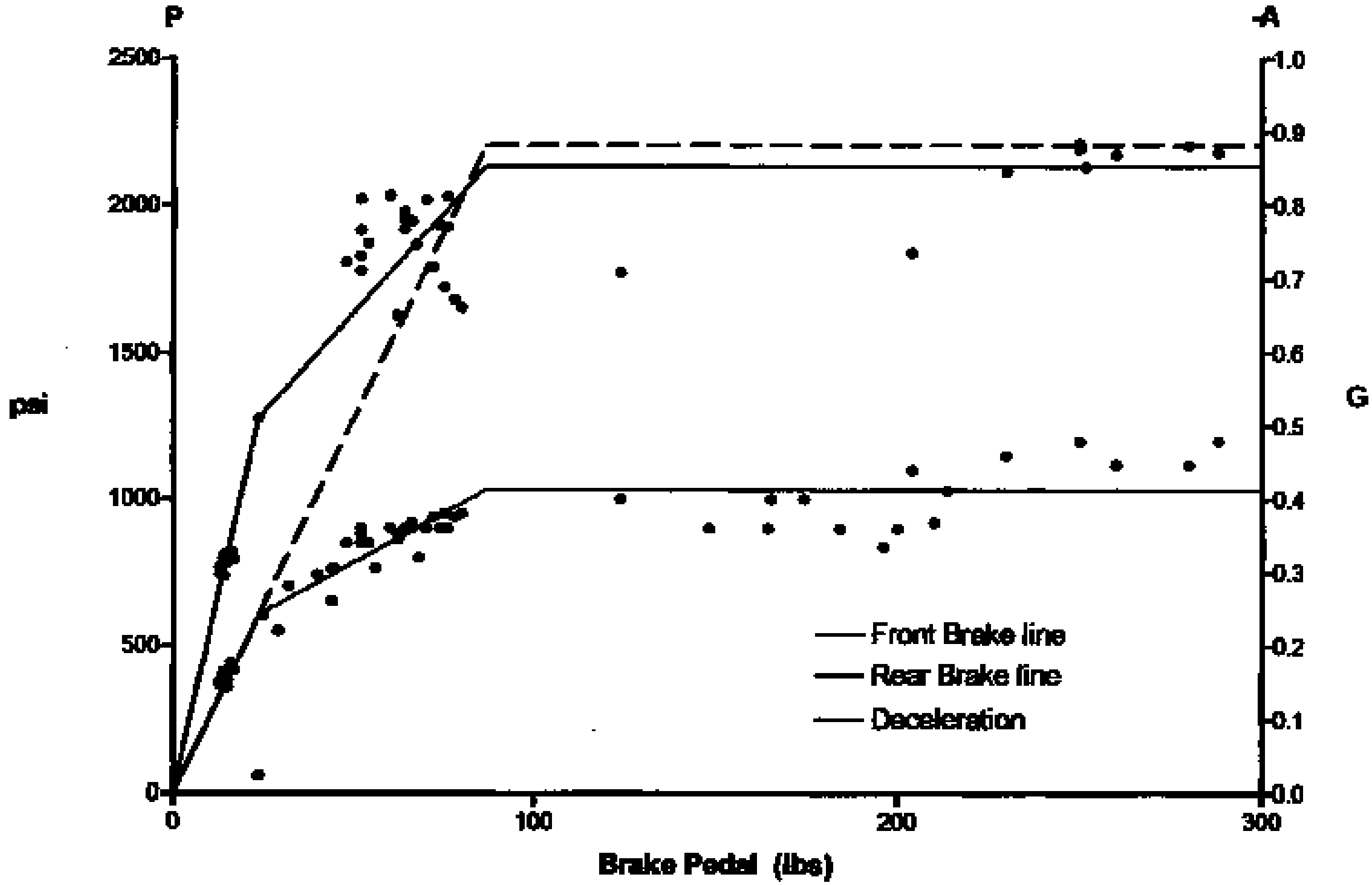
run	F lb	P_r psi	-A G		
3-7	32	700			
0-3	40	740			
3-8	44	650			
0-2	44	760			
0-1	45	760			
1-10	48	850	0.724		
2-10	52	850	0.731		
2-7	52	880	0.767		
2-16	52	900	0.711		
2-12	52	900	0.809		
1-9	54	850	0.748		
3-10	56	765			
2-11	60	900	0.814		
2-13	62	880	0.651		
2-6	64	900	0.768		
2-14	64	900	0.783		
2-8	64	900	0.792		
2-17	66	920	0.779		
3-9	68	800			
1-8	70	900	0.808		
2-15	72	940	0.717		
1-7	74	900	0.773		
2-22	75	950	0.690		
2-9	76	900	0.771		
1-6	76	900	0.813		

1/2/01
52930

run	F lb	P_T psi	-A G	$\frac{\Delta P}{\Delta F}$	$-\frac{\Delta A}{\Delta F}$	$\frac{\Delta P_T}{\Delta P_F}$
2-20	78	940	0.678			
2-21	80	950	0.662			
2-19 a	124	1000	0.709			
3-1 b	148	900				
3-2	164	980				
0-4	165	1000				
0-5	174	1000				
3-3	184	900				
3-4	196	840				
3-11	200	900				
2-18	204	1100	0.786			
3-12	210	920				
2-23	230	1150	0.846			
1-11	250	1200	0.878			
2-24	250	1200	0.885			
2-26	260	1120	0.870			
2-25	280	1120	0.882			
2-27	288	1200	0.873			
ΔF_a = F-23.59						
ΔP_a = P-600						
$-\Delta A_a$ = -A-0.5103						
Ave_{12a}	67.38		0.7473		5.412×10^{-5}	
Ave_{2a}	62.29	863.75		6.815		0.268
Ave_{12b}	251.71		0.8529		0	
Ave_{2b}	213.58	1030.00		0		0
ΔF_{abP}	63.10					
ΔF_{abA}	63.30					

Ford Brake Test Data

1992 Town Car VIN 1LNLM81W3NY669063



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Lincoln Test Data Maximum Rear Pressures by Test Run

Filename	Run #	Description	Max. Rear Pressure	Brake Pedal Effort at Max (lbs)	Pressure at Switch Deactivation
[illegible]	27	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	13	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	25	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	26	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	28	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MAX PRESSURES [illegible]

Channel #	Description
1	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	[illegible]
6	[illegible]
7	[illegible]
8	[illegible]
9	[illegible]

Pressures are Values from Data Graphs

Average Deceleration vs. Rear Pressure Data

Test Number		Average Deceleration	Max. Rear Pressure
Lincol1	1	0.317	420
Lincol1	2	0.324	360
Lincol1	3	0.313	380
Lincol1	4	0.319	370
Lincol1	5	0.323	380
Lincol1	6	0.813	[illegible]
Lincol1	7	0.772	900
Lincol1	8	[illegible]	900
Lincol1	9	0.740	860
Lincol1	10	0.724	[illegible]
Lincol1	11	0.878	1280
Lincol2	1	[illegible]	440
Lincol2	2	[illegible]	480
Lincol2	3	0.290	[illegible]
Lincol2	4	0.313	410
Lincol2	5	[illegible]	370
Lincol2	6	0.708	[illegible]
Lincol2	7	0.707	[illegible]
Lincol2	8	0.782	900
Lincol2	9	0.771	900
Lincol2	10	0.731	[illegible]
Lincol2	11	0.814	[illegible]
Lincol2	12	[illegible]	900
Lincol2	13	0.851	[illegible]
Lincol2	14	0.703	900
Lincol2	15	0.717	940
Lincol2	16	0.711	900
Lincol2	17	0.779	[illegible]
Lincol2	18	0.736	1100
Lincol2	19	0.709	1000
Lincol2	20	0.873	940
Lincol2	21	[illegible]	950
Lincol2	22	[illegible]	950
Lincol2	23	[illegible]	1100
Lincol2	24	[illegible]	1200
Lincol2	25	[illegible]	1120
Lincol2	26	[illegible]	1120
Lincol2	27	0.873	1200

TI-NHTSA 014472

FORD MOTOR CORP

FORD

The Ford Motor Company car lines: Ford, Lincoln, Mercury and Merkur have been incorporated into this section. Since they all utilize the same descriptive data used in VIN positions 1,2,3,4,5,8, and 11, the information relating to these positions is displayed in the VIN structure below.

VIN STRUCTURE

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	F	A	L	P	4	2	D	8	S	F	1	6	4	7	2	3

- (1) NATION OF ORIGIN
- (2) MANUFACTURER
- (3) VEHICLE TYPE
- (4) RESTRAINT SYSTEM
- (5) DESIGNATION
- (6, 7) BODY TYPE
- (8) ENGINE
- (9) CHECK DIGIT
- (10) MODEL YEAR R-1994 S-1995
- (11) ASSEMBLY PLANT
- (12–17) SEQ. PRODUCTION NUMBER

NATION OF ORIGIN

(VIN pos. 1)	95	94	93	92	91
USA	1	1	1	1	1
CANADA	2	2	2	2	2
MEXICO	3	3	3	3	3
USA (MAZDA)	4	4	4	4	4
AUSTRALIA (IMPORTED MERCURY CAPRI)	6	6	6	6	6
KOREA (IMPORTED FESTIVA)	K	K	K	K	K

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MANUFACTURER

(VIN pos. 2)	95	94	93	92	91
Mazda Motor Corporation	F	F	F	F	F
Ford Motor Company (FORD)	F	F	F	F	F
Ford Motor Company (LINCOLN)	L	L	L	L	L
Ford Motor Company (MERCURY)	M	M	M	M	M
KIA Motors Inc., Korea (FESTIVA)	N	N	N	N	N
Ford Motor Company (DIESEL)	N	N	-	-	-
Mazda Motor Corporation, USA	-	-	Z	Z	Z
AutoAlliance International, Inc.	Z	Z	-	-	-

VEHICLE TYPE

(VIN pos. 3)	95	94	93	92	91
Passenger Car (USA)	A	A	A	A	A
Passenger Car (MEXICO)	A	A	A	A	A
Stripped Chassis (MEXICO)	C	C	C	C	C
Incomplete Vehicle (FORD)	D	D	D	D	D
Passenger Car (MERCURY)	E	G	E	G	E
Incomplete Vehicle (MERCURY)	H	H	H	H	H
Incomplete Vehicle (LINCOLN)	J	J	J	J	J
Passenger Car (FESTIVA-Imported)	J	J	J	J	J
Passenger Car (LINCOLN)	N	N	N	N	N
Passenger Car (AUSTRALIA)	-	P	P	P	P
Passenger Car (MAZDA/FORD)	-	-	V	V	V
Passenger Car (MERKUR)	-	-	-	-	I
Incomplete Vehicle (MAZDA)	8	8	8	8	8
AutoAlliance International, Inc.	V	Y	-	-	-

RESTRAINT SYSTEM

(VIN pos. 4)	95	94	93	92	91
Driver Air Bag w/Active Belts & Passive Pass. Belts	A	A	-	-	-
Active Belts	B	B	B	B	B
Driver Air Bag w/ Active Belts	C	C	C	C	C
Air Bags (Front) w/ Active Belts (All Positions)	L	L	L	L	L
Passive Belts (Front) Active Belts (Rear)	P	-	P	P	P
Driver Air Bag/Passive Belts (Front) Active Belts (Rear)	R	R	-	-	-
Dr. & Pass. Air Bag/Passive Belts (Front) Active Belts (Rear)	R	R	-	-	-

DESIGNATION

(VIN pos. 5)	95	94	93	92	91
"LINCOLN" OR "MERCURY" MAKE	M	M	M	M	M
"FORD" MAKE	P	P	P	P	P
Imported from outside North America or Non-Ford built car marketed by Ford in North America	T	T	T	T	T

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ENGINE

(VIN pos. 8)	95	94	93	92	91
2.0L I-4 EFI DOHC	A	A	A	-	-
2.5L V-6 EFI DOHC	B	B	-	-	-
2.3L I-4 EFI (Probe Only)	-	-	-	C	D
3.0L V-6 EFI SHP (Mustang Cobra only)	D	D	-	-	-
5.0L V-8 HO EFI (Mustang & Mark VII)	-	-	K	E	E
3.8L V-6 2 BBL EFI	-	-	-	-	F
5.0L V-8 EFI	-	-	Q	-	-
1.6L I-4 EFI	H	H	H	H	H
1.9L I-4 EFI	J	J	J	J	J
2.3L I-4 EFI TC/AC (Turbo)	-	-	-	L	L
2.5L V-6 EFI DOHC	L	-	-	-	-
2.5L I-4 CHO EFI	-	-	M	M	M
2.3L I-4 CFI	-	-	-	-	X
3.2L V-6 EFI SHO DOHC	P	P	P	-	-
3.8L V-6 EFI SC	R	R	R	R	R
2.3L I-4 HSC-EFI	-	-	-	-	S
5.0L V-8 EFI HO (Thunderbird, Cougar)	-	-	T	T	T
5.0L V-8 EFI HO (Mustang)	T	T	-	-	-
3.8L V-6 EFI	U	U	U	U	U
4.6L V-8 EFI DOHC	V	V	V	-	-
4.6L V-8 EFI	W	W	W	W	W
2.3L I-4 HSC-EFI	-	X	X	X	X
3.0L V-6 EFI SHO(SHO)	Y	Y	Y	Y	Y
1.8L I-4 EFI-DOHC	-	Z	Z	Z	Z
3.0L V-6 Flexible Fuel	1	1	1	-	-
2.0L I-4 EFI DOHC	3	-	-	-	-
3.8L V-6 EFI	4	4	4	4	4
1.6L I-4 EFI-TC (Turbo)	-	8	8	6	8
1.8L I-4 EFI DOHC	8	8	8	5	8

ASSEMBLY PLANT

(VIN pos. 11)	95	94	93	92	91
Hapeville, Georgia (Atlanta)	A	A	A	A	A
Oakville, Ontario, Canada	-	-	B	B	B
Cologne, West Germany	-	-	-	-	E
Dearborn, Michigan	F	F	F	F	F
Chicago, Illinois	G	G	G	G	G
Lorain, Ohio	H	H	H	H	-
Claycomo, Missouri (Kansas City)	K	K	K	K	K
Cuautitlan, Mexico	M	-	-	-	-
Hermosillo, Mexico	R	R	R	R	R
Edison, New Jersey	-	-	-	-	T
Wayne, Michigan	W	W	W	W	W
Talbotville (St. Thomas), Ontario, Canada	X	X	X	X	X
Wixom, Michigan	Y	Y	Y	Y	Y
Flat Rock, Michigan	5	5	5	5	5
Kyung Ki-Do, Korea (MAZDA-KIA)	6	6	6	6	6
Campbellfield (Broadmeadows), Australia	-	8	8	8	8

60

[redacted]

SAMPLE VIN:

1 L N L M [redacted] V 8 S Y 6 0 0 0 0 6

CAR LINE

(VIN pos. 6 & 7)	95	94	93	92	91
TOWN CAR (BASE) 4-Dr Sedan	81	81	81	81	81
TOWN CAR SIGNATURE 4-Dr Sedan	82	82	82	82	82
TOWN CAR CARTIER 4-Dr Sedan	83	83	83	83	83
MARK VIII 2-Dr Coupe	91	91	91	-	-
MARK VII BLASS 2-Dr Coupe	-	-	-	92	92
MARK VII LSC 2-Dr Coupe	-	-	-	93	93
CONTINENTAL EXECUTIVE 4-Dr Sedan	97	97	97	97	97
CONTINENTAL SIGNATURE 4-Dr Sedan	-	98	98	98	98

TI-NHTSA 014474

Manufacturers of accessory plugs to energize devices such as trouble lamps and razors are cautioned to conform to the provisions given in this document.

Live contact of any accessory plug shall be made with the center stud; the contacting member must not be less than 3.56 mm in diameter and have a minimum spherical radius of 2.54 mm at the contacting end.

To prevent damage, the body of an accessory plug back of the contact end should be large enough to serve as a centering guide when it is inserted into the receptacle. The contact end of any accessory plug should have sufficient taper so as not to interfere with the receptacle bimetal fingers. Any ground contact fingers should be so designed as not to interfere with, distort, or catch on the grounding lances in the receptacle when the plug is rotated.

Wiring capacity and overload protection, as provided by the automotive industry to the 12 V lighter receptacle, restricts accessory plug devices to a maximum current draw of 8.0 A.

Accessory plugs shall be permanently marked "6 volt" or "12 volt" in letters 4.7 mm high minimum.

TABLE 1—DIAMETERS OF RECEPTACLE AND LIGHTER PLUG

Volts	Inside Dia. B, mm	Plug Body Dia, mm
6	21.44-21.46	21.08-21.23
12	20.93-21.01[a]	20.73-20.88
12	21.41-21.51[b]	21.13-21.28

[a] Receptacles providing bimetal finger contact to the outer periphery of the heating element cup.
[b] Receptacles providing bimetal finger contact to the inner periphery of the heating element cup.

(R) PERFORMANCE LEVELS AND METHODS OF MEASUREMENT OF ELECTROMAGNETIC COMPATIBILITY OF VEHICLES AND DEVICES (60 Hz to 18 GHz)—SAE J551-1 JUN96

SAE Standard

Report of the SAE EMI Standards Committee approved March 1994. Rationale statement available. Completely revised by the SAE EMI and EMR Standards Committees June 1996.

Foreword—This document brings together methodology for testing the electromagnetic emissions and immunity characteristics of vehicles[1] and devices[2]. The writers of this document have participated extensively in the drafting of CISPR Subcommittee D and ISO TC 22 Subcommittee 3 Working Group 3 documents.

By intent, the methods and limits of this document closely resemble the counterpart international standards.

SAE J551 consists of the following parts:

SAE J551-1—General and Definitions

SAE J551-2—Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles, Motorboats and Spark-Ignited Engine-driven Devices

[Part 3 reserved for future use]

SAE J551-4—Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles and Devices, Broadband and Narrowband, 150 kHz to 1000 MHz

SAE J551-5—Performance Levels and Methods of Measurement of Magnetic and Electric Field Strength from Electric Vehicles, Broadband, 9 kHz to 30 MHz

[Parts 6 thru 10 reserved for future use]

SAE J551-11—Vehicle Electromagnetic Immunity—Off-vehicle Source

SAE J551-12—Vehicle Electromagnetic Immunity—On-board Transmitter Simulation

SAE J551-13—Vehicle Electromagnetic Immunity—Bulk Current Injection (BCI)

SAE J551-14—Vehicle Electromagnetic Immunity—Reverberation Chamber [Draft Only]

SAE J551-15—Vehicle Electromagnetic Immunity—Electrostatic Discharge (ESD)

Reference to SAE J551 without a suffix (-_) shall be interpreted to mean SAE J551-1 and J551-2.

1. Scope—This SAE Standard covers the measurement of radio frequency radiated emissions and immunity. Each part details the requirements for a specific type of electromagnetic compatibility (EMC) test and the applicable frequency range of the test method.

The methods are applicable to a vehicle or device powered by an internal combustion engine or electric motor. Operation of all engines (main and auxiliary) of a vehicle or device is included. All equipment normally operating when the engine is running is included. Operator controlled equipment is included or excluded as specified in the individual document parts.

The recommended levels apply only to complete vehicles in their final manufactured form. Vehicle-mounted rectifiers used for charging in electric vehicles are included in Part 2 of this document when operated in their charging mode. Additional charger requirements are under development in SAE J551-5.

Emissions from intentional radiators are not controlled by this document. (See applicable, appropriate regulatory documents.) The immunity of commercial mains powered equipment to overvoltages and line transients is not covered by this document. (See applicable UL or other appropriate agency documents.)

2. References

2.1 *Applicable Documents*—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J551-2—Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles, Motorboats, and Spark-Ignited Engine-driven Devices

SAE J1812—Function Performance Status Classification for EMC Immunity Testing

2.1.2 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002 or IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331

ANSI C63.2-1987—American National Standard for Instrumentation—Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz—Specifications

ANSI C63.4-1992—American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz

ANSI C63.14-1992—Standard Dictionary for Technologies of Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP), and Electrostatic Discharge (ESD)

ANSI C95.1-1992—American National Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

ANSI/IEEE STD 100-1988—Standard Dictionary of Electrical and Electronic Terms

2.1.3 CISPR PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

CISPR 12 4th Edition:1997—Limits and methods of measurement of radio disturbance characteristics of vehicles, motorboats, and spark-ignited engine-driven devices

CISPR 16:1987—CISPR specification for radio interference measuring apparatus and measurement methods. (New edition under development.)

CISPR 16-1:1993—Specification for radio disturbance and immunity measuring apparatus and methods—Part 1: Radio disturbance and immunity measuring apparatus

[1] See 3.36 for definition.
[2] See 3.18 for definition.

[illegible] SLO-BLO FUSES

3AG "Slo-Blo" Fuses

Electrical Characteristics

Rating	Blow Time
110%	4 hours, Minimum
135%	1 hour, Maximum
200%	5 seconds, Minimum

For Time-Current Blowing Chart, see page 92.
Listed by Underwriters' Laboratories and certified by CSA through 7 amperes.
Dimensions of Fuse:
Diameter, 1/4 inch,
Length, 1-1/4 inches.

Catalog Number	Ampere Rating	Voltage Rating	Catalog Number	Ampere Rating	Voltage Rating
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Littelfuse 313 000 Series Fuses—These fuses are of the "slo-blo" type, designed to withstand momentary high-current surges but still blow quickly on shorts. They provide protection for equipment having high inrush current surges or heavy starting currents—a common characteristic of magnets, solenoids, motors and lamp circuits. "Pioneered By Littelfuse."

[illegible]

4AG "Slo-Blo" Fuses

Electrical Characteristics

Rating	Blow Time
110%	4 hours, Minimum
135%	1 hour, Maximum
200%	5 seconds, Minimum

Dimensions of Fuse:
Diameter, 9/32 inch,
Length, 1-1/4 inches.

Catalog Number	Ampere Rating	Voltage Rating	Catalog Number	Ampere Rating	Voltage Rating
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Littelfuse 413 000 Series Fuses—Developed for aircraft use with long time-lag to withstand heavy surges. Offer greater protection by permitting lower amperage-rated fuses to be used on inductive loads. Spring-and-link element structure of these fuses takes up thermal expansion and contraction and reduces cyclic fatigue, crystallization of the fuse link. When the compound-element temperature reaches the melting point of the alloy, spring pulls away from the link. On short-circuits the link blows instantly. "Pioneered By Littelfuse."

[illegible]

Electrical Characteristics

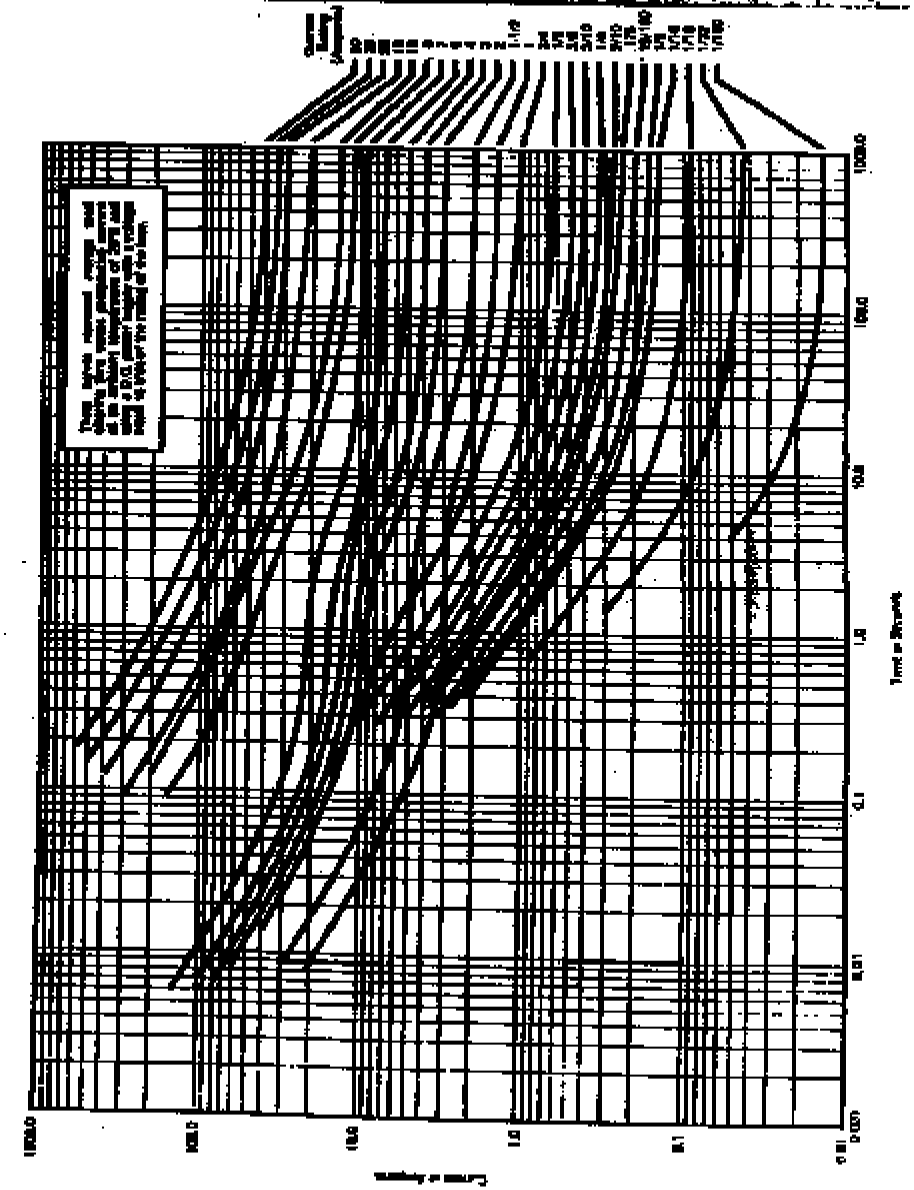
Rating	Blow Time
110%	4 hours, Minimum
135%	1 hour, Maximum
200%	5 seconds, Maximum

Dimensions of Fuse:
Diameter, 13/32 inch,
Length, 1-1/2 inch.

Catalog Number	Ampere Rating	Voltage Rating
[illegible]	[illegible]	[illegible]

Littelfuse 513 000 Series Fuses—These fuses are larger than the 3AG and 4AG versions – with long time-lag to withstand heavy surges. Recommended for aircraft equipment, motors, relays and industrial applications in which factors of long time-lag coupled with sustained overload and short-circuit protection are desirable.

TIME-CURRENT CHARACTERISTICS — Littelfuse 313 and 315 000 Series Fuses



TI-NHTSA 014477

Scenario #4 Round Keypad
Potential Cost calc's
what if Scenario's

Scenario #4 1.0 only a Ford Aus req. 25k/Yr
2.0 manual Sense belt used
3.0 accounting of part degrad...

Mat. Change :

From Sq. to Rd. +59.02

Potential Function test loss :

.75¢ per switch 5% loss + 37.50
10% loss + 75.00

Labor Change :

From AMI to BELT + 87.13

ALTERNATIVES:

Option 1: Use the standard design, unmodified, and the high-vacuum assembly plant fill procedure.

Benefits:

* The standard design is fully production tooled, ISR'ed, and in full-scale production for various applications

* No cost or schedule impact related to diaphragm redesign

Risks:

* It has been shown in a controlled experiment that the Ford-Australia vacuum level has a negative impact on diaphragm life. Weibull analysis of the data indicates high vacuum exposure also results in decreased statistical certainty about diaprhagm life; i.e. diaphragm life becomes less predictable, and demonstration of a given life expectancy during an ISR test may not correlate well with field experience.

Option 2: Use the standard design, unmodified, and reduce the vacuum level of the assembly plant fill procedure.

Benefits:

* The standard design is fully production tooled, ISR'ed, and in full-scale production for various applications

* No cost or schedule impact related to diaphragm redesign

* No issues with diaphragm life are expected to arise, which is backed up by field experience.

Risks:

* The spongy pedal issue will result, according to information from Ford, and TI is not in a position of expertise to address this issue. Therefore, this is not considered a real option.

Option 3: Use the rubber diaphragm design approach

Benefits:

* In one experiment, this design has shown a dramatic improvement in diaphragm life under high vacuum. Test aborted at 2.7KK cycles with no failures in this lot.

* This design results in minimal modification to automated production tooling, and could be built on this existing equipment.

* The overall cost impact of this design is expected to be smaller compared with Option 4.

Risks:

* The performance over the full range of expected conditions must be further quantified

* The impact of any variability of material properties over time must be quantified

* The impact of production process variability must be quantified

* Bench-testing only; no on-vehicle experience exists.

Option 4: Use the full-round Kapton design approach

Benefits:

* In one experiment, this design has shown a significant improvement in diaphragm life under high vacuum, but not as good as the rubber diaphragm.

* This design represents essentially no departure from the standard design in terms of pressure- and fluid-exposed materials and geometries.

Risks:

* The performance over the full range of expected conditions must be further quantified

* The impact of production process variability must be quantified

* Bench-testing only; no on-vehicle experience exists.

* To automate this design would require major tooling modifications to existing equipment, which is unfeasible due to the fact that other applications also use this equipment.

* Due to an increased quantity of Kapton required, and the strong possibility that automated assembly is not an option, this design is more costly to build.

Customer 150,000 Miles Usage Correlation to Impulse Test Specification

Brake Application Definition	Decleration (ft/sec2)	Deceleration (g)	Hours at Decel for 90% Values	Percent of Hours at Decel	Maximum Rear Line Pressure at Decel (psi)	Brake Applications at Decel	Durability Index (Applications x Pressure)
Mild Braking	0 - 6	0 - 0.186	2944	95.31%	225	1,701,204	382,770,917
Moderate Braking	6-15 ft/sec2	.0186 - .465	144	4.66%	575	83,211	47,846,365
Heavy Braking	>15 ft/sec2	>.465	1	0.03%	1200	578	693,426
Total			3089	100.00%		1,784,993	431,310,707

Impulse Test Specification = 500,000 cycles @ 1450 psi = **725,000,000**

Sources:
1992 Crown Victoria North American Powertrain Customer Correlation Program; March 1996

1992 Lincoln Town Car Tests; 1LNLM81W3NY669063

Customer 150,000 Miles Usage Correlation to Impulse Test Specification

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Impulse Test Specification = 500,000 cycles @ 1450 psi = **725,000,000**

D.I.	Brake appl.	Kopler Quality Index
.0175	1,701,204	29,771
.0188	83,211	1564
.0188	578	10.9
		31,346

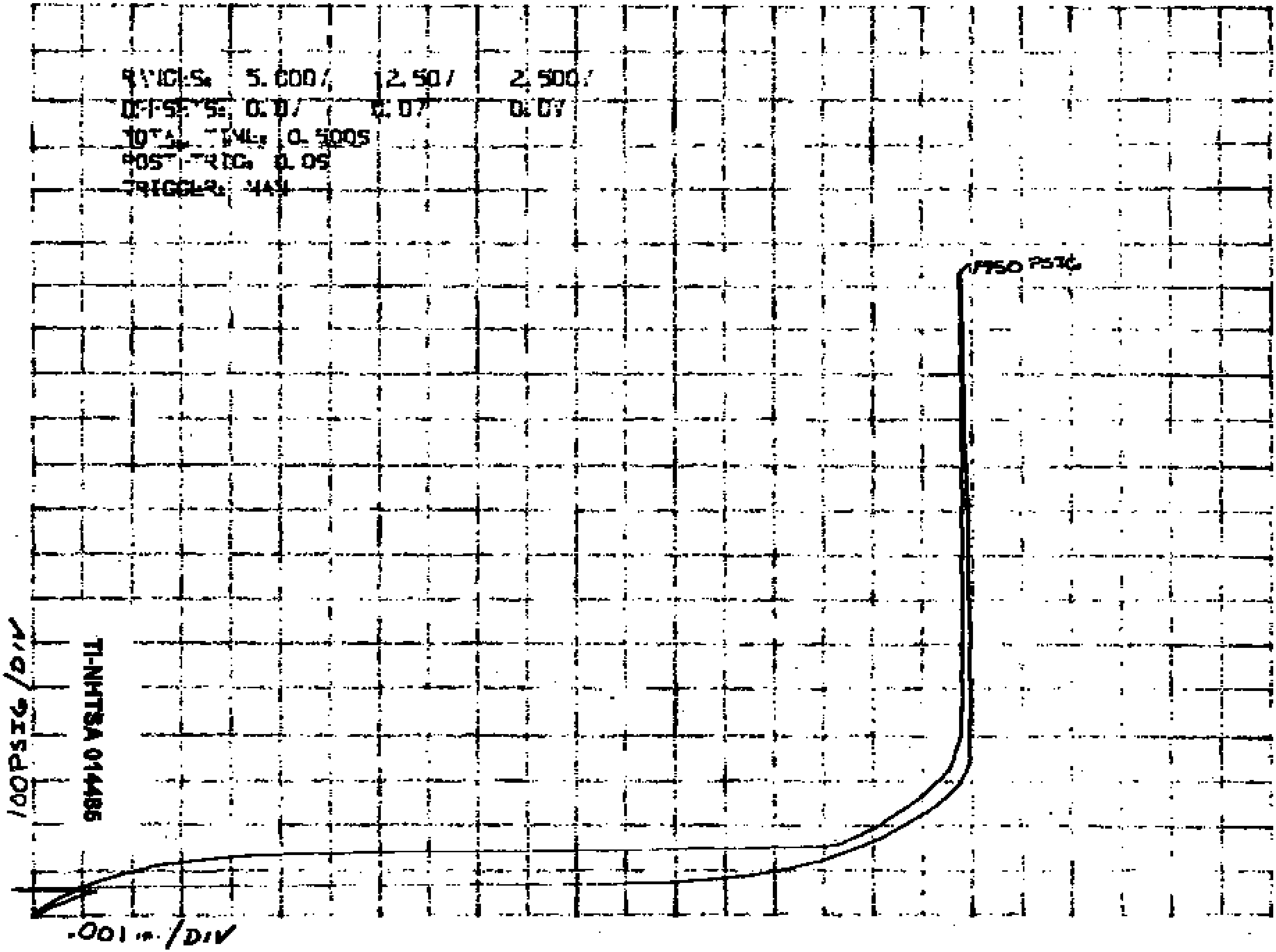
Spec = 500,000 cycles at .0188" = **9,400**

$\frac{9400}{31,346} \times 150,000 = 45,000$ miles

Sources:

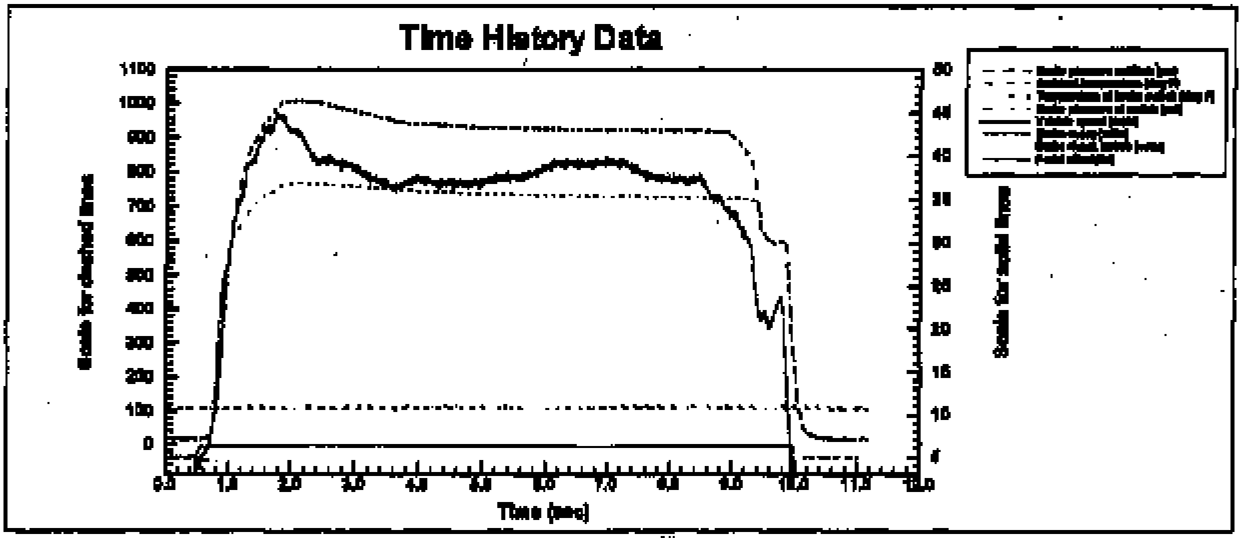
1992 Crown Victoria North American Powertrain Customer Correlation Program; March 1996

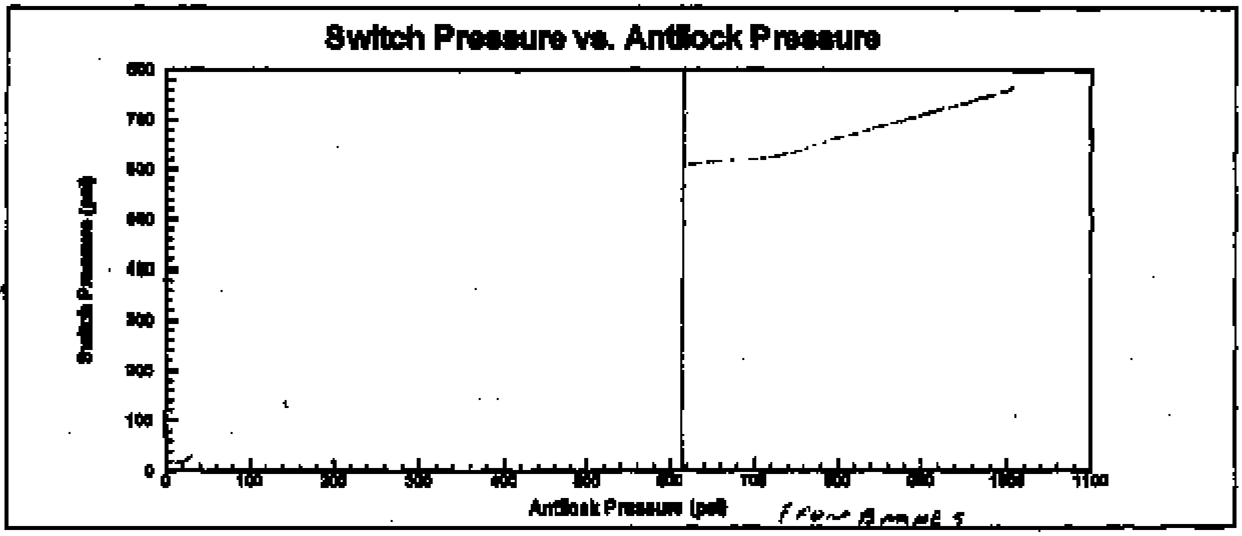
1992 Lincoln Town Car Tests; 1LNLM81W3NY688083

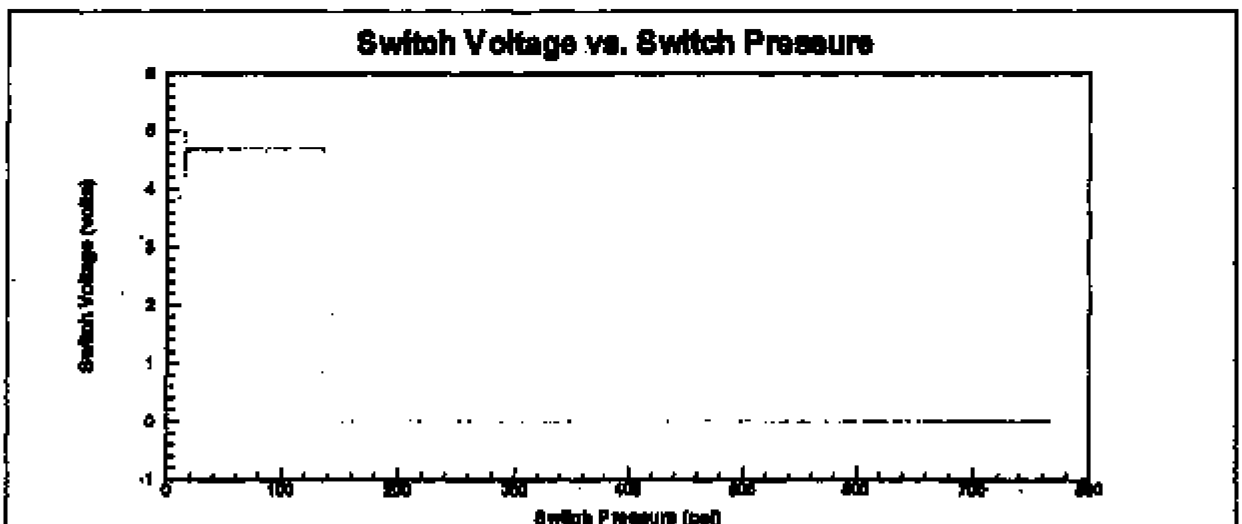


5.000/
2.50/
2.500/
0.500S
0.05
1750 PSIG
100PSIG/DIV
.001 in./DIV
TI-NHTSA 014486

static brake effort	Ford Test Data: Lincoln Towncar	File Name: ILincoln.001





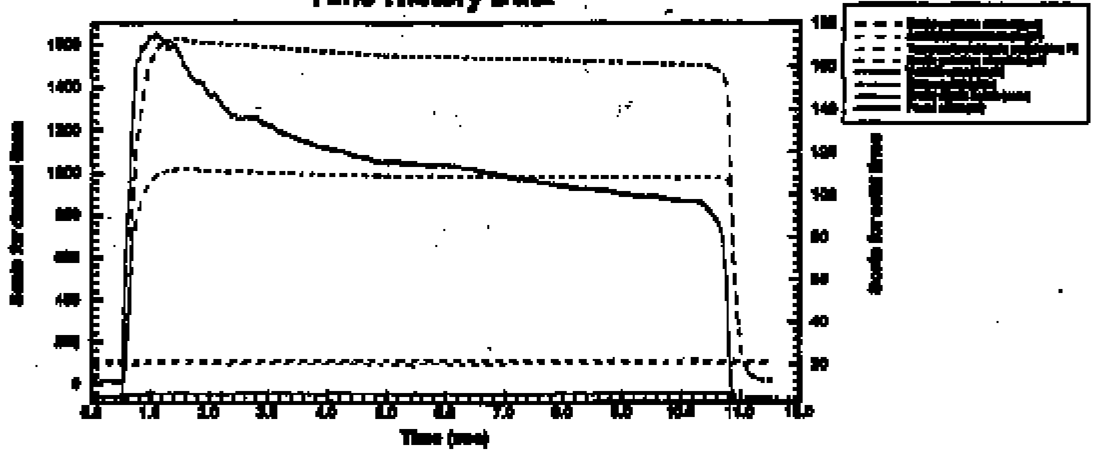


Design Research Engineering

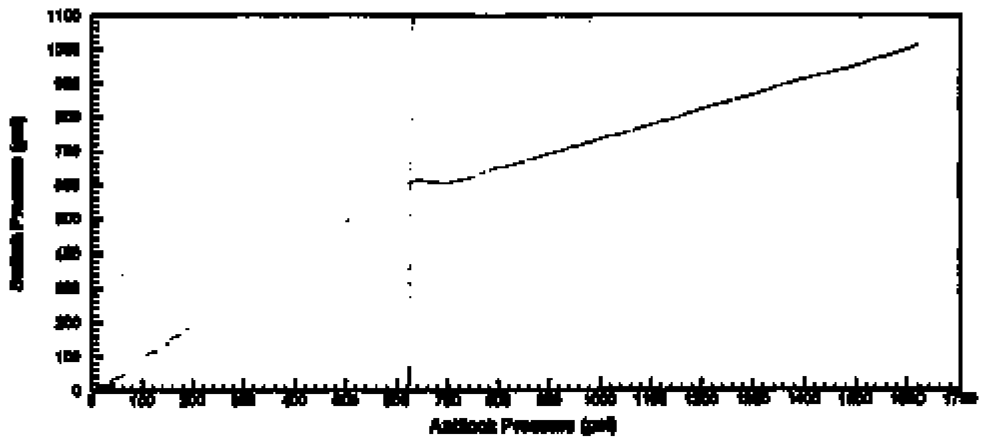
TI-NHTSA 014496

static brake effort | Ford Test Data: Lincoln Towncar | File Name: [illegible]

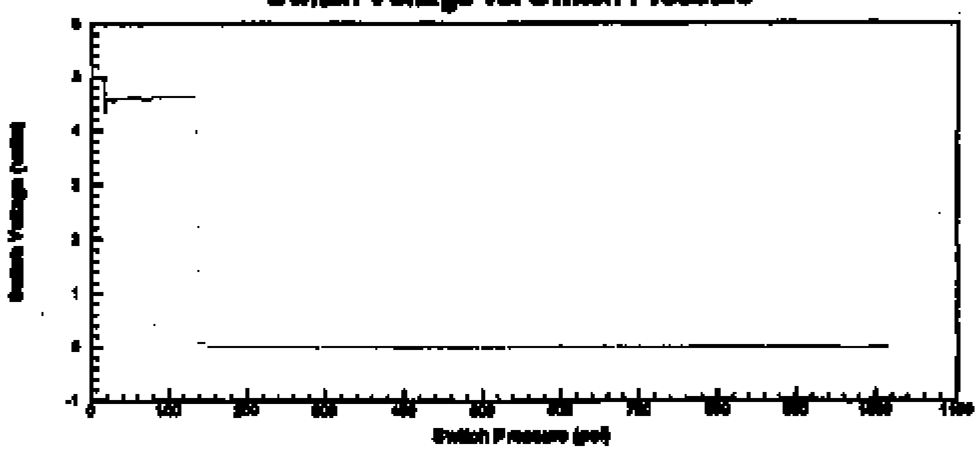
Time History Data



Switch Pressure vs. Antilock Pressure

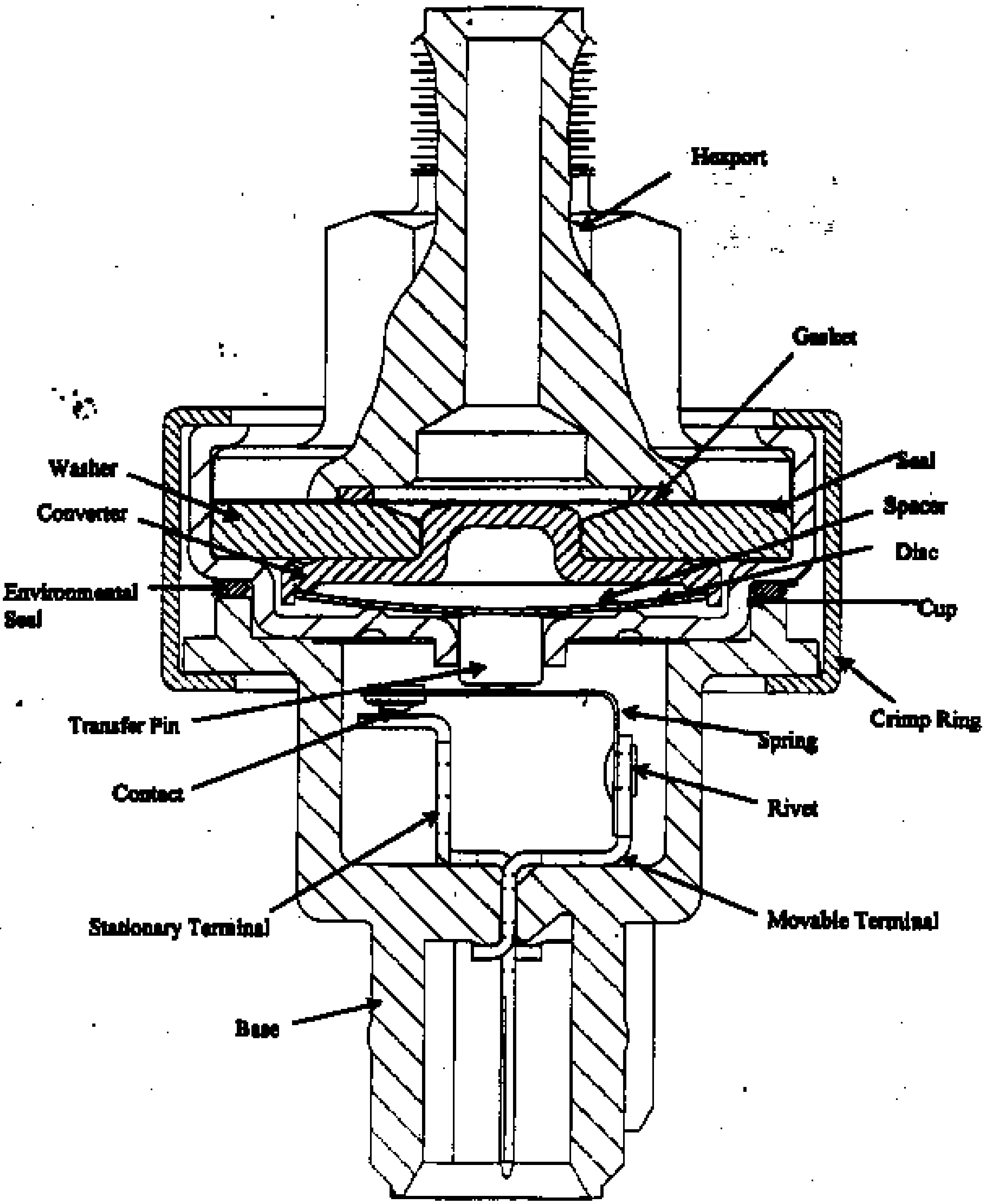


Switch Voltage vs. Switch Pressure



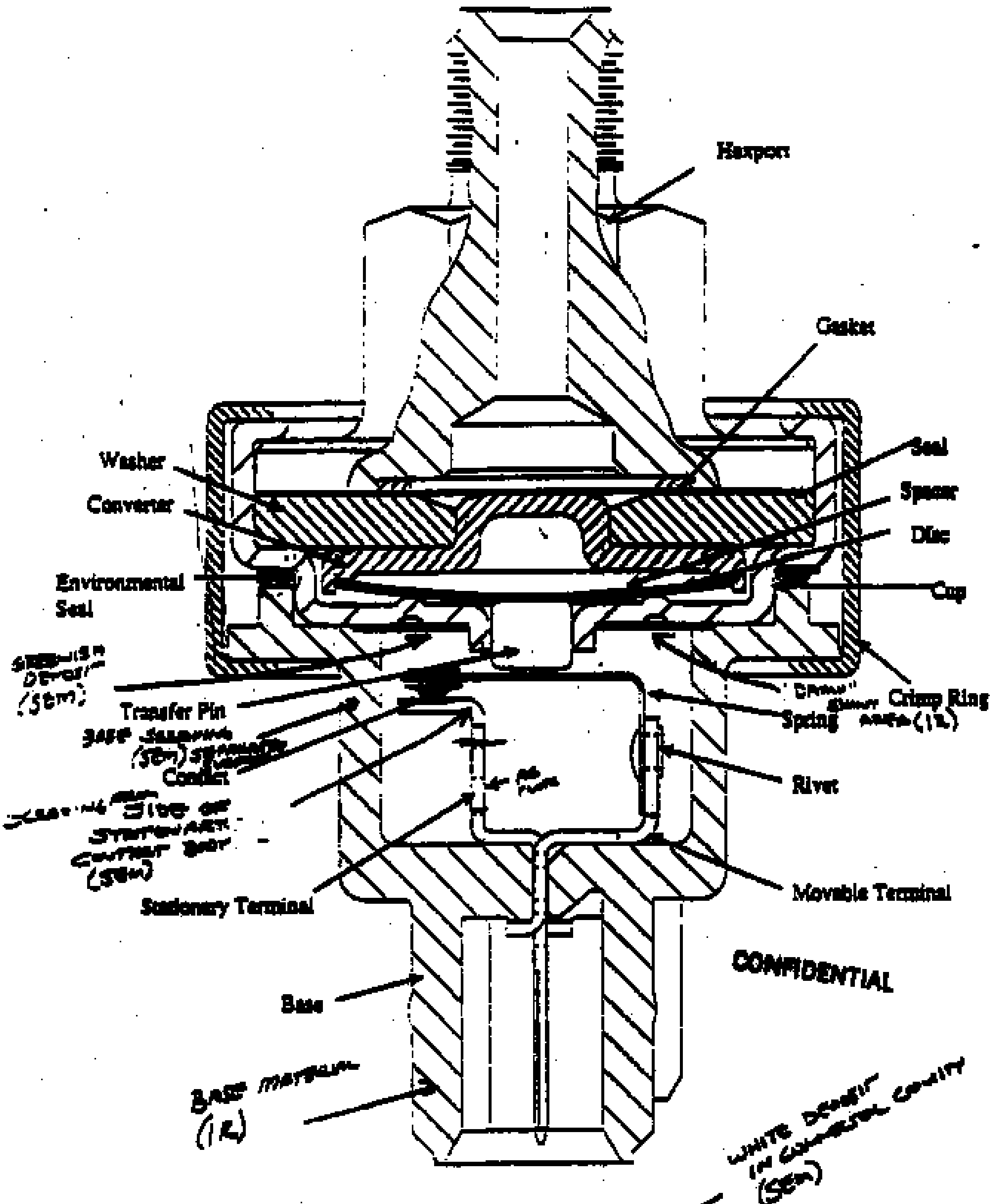
Design Research Engineering

Hydraulic Pressure Switch Cross Section



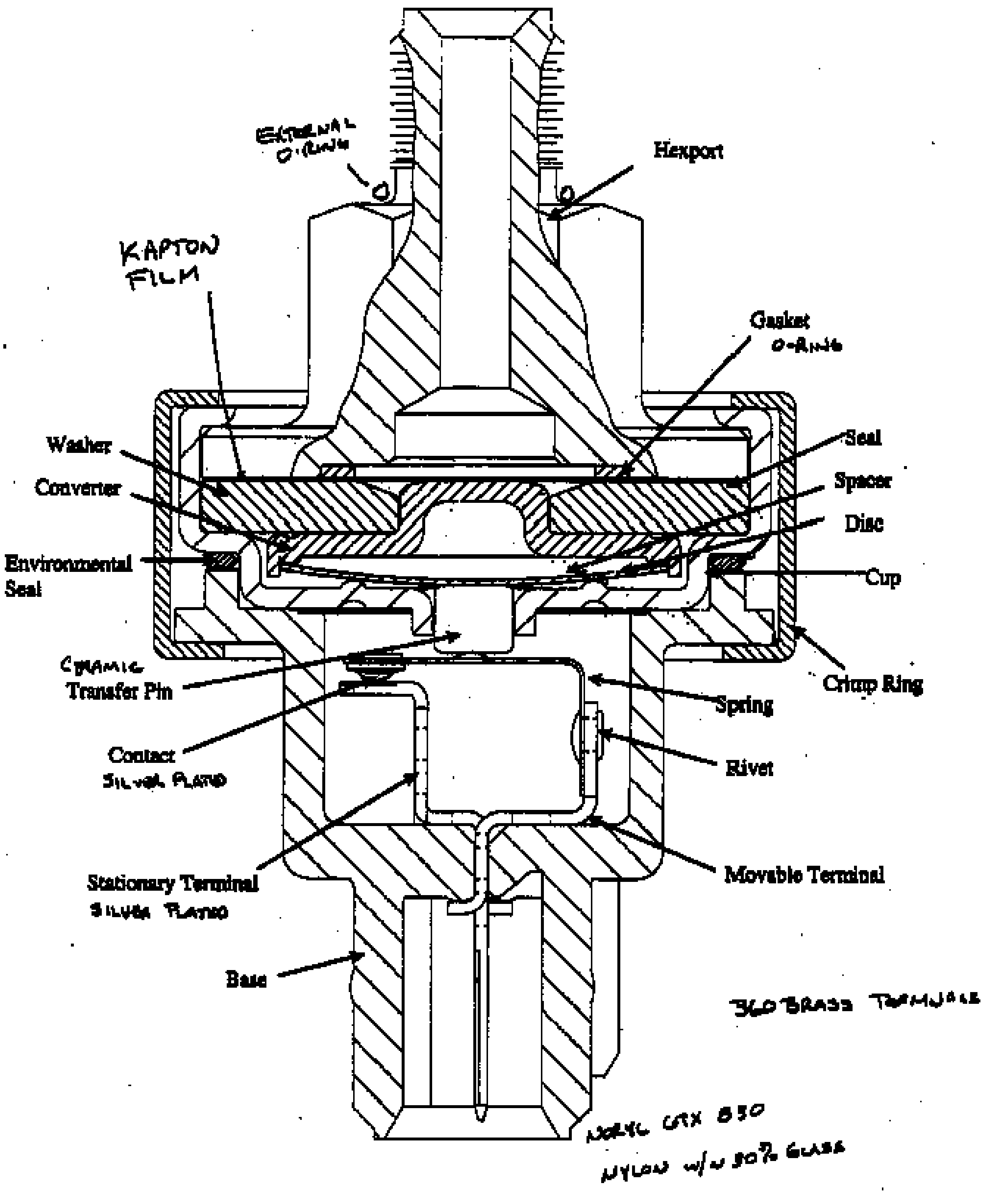
TI-NHTSA 014488

Hydraulic Pressure Switch Cross Section



CONFIDENTIAL

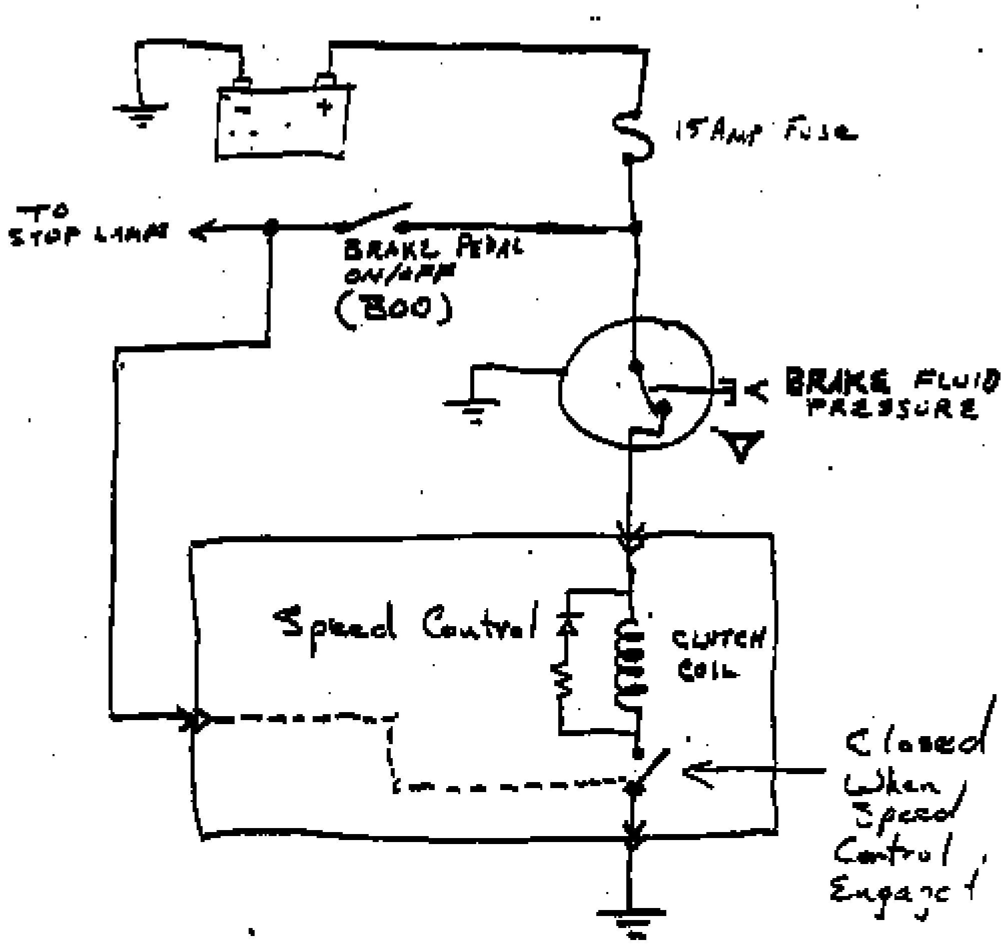
Hydraulic Pressure Switch Cross Section



Brake Pressure Switch Function-

- **Provide power to Speed Control Clutch circuit. Clutch engages servo-motor to pull throttle cable.**

- **Provide redundant sensing of brake application independent of the primary system deactivation mode by disconnecting power to clutch circuit causing servo-motor to release throttle cable.**
  - **Under Hard Braking only**
  - **Stop lamp signal is primary (normal braking).**



Brake Pressure Switch
F2VC-9F924-AB
Material List for MY 92/93

[illegible]	[illegible]	[illegible]
Gasket	Elastomer Ethylene Propylene	JBL Compound # E-7104-70
Diaphragm	Kapton, Polyimide	Dupont 500 FN131L, 3 Diaphragms per switch
Base	PBT, Plastic	Grade Celanex 4300
Crimp Ring	Aluminum	Grade # 5052
Spacer	Kapton, Polyimide	Dupont #200H,Friction Reducer on Disc
Rivet	Brass	CDA 260
Transfer Pin	Ceramic	Steatite , L-3 Grade
Environmental Seal	Silicone	JBL Compound # S7519
Converter	Cold Rolled Steel	Grade # 1008
Washer	Cold Rolled Steel, Zinc Plated	Grade # 1050
Cup	Cold Rolled Steel	Grade 1010
Spring Arm	Beryllium Copper	Grade # C17200
Movable Contact	Silver Plated Copper	Oxygen Free Cu, Fine Silver
Stationary Terminal	Brass + Silver Inlay	CDA 260
Movable Terminal	Brass	CDA 260
Disc	Stainless Steel	Grade 302
Hexport	Cold Rolled Steel, Zinc Plated	C10L10
Thread Cap	LDPE, Plastic