EA02025

TEXAS INSTRUMENTS, INC.'S

09/10/03 LETTER TO ODI

REQUEST 11

BOX 13
PART A – C
PART A

Morris, Irene

From:	Ha, Di
Sent:	Thursday, October 29, 1998 12:25 PM
To:	Douglas, Charles
Subject:	Potential modes of failure for leakage

Charlie,
Here's the list you requested for potential causes of switch leakage:

System:

- Device not screwed in properly — Leakage at thread area
- Improper sealing due to mating port damage — Leakage at thread area
- Device exposed to excessive pressure — Burst device
- Device exposed to excessive temperature — Gasket seal impaired
- Device exposed to excessive number of cycles — Diaphragm leakage
- Water (or other contaminants) in system degrades Kapton diaphragm — Diaphragm leakage
- Water (or other contaminants) ingresses switch through base and causes Kapton degradation — Diaphragm leakage

Manufacturing:

- Misplaced/missing gasket
- Misplaced/missing Kapton
- Improper gasket material (incompatible with brake fluid)
- Incorrect # of Kapton (switches require 3 diaphragms because brake fluid is more aggressive)
- Incorrect sensor crimp
- Incorrect device crimp (fluid works its way in from the crimp to the base cavity into the sensor assy)

**Note: Items in red would be associated with infant mortality

FYI, we have had a car fire occurrence involving our switch in the past. See PS/96/34 in which a 52PS device was analyzed after a car fire. Diagnosis showed that the switch leakage occurred after the fire due to the high temps, and not the other way around.

Please let me know if you need anything further.

Regards,
Di

TI-05 15749

TI-NHTSA 018582A

Degue, Bryan

From: Douglas, Charles
Sent: Tuesday, December 15, 1998 2:22 PM
To: Degue, Bryan
Subject: FW: Potential modes of failure for leakage

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1586 (F)
c-douglas2@ti.com

From: Ho, Di
Sent: Thursday, October 29, 1998 11:25 AM
To: Douglas, Charles
Subject: Potential modes of failure for leakage

CONFIDENTIAL

Charlie,
Here's the list you requested for potential causes of switch leakage:

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- Incorrect device crimp (fluid works its way in from the crimp to the base cavity into the sensor assy)

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Please let me know if you need anything further.

Regards,
Di

Epstein, Sally

From: Hopkins, AL [ahopkins@email.mc.ti.com]
Sent: Tuesday, December 15, 1998 3:27 PM
To: McGuirk, Andy; Pechonis, John; Gildea, Robert; Watt, Jim; Douglas, Charles; Proia, Stephen
Subject: RE: 77PS - 8D updates

The only addition I would make is that the Ford returns didn't show any attack on that part of the terminal that was within the switch cavity itself. In contrast, both the Raw Terminals found at Bassler and two of the devices brought back by Bob from Sumter showed the corrosion within the switch cavity area of the terminal.

Regards,

Al

From: Proia, Stephen
Sent: Tuesday, December 15, 1998 1:39 PM
To: McGuirk, Andy; Pechonis, John; Hopkins, AL; Gildea, Robert; Watt, Jim; Douglas, Charles
Subject: 77PS - 8D updates

<<File: car98_49a.doc>><<File: car98_49b.doc>>

Team,
I have not made any changes to "car98-49a".

I've taken a first cut at the terminal supplier 8D in "car98-49b". Please take a look with a skeptical eye and let me know your comments.

Al,

You may find that I need to better define the splash/finger print stains. Please let me know. It looks O.K. to me considering the purpose of this exercise.

Bob,

Continue working with Bassler and understand what we can do to minimize terminal strip handling. Can we update their process spec, pfmea, etc.

I'd like to get these out by tomorrow afternoon.

Regards,

Steve

Epstein, Sally

From: Terino, Gerard [gterino@email.mc.ti.com]
Sent: Wednesday, December 16, 1998 5:07 PM
To: Sharpe, Robert; Hall, Alison; Dodd, Bob
Cc: McGuirk, Andy; Pechonis, John; Watt, Jim

Importance: High
Sensitivity: Confidential

12/16/98
ROB SHARPE - ALISON HALL - BOB DODD, PLEASE GIVE ME A CALL TOMORROW.

FORD HAS REPORTED A POSSIBLE ISSUE WITH AN ASSEMBLY FROM HILITES IND.

I LEFT A MSG WITH THE QC PEOPLE AT HILITES AND FORD
I WILL UPDATE, AS SOON I HAVE A CONFIRMED ISSUE.

I KNOW THIS IS NOT MUCH INFO - PLEASE BEAR WITH ME.

REGARDS , GERRY TERINO
TEL . 508-236-3009 FAX 508-236-2328
MAIL STOP 12-37 MSID GTRR
GTERINO@TI.COM

TEXAS INSTRUMENTS INC.
34 FOREST STREET
ATTLEBORO, MA 02703-0964

• 21 fires total > 20 MY92, 1 MY93
-> 10 Left front wheel well
-> 9 Engine
-> 2 M/C Area

Dates Reports Filed

1) • 3/22/97 -> Vehicle purchased used (LFF - 24 hours off)

2) • 8/21/97 -> Vehicle purchased new Houston, TX

- Short circuit in ignition wiring

3) • 1/10/97 -> Vehicle purchased used Melbourne FL

- Engine compartment, rain during day

4) • 1/4/97 -> Vehicle purchased used

5) • No date or details

6) • 6/24/97 -> Vehicle purchased used

- Noted "explosion" then fire (Short circuit in engine)

• 4.6L Engine -> said to be engine specific

7) • 10/23/96 -> Vehicle purchased used

- Minor Explosion

- letter on recall of 8.7 M vehicles citing faulty ignition switch including MY92 Town Car

8) • 5/8/98 -> Pressure switch noted as area in which fire initiated -> brake fluid leak shorting out electrical connector

9) • 12/26/97 -> Fire "electrical in nature" Florida

10) • 12/0/97 -> Vehicle purchased used Atlanta, GA

- Probable engine compartment malfunction

11) • No date, incident occurred in Florida

- LFF start (between "RELAY CENTER" and rear of headlight)

12 • 12/26/98 Vehicle purchased new (LFF)

- Report stated awareness of 1420 similar fires

13) • 4/30/98 Vehicle purchased used Jackson, MS

- Short circuit in wire harness

14) • 11/28/97 Vehicle purchased used

15) • 7/1/98 Vehicle purchased used Orlando, FL

16) • 6/13/96 / no details Florida

17) date not needed / report filed 4/27/98 MY93

18) • 5/98 Vehicle purchased used Florida MY93

- Short in wiring

Baker, Gary

From: McGuirk, Andy
Sent: Monday, January 04, 1999 10:24 AM
To: Beringhause, Steven; Baker, Gary
Cc: Pachonis, John; Rowland, Thomas; Douglas, Charles; Dague, Bryan
Subject: Ford Lincoln '92 town car 'thermal events'

We have now had an opportunity to understand Ford's position and relevant facts regarding 'thermal events' with the '92 Town Car associated with our power steering pressure switch.

Please come to Tom's staff meeting Tuesday the 5th prepared to brief the organization as to proposed next steps in the process. One issue that should be resolved is how high in the TI organization do we want our Ford visitors (coming Weds the 6th) to have audience with........I think it would be prudent to have Tom Rowland briefly meet the visitors to assure we deliver our commitment for quick and full support of the process.

A

AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-[illegible]
FAX : (508) 236-[illegible]
PAGE: (800) 467-[illegible] PIN 484-2044

TI-NHTSA 018588

Morris, Irene

From: Douglas, Charles
Sent: Tuesday, January 05, 1999 1:25 PM
To: Degue, Bryan; Hopkins, AL; Prola, Stephen
Cc: Baker, Gary; Baumann, Russ; Beringhause, Steven; McGuirk, Andrew; Pechonis, John; Sharpe, Robert
Subject: RE: Ford 77PS Town Car Visit

Team,

Here is the latest update on the visit. Visit will definitely take place on Thursday. When all is said and done, we may only have one visitor from Ford. Fred Porter will not be coming in. Norm LaPointe will definitely be coming in and one additional visitor may also be coming.

Norm will be flying in Thursday morning and leaving on the 7 PM flight. Since Rob cannot make it, I will pick up Norm at the airport. The meeting will start at 9:30 and will be housed in 12-1B.

TI participants should be limited to those directly addressed. Also, at both Norm and Fred Porter's request, no presentations or line tours will take place to start the meeting. Beyond introductions, we will go right into the tear down analysis per the protocol that Al will publish later today.

At this point, unless you hear otherwise, assume casual dress for this visit.

Any questions / issues, please let me know.

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1696 (F)
c-douglas2@ti.com

From: Douglas, Charles
Sent: Monday, January 04, 1999 2:16 PM
To: Degue, Bryan; Gildea, Robert; Hopkins, AL; Prola, Stephen; Douglas, Charles
Cc: Baker, Gary; Baumann, Russ; Beringhause, Steven; McGuirk, Andy; Pechonis, John; Sharpe, Robert
Subject: RE: Ford 77PS Town Car Visit

As an update, three different people at Ford have made three different sets of reservations for coming out here --> one flying in Tuesday evening for Wednesday visit, one flying in Wednesday evening for Thursday visit, and one flying in Thursday morning for Thursday visit. The Ford folks are currently working to coordinate their schedules so we may not know until tomorrow morning whether the visit is Wednesday or Thursday though my best guess at this point would be a Thursday visit.

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1696 (F)
c-douglas2@ti.com

From: Douglas, Charles
Sent: Monday, January 04, 1999 12:17 PM
To: Dague, Bryan; Gildea, Robert; Hopkins, AL; Prois, Stephen
Cc: Baker, Gary; Baumann, Russ; Seringhause, Steven; McGuirk, Andy; Pechonis, John; Sharpe, Robert
Subject: Ford 77PS Town Car Visit

Team,

A quick msg on this subject. There is some question as to whether this visit will take place on Wednesday or Thursday. Rob is currently working to nail this down. Weather in Detroit may be keeping Ford personnel out today or resulting in them getting into the office late today.

Relative to framework for an agenda, we are going to keep it fairly simple. Before actually conducting the tear down analysis, we should present a process overview and take them up to the assembly line. Also, we should have both P and D fmea's available.

Bryan,

Any information we can pull together from the MY92 Econoline excursion will also be of use.

The meeting is going to be housed in 12-1B.

More information will be forthcoming hopefully by late afternoon.

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

TI-NHTSA 018890

Baumann, Russ

From: Hopkins, AL
Sent: Tuesday, January 05, 1999 6:38 PM
To: Dague, Bryan; Prois, Stephen; Douglas, Charles
Cc: Baumann, Russ; Baker, Gary; McGuirk, Andy; Beringhause, Steven; Andres, Amy; Siuzdak, Allen; Pavao, Joe
Subject: 99-003: PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

Here's a rough pass, what do you guys think?

PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

- Review Ford's Analysis data that they are bringing in.
- Examine threads and determine if it is OK to just chase the threads to get a good seal or should we remove material for analysis.
- Pressure Leak Test the device (15 minute static-hold, air-pressurized test).
- Decide if we should remove any material or try any other analysis before we start disassembling the device.
- Do a practice decap using the below procedure on a deliberately fractured part (to mimic the condition that the returned device will be in) before performing it on the real sample. Bryan, you and I could do this now.
- Procedure to remove aluminum crimp ring
- Use aluminum foil (or plastic if Ford prefers) to mask the analysis surface.
- Also create a paper/tape shield to further reduce chance of contamination during cutting of crimp ring.
- Place a piece of tape over the area to be cut.
- Cut crimp ring using jewelers saw or Dremel cutoff wheel in one of the two areas indicated on optical photo.
- Cut corners of ring at 180 degree orientation
- Unfold crimp ring
- Optically examine revealed surfaces. Take optical photographs (Digital camera with macro lens plus instant microphotography) and document observations where appropriate. Examine the following areas
  - Inside surface of crimp ring.
  - Seal area and underside of base
  - Top of cap
- Start SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis on the inside of the ring and on various surfaces of the plastic base.
- Reprotect the cap surface and remove the cap. Bryan had originally suggested just using an end mill to remove the cap. I wouldn't, however, go all the way through with the end mill. I would leave some material behind as a shield. I would suggest then bending the cap off.
- Optically document all revealed surfaces starting with cap.

- Meanwhile, start SEM-EDX analysis on top side of cap. Particularly focus in on the edges of the ceramic pin guide and on the indented ring that lines up with interior wall of the switch cavity. Particularly look for evidence of corrosion or arcing.
- Decide if we should try to flake off any of the overlaying debris to try to examine the underlying metal surface.
- Proceed to perform SEM-EDX analysis on other component surfaces revealed by removal of cap.
- Non-destructively probe inside of the grommet to determine its resilience which will give us an indication of the temperature that it saw. Another indication might be the depth of the indentations left by the grommet seal rings in the wire.
- Decide if it makes sense to further examine the mating connector or grommet seal.

Regards,

Al

Graveline, Dora

From: Prois, Stephen
Sent: Wednesday, January 06, 1999 7:52 AM
To: Douglas, Charles; Hopkins, AL; McGuirk, Andy; Baker, Gary; Dague, Bryan; Baumann, Russ
Subject: 77ps.ppt

77ps.ppt

Here's the "Cause & Effect" diagram we discussed yesterday. Please review and comment. Thanks

Regards,

Steve

TI-NHTSA 018693

From: McGuirk, Andy
Sent: Wednesday, January 06, 1999 8:08 AM
To: Douglas, Charles; Hopkins, AL; Baker, Gary; Dague, Bryan; Baumann, Russ; Prola, Stephen
Cc: Pachonis, John
Subject: RE: 77ps.ppt

steve, thanks for a great job pulling the preliminary draft together for theories about possible contributors to a thermal event.

I think the heading needs to be very descriptive about just what the document is intended to be.....possible theories of contributors to thermal events in '92-93 town cars.

I am struggling with how to pull in the concept of that this document is the product of some 'brainstormed' ideas...should be stated and revision control dated so history will know it was the product of a few key people and when in time it was done. (also, we probably should also subject the ideas to other respected contributors in the business like beringhause and maybe dodd as well as key supplier inputs like roy.) further, we have 'mixed' together ideas about what might contribute or cause (as in a true cause and effect diagram) as well as facts and data surrounding the situations (which is informational, but not correct). we need to fix that mixing.

I have to run to a meeting and will pick up these ideas in an hour

a
AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 23-05
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FAX : (508) 236-3745
PAGE: (800) 437-3780 PIN 604-3044

From: Prola, Stephen
Sent: Wednesday, January 06, 1999 7:52 AM
To: Douglas, Charles; Hopkins, AL; McGuirk, Andy; Baker, Gary; Dague, Bryan; Baumann, Russ
Subject: 77ps.ppt

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From: Prois, Stephen
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77ps.ppt

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Regards,

Steve

TI-NHTSA 016595

Graveline, Dora

From:	Dague, Bryan
Sent:	Wednesday, January 06, 1999 8:04 AM
To:	Prois, Stephen; Douglas, Charles; Hopkins, AL
Cc:	Baumann, Russ; Baker, Gary; McGuirk, Andy; Beringhause, Steven; Andres, Amy; Siuzdak, Allan; Pavao, Joe
Subject:	RE: 99-003: PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

Al,
Looks pretty good to me. We can also make changes as we go through it with Ford on Thursday.

Charlie,
Please make sure Fred passes this along to Norm.

Regards,
Bry

From:	Hopkins, AL
Sent:	Tuesday, January 05, 1999 7:37 PM
To:	Dague, Bryan; Prois, Stephen; Douglas, Charles
Cc:	Baumann, Russ; Baker, Gary; McGuirk, Andy; Beringhause, Steven; Andres, Amy; Siuzdak, Allan; Pavao, Joe
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TI-NHTSA 018596

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Epstein, Sally

From:	McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent:	Wednesday, January 06, 1999 8:08 AM
To:	Douglas, Charles; Hopkins, AL; Baker, Gary; Dague, Bryan; Baumann, Russ; Proia, Stephen
Cc:	Pechonis, John
Subject:	RE: 77ps.ppt

steve, thanks for a great job pulling the preliminary draft together for theories about possible contributors to a thermal event.

i think the heading needs to be very descriptive about just what the document is intended to be......possible theories of contributors to thermal events in '92-93 town cars.

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i have to run to a meeting and will pick up these ideas in an hour

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AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
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From: Proia, Stephen
Sent: Wednesday, January 06, 1999 7:52 AM
To: Douglas, Charles; Hopkins, AL; McGuirk, Andy; Baker, Gary; Dague, Bryan; Baumann, Russ
Subject: 77ps.ppt

<<File: 77ps.ppt>>
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Steve

Baker, Gary

From: McGuirk, Andy
Sent: Wednesday, January 06, 1999 10:07 AM
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From: Prola, Stephen
Sent: Wednesday, January 06, 1999 7:52 AM
To: Douglas, Charles; Hopkins, AL; McGuirk, Andy; Baker, Gary; Dague, Bryan; Baumann, Russ
Subject: 77ps.ppt

<<File: 77ps.ppt>>
Here's the "Cause & Effect" diagram we discussed yesterday. Please review and comment. Thanks

Regards,

Steve

Baumann, Russ

From: McGuirk, Andy
Sent: Monday, January 11, 1999 2:48 PM
To: Sullivan, Martha; Rowland, Thomas
Cc: Baumann, Russ; Douglas, Charles; Pechonis, John
Subject: Lincoln Town Car "thermal events"

Our core Pressure Switch team is assisting Ford Motor Co. in understanding the cruise control (77P/S family) pressure switch design as part of an investigation into MY '92 & '93 Lincoln Town Car "thermal events". Ford representatives indicated some 20 events have been reported in the MY '92 Town Car.

On January 7th we hosted two Ford representatives and completed a failure analysis of a 77P/S pressure switch reported to be involved in a MY '93 Town Car issue. We are providing complete technical support and the preliminary results regarding pressure switch involvement from this failure analysis are inconclusive.

Charlie Douglas, from our Marketing Leadership, continues to lead the process for TI with excellent support from Russ Baumann supported by Bryan Dague, Al Hopkins, and Steve Prola.

AUTOMOTIVE SENSORS AND CONTROLS QFA MANAGER
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PAGE: (800) 447-3104 PIN 404-[illegible]

Graveline, Dora

From: McGuirk, Andy
Sent: Monday, January 11, 1999 3:46 PM
To: Sullivan, Martha; Rowland, Thomas
Cc: Baumann, Russ; Douglas, Charles; Pachonis, John
Subject: Lincoln Town Car "thermal events"

Our core Pressure Switch team is assisting [redacted] in understanding the cruise control (77P/S family) pressure switch design as part of an investigation into MY '92 & '93 Lincoln Town Car "thermal events". Ford representatives indicated some 20 events have been reported in the MY '92 Town Car.

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[illegible]

AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
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FAX : (508) 236-3748
PAGE: (800) 487-3706 PIN 604-3044

Epstein, Sally

From:	Hopkins, AL [ahopkins@email.mc.ti.com]
Sent:	Friday, January 15, 1999 5:06 PM
To:	Lincoln, Maureen
Cc:	Deque, Bryan; Prola, Stephen; McGuirk, Andy; Chura, Stephen; Pavao, Joe
Subject:	99-030: TSL # 150366: HIGH FALLOUT RATE ON ASSEMBLY LINE DUE TO N O-CONTINUITY: Status Report

OBJECTIVE:
Perform SEM analysis on Terminal 2 stationary contact to check for contamination.

RESULTS AND DISCUSSION:
The original samples were from a lot that was giving high fallout. I examined all the samples visually and only found one that gave indications to me that there was a significant amount of contamination present. SEM-EDX analysis of this sample showed mainly particles of the PPS plastic base and the glass fibers thar are used to reinforce the plastic.

At this point I asked Maureen to send over some known failures. She sent over four samples and out of this group, one had a visible particle on the contact and another had a plastic fiber on it. We removed the large particle on the first sample and determined that it was again PPS. Do you want us to have the Chem Lab determine the identity of the plastic fiber on the second sample?

We also examined one of the devices that didn't have any optically detectable (by me) contamination on it. Again, we found that particles of the casing plastic and fragments of glass reinforcing fibers were the main constituents.

This is not to say that there weren't other species present on the above devices. We found sodium, chlorine, titanium, potassium, etc; the amounts, however, weren't large enough to explain the problem.

We will be looking at the last of this group of 4. Maureen, you also had sent over a base that was still attached to the brass hex; it didn't come apart easy. I don't know if I caused damage during my disassembly or if all those drill holes were the cause. Please let me know more about this particular sample. Also, could I have a schematic of the device?

The data was collected under the guidelines of TSL-S-71, Rev A which can be accessed at http://www-mod.mc.ti.com/tsl/. SEM-EDAX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis was used in the above described analysis. The data will be sent through the internal mail.

AL HOPKINS MSG ID: AHOP PHONE: 508/236-3040

TI-NHTSA 018602

Post-it Fax Note 7671	Date 1/15/99	# of pages ▸ 1
To Charlie Douglas	From Rob Sharpe	
Co./Dept. TI-Attleboro	Co.	
Phone # (508) 236-3657	Phone #	
Fax # (508) 236-1598	Fax #	

January 15, 1999

The cup is partially covered with a greenish residue. Residue appears to be primarily an oxide of the brass contact material with possibly a sulfur compound. This suggests transfer of oxide or corrosion product from the brass contacts to the cup.

The stationary contact exhibits intergranular cracks which indicate stress corrosion cracking (SCC). SCC is caused by combination of a specific corrosive environment and a sustained tensile stress (can be localized). Ammonia, ammonia compounds, sulfur compounds, and moisture are known to cause SCC in brass. The contact material has been reported to be 360 brass, which is highly susceptible to SCC.

The presence of brake fluid on the switch side of the diaphragm has been determined. Black residues in the hex port and on the cup, converter, and disc appear to be compounds which may have formed from a reaction between decomposition products (acids) of the polyester base, the brake fluid, and metals in the switch. This suggests that the brake fluid was present on both sides of the diaphragm during the thermal event.

All three diaphragms exhibit what appears to be mechanical damage. The damage does not match up with any mating parts of the switch. This suggests that damage may have occurred prior to assembly. The diaphragm has become brittle and cracked in the vicinity of the damage. Brake fluid has become entrained between the layers (Teflon and capton) of the diaphragms.

The post of the movable contact melted back into the bulkhead between the switch and terminal cavities of the base. There is also arc damage (localized melting) to one corner of the bridge of the stationary contact. This damage appears fresh (surfaces bright and shiny) which suggests that it may have occurred in the later stages of the thermal event.

The terminals exhibit deposits which appear to be primarily sulfur compounds of the terminal material (tin plated brass). Although these deposits appear visually similar to the deposit found on the cup, they appear to be of different composition.

The white residue found in the connector cavity contains elements found in dry chemical fire extinguishers (Muscovite and phosphorus)

- Service history on 21 NHTSA vehicles Steve LaRouche
- Fuse slow blow or fast blow?

TI-NHTSA 018603

Epstein, Sally

From:	Hopkins, AL [ahopkins@email.mc.ti.com]
Sent:	Wednesday, January 20, 1999 10:22 AM
To:	Dague, Bryan; Baumann, Russ
Cc:	McGuirk, Andy; Andrea, Amy
Subject:	99-033; TSL # 150709: ANALYSIS OF MATERIAL REMOVED FROM 77PS THER MAL EVENT

ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

OBJECTIVE:
Determine nature of deposit; in particular, determine if it is consistent with the results from Ford's analysis.

SUMMARY:
The results were very similar to those found by Ford. The main difference is that our EDX detector has a much better low energy cutoff than did the Ford detector. Their detector is unable to detect carbon and oxygen. Our analysis showed large amounts of carbon and oxygen on all three samples.

RESULTS AND DISCUSSION:
All of the samples were comprised of a mixture of different phases that had agglomerated together. A description of our findings is shown below:

BLACK FLAKE FROM TROUGH: We found the following elements which are listed in a very approximate decreasing order of preponderance: copper, oxygen, carbon, chrome, zinc, potassium, sulfur, and silver.

MATERIAL SCRAPPED FROM CUP ASSEMBLY: There were a very large number of glass fibers present which had the composition that is typically used in plastics for reinforcing purposes. In other words, this is almost certainly from thermal decomposition of the plastic base. The EDX detectable elements in these fibers are calcium, aluminum, silicon and oxygen. The rest of the material was very similar in composition to that reported for the above sample although we also detected some phosphorous in this sample.

GREEN MATERIAL ON CUP: This material was similar to that found on the first sample although the amount of chrome was much less.

The data was collected under the guidelines of TSL-S-71, Rev A which can be accessed at http://www-mcd.mc.ti.com/tsl/. SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis was used in the above described analysis. The data will be sent through the internal mail.

AL HOPKINS MSG ID: AHOP PHONE: 508/236-3040

Graveline, Dora

From: Sharpe, Robert
Sent: Thursday, January 21, 1999 7:53 AM
To: Beringhause, Steven; Douglas, Charles
Cc: Baumann, Russ; Dodd, Bob
Subject: Lincoln Town Car Testing at Ford 1/25/99

Next weeks testing/analysis of the brake switch will be conducted at Ford's Central Labs in Dearborn. Steve LaRouche will coordinate this testing and can be reached directly at (313) 845-4876. This analysis will begin at 8:30am on Monday, 1/25/99. It appears that Steve's priority will be to examine 4 brake switches returned from Lincoln Town Car's (3 from cars that experienced actual thermal events, 1 removed as a reported "leaker" (no thermal event)). In addition, Ford has 2-3 samples removed from high mile mileage vehicles in Florida that may be examined on Monday if time allows.

Steve B., I will pick you up at the Courtyard Marriott in Dearborn (located on Mercury Drive, between Ford Rd and Michigan Ave, East of the Southfield Frwy, ph# 313-271-1400) on Monday morning between 8:00am and 8:15am. If you need to contact me over the weekend, my home phone# is (517) 552-9997. My car phone is (248) 568-6642.

Best Regards,

Rob Sharpe

Texas Instruments
Phone (248) 305-5729
Fax (248) 305-5734
rsharpe@ti.com

TI-NHTSA 018805

[illegible]		TO BE USED FOR REFERENCE ONLY											
		CUSTOMER		[illegible]		[illegible]	[illegible]						
	TI P/N	PART NO.	CUSTOMER	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Vehicles	Base Material	Specification
1	[illegible]	[illegible]	Ford NA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Crown Vic, Grand Marquis, Mark, Town Car	[illegible]	[illegible]
2	[illegible]	[illegible]	Mills Ind.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Econoline, Club Wagon	[illegible]	[illegible]
3	[illegible]	[illegible]	FO - [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Crown Vic, Grand Marquis, Mark, Town Car	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Windstar	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible], F-Series, Ranger, Explorer, Navigator, Expedition, Econoline, Club Wagon	[illegible]	[illegible]
6	[illegible]	[illegible]	Aust - [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Taurus	[illegible]	[illegible]
8	[illegible]	[illegible]	Aust - Capri	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Capri	[illegible]	[illegible]

1) Need to affect application
2) TI interest
3) Be responsive to Ford

* Volume production ending on L2-1
* Run testing to re-create fire conditions
* List all items which can lead to water in brake fluid
* ppm level on leak related defects
* 151PS Circuit / Application
* List of tests TI will run

TI-NHTSA 018606

2/6/00 10:44 AM

Epstein, Sally

From:	Douglas, Charles [c-douglas2@email.mc.ti.com]
Sent:	Thursday, February 04, 1999 12:57 PM
To:	Sullivan, Martha; Baumann, Russ; McGuirk, Andy
Cc:	Beringhause, Steven; Baker, Gary; Rowland, Thomas
Subject:	RE: Ford Lincoln Cruise control

attorney - client privileged information.

As additional and new information. Fred Porter just phoned in and this whole situation appears to be escalating. Ford is very concerned that NHTSA is going to issue a final ruling (with or without Ford input) and that the ruling could literally come down within the next few days. I did not attempt to get into specifics as to implications from a NHTSA ruling.

Rob Sharpe has been called in to attend an emergency meeting at Ford at 2:00 pm today. Only questions Rob will be prepared to answer center around capacity on the 77PS assembly line. Meeting was called by Fred Porter's group.

Fred had several technical requests all of which were deferred to Steve. Fred also requested an assembly process overview. If there are any issues with honoring this request, please let me know asap as I have committed to a response of no later than Friday am.

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

From: McGuirk, Andy
Sent: Thursday, February 04, 1999 12:45 PM
To: Sullivan, Martha; Baumann, Russ
Cc: Douglas, Charles; Beringhause, Steven; Baker, Gary
Subject: Ford Lincoln Cruise control

attorney - client privileged communication

We have spent a little time estimating what we think the typical Ford Dealer cruise control pressure switch replacement labor time might be for the platform of discussion.

A check through our contacts at Tasca Mercury dealership indicates the 'computer' says 1.5 hours or $90 plus switch (service charges $17.44 for a pressure switch). We thought this was very high given that the switch is so easy to access on the proportional valve in the engine compartment. We are theorizing that the labor is so high because of a need to evacuate and refill the system with brake fluid and possibly bleed the system.

We had brain-stormed a replacement scenario prior to connecting with Tasca of a 'swap out strategy' whereby one would pre-fill the switch 'port' cavity of the switch with fluid to eliminate air and insert into the proportional valve 'loosely' such that one could 'bleed' out the micro-amount of trapped air (via leakage around port threads). If this were the replacement process and it worked then we would be talking about ten minutes which probably charges out at 1/2 hour service cycle.

summary:
223 k cars in '92 and '93 Town Car platform.... attrition at 95% results in 212 k

1

vehicles on the road

212 k at $93 each (90 labor and 3 cost of switch) results in $ 19,716 K per the 'computer'

(if the speedy swap is viable, it would be 212 K at $33 (30 labor and 3 switch) resulting in $6,996 K)

this dialogue led us (Charlie Douglas and Andy McGuirk) to a number of vehicle specific questions.... the '92 model had 6 (six !) service bulletins published for brakes. (one for ABS 'coming on' during just rough road driving, one for ABS 'staying on' when brake pedal fails to return to normal up position !)

Did each bulletin result in vehicle brake service and evacuation ? is the fluid in the southern states water contaminated because of humidity ? have the thermal event vehicles been serviced multiple times for brakes ? is there a connection here that creates the environment for a thermal event ? Is ABS a common element? We'll need to generate some questions and answers here.

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FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

TI-NHTSA 018608

Morris, Irene

From: Sullivan, Martha
Sent: Friday, February 05, 1999 8:03 AM
To: Rowland, Thomas
Subject: FW: Ford Lincoln Cruise control

There has been discussion about tapping Aziz Rahman to be resident at Ford. Please be prepared to discuss this at the meeting today.

REDACTED

REDACTED

REDACTED

REDACTED

Baumann, Russ

From:	McGuirk, Andy
Sent:	Saturday, February 06, 1999 10:55 AM
To:	Baumann, Russ; Ross, Elaine; Watt, Jim
Cc:	Beringhause, Steven; Dague, Bryan; Pechonis, John; Rowland, Thomas; Sullivan, Martha; Baker, Gary; Rahman, Aziz; Sharpe, Robert
Subject:	77 p/s 'durability' baseline information

attorney - client privileged communication

Jim and Elaine, as I mentioned in my telecons, I would like us to move forward in quickly assembling data that we can use to help Ford understand our 'sensor' assembly durability baseline in the brake switch package. This, as I see it, would be composed of 3 major sections per below (please feel free to insert your ideas also) and for the most part needs to be delivered early w/o Feb 8th:

A) I want to demonstrate that manufacturing anomalies did not escape to the field in the form of a projection of hydraulic fluid leakers through the supply chain.... and we can help achieve this objective by assembling data that demonstrates our history of hydraulic leak rates in the subject time-frame of MY92 and MY 93 as seen in our factory floor and/or customer feedback. Jim, please take the lead on getting this done ASAP. we should consider customer AIQ spreadsheets and RMR data coupled with 8D's of the time to build a case for the low PPM leak rates of the sensor assembly further protected by downstream supply chain testing at the TIER-one and OEM. Also, there may be an opportunity to integrate manufacturing test data as a validator of that leak rate number as well as using the leak test data from impulse testing as an alternate source. there will be a building need to deliver data and evidence by Tuesday via Aziz and we should consider an alternate path of anecdotal estimate should the records not be readily available. (I know we will need to identify and recall records and that will take time)

B) I want to demonstrate that the sensor assembly is mechanically durable and surpasses the 'expected' life cycles as expressed on the Ford specs....and we can achieve this objective by assembling ES 'impulse' testing data from the timeframe of interest. In an ideal situation we would take this raw data and project into WEIBULL success-testing estimate of cycle capability in the 'accelerated simulated' cyclers used in our process controls. Elaine please coordinate the data collection here. (We will likely turn to reliability experienced quality engineers Paul spacerman and Tushar Parikh to convert the data to information). Again, should we run out of time, we will need to turn to whatever relevant 'recent' data we have to propose our position and support with historical based data once we sort through the files and record recall process. Bryan, please inject any life test data from other qualification platforms here so we have 'test-to-failure' data if available.
Also, we should make a side note of the pressure profile used in the cycler process for future use with Aziz during his upcoming dialogues with Ford.

C) I want to demonstrate that the sensor is chemically resistant per the IP and PPAP testing and surpasses 'expected' exposures per the Ford Specs... and we can achieve this by assembling both relevant IP testing and PPAP results to demonstrate compliance. There may also be other testing history of the period that would convey that durability of the switch assembly in the typical automotive fluid environment of gas-oil-coolant-fluids in the proper orientation and connector protection. Elaine, please assemble this data and we will provide to Aziz to deliver to Ford. Again, should we run out of time, delivery of the readily available records from '95-'96-'97 per your Friday work would suffice as a starting point.

To provide some further clarity, I have included the focal part numbers from Charlie Douglas below. As we assemble data and translate into information please track the differences between 57 and 77 and 87 styles but also integrate the brake sensor assembly data and treat it as a family. As you discover the level of effort and resource needs, pls see John or me for help in getting people assigned or priority provided.

thank you for your continued support here.

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
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ATTLEBORO, MA 02703
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PAGE: (800) 467-3700 PIN 504-2044

From: Douglas, Charles
Sent: Friday, February 05, 1999 8:43 AM
To: McGuirk, Andy; Ross, Elaine
Subject: 77PS Matrix

Andy / Elaine,

Per our discussion:

Lincoln.doc

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

TI-NHTSA 018611

Potential Cruise Control Circuit Modification

- Present cruise control circuit results in a continuous application of battery voltage to the cruise control pressure switch

- Water ingress into the switch due to misuse (power washing) or seal degradation presents an electrolyte to the switch electrical conductors
  - accelerated corrosion can result
  - Kapton degradation can result

- Cruise control circuit modification to remove continuous application of battery voltage is recommended
  - Insertion of a Normally Open relay in series (upstream) of the cruise control pressure switch, that is closed (energized) only when cruise control is switched on is recommended

- This circuit change will remove the continuously applied battery voltage as a potential source of ignition of brake and other automotive fluids

Morris, Irene

From:	McGuirk, Andy
Sent:	Saturday, February 06, 1999 11:54 AM
To:	Baumann, Russ; Ross, Elaine; Watt, Jim
Cc:	Beringhause, Steven; Dague, Bryan; Pechonis, John; Rowland, Thomas; Sullivan, Martha; Baker, Gary; Rahman, Aziz; Sharpe, Robert
Subject:	77 p/s 'durability' baseline information

attorney - client privileged communication

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thank you for your continued support here,

TI-NHTSA 018813

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AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 21-08
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FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Douglas, Charles
Sent: Friday, February 05, 1999 8:43 AM
To: McGuirk, Andy; Rose, Elaine
Subject: 77PS Matrix

Andy / Elaine,

Per our discussion:

Lincoln.doc

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

TI-NHTSA 018814

Epstein, Sally

From:	Douglas, Charles [c-douglas2@email.mc.ti.com]
Sent:	Monday, February 08, 1999 12:42 PM
To:	McGuirk, Andy; Sullivan, Martha
Cc:	Beringhause, Steven; Rowland, Thomas
Subject:	RE: Ford ISAC Meeting

Usage Matrix - Speed Control D... Lincoln.doc

Martha,

Andy asked me to provide as much of the consolidated information as I am aware of. Attached, please find two pieces of direct correspondence from myself to Ford delineating application usage information:

<<Usage Matrix - Speed Control Deactivation Pressure Switch>>
<<Lincoln.doc>>

In addition, we have provided the following in direct response to Ford requests / questions:

* Overview of switch design / function
* Copy of 8D delineating mating connector issue on Econoline
* Component level prints for 77PS
* Assembly process flow for 77PS
* Melt / Char temperature information related to Noryl GTX material and Kapton
* Design change matrix / history (will be carried out by Aziz tonight)
* Hosted Ford visit on January 6 to perform joint failure analysis on one switch captured from fire vehicle
* Ideas for fusing the switch in circuit (Discussion between Steve B. and Fred P.)

Information we owe / questions we have been asked:

* Process change history (likely complete tomorrow)
* Flash points for all components / materials used in switch
* Are material specs submitted to Ford the same as the material specs used on the MY92/93 applications
* Does our DFMEA or PFMEA identify any potential fire occurrences
* How do we control terminal positioning in production, any chance of the terminals to short?
* Has our in-process testing showed any failures or concerns
* Are there material differences between the different colored bases (will be answered by Design Change Matrix)
* What testing / investigating is TI doing internally
* Do we sell the brake switch outside of Ford applications (yes, Land Rover)
* Provide color pictures of Econoline failure analysis report

Steve,

If there are other questions which Fred may have put to you directly that I am not aware of, or additional information we may have volunteered (i.e. in-line relay?) please add to this msg.

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

From: Sullivan, Martha
Sent: Monday, February 08, 1999 9:02 AM
To: McGuirk, Andy
Cc: Douglas, Charles; Beringhause, Steven; Rowland, Thomas
Subject: Ford ISAC Meeting

I am leaving for a Ford ISAC meeting tomorrow. Given reports of executive level exposure on the Town Car issue, I expect some questions. Could you please consolidate the questions we've been asked and our responses to date.

McGuirk, Andy

To: Baumann, Russ; Rose, Elaine; Watt, Jim
Cc: Beringhause, Steven; Dague, Bryan; Pechonis, John; Rowland, Thomas; Sullivan, Martha; Baker, Gary; Rahman, Aziz; Sharpe, Robert
Subject: 77 p/s 'durability'data

attorney - client privileged communication

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thank you for your continued support here,

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER

TI-NHTSA 018617

34 FOREST ST M/S 23-08
ATTLEBORO, MA 02703
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PAGE: (800) 467-3700 PIN 604-3044

From: Douglas, Charles
Sent: Friday, February 05, 1999 8:43 AM
To: McGuirk, Andy; Rose, Elaine
Subject: 77PS Matrix

Andy / Elaine,

Per our discussion:

Lincoln.doc

Regards,

Charlie

Charlie Douglas
(508) 236-3667 (P)
(508) 236-1596 (F)
c-douglas2@ti.com

T/-NHTSA 018618

Dague, Bryan

From:	Douglas, Charles
Sent:	Monday, February 08, 1999 1:50 PM
To:	Dague, Bryan
Subject:	FW: Ford ISAC Meeting

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1606 (F)
c-douglas2@ti.com

From:	Douglas, Charles
Sent:	Monday, February 08, 1999 1:41 PM
To:	McGuirk, Andy; Sullivan, Martha
Cc:	Beringhause, Steven; Rowland, Thomas
Subject:	RE: Ford ISAC Meeting

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TI-NHTSA 018819

- Are there material differences between the different colored bases (will be answered by Design Change Matrix)
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- Do we sell the brake switch outside of Ford applications (yes, Land Rover)
- Provide color pictures of Econoline failure analysis report

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Regards,

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Charlie Douglas
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Sent: Monday, February 08, 1999 9:02 AM
To: McGuirk, Andy
Cc: Douglas, Charles; Beringhause, Steven; Rowland, Thomas
Subject: Ford ISAC Meeting

I am leaving for a Ford ISAC meeting tomorrow. Given reports of executive level exposure on the Town Car issue, I expect some questions. Could you please consolidate the questions we've been asked and our responses to date.

Morris, Irene

From: McGuirk, Andy
Sent: Monday, February 08, 1999 2:54 PM
To: Rahman, Aziz; Dague, Bryan
Cc: Baumann, Russ
Subject: FW: Ford ISAC Meeting
Importance: High

for your meeting this pm

8

AUTOMOTIVE SENSORS AND CONTROLS QRA [illegible]
14 FOREST ST M/S 21-05
ATTLEBORO, MA 02703
TEL : (508) 236-3050
FAX : (508) 236-3745
PAGE: (800) 487-3700 PIN 804-2044

From: Douglas, Charles
Sent: Monday, February 08, 1999 1:41 PM
To: McGuirk, Andy; Sullivan, Martha
Cc: Beringhause, Steven; Rowland, Thomas
Subject: RE: Ford ISAC Meeting

Martha,

Andy asked me to provide as much of the consolidated information as I am aware of. Attached, please find two pieces of direct correspondence from myself to Ford delineating application usage information:

Usage Matrix - Speed Control Deactiv...   Lincoln.doc

In addition, we have provided the following in direct response to Ford requests / questions:

- Overview of switch design / function
- Copy of 8D delineating mating connector issue on Econoline
- Component level prints for 77PS
- Assembly process flow for 77PS
- Melt / Char temperature information related to Noryl GTX material and Kapton
- Design change matrix / history (will be carried out by Aziz tonight)
- Hosted Ford visit on January 6 to perform joint failure analysis on one switch captured from fire vehicle
- Ideas for fusing the switch in circuit (Discussion between Steve B. and Fred P.)

Information we owe / questions we have been asked:

- Process change history (likely complete tomorrow)
- Flash points for all components / materials used in switch
- Are material specs submitted to Ford the same as the material specs used on the MY92/93 applications

TI-NHTSA 018621

- Does our DFMEA or PFMEA identify any potential fire occurrences
- How do we control terminal positioning in production, any chance of the terminals to short?
- Has our in-process testing showed any failures or concerns
- Are there material differences between the different colored bases (will be answered by Design Change Matrix)
- What testing / Investigating is TI doing internally
- Do we sell the brake switch outside of Ford applications (yes, Land Rover)
- Provide color pictures of Econoline failure analysis report

Steve,

If there are other questions which Fred may have put to you directly that I am not aware of, or additional information we may have volunteered (i.e. in-line relay?) please add to this msg.

Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

From: Sullivan, Martha
Sent: Monday, February 08, 1999 9:02 AM
To: McGuirk, Andy
Cc: Douglas, Charles; Beringhause, Steven; Rowland, Thomas
Subject: Ford ISAC Meeting

I am leaving for a Ford ISAC meeting tomorrow. Given reports of executive level exposure on the Town Car issue, I expect some questions. Could you please consolidate the questions we've been asked and our responses to date.

Fred,

I believe that your list includes some service part numbers, older rev levels, as well as pre-production or prototype part numbers. Overall, including Ford Australia, there are eight different production parts. Differences from part to part are fairly minor and include, actuation calibration, release pressure, hexport style, position tab / color of connector base, thread style, and snap noise associated with the pressure disc. The following matrix, helps summarize this information:

Part Number	Actuation		Release	Base	Hexport	Thread	S or Q
F7VC 9F924 AB	90-160	(1)	20 min	Brown / pos 2	J512	3/8-24M	Snap
F6LC 9F924 AA	200-300	(2)	40 min	Black / pos 1	J512	3/8-24M	Snap
F2AC 9F924 AA	90-200	(3)	20 min	Natural / pos 2	J512	3/8-24M	Quiet
F58A 9F924 AA	90-160	(4)	20 min	Grey / pos 1	J512	3/8-24M	Quiet
F3TA 9F924 CA	200-300	(5)	40 min	Red / pos 1	J512	3/8-24M	Snap
94DA 9F924 AA	90-160	(6)	20 min	Natural / pos 2	o-ring	M10x1.0M	Quiet
F3DC 9F924 AA	90-160	(7)	20 min	Natural / pos 2	Snubber	3/8-24M	Quiet
94IA 9F924 AB	90-160	(8)	20 min	Grey / pos 1	o-ring	3/8-24M	Quiet

Vehicle – Part Number Correlation

(1) Crown Vic, Grand Marquis, Mark, Town Car
(2) Econoline, Club Wagon
(3) Crown Vic, Grand Marquis, Mark, Town Car
(4) Windstar
(5) Bronco, F-Series, Ranger, Explorer, Navigator, Expedition, Econoline, Club Wagon
(6) Falcon
(7) SHO Taurus
(8) Capri

TI P/N Correlation to Above

(1) 77PSL2-1
(2) 77PSL2-3
(3) 77PSL3-1
(4) 77PSL3-2
(5) 77PSL3-3
(6) 77PSL4-1
(7) 77PSL5-2
(8) 77PSL6-1

Dague, Bryan

From: McGuirk, Andy
Sent: Monday, February 08, 1999 1:54 PM
To: Rahman, Aziz; Dague, Bryan
Cc: Baumann, Russ
Subject: FW: Ford ISAC Meeting
Importance: High

for your meeting this pm

a

AUTOMOTIVE SENSORS AND CONTROLS QRA ENGINEER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

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To: McGuirk, Andy; Sullivan, Martha
Cc: Beringhause, Steven; Rowland, Thomas
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TI-NHTSA 019625

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Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

From: Sullivan, Martha
Sent: Monday, February 08, 1999 9:02 AM
To: McGuirk, Andy
Cc: Douglas, Charles; Beringhause, Steven; Rowland, Thomas
Subject: Ford ISAC Meeting

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Dogue, Bryan

From: Douglas, Charles
Sent: Monday, February 08, 1999 1:50 PM
To: Dogue, Bryan
Subject: FW: Ford ISAC Meeting

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

From:	Douglas, Charles
Sent:	Monday, February 08, 1999 1:41 PM
To:	McGuirk, Andy; Sullivan, Martha
Cc:	Beringhause, Steven; Rowland, Thomas
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Steve,

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Regards,

To: bdague@ti.com; sberinghause@ti.com
Subject: Manufacturer List from Performance Polymers

ATT18071.htm.html

http://perfpoly.idesinc.com/

Dague, Bryan

From: Hopkins, AL
Sent: Thursday, March 04, 1999 10:39 AM
To: Beringhause, Steven; Dague, Bryan
Subject: CONCENTRATIONS OF OXALIC ACID CLEANING SOLUTIONS

I just spoke to a tech representative from Oakite which is a major supplier of industrial cleaning solutions. He told me that most of their products that they sell for removing rust from steel and which contain oxalic acid, do so in the 5-10% range. Furthermore, the instructions say to dilute these solutions at the 4-6 ounces per gallon of water level. This works out to about the 0.3% level

I also did some Internet research and found that many people recommend using Oxalic acid at the 5-10% level for uses around the home and in the garage; with much fewer concerns about saftey.

Regards,

Al

Dague, Bryan

From: Rahman, Aziz
Sent: Tuesday, March 02, 1999 5:11 PM
To: McGuirk, Andy; Dague, Bryan; Douglas, Charles; Sharpe, Robert; Baumann, Russ; Beringhause, Steven
Subject: FW: SAE paper discuss at Ford meeting

Steve/Bryan

Sounds like a good paper for info on brake fluid degradation. It may be available online??

TI-NHTSA 018628

From: Kitt, Michael (MB)(SMTP:mkitt@dow.com)
Sent: Thursday, February 25, 1999 9:03 AM
To: 'aziz@ti.com'
Subject: SAE paper discuss at Ford meeting

Aziz,
The SAE paper that discusses brake fluid corrosion is SAE paper # 971007. It from the Corrosion Prevention (SP-1265) series of papers.
Hope this helps,
Mike Kitt

Dague, Bryan

From: Rahman, Aziz
Sent: Tuesday, March 02, 1999 4:24 PM
To: McGuirk, Andy; Dague, Bryan; Douglas, Charles; Sharpe, Robert; Baumann, Russ; Beringhause, Steven
Subject: FW: Central Lab Analyses

fyi

From: LaRouche, Steve (S.)(SMTP:slarouch@ford.com)
Sent: Tuesday, March 02, 1999 11:56 AM
To: Porter, Fred (F.J.); LaPointe, Norman (N.R.); Reimers, Steve (S.J.); 'A. Rahman'; McCarthy, Shaun (S.L.); LaRouche, Steve (S.)

We have found three switches so far (including the one to be analyzed by the Sci Lab), that will not open electrically when disc is heard to snap under application of air pressure. I sectioned one of these switches and found what appears to be water (it evaporated rather quickly at room temp) and corrosion product. I found that the transfer pin has been stuck in place by the corrosion products. What this means, is that even if the disc snaps, the pin will not pull back, and the contacts will not open. None of these switches showed evidence of diaphragm leakage on the test stand.

Steve LaRouche (SLAROUCH)
Metallurgy Section, Central Laboratory, Room N410
(313) 845-4876 (313) 322-1614 FAX

Dague, Bryan

From: Amore, Alan
Sent: Tuesday, March 02, 1999 12:01 PM
To: Douglas, Charles; Dague, Bryan
Subject: Info on plastic base materials

The attached info was gathered from material properties data sheets and from the MSDS system.

Not all data is complete but probably could be completed if the right plastics people were identified.

I would say that the Ultems and the Fortrons are probably best from ignition standpoints while the Fortrons and Stanyls are best from a the standpoint of strength and deflection temps.

If you need more info, let me know.

bose plastic.xls

BEST REGARDS,

[illegible]

Dague, Bryan

From: Watt, Jim
Sent: Monday, March 01, 1999 4:54 PM
To: Baumann, Russ; Beringhause, Steven; Dague, Bryan; Pechonis, John; Rahman, Aziz; Rowland, Thomas; Douglas, Charles; Pawlowski, Robin; Baker, Gary; O'Neill, Ed; Haskell, Beth; Sharpe, Robert; McGuirk, Andy
Subject: RE: FORD P/S TRANSITIONS OF CURRENT INTEREST

Andy,

Below are the files you were requesting:

1. Town Car Switch Usage Sequence:

77PStimeline.ppt

2. 77PS Suppliers' Request For Engineering Analysis (SREA) history:

77PS SREA-ALERT UPDATE.XLS

3. Part Number 46515 (77PS Molded Base Material History):

77PS Molded Base
P.N. 46515 UPDATE.XLS

Jim Watt, QRA, msgid: jw02; mail station 12-33; page (508)236-1010, no. (0696)
ph (508) 236-1719;
fax (508)236-3153

From: McGuirk, Andy
Sent: Monday, March 01, 1999 10:22 AM
To: Baumann, Russ; Beringhause, Steven; Dague, Bryan; Pechonis, John; Rahman, Aziz; Rowland, Thomas; Douglas, Charles; Watt, Jim; Pawlowski, Robin; Baker, Gary; O'Neil, Ed; Haskell, Beth; Sharpe, Robert
Subject: FORD P/S TRANSITIONS OF CURRENT INTEREST

JIM WATT, PLS PULL TOGETHER THE TEAM OF CHARLIE DOUGLAS AND ROBIN PAWLOWSKI AND OTHERS TO RECONSTRUCT THE TIME-LINE OF TI PRESSURE SWITCH 77PS FAMILY.

SPECIFIC AREAS OF INTEREST ARE QUIET SWITCH AND NORMAL SWITCH AS WELL AS GE PLASTIC AND CELENEX PLASTIC AS INSTALLED INTO THE FORD TOWN CAR PLATFORM IN MODEL YEAR '92 AND '93. I UNDERSTAND WE ARE ABLE TO DEFINE THE TIER-ONE CUSTOMERS AND THERE WILL BE A NEED TO CONNECT THEM TO THIS PLATFORM AND YOU SHOULD USE VARIOUS AVENUES TO ACCOMPLISH SAME.

PLEASE PLAN A 'MINI' TEAM MEETING WITH JOHN PECHONIS AND CHARLIE DOUGLAS AND YOURSELF (AND OTHER IF YOU FEEL VALUE IS ADDED) (AT JOHN'S OFFICE) TO REVIEW OUR STATUS LATER TODAY...SAY 4-ISH. IT IS IMPORTANT THIS INFO BE ACCURATE AS WELL AS PROMPT. THE RESULTING PRODUCT WOULD BE REVIEWED WITH RUSS TOMORROW MORNING BY ME.

A

AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 23-06
ATTLEBORO, MA 02703
TEL : (508) 236-3068
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2046

Epstein, Sally

From:	Watt, Jim [jwatt@email.mc.ti.com]
Sent:	Monday, February 08, 1999 3:32 PM
To:	McGuirk, Andy; Douglas, Charles
Subject:	RE: 77 p/s 'durability' baseline information
Importance:	High
Sensitivity:	Confidential

Andy,

the below 8-D file references the only leaker for the data base that I forwarded to you earlier today. The leaker was found and returned from Tokico USA, Berea, KY, and caused by a misplaced gasket on a sensor assembly:

<<car95_30.doc>>

Jim Watt, QRA, msgid: jw02; mail station 12-33; page (508)236-1010, no. (0696)
ph (508) 236-1719;
fax (508)236-3153

From: McGuirk, Andy
Sent: Saturday, February 06, 1999 10:54 AM
To: Baumann, Russ; Rese, Elaine; Watt, Jim
Cc: Beringhause, Steven; Dague, Bryan; Fechonis, John; Rowland, Thomas; Sullivan, Martha; Baker, Gary; Rahman, Aziz; Sharpe, Robert
Subject: 77 p/s 'durability' baseline information

attorney - client privileged communication

Jim and Elaine, as I mentioned in my telecons, I would like us to move forward in quickly assembling data that we can use to help Ford understand our 'sensor' assembly durability baseline in the brake switch package. This, as I see it, would be composed of 3 major sections per below (please feel free to insert your ideas also) and for the most part needs to be delivered early w/o Feb 8th:

A) I want to demonstrate that manufacturing anomalies did not escape to the field in the form of a projection of hydraulic fluid leakers through the supply chain.... and we can help achieve this objective by assembling data that demonstrates our history of hydraulic leak rates in the subject time-frame of MY92 and MY 93 as seen in our factory floor and/or customer feedback. Jim, please take the lead on getting this done ASAP. we should consider customer AIQ spreadsheets and RMR data coupled with 8D's of the time to build a case for the low PPM leak rates of the sensor assembly further protected by downstream supply chain testing at the TIER-one and OEM. Also, there may be an opportunity to integrate manufacturing test data as a validator of that leak rate number as well as using the leak test data from impulse testing as an alternate source.

there will be a building need to deliver data and evidence by Tuesday via Aziz and we should consider an alternate path of anecdotal estimate should the records not be readily available. (I know we will need to identify and recall records and that will take time)

B) I want to demonstrate that the sensor assembly is mechanically durable and surpasses the 'expected' life cycles as expressed on the Ford specs....and we can achieve this objective by assembling ES 'impulse' testing data from the timeframe of interest. In an ideal situation we would take this raw data and project into WEIBULL success-testing estimate of cycle capability in the 'accelerated simulated' cyclers used in our process controls. Elaine please coordinate the data collection here. (We will likely turn to reliability experienced quality engineers Paul spaceman and Tushar Parikh to convert the data to information). Again, should we run out of time, we will need to turn to whatever relevant 'recent' data we have to propose our position and support with historical based data once we sort through the files and record recall process. Bryan, please inject any life test data from other qualification platforms here so we have 'test-to-failure' data if available.

Also, we should make a side note of the pressure profile used in the cycler process for future use with Aziz during his upcoming dialogues with Ford.

C) I want to demonstrate that the sensor is chemically resistant per the IP and PPAP testing and surpasses 'expected' exposures per the Ford Specs... and we can achieve this by assembling both relevant IP testing and PPAP results to demonstrate compliance. There may also be other testing history of the period that would convey that durability of the switch assembly in the typical automotive fluid environment of gas-oil-coolant-fluids in the proper orientation and connector protection. Elaine, please assemble this data and we will provide to Aziz to deliver to Ford. Again, should we run out of time, delivery of the readily available records from '95-'96-'97 per your Friday work would suffice as a starting point.

To provide some further clarity, I have included the focal part numbers from Charlie Douglas below. As we assemble data and translate into information please track the differences between 57 and 77 and 87 styles but also integrate the brake sensor assembly data and treat it as a family. As you discover the level of effort and resource needs, pls see John or me for help in getting people assigned or priority provided.

thank you for your continued support here,

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Douglas, Charles
Sent: Friday, February 05, 1999 8:43 AM
To: McGuirk, Andy; Rose, Elaine
Subject: 7790 Matrix

Andy / Elaine,

Per our discussion:

<<File: Lincoln.doc>>
Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

Epstein, Sally

From:	McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent:	Tuesday, February 09, 1999 10:35 AM
To:	Rahman, Aziz; Beringhause, Steven
Subject:	FW: 77 p/s 'durability' baseline information
Importance:	High
Sensitivity:	Confidential

AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
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PAGE: (800) 467-3700 PIN 604-2044

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Sent: Monday, February 08, 1999 4:31 PM
To: McGuirk, Andy; Douglas, Charles
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Sensitivity: Confidential

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34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Douglas, Charles
Sent: Friday, February 05, 1999 8:43 AM
To: McGuirk, Andy; Rose, Elaine
Subject: 77PS Matrix

Andy / Elaine,

Per our discussion:

<<File: Lincoln.doc>>
Regards,

Charlie

Charlie Douglas
(508) 236-3657 (P)
(508) 236-1598 (F)
c-douglas2@ti.com

TEXAS INSTRUMENTS INCORPORATED
CORRECTIVE ACTION REPORT

Status:	**Closed**
Report Number:	**car95_30.doc**
Date Opened:	**June 26, 1995 (original)**
Update:	**October 13, 1995**
Customer:	**Tokico USA**
TI p/n (s):	**77PSL3-3**
Customer p/n (s):	**F3TA-9F924-CA**
CAR description:	**Device leak**

(Step 1) Champion and Team Members

Matt Sellers	Manufacturing Engineering	(Champion)
Ann Rea	Manufacturing Engineering	
Keith Rosiello	Design Engineering	
Jim Watt	Quality Engineering	
Claire Balthazar	Learning Analysis Lab (LAL) Coordinator	
Peggy Allen	Manufacturing Supervisor	
Chris Wagner	Design Engineering	
Lou Rocha	R&M	

(Step 2) Problem Description

Barry Stewart, Tokico quality, reported one 77PSL3-3 pressure switch failing end of line pressure decay testing at Tokico facilities in Berea, KT. (Customer rejection # 448. TI CARE # 1408266.). Specific Tokico test parameters are unknown at this point - Jim Watt follow-up.

There is no history of any past leak failures at Tokico USA, and no additional failures have been reported by Tokico to date.

Date code of the returned switch is 5124. May 4, 1995.

Failure analysis at TI Attleboro demonstrated a pressure decay rate and calibration within final test limits, however, further lab fine leak testing confirmed leak rates higher than normal. Disassembly inspection was performed and the internal gasket was found outside of the hexport gasket gland.

Further visual analysis confirms that the sensor assembly was assembled on the automated sensor assembly machine as evidenced by the presence of pre-crimp marks around the cup periphery. All other device characteristics appear normal and according to standard production.

July 14, 1995 update:

No additional failures have been reported by Tokico to date.

August 25, 1995 update:

Tokico test parameters were received.

Tokico reported one additional 77PSL3-3 pressure switch failing end of line pressure decay testing. (Customer rejection # 566, TI CARE # 1461501)

Date code of switch is 5201, which corresponds to July 20, 1995.

Again, failure analysis at TI Attleboro demonstrated pressure decay rate and calibration within final test limits. Lab analysis confirmed higher than normal leak rates. The device was disassembled and the internal gasket was found outside of the hexport gasket gland. All other device characteristics appear normal.

The device was assembled automatically on the sensor assembly machine.

September 1, 1995 update:

Regarding Tokico Customer rejection # 566, TI CARE # 1461501. Upon further analysis it has been determined that the out of place gasket was due to a pilot handling procedural error - not related to the pre-crimp station located on the sensor assembly machine as was the previous switch related to Tokico Customer rejection # 448, TI CARE # 1408266.

This procedural error is under review by Peggy Allen (Manufacturing Supervisor). Immediate actions were taken to highlight the error to all associated pilot makers.

September 8, 1995 update:

No additional failures have been reported by Tokico to date.

October 13, 1995 update:

No additional failures have been reported by Tokico to date.

(Step 3) Containment and Short Term Corrective Actions

* Review LAL team post-mortem analysis reports of confirmed final function test leak fallout. Align LAL team sensitivity.	Balthazar Complete
* Next 8D update to Tokico is 10/13/95.	Sellers Complete

(Step 4) Definition and Verification of Root Cause

July 14, 1995 update:

Customer rejection # 448. TI CARE # 1408266. Likely cause is inadequate pre-crimp prior to puck transfer. See C/A's for actions to prevent re-occurrence.

August 25, 1995 update:

Customer rejection # 448. TI CARE # 1408266. Likely cause is inadequate pre-crimp prior to puck transfer. See C/A's for actions to prevent re-occurrence.

September 1, 1995 update:

Tokico Customer rejection # 566. TI CARE # 1461501. Pilot handling procedural error is the determined cause.

(Step 5) Permanent Corrective Actions

July 14, 1995 update:

* Augment sensor assembly process specification set-up procedures with improved pre-crimp inspection criteria.	Sellers Complete
* Determine feasibility of go no-go pre-crimp master.	Sellers Complete

September 1, 1995 update:

* Complete build and qualification of pre-crimp go/no-go master. P. Spec set-up instructions updated.	Rea Complete

September 8, 1995 update:

* Evaluate perm. design-solution. (Gasket/Gasket gland enhancements) (No reasonably valid pressure switch design solutions have been highlighted as warranting further action). — Rosiello Complete

(Step 6) Verification of Permanent Corrective Actions

* On-going LAL post-mortem review of all leak fallout at final function test. — Balthazar Complete

* Jim Watt will continue to close with Tokico USA on installation and final leak test fallout. — Watt Complete

(Step 7) Prevent Recurrence

* Completion of sensor assembly process set-up procedure enhancements and pilot procedural handling training with all associated pilot makers provides good confidence in the prevention of mis-placed gaskets.

* Enhancements to TI's detection capability to match the sensitivity level specified by Tokico internal engineering standards would require significant modifications to TI's assembly/test processes. Prevention of the anomaly will continue to be the primary focus of the TI QOS operations team. We place high priority in continuously improving our processes.

* Further engineering discussions are necessary as more refined leak detection capability is required. TI contacts are Jim Watt, Matt Sellers, and Keith Rosiello.

- end report -

Epstein, Sally

From:	McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent:	Wednesday, February 10, 1999 2:08 PM
To:	Baumann, Russ RUSB; Dague, Bryan
Cc:	Beringhause, Steven; 'Rahman, Aziz ZIZ'; Watt, Jim
Subject:	RE: 77PS Design explanation

Attorney Client Privileged Information

overall, an outstanding document draft.   i made a number of changes and am on callback to discuss my thoughts.

i think it might be of value to discuss weibull success factor projections from the 'zillions' of 'as' test results we must have?   we should also speak to the thunderbird applications ?   maybe refer to the econoline issue of '93 with connector issues ?

we need some summary statement as to the ending of this document......

a
AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Dague, Bryan
Sent: Wednesday, February 10, 1999 1:24 PM
To: Baumann, Russ RUSB
Cc: Beringhause, Steven; Rahman, Aziz ZIZ; McGuirk, Andy
Subject: 77PS Design explanation

Folks,

Here is a summary of how and why the 77PS is designed as it is. Please give me any comments you might have.

Aziz,
Read this and use the information as you see fit, but do not distribute it until we all agree on the wording.

Regards,
Bryan

****
Attorney Client Privileged Information

Brake Fluid Intrusion
2/10/99
TI's 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid and transmit force and movement to the sensing portion of the switch over the life of the 500,000 cycle specification which in turn traslates into an electrical switching reaction used in the automobile system as a redundant safety related cruise control shutoff switch..

Background:
The pressure cavity is composed of the hexport, gasket, and Kapton

diaphragms (Called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and diaphragms. The purpose of the Kapton diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore, the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity is varied.

There are two different ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity. Brake fluid could potentially leak past an impaired gasket seal, or leak through a damaged or 'worn out' Kapton diaphragm.

The Gasket:

In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the seal material to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid and expected thermal ranges of the environment and application.

Fluid compatibility is typically established by the use of published tables. These tables list fluid groups and general material types. Lab testing is done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Etylene Propylene for brake applications is common practice throughout the industry for seal gasket materials , and TI has been using this material in brake applications since 1988.

The gasket compression target was obtained from publish industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24%was selected. The depth of the hexport gland shown on attachment #2 controls this attribute. This gland dimension is cut into the hexport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimp together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled and restrained. This design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specifics details of these tests and the results can be seen in a number the following PV test reports:

Test Report #	TI Switch Part number	Year Tested
1. PS/91/48	77PSL2-3	1991
2. PS/91/49	77PSL2-1	1991
3. PS/92/49	77PSL3-1	1992
4. PS/92/80	77PSL5-2	1992
5. PS/92/82	77PSL3-1	1992
6. PS/93/11	77PSL6-1	1993
7. PS/93/44	77PSL4-1	1993

also, there are IP-2 tests of 6/95, 10/95, 1/96 and 8 /96 that are readily at hand and show fluid capability resistances

TI-NHTSA 018643

In order to protect TI's customer supply chain from gasket-manufacturing issues there are several preventative actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment

As a result of the process and product controls, TI's customer return rates including line fallout rates and end of line acceptance tests indicate gasket-manufacturing anomalies are below measurable limits (one leak return in 5 years from master cylinder leak testing or less then 1 ppm). Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket, or sealing surfaces, and as a result, may cause leaks early in life but in our expert opinion not in late life without early leak signs.

Kapton Diaphragms:

A pressure switch diaphragm must seal the pressure cavity, transmit pressures forces to the converter, and follow the converter motion without significantly affecting the switch calibration points. In addition, the diaphragm material must be resistant to chemical attack of the brake fluid.

Basically, a single piece of Kapton in this design consists of a 0.003-inch thick polyimide film laminated on both sides with a 0.001-inch thick FEP Teflon film. The polymide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton was selected for its mechanical and chemical properties. Moreover, TI has been using this material in a wide variety of pressure switch applications since 1981.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's capability to meet the specified requirements (see PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton diaphragms, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch is around 1 million cycles which is well above the 500,000 cycles specified in the Ford (ES-F2VC-9F924-AA) See Life Testing to Failure (PS/98/14).

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time and that the design intent is consistently being achieved. See attached IP reports.

While the similar manufacturing anomalies listed above can affect the Kapton diaphragms (see PFMEA Document # 503831), additional factors can cause leakage via the Kapton diaphragm. Material/chemical compatibility and stress/strain concentrations can also cause the Kapton diaphragms to leak. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton fatigue occurs well over 0.5 million full-scale pressure cycles in our history of simulated and accelerated life testing. When Kapton rupture does occur, there are visual signs of de-lamination, cracking, and embritlement. The Kapton diaphragms break down first in the areas of highest stress and or strain. In our expert opinion, the first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure.

The above_mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions. Water will accelerate the aging of the base polymide. Chemical attach can come from two directions:

1) By entering the contact cavity via the electrical connector,

2) By being in solution in the brake fluid and entering the switch via the pressure port.

When water enters the connector it will "age" the Kapton diaphragms and make them appear as though they have reached the end of life. This condition leaves visual clues. Classic signs of chemical attack of the Kapton include de-lamination of the Teflon from the base polymide base, embrittlement, and cracking of the base polymer. See Endurance Test (report 95/98/53).

End of Document.

-MSG M#- 947390 FR=DAGU TO=RUSB SENT=02/10/99 12:24 PM
R#=059 ST=C DIV=0050 CC=00357 BY=DAGU AT=02/10/99 12:24 PM

To: Baumann <Baumann>
Russ RUSB RUSB

py: Beringhause <Beringhause>
Steven <sberinghause@email.mc.ti.com>
Rahman <Rahman>
Aziz ZIZ ZIZ
McGuirk <McGuirk>
Andy <a-mcguirk@email.mc.ti.com>

From: "Dague, Bryan" <bdague@email.mc.ti.com>

Subj: 77PS Design explanation

Folks,

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Aziz,
Read this and use the information as you see fit, but do not distribute it until we all agree on the wording.

Regards,
Bryan
****
Attorney Client Privileged Information

Brake Fluid Intrusion
2/10/99
'a 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid and transmit force and movement to the sensing portion of the switch over the life of the application.

Background:
The pressure cavity is composed of the hexport, gasket, and Kapton diaphragms (Called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and diaphragms. The purpose of the Kapton diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore, the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity is varied.

There are two different ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity. Brake fluid could potentially leak past an impaired gasket seal, or leak through a damaged Kapton diaphragm.

The Gasket:
In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the seal material to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid.

Fluid compatibility is typically established by the use of published tables. ese tables list fluid groups and general material types. Lab testing is always done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Etylene Propylene for brake applications is common practice throughout the industry, and TI has been using this material in brake applications since 1988.

The gasket compression target was obtained from publish industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24%was selected. The depth of the hexport gland shown on ᐟᐟtachment #2 controls this attribute. This gland dimension is cut into the xport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimp together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled. This design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specifics details of these tests and the results can be seen in a number the following PV test reports:

Test Report #		TI Switch Part number	Year Tested
1.	PS/91/48	77PSL2-3	1991
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4.	PS/92/80	77PSL5-2	1992
5.	PS/92/82	77PSL3-1	1992
6	PS/93/11	77PSL6-1	1993
	PS/93/44	77PSL4-1	1993

In order to protect TI's customers from gasket-manufacturing issues there are several preventative actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment As a result, TI's customer return rates, line fallout rates, and end of line acceptance tests indicate gasket-manufacturing anomalies are below measurable limits (less then 1 ppm). Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket, or sealing surfaces, and as a result, may cause leaks early in life.

Kapton Diaphragms:

A pressure switch diaphragm must seal the pressure cavity, transmit pressures forces to the converter, and follow the converter motion without significantly affecting the switch calibration points. In addition, the diaphragm material must resistant chemical attack of the brake fluid.

Basically, a single piece of Kapton consists of a 0.003-inch thick polyimide film laminated on both sides with a 0.001-inch thick FEP Teflon film. The polymide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton was selected for its mechanical and chemical properties. Moreover, TI has been using this material in pressure switch applications since 1981.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's ility to meet the specified requirements (see PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton diaphragms, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch is around 1 million cycles. See Life Testing to Failure (PS/98/14).

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time. See attached IP reports.

While the similar manufacturing anomalies listed above can affect the Kapton diaphragms (see PFMEA Document # 503831), additional factors can cause leakage via the Kapton diaphragm. Material/chemical compatibility and stress/strain concentrations can also cause the Kapton diaphragms to leak. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton fatigue occurs well over 0.5 million full-scale pressure cycles. When Kapton rupture does occur, there are visual signs of de-lamination, cracking, and embattlement. The Kapton diaphragms break down first in the areas of highest stress and or strain. The first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure.

The above mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions. Water will accelerate the aging of the base polymide. Chemical attach can come from two directions:

1) By entering the contact cavity via the connector,
2) By being in solution in the brake fluid and entering the switch via the pressure port.

...en water enters the connector it will "age" the Kapton diaphragms and make them appear as though they have reached the end of life. This condition leaves visual clues. Classic signs of chemical attack of the Kapton include de-lamination of the Teflon from the base polymide base, embrittlement, and cracking of the base polymer. See Endurance Test (report PS/98/53).

End of Document.

Epstein, Sally

From: Parikh, Tushar [tparikh@email.mc.ti.com]
Sent: Thursday, February 11, 1999 7:42 AM
To: Watt, Jim
Cc: McGuirk, Andy
Subject: Impulse Test: Reliability Demonstration

Jim,

After talking to you and Andy yesterday, I have done my literature research last night. The following is my findings:

This test falls into reliability demonstration category as reliability life tests terminated at prearranged time.

Brief Description of the test:

It is based on DOD Handbook H108. This kind of life test is stopped upon reaching a computed termination time (number of operation, cycles , etc) T provided the specified number of failures (in this case 1) did not occur before. The test is also stopped if the specified number of failures is reached before time T. This procedure is applicable to testing with or without replacement of failed parts.

The acceptability of a lot is determined by the time required for a predetermined number of failures, rf (in this case 1), to occur in a sample size n (in this case 6), and a comparison of this time with the test termination time T multiplied by a constant k. The value of constant k with .05 % producer's risk , for a sample size of 6 is .009. A lot is accepted if the predetermined number of failures rf (One) has not yet occurred before termination time T is reached.

T= K * mean life specified as acceptable

Mean life (specified Ford)= 500,000

T= .009 * 500,000=4500 Cycles

From the data provided to me yesterday, if the product does not fail before 4500 cycles during impulse Test, then we can make the statement that " the lot is acceptable and would have minimum mean life of 500,000 cycles." In our case, we need six samples that would have gone through at least 4500 Cycles without any failure. The number Andy gave me has six samples about twenty five times and fifty cycles. That is about 1250 cycles so far, for six samples, far short of 4500 cycles. If we have ninety times of fifty cycle test with six number of samples without any failure, than our statement would be valid.

I will talk to Rick to find out whether we could find all the data to support our calculation.

Let me know if this makes any sense to you.

Thanks.

Best Regards,

Tushar Parikh

TI-NHTSA 018649

Graveline, Dora

From: Dague, Bryan
Sent: Thursday, February 11, 1999 8:48 AM
To: Baumann, Russell; Beringhause, Steven; Rahman, Aziz; McGuirk, Andrew
Subject: 77PS Overview

Guys,

Here is the finial draft. Aziz to deliver to the customer!?

Please advise if I need to fax it to somone.

I am having copies of the appendix made today.

Regards.
Bry

****

Proprietary Information

77PS Overview
2/10/99

TI's 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid pressure and transmit pressure and movement to the sensing portion of the swirch over the life as defined in Ford ES -F2VC-9F924-AA.

Background:
The pressure cavity is composed of the hexport, gasket, and three Kapton ™ diaphragms (called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and the diaphragms. The purpose of the Kapton ™ diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore. the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity (brake line pressure) is varied.

Two known ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity are i. brake fluid could leak past an impaired gasket seal, or ii. brake fluid could leak through a damaged or 'worn out' Kapton ™ diaphragm.

The Gasket:
In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the elatomer to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid.

Fluid compatibility is typically established by the use of published tables. These tables list fluid groups and general material types. Lab testing is always done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Ethylene Propylene is used in the 77PS and is standard throughout the industry for seal gasket materials. TI has been using this material in brake applications since 1988.

The gasket compression target was obtained from published industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24%was selected. The depth of the hexport gland shown on attachment #2 controls this attribute. This gland dimension is cut into the hexport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimped together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled and restrained. This design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specific details of these tests and the results can be seen in the PV test report numbers listed below: (copies can be provided on request).

Test Report #	TI Switch Part number	Year Tested
1. PS/91/48	77PSL2-3	1991
2. PS/91/49	77PSL2-1	1991
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6. PS/93/11	77PSL6-1	1993
7. PS/93/44	77PSL4-1	1993

Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket or sealing surfaces, and as a result, may cause leaks early in life. In order to protect TI's customer supply chain from gasket-manufacturing issues there are several preventative actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment. TI's customer return rates indicated by past return and analysis records are less than 1 ppm (one leaker return in 5 years from master cylinder leak testing).

Kapton ™ Diaphragms:
A pressure switch diaphragm must seal the pressure cavity, transmit pressure forces to the converter, and follow the converter motion without significantly affecting the switch calibration points. In addition, the diaphragm material must be resistant to chemical attack by the brake fluid.

Basically, a single piece of Kapton ™ in this design consists of a 0.003-inch thick polyimide film laminated on both sides with a 0.001-inch thick FEP Teflon film. The polyimide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton ™ was selected for its mechanical and chemical properties. Moreover, TI has been using this material in pressure switch applications since 1981. In this application three stacked Kapton ™ layers were used as the diaphragm seal.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's ™ ability to meet the specified requirements (PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton ™ diaphragms, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch can vary, but typically is around 1 million cycles which is well above the 500,000 cycles specified in the Ford specification (ES-F2VC-9F924-AA). (See Life Testing to Failure (PS/98/14))

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time and that the design intent is consistently being achieved. See attached IP reports which confirm 100% successful passing of all tests defined in the specification.

Manufacturing & PV anomalies such as pinched Kapton ™ can affect the Kapton ™ diaphragm seal performance (see PFMEA Document # 503831). Material/chemical compatibility and stress/strain concentrations can also cause the Kapton ™ diaphragms to fatigue. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton ™ fatigue occurs well over 0.5 million full-scale pressure cycles in our history of simulated and accelerated life testing. When Kapton ™ fatigue does occur, there are visual signs of de-lamination, cracking, and embrittlement. The Kapton ™ diaphragms break down first in the areas of highest stress and or strain. Typically, the first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure. The above mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions.

Water has been shown to accelerate the aging of the base polymide. Water can be introduced in two known ways:

1) By entering the contact cavity via the electrical connector
2) By being in solution in the brake fluid and entering the switch via the pressure port.

When water enters the connector it will "age" the Kapton ™ diaphragms and make them appear as though they have reached the end of life. This condition leaves visual clues. Classic signs of chemical attack of the Kapton ™ include de-lamination of the Teflon from the base polymide base, embrittlement, and cracking of the base polymer. See Endurance Test (report PS/98/53).

Authored by Bryan Dague. Call Andy Mcguirk or Bryan Dague with questions.

77PS Overview Appendix

1. **Pressure Switch Cross Section**
2. **Hexport Print (TI # 36900)**
3. **Gasket Print (TI# 74353)**
4. **DFMEA for Gasket and Kapton Seal**
5. **Life Test to Failure Test Report (Weibull Analysis)**
6. **Customer Specification (ES-F2VC-9F924_AA)**
7. **PFMEA**
8. **IP Test Reports**
9. **Endurance Test Report**

Currey, Pat

From: Beringhause, Steven [sberinghause@email.mc.ti.com]
Sent: Thursday, February 11, 1999 9:10 AM
To: Sullivan, Martha
Subject: FW: 77PS Overview

From: Dague, Bryan
Sent: Thursday, February 11, 1999 8:48 AM
To: Baumann, Russell; Beringhause, Steven; Rahman, Aziz; McGuirk, Andrew
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2/10/99

TI's 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid pressure and transmit pressure and movement to the sensing portion of the switch over the life as defined in Ford ES -F2VC-9F924-AA.

Background:
The pressure cavity is composed of the hexport, gasket, and three Kapton TM diaphragms (called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and the diaphragms. The purpose of the Kapton TM diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore, the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity (brake line pressure) is varied.

Two known ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity are i. brake fluid could leak past an impaired gasket seal, or ii. brake fluid could leak through a damaged or 'worn out' Kapton TM diaphragm.

The Gasket:
In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the elatomer to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid.

Fluid compatibility is typically established by the use of published tables. These tables list fluid groups and general material types. Lab testing is always done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Ethylene Propylene is used in the 77PS and is standard throughout the industry for seal gasket materials. TI has been using this material in brake applications since 1988.

The gasket compression target was obtained from published industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24%was selected. The depth of the hexport gland shown on attachment #2 controls this attribute. This gland dimension is cut into the hexport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimped together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled and restrained. This design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specific details of these tests and the results can be seen in the PV test report numbers listed below: (copies can be provided on request).

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4.	PS/92/80	77PSL5-2	1992
5.	PS/92/82	77PSL3-1	1992
6.	PS/93/11	77PSL6-1	1993
7.	PS/93/44	77PSL4-1	1993

Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket or sealing surfaces, and as a result, may cause leaks early in life. In order to protect TI's customer supply chain from gasket-manufacturing issues there are several preventative actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment. TI's customer return rates indicated by past return and analysis records are less then 1 ppm (one leaker return in 5 years from master cylinder leak testing).

Kapton TM Diaphragms:
A pressure switch diaphragm must seal the pressure cavity, transmit pressure forces to the converter, and follow the converter motion without significantly affecting the switch calibr[illegible] points. In addition, the diaphragm material must be resistant to [illegible] attack by the brake fluid.

Basically, a single piece of Kapton TM l[illegible] consists of a 0.003-inch thick polyimide film laminated [illegible] sides with a 0.001-inch thick FEP Teflon film. The polymide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton TM was selected for its mechanical and chemical properties. Moreover, TI has been using this material in pressure switch applications since 1981. In this application three stacked Kapton TM layers were used as the diaphragm seal.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's TM ability to meet the specified requirements (PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton TM diaphragms, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch can vary, but typically is around 1 million cycles which is well above the 500,000 cycles specified in the Ford specification (ES-F2VC-9F924-AA). (See Life Testing to Failure (PS/98/14))

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time and that the design intent is consistently being achieved. See attached IP reports which confirm 100% successful passing of all tests defined in the specification.

Manufacturing & PV anomalies such as pinched Kapton TM can affect the Kapton TM diaphragm seal performance (see PFMEA Document # 503831). Material/chemical compatibility and stress/strain concentrations can also cause the Kapton TM diaphragms to fatigue. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton TM fatigue occurs well over 0.5 million full-scale pressure cycles in our history of simulated and accelerated life testing. When Kapton TM fatigue does occur, there are visual signs of de-lamination, cracking, and embrittement. The Kapton TM diaphragms break down first in the areas of highest stress and or strain. Typically, the first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure. The above mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions.

Water has been shown to accelerate the aging of the base polymide. Water can be introduced in two known ways:

1) By entering the contact cavity via the electrical connector
2) By being in solution in the brake fluid and entering the switch via the pressure port.

When water enters the connector it will "age" the Kapton TM diaphragms and make them appear as though they have reached the end of life. This condition leaves visual clues. Classic signs of chemical attack of the Kapton TM include de-lamination of the Teflon from the base polymide base, embrittlement, and cracking of the base polymer. See Endurance Test (report PS/98/53).

Authored by Bryan Dague. Call Andy Mcguirk or Bryan Dague with questions.

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Graveline, Dora

From: Rahman, Aziz
Sent: Thursday, February 11, 1999 11:02 AM
To: Baumann, Russ; Beringhause, Steven; McGuirk, Andy; Dague, Bryan
Subject: RE: 77PS Overview

Team,

Thanks for the info below. I have reviewed test report 98/14 with them and will review this info at the next opportune time. I will let you know if I need a hard copy.

> **From:** Dague, Bryan
> **Sent:** Thursday, February 11, 1999 8:48 AM
> **To:** Baumann, Russell; Beringhause, Steven; Rahman, Aziz; McGuirk, Andrew
> **Subject:** 77PS Overview
>
> Guys,
>
> Here is the final draft. Aziz to deliver to the customer??
>
> Please advise if I need to fax it to someone.
>
> I am having copies of the appendix made today.
>
> Regards,
> Bry

****

Proprietary Information

77PS Overview
2/10/99

TI's 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid pressure and transmit pressure and movement to the sensing portion of the switch over the life as defined in Ford ES -F2VC-9F924-AA.

Background:
The pressure cavity is composed of the hexport, gasket, and three Kapton ™ diaphragms (called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and the diaphragms. The purpose of the Kapton ™ diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore, the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity (brake line pressure) is varied.

Two known ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity are i. brake fluid could leak past an impaired gasket seal, or ii. brake fluid could leak through a damaged or 'worn out' Kapton ™ diaphragm.

The Gasket:
In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the elastomer to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid.

TI-NHTSA 018667

Fluid compatibility is typically established by the use of published tables. These tables list fluid groups and general material types. Lab testing is always done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Ethylene Propylene is used in the 77PS and is standard throughout the industry for seal gasket materials. TI has been using this material in brake applications since 1988.

The gasket compression target was obtained from published industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24%was selected. The depth of the hexport gland shown on attachment #2 controls this attribute. This gland dimension is cut into the hexport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimped together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled and restrained. This design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specific details of these tests and the results can be seen in the PV test report numbers listed below: (copies can be provided on request).

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5. PS/92/82	77PSL3-1	1992
6. PS/93/11	77PSL6-1	1993
7. PS/93/44	77PSL4-1	1993

Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket or sealing surfaces, and as a result, may cause leaks early in life. In order to protect TI's customer supply chain from gasket-manufacturing issues there are several preventative actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment. TI's customer return rates indicated by past return and analysis records are less then 1 ppm (one leaker return in 5 years from master cylinder leak testing).

Kapton ™ Diaphragm

A pressure switch diaphragm must seal the pressure cavity, transmit pressure forces to the converter, and follow the converter motion without significantly affecting the switch calibration points. In addition, the diaphragm material must be resistant to chemical attack by the brake fluid.

Basically, a single piece of Kapton ™ in this design consists of a 0.003-inch thick polyimide film laminated on both sides with a 0.001-inch thick FEP Teflon film. The polymide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton ™ was selected for its mechanical and chemical properties. Moreover, TI has been using this material in pressure switch applications since 1981. In this application three stacked Kapton ™ layers were used as the diaphragm seal.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's ™ ability to meet the specified requirements (PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton ™ diaphragm, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch can vary, but typically is around 1 million cycles which is well above the 500,000 cycles specified in the Ford specification (ES-F2VC-9F924-AA). (See Life Testing to Failure (PS/98/14))

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time and that the design intent is consistently being achieved. See attached IP reports which confirm 100% successful passing of all tests defined in the specification.

Manufacturing & PV anomalies such as pinched Kapton ™ can affect the Kapton ™ diaphragm seal performance (see PFMEA Document # 503831). Material/chemical compatibility and stress/strain concentrations can also cause the Kapton ™ diaphragms to fatigue. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton ™ fatigue occurs well over 0.5 million full-scale pressure cycles in our history of simulated and accelerated life testing. When Kapton ™ fatigue does occur, there are visual signs of de-lamination, cracking, and embrittlement. The Kapton ™ diaphragms break down first in the areas of highest stress and or strain. Typically, the first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure. The above mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions.

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Authored by Bryan Dague. Call Andy Mcguirk or Bryan Dague with questions.

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TI-NHTSA 018660

Test Report #	TI Switch Part number	Year Tested
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7. **PFMEA**
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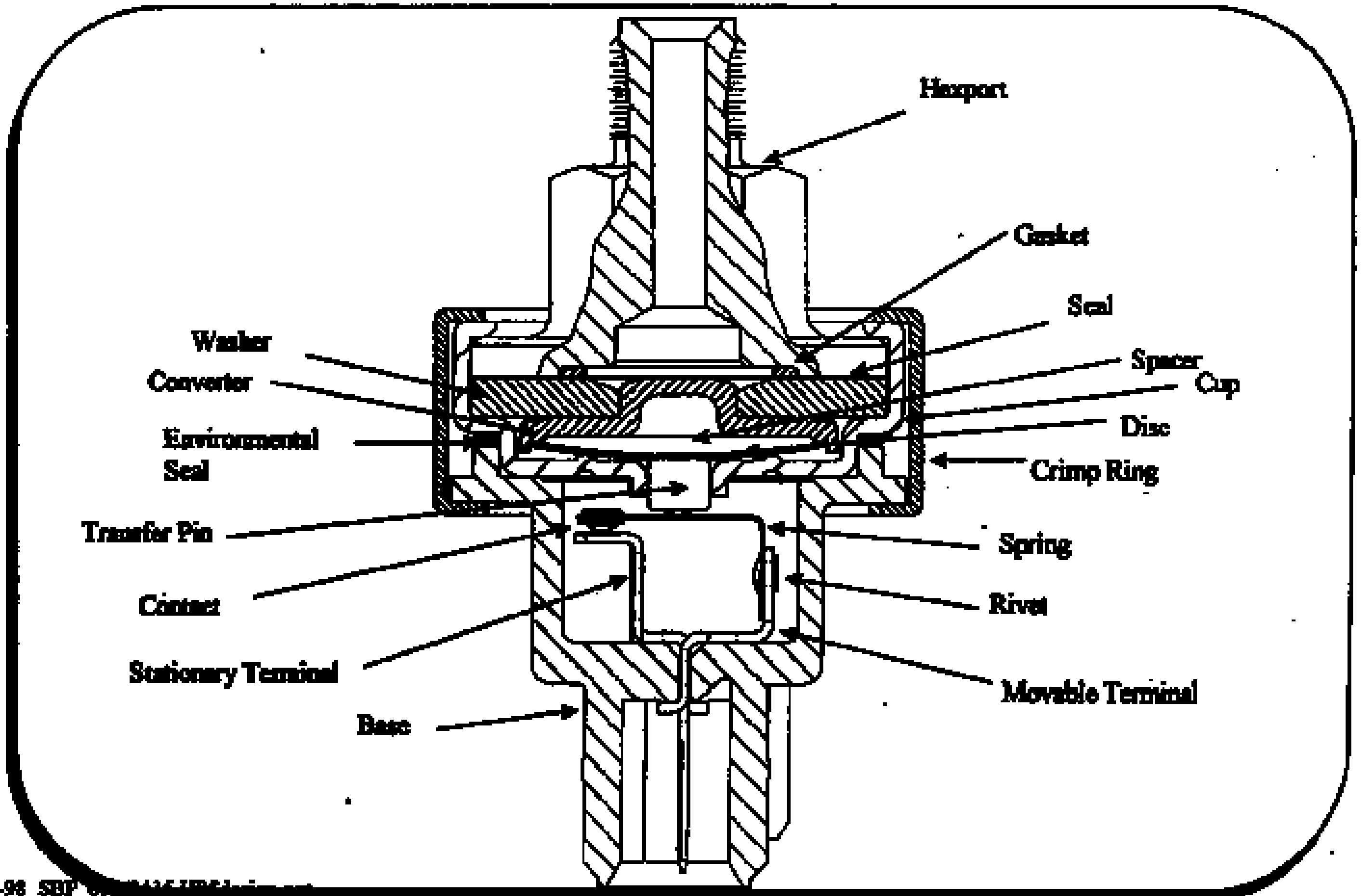
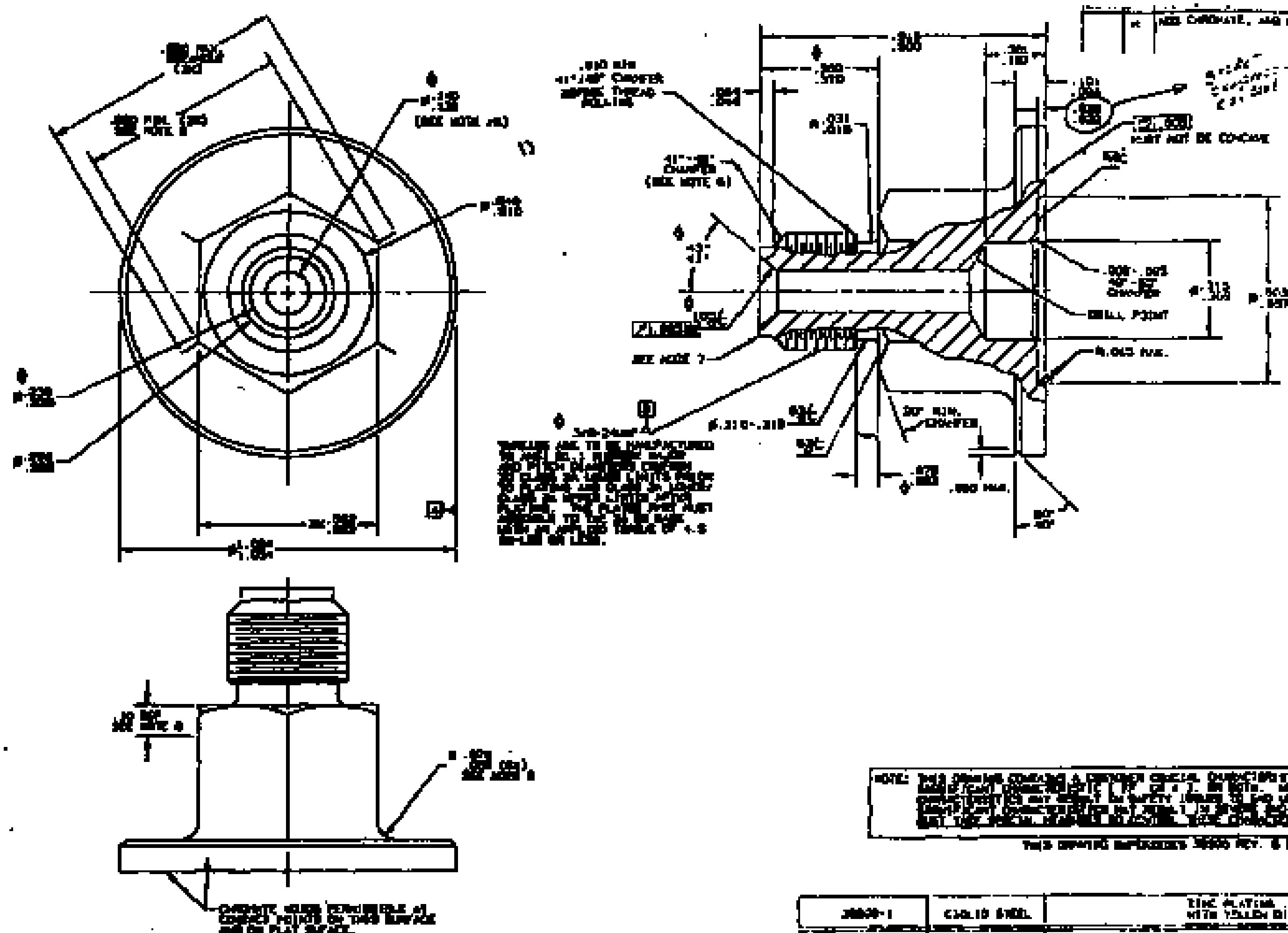
Pressure Switch Cross Section





NOTE:

1. DIMENSIONS APPLY AFTER PLATING.
2. [illegible] TO BE SHIPPED, ISSUED, AND STORED IN SEALED PLASTIC [illegible].
3. FINISHED PART FLANGE HARDNESS TO BE ROCKWELL B-75 MINIMUM.
4. THREAD MUST CONFORM TO FORD SPEC. [illegible] (4.5 [illegible] MAX. [illegible]
5. .015" MAX. MISMATCH ALLOWABLE [illegible] THROUGH HOLE WHEN DRILLED FROM BOTH ENDS OF PART.
6. 41°-49° CHAMFER ANGLE APPLIES IN AREAS WITHOUT THREAD.
7. BREAK EDGE WITH RADIUS OR 45° REF. CHAMFER .010" MAX.
8. [illegible] MIN. TO BE MEASURED WITHIN AREA SHOWN. [illegible] ALLOWED AT CENTER OF UNDERFILL OR VOID
9. MEASURE AT THE CENTER OF HEX FLAT. TRANSITION RADIUS ALLOWED AT HEX CORNER.

NOTE: THIS DRAWING CONTAINS A CUSTOMER CRITICAL CHARACTERISTIC [illegible]

THIS DRAWING SUPERSEDES 36900 REV. [illegible] DATED [illegible]

PART NO.	MATERIAL	FINISH
36900-1	C1010 STEEL	ZINC PLATING .0002 MIN. THICK WITH YELLOW DICHROMATE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	DRAWN J.D. MAYALL	DATE 10-18-90
TOLERANCE ON FRACTIONS DECIMALS ANGLES	CHECKED C.D. WAGNER	5-1-96
	APPROVED M.J. SELLERS	5-1-96
MATERIAL	APPROVED	
	SIGNATURES ON FILE REFER TO ELECTRONIC CHANGE NOTICE	

TEXAS INSTRUMENTS

TITLE: MODIFIED SAE J512 HEX PORT

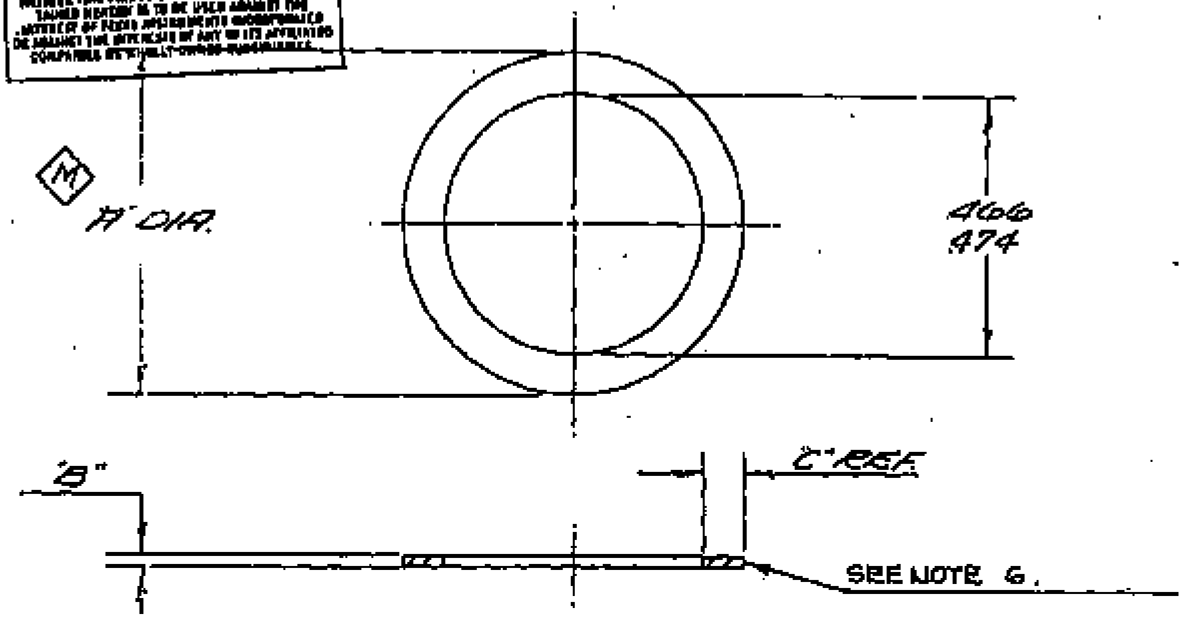
SIZE	CODE IDENT NO.	
C	82647	36900

TITLE: GASKET

REV. H **74353**

FOR REFERENCE ONLY
CHECK LATEST REVISION
BEFORE USING

Parts Made To This Print Must Conform To
ENG. STD. E9898 REV. E
Date JAN 1 9 1999



NOTES:

1. PARTS MUST BE PURCHASED FROM T.I. ENGINEERING APPROVED VENDORS, LISTED BELOW.
2. MATERIAL CERTIFICATION REQUIRED WITH EACH SHIPMENT.
3. MATERIAL TO BE COMPATIBLE WITH FREON-12 & REFRIGERANT OIL.
4. PARTS TO BE SHIPPED, ISSUED, AND STORED ON A FOOT +/- 6 INCH MANDRELS, SEALED IN PLASTIC BAGS AND SHIPPED IN CARDBOARD TUBES.
5. ALL CONTAINERS OF PARTS MUST BE MARKED TO REFLECT ANY MATERIAL LOT, TOOL OR PROCESS CHANGE.
6. (M) DASH 1 (-1) AND DASH 4 (-4) GASKET MUST HAVE FOUR (4) WHITE STRIPING INK MARKS, EQUALLY SPACED AROUND THE CIRCUMFERENCE, AND NOT LESS THAN 1/8 INCH WIDE. NO INK IS ALLOWED ON ANY OTHER SURFACE.

PART NO.	MATERIAL	DUROMETER	COLOR	A (M)	B (M)	C
74353-4	ETYLENE PROPYLENE JBL COMPOUND E-7104-70 JBL PART NO. 6197E	70	BLACK	.670-.662	.030-.036	.06
74353-3	ETHYLENE PROPYLENE JBL COMPOUND E-7064	70	WHITE	.670-.662	.030-.036	.0
74353-2	ETHYLENE PROPYLENE JBL COMPOUND E-7054	70	WHITE	.599-.591	.030-.036	.0
74353-1	ETHYLENE PROPYLENE JBL COMPOUND E-7104-70 JBL PART NO. 6197E	70	BLACK	.599-.591	.030-.036	.0

BY T. Dail 3.18.85

TEXAS INSTRUMENTS INCORPORATED

KLIXON

DWG. SIZE A

PARTS LIST 74353

TI-NHTSA 018666

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503798
Revision Level D
Revision Date 4-Nov-96
Original (Initial) Date 30-Dec-83
Prepared By C. Wagner

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
DIAPHRAGM (OR SEAL) [ER] [74179] Forms flexible element of fluid containment cavity.	Fails to contain fluid.	Fluid leakage.	9		*Gradual rupture over life due to improper design of supporting elements.* Gradual rupture over life due to excessive flexure/displacement. Gradual rupture over life due to stress concentrations caused by asymmetric strain distributions. Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm material. Insufficient location/clamping of diaphragm.	1	Burst, impulse, and thermal cycle tests. Material mfg. recommendations. Comparison of design with similar products.	1	9							
Transfers pressure from fluid to pressure-sensing elements.	Change in area of pressure transfer over life.	Shift in setpoints over life.	5		Diaphragm too stiff. Incorrect material specified.	1	Life testing w/ characteristics at intermediate points.	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number [illegible]
Revision Level D
Revision Date 4-Nov-96

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
DIAPHRAGM (OR SEAL) [SP] (74178)	Excessive change of pressure transfer area versus pressure.	Excessively high pressures needed to adequately force pressure transfer area; wide sigma on setpoints due to unpredictability at lower pressures.	6		Diaphragm too stiff.	1	Force and pressure versus deflection testing to calculate effective areas.	1	6							
					Incorrect material specified.											

TI-NHTSA 018668

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number [illegible]
Revision Level C
Revision Date 4-Nov-98

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date [illegible]

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
GASKET ([illegible]) Provides fluid seal between hexport and diaphragm.	Fails to provide adequate fluid seal.	Brake fluid leakage.	9		Insufficient compression specified. Very excessive compression specified, leading to displacement from gland. Incorrect ID and/or OD leading to displacement from gland. Incorrect cross-section shape specified. Incorrect material specified, fluid incompatibility. Incorrect design of sealing mechanism.	1	Review of general seal design principles. Manufacturer's recommendations. Burst, impulse, and thermal cycle tests. Comparison with design of similar products.	1	9							

Life Testing (to Failure) of 77PS Style Device
Summary of Test Series 559-15-24

Author: Di Ha, Design Engineering
Date: April 8, 1998
Report No.: PS/98/14

Purpose

The purpose of this test was to study the life expectancy of a 77PS style hydraulic pressure switch. The endurance test was run out to failure and a Weibull analysis performed. Failure was considered to be a leaking device.

Sample Description

The devices placed on test was a 77PS brake pressure switch with a quiet disc. The use of a quiet disc results in less energy in the system due to a smaller displacement of the disc during actuation and release. The 77PSL3-4 device was used for test. Calibration requirements for this device are as follows:

Actuation Pressure: 200-300 psig
Release Pressure: 40 psig min.

Procedure

24 switches were built on the manufacturing line. These parts were then calibrated prior to impulse testing. Results are included in this report.

Endurance testing was run to the following specification:

Temperature: 135C
Frequency: 2Hz
Total Cycles: 500,000
Electrical Load:
- 0-475,000 cycles: 13V +/- 1V, trace current
- 475,001-500,000 cycles: 13 +/- 1V, 750 +/- 50 mA

Operating Pressures:
- Pressure (Low): 0-40psig
- Pressure (High): 1400-1500 psig

After the completion of the 500,000 cycles, the switches were taken off test and calibrated to ensure they were functioning properly. They were then replaced on test and cycled to failure. The number of cycles at which each switch failed/leaked was noted. The test was stopped at 1,634,921 cycles. Six devices were on test when the test was suspended.

Results

All 24 switches passed the specification requirement of 500,000 cycles. Actuation drift after cycling was normal, averaging less than 5%. All devices were within specification after the post-500K calibrations.

Failure of the devices was first seen at 994K. Failures were seen up to 1,634,921 cycles, when the test was stopped.

Conclusion

Reliability of the switches to 500K cycles is 100 percent. However, we cannot guarantee a life cycle requirement of 1 million cycles, as there were leakage failures prior to the completion of 1 million cycles.

Raw Data

Device	Pre-Test Data Actuation (psig)	Release (psig)	Diff (psig)	Post 500K Actuation (psig)	Release (psig)	Diff (psig)	mvD (LifeTest)	Act %Drift	# Cycles to Failure
1	255.6	186.8	68.8	245.8	182.0	63.8	0.18	-3.8	**
2	253.6	184.1	69.5	243.5	178.5	65.0	0.15	-4.0	1,587,659
3	248.3	187.3	61.0	243.5	183.6	59.9	0.13	-1.9	**
4	249.5	182.0	67.5	240.2	177.6	62.6	0.16	-3.7	**
5	241.1	175.4	65.7	232.7	172.4	60.3	0.12	-3.5	1,403,522
6	248.8	183.1	65.7	244.0	186.0	58.0	0.09	-1.9	1,302,691
7	255.8	187.9	67.9	238.4	179.3	59.1	0.12	-6.8	1,344,673
8	247.5	185.9	61.6	246.5	184.9	61.6	0.13	-0.4	1,403,522
9	245.7	178.1	67.6	233.0	178.8	54.2	0.1	-5.2	1,403,522
10	249.9	184.1	65.8	240.4	179.3	61.1	0.13	-3.8	1,131,102
11	264.1	197.2	66.9	252.8	193.7	59.1	0.1	-4.3	994,232
12	255.1	187.5	67.6	247.9	183.3	64.6	0.32	-2.8	**
13	248.2	186.2	62.0	239.0	176.2	62.8	0.3	-3.7	1,488,221
14	261.4	189.6	71.8	250.3	191.5	58.8	0.07	-4.2	994,232
15	250.4	188.0	62.4	240.1	181.2	58.9	0.09	-4.1	1,131,102
16	255.1	183.4	71.7	240.7	176.7	64.0	0.31	-5.6	1,359,659
17	244.2	176.2	68.0	234.7	176.2	58.5	0.11	-3.9	1,418,250
18	251.5	187.8	63.7	240.1	183.1	57.0	2.37	-4.5	1,472,621
19	254.0	192.2	61.8	247.1	182.1	65.0	3.48	-2.7	1,511,726
20	256.8	190.7	66.1	252.2	189.6	62.6	0.3	-1.8	1,418,250
21	251.7	182.3	69.4	241.6	182.4	59.2	0.08	-4.0	1,325,190
22	250.1	183.6	66.5	239.7	182.9	56.8	0.12	-4.2	1,359,659
23	249.1	180.4	68.7	246.6	182.4	64.2	0.22	-1.0	**
24	257.4	184.1	73.3	246.6	183.4	63.2	0.24	-4.2	**
Average	251.9	185.2	66.7	242.8	182.0	60.8	0.4	-3.6	**
Sigma	5.3	4.9	3.4	5.4	4.9	3.0	0.8	1.4	

** Indicates that these devices were impulse tested to 1,634,921 cycles without failures.
The test was stopped with 1,634,921 cycles on 4/1/98.

Weibull Analysis

2 and 3 parameter WEIBULL ANALYSIS

[illegible]

Time to Failure	Suspended
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

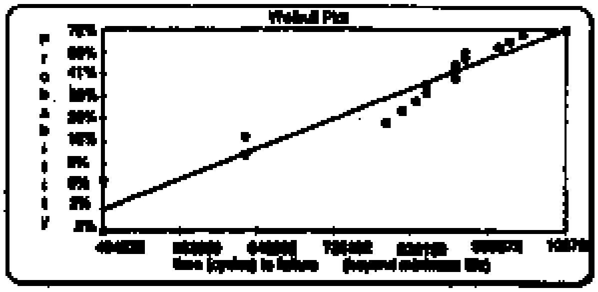
Minimum life: [illegible]

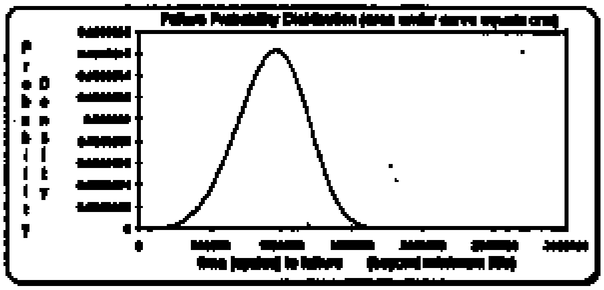
Time to fail / Reliability %: [illegible] [illegible]

Reliability % / Time to fail: [illegible] [illegible]

Calculated Outputs

Beta = 4.481
Vtot = -44.163
Alpha = [illegible]
Pve = 3.538





NOTES: 77-RAL2-4 Impulse Testing.

DI Ha 4/1/96

TI-NHTSA 018673

Document #: [illegible]

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)

PROCESS: AUTOMATED SENSOR ASSEMBLY

MODEL YEAR(S)/VEHICLE(S): 52/57/77/80/87PS

PROCESS RESPONSIBILITY: MATT SELLERS/ANN REA

DESIGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

PREPARED BY: MATT SELLERS

FMEA DATE (ORIG.): [illegible]
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
1	FEED AND ASSEMBLE HEXPORT TO NEST.	DOES NOT FEED	NO SUBSEQUENT ASSEMBLY PERMISSIBLE YIELD LOSS	[illegible]		MACHINE ERROR	[illegible]	PREVENTIVE MAINT. 100% PRESENCE CHECK VERIFY OPERATION OF CHECK PROBE	1	[illegible]							
		DOES NOT NEST PROPERLY	NO SUBSEQUENT ASSEMBLY PERMISSIBLE	[illegible]		DEBRIS IN NEST; MACHINE ERROR	1	PREVENTATIVE MAINT. 100% PRESENCE CHECK	1	5							
		LOADS MULTIPLE HEXPORT	NO SUBSEQUENT ASSEMBLY PERMISSIBLE	5		MACHINE ERROR	1	PREVENTATIVE MAINT. 100% PRESENCE CHECK	1	5							
2	CONFIRM HEXPORT PRESENCE AND STYLE.	FAILS TO IDENTIFY OUT OF RANGE HEXPORT	MIXED HEXPORT	4		SET-UP ERROR	1	SET-UP MASTERS	1	[illegible]							
3	FEED AND ASSEMBLE GASKET TO HEXPORT ISLAND.	MISPLACED GASKET	LEAK BURST RESISTANCE DEGRADATION	[illegible]		MACHINE ERROR OPERATOR INTERVENTION	[illegible]	100% FUNCTION TEST CONTINUITY PROBE CYCLING AUDITS	1	[illegible]							
		NO GASKET	LEAK BURST RESISTANCE DEGRADATION	[illegible]		MACHINE ERROR OPERATOR INTERVENTION	1	100% FUNCTION TEST CONTINUITY PROBE CYCLING AUDITS	1	[illegible]							
		MULTIPLE GASKET	LEAK BURST RESISTANCE DEGRADATIO YIELD LOSS	[illegible]		OPERATOR INTERVENTION	1	100% FUNCTION TEST	1	[illegible]							
4	CONFIRM GASKET PRESENCE.	FAILS TO IDENTIFY MISSING OR OUT OF PLACE GASKET	LEAK	[illegible]		MACHINE ERROR	1	SET-UP MASTERS	1	[illegible]							
5	BLANK AND ASSEMBLE (2) SEALS	ONLY (1) SEAL LOADED	REDUCED DIAPHRAGM LIFE	[illegible]		OPERATOR DOES NOT TURN ON 3RD STATION	1	PROCESS SPECS MACHINE SET-UP MATERIAL KITTING	1	[illegible]							

1

TI-NHTSA 018874

PROCESS: AUTOMATED SENSOR ASSEMBLY

PROCESS RESPONSIBILITY: MATT SELLERSMANN REA

MODEL YEAR(S)/VEHICLE(S): [illegible]

DESIGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) [illegible]
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
		NO SEAL LOADED	LEAK	[illegible]		MACHINE ERROR	1	100% FUNCTION TEST CONTINUITY PROBE	1	[illegible]							
		IMPROPERLY CUT SEAL	LEAK DIAPHRAGM LIFE FAILURE YIELD LOSS	[illegible]		MACHINE ERROR	1	100% FUNCTION TEST CONTINUITY PROBE CYCLING AUDITS PREVENTIVE MAINT.	1	[illegible]							
		MISPLACED SEAL	LEAK REDUCED DIAPHRAGM LIFE	[illegible]		MACHINE ERROR OR STATIC	1	100% FUNCTION TEST CONTINUITY PROBE ANTI-STATIC STATION PREVENTIVE MAINT. CYCLING AUDITS	1	[illegible]							
		MORE THAN (1) SEALS LOADED	SHIFT IN SET POINTS	[illegible]		STATIC BUILD UP	1	ANTI-STATIC STATION	1	[illegible]							
6	CONFIRM (1) SEALS PRESENCE	FAILS TO IDENTIFY MISSING OR OUT OF PLACE SEAL(S).	LEAK	[illegible]		MACHINE ERROR	1	SET-UP MASTERS	1	[illegible]							
7	[illegible] BLANK AND ASSEMBLE (3RD) SEAL FOR BRAKE APPLICATIONS	NO SEAL LOADED	LEAK	[illegible]		MACHINE ERROR	1	100% FUNCTION TEST CONTINUITY PROBE	1	[illegible]							
		IMPROPERLY CUT SEAL	LEAK DIAPHRAGM LIFE FAILURE PREVENTS SUBSEQUENT ASSEMBLY YIELD LOSS	[illegible]		MACHINE ERROR	1	100% FUNCTION TEST CONTINUITY PROBE CYCLING AUDITS PREVENTIVE MAINT.	1	[illegible]							
		MISPLACED SEAL	LEAK REDUCED DIAPHRAGM LIFE	[illegible]		MACHINE ERROR OR STATIC	1	100% FUNCTION TEST CONTINUITY PROBE ANTI-STATIC STATION PREVENTIVE MAINT. CYCLING AUDITS	1	[illegible]							
		MORE THAN (1) SEAL LOADED	SHIFT IN SET POINTS	[illegible]		STATIC BUILD UP	1	ANTI-STATIC STATION	1	[illegible]							

TI-NHTSA 018675

PROCESS: AUTOMATED SENSOR ASSEMBLY

MODEL YEAR(S)/VEHICLE(S): [illegible]

PROCESS RESPONSIBILITY: MATT SELLERS/ANN REA

DESIGN/QUAL/MFG RESPONSIBILITY: KEITH ROSSELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) [illegible]
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
8	WHERE APPLICABLE, CONFIRM (SRD) SEAL PRESENCE	FAILS TO IDENTIFY MISSING OR OUT OF PLACE SEAL	LEAK	[illegible]		MACHINE ERROR	1	SET-UP MASTERS	1	[illegible]							
9	FEED AND ASSEMBLE CONVERTER TO WASHER	MISSED CONVERTER	INOPERATIVE SWITCH	[illegible]		MACHINE MISFEED	[illegible]	100% PRESENCE CHECK 100% FUNCTION TEST	1	[illegible]							
		MISSED WASHER	INOPERATIVE DEVICE LEAK	[illegible]		MACHINE MISFEED	[illegible]	100% PRESENCE CHECK 100% FUNCTION TEST	1	27							
		UPSIDE DOWN WASHER	SHIFT IN DEVICE SET POINTS REDUCED KAPTON LIFE	[illegible]		MACHINE MISFEED OPERATOR ERROR	1	POKE YOKE UP. TRACK 100% FUNCTION TEST CYCLING AUDITS	1	[illegible]							
10	FEED AND ASSEMBLE WASHER/CONVERTER ASSEMBLY	DISLODGMENT OF CONVERTER	INOPERATIVE DEVICE	[illegible]		AIR PICK AND PLACE ERROR	1	OPERATOR SET-UP 100% FUNCTION TEST- 100% PRESENCE CHECK PREVENTIVE MAINT. CYCLING AUDITS	1	[illegible]							
		NON-CONCENTRIC PLACEMENT	MISPLACED KAPTON REDUCED KAPTON LIFE MISPLACED DISC INOPERATIVE DEVICE	[illegible]		AIR PICK AND PLACE ALIGNMENT ERROR	1	OPERATOR SET-UP 100% FUNCTION TEST 100% PRESENCE CHECK PREVENTIVE MAINT. CYCLING AUDITS	[illegible]	[illegible]							
		FAILS TO LOAD ASSEMBLY	NO SUBSEQUENT ASSEMBLY POSSIBLE YIELD LOSS	[illegible]		MACHINE ERROR	1	PREVENTIVE MAINT. 100% PRESENCE CHECK VERIFY OPERATION OF CHECK PROBE	1	[illegible]							
		LOADS MULTIPLE ASSEMBLIES	NO SUBSEQUENT ASSEMBLY POSSIBLE	[illegible]		MACHINE ERROR	1	PREVENTIVE MAINT. 100% PRESENCE CHECK	1	[illegible]							
11	CONFIRM WASHER CONVERTER ASSEMBLY PRESENCE	FAILS TO IDENTIFY MISSING OR OUT OF PLACE WASHER CONVERTER ASSEMBLY.	INOPERATIVE DEVICE	[illegible]		MACHINE ERROR	1	YIELD MONITORING	1	[illegible]							
12	BLANK AND ASSEMBLE SPACER	MISPLACED SPACER	REDUCED DISC LIFE	7		MACHINE ERROR	1	100% FUNCTION TEST	1	7							

TI-NHTSA 018676

PROCESS: AUTOMATED SENSOR ASSEMBLY

PROCESS RESPONSIBILITY: MATT SELLERS/ANN REA

MODEL YEAR(S)/VEHICLE(S): 98/57/77/80/87PS

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) 4/29/96
FMEA REVISION: 5

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
			CONTINUITY FAILURE LOSS OF CALIBRATION [illegible] OVER LIFE					CONTINUITY PROBE CYCLING AUDITS TRAPPED DISC PROBE									
		NO SPACER	REDUCED DISC LIFE LOSS OF CALIBRATION	7		MACHINE ERROR TOOL DULL, BROKEN, OR OTHERWISE MALF.	1	100% FUNCTION TEST CONTINUITY PROBE	1	7							
			DRIFT OVER LIFE					CYCLING AUDITS PREVENTIVE MAINT.									
		IMPROPERLY CUT SPACER, TOO LARGE	REDUCED DISC LIFE	7		MACHINE ERROR	1	100% FUNCTION TEST	1	7							
			LOSS OF CALIBRATION			TOOL DULL, BROKEN, OR OTHERWISE MALF.		CONTINUITY PROBE									
			DRIFT OVER LIFE CONTINUITY FAILURE					CYCLING AUDITS PREVENTIVE MAINT.									
		IMPROPERLY CUT SPACER, TOO SMALL	REDUCED DISC LIFE	7		MACHINE ERROR	1		1	7							
			LOSS OF CALIBRATION			TOOL DULL, BROKEN, OR OTHERWISE MALF.											
			DRIFT OVER LIFE														
		2 OR MORE SPACERS LOADED	CONTINUITY FAILURE	7		STATIC BUILD-UP	1	ANTI-STATIC STATION	1	7							
			LOSS OF CALIBRATION DRIFT OVER LIFE														
13	CONFIRM SPACER PRESENCE.	FAILS TO IDENTIFY MISSING OR OUT OF PLACE SPACER	REDUCED DISC LIFE	7		MACHINE ERROR	1	SET-UP MASTERS	1	7							
14	FEED AND ASSEMBLE DISC	MISPLACED DISC (TRAPPED)	CONTINUITY FAILURE	5		MACHINE ERROR	3	PRESSURE PROBE	1	15							
								TRAPPED DISC PROBE 100% FUNCTION TEST									
		UPSIDE DOWN DISC	CONTINUITY FAILURE	5		MACHINE ERROR	3	100% DISC PROBE	1	15							
								TRAPPED DISC PROBE 100% FUNCTION TEST									
		MULTIPLE DISC	CONTINUITY FAILURE ACTUATION FAILURE	5		MACHINE ERROR	3	100% DISC PROBE TRAPPED DISC PROBE	1	15							
		WRONG DISC	LOSS OF CALIBRATION	5		MIXING	1	100% FUNCTION TEST DISC SLIPS ROUTE SLIPS	1	5							
			AUDIBLE SNAP ON QUIET														

TI-NHTSA 018677

PROCESS: AUTOMATED SENSOR ASSEMBLY

MODEL YEAR(S)/VEHICLE(S): [illegible]

PROCESS RESPONSIBILITY: MATT SELLERSANN FEA

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) 4/29/96
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken	Sev	Occ	Det	R.P.N.
			APPLICATIONS														
		MISSING DISC	CONTINUITY FAILURE	[illegible]		MACHINE ERROR	1	100% DISC PROBE 100% FUNCTION TEST	[illegible]	[illegible]							
14	CONFIRM DISC PRESENCE	FAILS TO IDENTIFY MISSING OR OUT OF PLACE DISC.	INOPERATIVE DEVICE	7		MACHINE ERROR	1	YIELD MONITORING	1	7							
15	FEED AND ASSEMBLE CUP	MISSING CUP	NO DEVICE OPERATION	[illegible]		MACHINE INDEX ERROR	1	100% PRESENCE CHECK 100% FUNCTION CHECK	1	[illegible]							
		DISLODGMENT OF INTERNAL COMPONENTS	INOPERATIVE DEVICE LEAK	[illegible]		MALALIGNED AIR PICK AND PLACE	1	TRAPPED DISC PROBE - 100% FUNCTION TEST CYCLING ALERTS	1	[illegible]							
		MULTIPLE CUPS LOADED	NO SUBSEQUENT ASSEMBLY POSSIBLE	[illegible]		MACHINE ERROR INCORRECT OPERATOR INTERVENTION	1	100% PRESENCE CHECK	1	[illegible]							
		LOW RATIO CUP LOADED IN PLACE OF HIGH RATIO CUP	SHIFT IN DEVICE SET POINTS	[illegible]		MIXING ERROR	1	100% FUNCTION CHECK	1	[illegible]							
			EXCESSIVE SPRING PRE-LOAD CREEP CONTINUITY FAILURE			OPERATOR ERROR		RAW BAN LOT CONTROL									
		HIGH RATIO CUP LOADED IN PLACE OF LOW RATIO CUP	SHIFT IN DEVICE SET POINTS	[illegible]		MIXING ERROR	1	100% FUNCTION CHECK	1	[illegible]							
			INSUFFICIENT SPRING PRE-LOAD CREEP CONTINUITY FAILURE			OPERATOR ERROR		RAW BAN LOT CONTROL									
17	CONFIRM CUP PRESENCE	FAILS TO IDENTIFY MISSING OR OUT OF PLACE CUP	INOPERATIVE DEVICE	7		MACHINE ERROR	1	YIELD MONITORING	1	7							

TI-NHTSA 018878

PROCESS: AUTOMATED SENSOR ASSEMBLY

MODEL YEAR(S)/VEHICLE(S): 52/57/77/80/87PS

PROCESS RESPONSIBILITY: MATT SELLE/SHAWN REA

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) 4/28/98
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
18	PRE-CRIMP SENSOR ASSEMBLY	UNDER CRIMP	DISLODGMENT OF INTERNAL COMPONENTS DURING TRANSFER TO [illegible]	5		BROKEN OR WORN TOOLS	3	OPERATOR SET-UP	1	15							
						PRESSURE TOO LOW		100% FUNCTION TEST PREVENTIVE MAINT.									
		OVER CRIMP	DIFFICULT FINAL CRIMP DUE TO SIDE WALL STIFFENING	5		EXCESS PRESSURE	3	PREVENTIVE MAINT.	1	15							
						SET-UP ERROR		SET-UP INSPECTION									
19	PROBE FOR TRAPPED DISC.	FAILS TO IDENTIFY MISSING OR TRAPPED DISC.	INOPERATIVE DEVICE. CONTINUITY FAILURE.	7		MACHINE ERROR	1	YIELD MONITORING	1	7							
20	TRANSFER PRE-CRIMPED SENSOR ASSEMBLY TO SENSOR CRIMPER	DISLODGED INTERNAL COMPONENTS	LEAK	8		INSUFFICIENT PRE-CRIMP	1	PREVENTIVE MAINT.	1	8							
			CONTINUITY FAILURE					100% FUNCTION TEST SET-UP INSPECTION									
		FAILS TO TRANSFER	EMPTY PUCK, NO EFFECT ON SUBSEQUENT OPERATIONS	5		MACHINE ERROR	1	PREVENTIVE MAINT.	1	5							
		TRANSFERS MULTIPLE SENSOR ASSEMBLIES	SENSOR DAMAGE	6		INCORRECT OPERATOR INTERVENTION	1	OPERATOR AWARENESS TRAINING	1	6							
21	UNLOAD BAD PARTS SENSOR ASSEMBLIES.	FAILS TO UNLOAD	HEXPORT LOADED ONTO OCCUPIED NEST.	8		UNLOAD FAILURE	1	EMPTY NEST PROBE	1	8							
22	CHECK EMPTY NEST.	FAILS TO IDENTIFY OCCUPIED NEST.	HEXPORT LOADED ONTO OCCUPIED NEST.	8		UNLOAD FAILURE	1	YIELD MONITORING	1	8							
23	[illegible] PLACE INTERNAL O-RING ON HEXPORT	FAILS TO PLACE O-RING ON PART	IF UNDETECTED IN SUBSEQUENT OPERATION COULD CAUSE LEAK IN APPLICATION	8		PICK & PLACE MIS-HANDLES O-RING	[illegible]	100% O-RING CHECK ON CRIMP TABLE	[illegible]	64	ADD O-RING CHECK TO FINAL FUNCTION TEST AS A REDUNDANT CHK.	MFG. ENGINEERING	COMPLETE 12/98	8	2	1	16
						NO O-RING PRESENT AT TRACK DUE TO EMPTY BOWL FEED, CONTAMINATION IN TRACK, MISALIGNED TRACK	2	O-RING STATION FAIL ROUTE SLIP AND VISUAL AIDS FOR O-RING REQUIREMENTS									

TI-NHTSA 018679

PROCESS: AUTOMATED SENSOR ASSEMBLY | PROCESS RESPONSIBILITY: MATT BELLERMANN REA
MODEL YEAR(S)/VEHICLE(S): [illegible]PS | DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) [illegible]
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
						O-RING STATION NOT ACTIVATED PICK & PLACE WORN, MISALIGNED OR NOT DESIGNED PROPERLY PUCK NOT LOCATED PROPERLY DUE TO MISALIGNED STOP OR CONTAMINATION BELT STRIPPER PIN FAILS TO REMOVE O-RING		100% VISUAL INSPECTION AT PRESSURE TEST AND PACKING									
		PLACES TWO O-RINGS ON ONE PART	HIGH ASSEMBLY TORQUE	4		PUCK STOP FAILS TO RELEASE PUCK AT END OF CYCLE	3	100% MULTIPLE O-RING CHECK ON CRIMP TABLE	2	24	ADD O-RING CHECK TO FINAL FUNCTION TEST	MFG. ENG.	COMPLETE 1/98	4	2	1	8
			POTENTIAL INABILITY TO FULLY ASSEMBLE IN APPLICATION	5			2	100% VISUAL INSPECTION AT PRESSURE TEST AND PACKING P.M. FOR O-RING STATION	3	30	TEST			5	2	1	10
		O-RING DAMAGED BY FEED SYSTEM OR PICK & PLACE	POSSIBLE LEAK IN APPLICATION	6		PICK & PLACE AND FEED SYSTEM WORN OR NOT DESIGNED PROPERLY	1	P.M. FOR PICK & PLACE AND FEED SYSTEM DESIGN VERIFICATION THROUGH DEBUG AND PROCESS HISTORY Q.C. AUDIT FROM EACH LOT SUBJECTED TO FLUID LEAK CHECK	2	12							
		THREADS DAMAGED BY PICK & PLACE	MAY RESULT IN HIGH INSTALLATION TORQUE	4		PICK & PLACE AND FEED SYSTEM WORN, MISALIGNED OR NOT DESIGNED PROPERLY	2	P.M. FOR PICK & PLACE AND FEED SYSTEM	2	16							
			FINISHED DEVICE WILL NOT ASSEMBLE AT CUSTOMER	5		PUCK NOT LOCATED PROPERLY	1	DESIGN VERIFICATION THROUGH DEBUG AND PROCESS HISTORY Q.C. AUDIT FROM EACH LOT SUBJECTED TO THREAD QUALITY CHECK	2	10							

TI-NHTSA 018680

PROCESS: AUTOMATED SENSOR ASSEMBLY

MODEL YEAR(S)/VEHICLE(S): [illegible]

PROCESS RESPONSIBILITY: MATT SELLERS/ANN REA

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) 4/29/96
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
		O-RING NOT LOCATED PROPERLY ON THE ASSY.	MAY RESULT IN HIGH INSTALLATION TORQUE	4		PICK & PLACE AND FEED SYSTEM WORN, MISALIGNED OR NOT DESIGNED PROPERLY	2	P.M. FOR PICK & PLACE AND FEED SYSTEM	2	16							
			POTENTIAL O-RING DAMAGE DURING ASSEMBLY RESULTING IN LEAK	5		PUCK NOT LOCATED PROPERLY	1	DESIGN VERIFICATION THROUGH DEBUG AND PROCESS HISTORY Q.C. AUDIT FROM EACH LOT SUBJECTED TO THREAD QUALITY CHECK. 100% VISUAL CHECK AT PRESSURE TEST AND PACK	3	15							
24	TRANSFER SENSOR ASSEMBLY TO ROTARY CRIMP NEST.	FAILS TO TRANSFER.	PRE-CRIMPED SENSOR ASSEMBLY LOADED ONTO OCCUPIED NEST.	5		UNLOAD FAILURE	1	YIELD MONITORING.	1	5							
25	45 DEGREE CRIMP SENSOR ASSEMBLY	UNDER CRIMP	LOSS OF SPC CONTROL OF DIAMETER OR HEIGHT POTENTIAL DIAPHRAGM LIFE PROBLEM	9		PRESSURE TOO LOW TOOL WEAR/BREAKAGE	1	SPC DIA. AND HEIGHT PROCESS SPEC SET-UP PREVENTIVE MAINT. 100% FUNCTION TEST CYCLING AUDITS	1	9							
		OVER CRIMP	CRIMP DIAMETER TOO LARGE, CAUSING DIFFICULT FINAL ASSY. COMPONENT DAMAGE POTENTIAL DIAPHRAGM LIFE PROBLEM	9		PRESSURE TOO HIGH	1	SPC. DIA. AND HEIGHT PROCESS SPEC SET-UP PREVENTIVE MAINT. 100% FUNCTION TEST CYCLING AUDITS	1	9							
		IMPROPER CRIMP	COMPONENT DAMAGE CRIMP DIAMETER AND HEIGHT OUT OF SPEC.	5		OPERATOR SET-UP 90 DEG. TOOL IN 45 DEG. STATION WRONG DIE GEOMETRY	3	SPC DIA. AND HEIGHT PROCESS SPEC SET-UP PREVENTIVE MAINT. 100% FUNCTION TEST CYCLING AUDITS	1	15							
		FAILS TO CRIMP	COMPONENT DAMAGE AT 90 DEGREE CRIMP CRIMP DIAMETER AND HEIGHT OUT OF SPEC.	5		MACHINE MALFUNCTION. SET-UP ERROR	1	PREVENTIVE MAINT. SET-UP SPECS	1	5							

T-NHTSA 018881

PROCESS: AUTOMATED SENSOR ASSEMBLY

PROCESS RESPONSIBILITY: MATT SELLERS/ANN REA

MODEL YEAR(S)/VEHICLE(S): 9X/97/98/97PS

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) 4/29/96
FMEA REVISION: 8

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
		IMPROPER TOOL REGISTRATION	MINOR REGISTRATION ERROR: SENSOR DIAMETER OUT OF ROUND SENSOR HEIGHT UNEVEN MAJOR REGISTRATION ERROR - COMPONENT [illegible]	5		INDEXER ERROR MAINTENANCE SET-UP ERROR	1	SPC DIA. AND HEIGHT PREVENTIVE MAINT.	1	5							
26	VERIFY O-RING PRESENT ON SENSOR	FAILS TO DETECT MISSING O-RING	PART WILL BE UNLOADED INTO GOOD BIN AND COULD CAUSE LEAK IN APPLICATION IF UNDETECTED IN SUBSEQUENT [illegible]	5		PROBE MISALIGNED, WORN OR IMPROPERLY DESIGNED	[illegible]	MASTER DEVICES REDUNDANT O-RING CHK ON FINAL FUNCTION CK	2	10							
						PROBE CONTAMINATION PROBE STATION NOT ACTIVATED		ALIGNMENT TOOL VISUAL INSPECTION PROBE FMA'S									
		FAILS TO DETECT O-RING PRESENT	PART WILL BE UNLOADED INTO BAD BIN RESULTING IN YIELD LOSS	2		PROBE MISALIGNED, WORN OR IMPROPERLY DESIGNED	2	MASTER DEVICES ALIGNMENT TOOL	1	4							
						PROBE CONTAMINATION PART ALIGNMENT IN NEST		PROBE DESIGN PROVEN THROUGH DEBUG & PROCESS HISTORY PROBE FMA'S									
		FAILS TO DETECT TWO O-RINGS PRESENT	PART WILL BE UNLOADED INTO GOOD BIN POSSIBLY RESULTING IN HIGH INSTALLATION TORQUE AT [illegible]	4		PROBE MISALIGNED, WORN OR IMPROPERLY DESIGNED	2	MASTER DEVICES ALIGNMENT TOOL	2	16							
						PROBE CONTAMINATION PROBE STATION NOT ACTIVATED		PROBE FMA'S ROUTE SLIPS VISUAL INSPECTION									
		O-RING DAMAGED BY PROBE TIP	LEAK IN APPLICATION	5		PROBE MISALIGNED WORN OR IMPROPERLY DESIGNED	1	PROBE DESIGNED TO MINIMIZE THREAD CONTACT PROBE FMA'S PROBE DESIGN PROVEN THROUGH RE-DEBUG AND PROCESS HISTORY	2	10							
27	90 DEGREE CRIMP SENSOR ASSEMBLY	UNDER CRIMP	BURST RESISTANCE DEGRADED	8		PRESSURE TOO LOW	1	SPC DIA. AND HEIGHT	1	8							

TI-NHTSA 018692

PROCESS: AUTOMATED SENSOR ASSEMBLY

PROCESS RESPONSIBILITY: MATT SELLERS/[illegible] REA

MODEL YEAR(S)/VEHICLE(S): [illegible]

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) [illegible]

FMEA REVISION: [illegible]

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken	Sev	Occ	Det	R.P.N.
			ASSY. CRIMP HEIGHT OUT OF SPEC. DIFFICULT FINAL ASSEMBLY CRIMPING			TOOL WEAR/BREAKAGE [illegible] DEG. TOOL IN [illegible] DEG. STATION		PROCESS SPEC SET-UP F.M.D.O. AUDITS 100% FUNCTION TEST CYCLING AUDITS									
		OVER CRIMP	CRIMP DIAMETER TOO LARGE CAUSING DIFFICULT FINAL ASSY	[illegible]		PRESSURE TOO HIGH	1	SPC. DIA. AND HEIGHT PROCESS SPEC SET-UP PREVENTIVE MAINT. 100% FUNCTION TEST CYCLING AUDITS	1	[illegible]							
25	OVER-PRESSURE SENSOR ASSEMBLY	INSUFFICIENT O/P	DRIFT OVER LIFE OR CALIBRATION CHANGE LEADING TO WELD LOSS	[illegible]		IMPROPER DESIGN OF O/P HEAD INCORRECT O/P SETTINGS INADEQUATE SEAL [illegible]	1	100% FUNCTION TEST. MIN. PRESSURE LEVEL GAGE.	[illegible]	[illegible]							
[illegible]	UNLOAD GOOD SENSOR ASSEMBLIES	FAILS TO UNLOAD GOOD SENSOR	TABLE WON'T INDEX PAST NEXT CYCLE (EMPTY NEST FAILURE)	[illegible]		LOOSE/ MISADJUSTED OR IMPROPERLY DESIGNED PICK-UP JAWS	[illegible]	EMPTY NEST PROBE [illegible] PART	1	[illegible]							
			YIELD/UPTIME LOSS	[illegible]			1	JAW DESIGN PROVEN THROUGH DEBUG & PROCESS HISTORY	[illegible]	[illegible]							
		THREAD DAMAGE	POSSIBLY RESULTING IN HIGH INSTALLATION TORQUE	[illegible]		JAWS WORN, MISALIGNED OR IMPROPERLY DESIGNED	[illegible]	JAW P.M.'S JAWS DESIGNED TO MINIMIZE THREAD CONTACT DESIGN PROVEN THROUGH DEBUG & PROCESS HISTORY	[illegible]	[illegible]							
[illegible]	PICK & UNLOAD ASSEMBLY [illegible]	FAILS TO UNLOAD BAD SENSOR	TABLE WON'T INDEX PAST NEXT CYCLE (EMPTY NEST FAILURE)	[illegible]		LOOSE/ MISALIGNED OR IMPROPERLY DESIGNED PICK UP JAWS	[illegible]	EMPTY NEST PROBE [illegible] PARTS JAW DESIGN PROVEN THROUGH DEBUG & PROCESS HISTORY	1	[illegible]							
			UPTIME LOSS	[illegible]			1		1	2							
		THREAD DAMAGE	POSSIBLY RESULTING IN HIGH INSTALLATION TORQUE AT CUSTOMER.	[illegible]		JAWS WORN, MISALIGNED OR IMPROPERLY DESIGNED	[illegible]	JAW P.M.'S JAWS DESIGNED TO MINIMIZE THREAD CONTACT DESIGN PROVEN THROUGH DEBUG & PROCESS HISTORY	[illegible]	16							

TI-NHTSA 018883

PROCESS: AUTOMATED SENSOR ASSEMBLY

MODEL YEAR(S)/VEHICLE(S): [illegible]

PROCESS RESPONSIBILITY: MATT SELLERS/ANN REA

DSGN/QUAL/MFG RESPONSIBILITY: KEITH ROSIELLO / JIM WATT / PEGGY ALLEN

FMEA DATE (ORIG.) 4/[illegible]/98
FMEA REVISION: B

Item	Process Function/ Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
31	CHECK EMPTY NEST.	FAIL TO IDENTIFY OCCUPIED NEST.	SENSOR ASSEMBLY LOADED ONTO OCCUPIED NEST.	5		UNLOAD FAILURE	1	YIELD MONITORING	1	5							

TI-NHTSA 018604

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

1.0 GENERAL

1.1 Customer: Ford Motor Company

1.2 TI Part Number: 77PSL2-1

1.3 Customer Part Number: (delta) F2VC-9F924-AB

1.4 Specifications: Ford Engineering Specification number (delta) ES-F2VC9F924-AA

1.5 Date Of Completion: 97/03/15

1.6 Quantity Of Units Tested: 54

1.7 Disposition Of Tested Units :

Devices tested were retained by Texas Instruments.

1.8 TI test series number: #1 through #6 (Vibration)
#7 through #12 (Vacuum)
#13 through #18 (Temp Cycling)
#19 through #54 (Fluid Resistance)

2.0 TEST PROCEDURES AND RESULTS

All switches were tested to Ford Engineering Specification (delta) ES-F2VC-9F924-AA. Tests were completed with production parts, selected on a random basis to represent the entire production population as much as possible.

Pre-test and post-test actual switch test results are attached at the end of this test summary.

2.1 Calibration

Procedure: Calibration was checked at room temperature (16 degrees C to 35 degrees C) using ambient air as the pressure medium. Calibration settings, as specified on the part drawing, are actuation (electrical contacts opening) at 90 - 160 psig, , and release (contacts reclosing) at 20 psig minimum. All tests were accomplished after the third cycle with the switch conducting 700 - 800 milliamps at 12.0 - 14.0 volts DC. The rate of pressure change (ramp-up, ramp down) was accomplished at 60 psig/sec.

Pre-test and Post-test results are in the Vibration/Vacuum/ Temp Cycling/Fluid Resistance test portions respectively.

TI-NHTSA 018885

CUSTOMER: Ford Motor Co.	TEST: IN-PROCESS IP-2 TEST SUMMARY	PAGE 1 OF 8
TESTED BY: E. Rose/ Eng Lab	TEXAS INSTRUMENTS INCORPORATED	DEVICE: 77PSL2-1
APPROVED BY: Jim Watt, QRA	MATERIALS & CONTROLS GROUP	DOC. : PS 97-14
DATE: April 04, 1997	ATTLEBORO, MASSACHUSETTS 02703	FILE NAME: IP TESTING

2.2 Voltage Drop

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

Pre-test and Post-test results are in the Vibration/Vacuum/ Temp Cycling/ Fluid Resistance test portions respectively.

2.3 Current Leakage

Current leakage was measured with 500 volts , 60 hertz alternating current. The current leakage checked were:

Between the switch leads with contacts open.

Between the terminals and case (switch housing) with contacts closed.

Between either terminal and case (switch housing) with contacts open.

Pre-test and Post-test results are in the Vibration/Vacuum/ Temp Cycling/ Fluid Resistance test portions respectively.

2.4 Proof

Calibration readings were recorded only after proof testing . Test pressure was 4000 psig per the part drawing. Equipment is Enerpak model P-392 hydraulic hand pump using Enerpak hydraulic fluid as the pressure medium. Fluid is removed from the devices using a combination of vacuum and residue-free solvent Sprayon (TM) Hi-Tech 02002 TF Electric Contact Cleaner. US Gauge #33714 reading to 5000psig with 100 psig increments, resolvable to 50 psig, calibrated quarterly. Custom TI designed and built safety enclosure.

Pre-test and Post-test results are in the Vibration/Vacuum/ Temp Cycling test portions respectively.

2.5 Vibration

Devices tested: TI #1 through #6.

Equipment used: Vibration table, Ling, model A395 with Hewlett-Packard model 5427 controls. Air tank with 350 psig minimum pressurized Nitrogen used to actuate devices with at least 1.1 times maximum actuation specification on part drawing; 300 psig x 1.1 = 330 psi minimum. Switches were mounted in the test port using the currently released electrical connector before the start of the test. Switches were vibrated in all 3 planes with electrical continuity monitored during the entire test, in ambient air. Internal pressure was maintained at zero Kpa G when the switch was in the closed position, and 1.1 times max actuation pressure shown on the print when the switch was in the open position. The switches were vibrated at 1.5mm displacement (peak to peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period, in alternate one-hour periods in the open and closed postions for a total of 8 hours in each plane, for a total test time of 24 hours.

Calibration Pre-test Results: The average actuation was 133.6 psig, and the standard deviation was 3.3. All values were well within the specification. The average release was 56.7 psig, and the standard deviation was 7.4. All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 130.3 psig, and the standard deviation was 4.6. All values were well within the specification. The average release was 64.3, and the standard deviation was 6.4. All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

All six switches met the acceptance criteria in the Ford ES specification.

TI-NHTSA 018887

CUSTOMER: Ford Motor Co.	TEST: IN-PROCESS IP-2 TEST SUMMARY	PAGE 3 OF 5
TESTED BY: E. Rose/ Eng Lab	TEXAS INSTRUMENTS INCORPORATED	DEVICE: 77PSL2-1
APPROVED BY: Jim Watt, QRA	MATERIALS & CONTROLS GROUP	DOC.: PS 97-14
DATE: April 04, 1997	ATTLEBORO, MASSACHUSETTS 02703	FILE NAME: IP TESTING

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

2.6 Vacuum

Devices tested: TI #7 through #12.

Equipment used: Kinney vacuum pump. Sensotec pressure transducer, serial no. 195033 Model Tile 727-02, range 0-25 psia calibrated quarterly, with Fluke model 8020B Digital Multimeter readout, calibrated quarterly.
Switches were mounted in the test at room temperature, ambient air as the pressure medium. Switches were subjected to 5 cycles of vacuum from atmosphSwitches were subjected to 5 cycles of vacuum from atmosphic pressure (760mm Hg) to an absolute pressure of 3-6 mm Hg, maintaining vacuum for 60 seconds.

Note: 3mm Hg = 0.058 psi = 0.400KPa
6mm Hg = 0.116 psi = 0.800kpa

Calibration Pre-test Results: The average actuation was 126.5 psig, and the standard deviation was 680. All values were well within the specification. The average release was 62.7 psig, and the standard deviation was 4.6 All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 126.2 psig, and the standard deviation was 4.5. All values were well within the specification. The average release was 65.3, and the standard deviation was 3.4. All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

All six switches met the acceptance criteria in the Ford ES specification.

2.7 Temperature Cycle

Devices tested: TI #13 through #18.

Equipment used: Thermotron model S-4 Mini-Max environmental chamber capable of - 55 degrees C to + 200 degrees C, humidity controlled. Custom TI designed and built cycler, utilizing Enerpak integrated hydraulic pressure source, TI315 Programmable Logic Controller, Moog servovalve and controller, Simpson signal generator, and opposing-piston fluid isolators, to produce a hydraulic-fluid flow-type primary with a brake-fluid dead-end -type secondary terminated with a 24-station manifold equipped with internal heaters. Capability to 5 hz at 0-1500 psig cycle. Custom TI designed and built 24 station Switch Monitor Circuit which automatically stops the cycler in the event of abnormal switch action, defined as continuity change which does not track the signal from the signal generator. Thermocouple readouts calibrated quarterly.

Calibration Pre-test Results: The average actuation was 129.7 psig, and the standard deviation was 4.3. All values were well within the specification. The average release was 63.8 psig, and the standard deviation was 4.3 All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 120.3 psig, and the standard deviation was 4.5. All values were well within the specification. The average release was 59.6, and the standard deviation was 2.9 All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: : Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: : Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

All six switches met the acceptance criteria in the Ford ES specification.

TI-NHTSA 018689

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

2.8 Fluid Resistance (The Fluid Resistance portion of testing was not repeated as this series of tests are once/ year only)

Devices tested: TI #19 through #54.

Equipment : Fluids as called out in ES table (frame 12 of 18); appropriate beakers and storage apparatus; vented hood.

Results: The 36 devices were divided into groups as follows for subsequent testing. Results of these tests are reported below.

Impulse:	#19 through 30
Terminal Strength:	#31 through 42
Humidity:	#43 through 48
Salt Spray:	#49 through 54

2.8.1 Impulse (#19 through 30)

Calibration Pre-test Results: The average actuation was 129.6 psig, and the standard deviation was 3.5. All values were well within the specification. The average release was 64.3 psig, and the standard deviation was 5.7 All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 118.1 psig, and the standard deviation as 3.4. All values were well within the specification. The average release was 65.2, and the standard deviation was 3.9 All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

All twelve switches met the acceptance criteria in the Ford ES specification.

TI-NHTSA 018690

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

2.8.2 Terminal Strength (#31 through 42)

Calibration Pre-test Results: The average actuation was 129.9 psig, and the standard deviation was 5.2. All values were well within the specification. The average release was 61.7 psig, and the standard deviation was 5.8 All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 131.3 psig, and the standard deviation was 4.7. All values were well within the specification. The average release was 64.5, and the standard deviation was 4.8. All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: Statistics not calculated . All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

All twelve switches met the acceptance criteria in the Ford ES specification.

2.8.3 Humidity (#43 through 48)

Calibration Pre-test Results: The average actuation was 132 psig, and the standard deviation was 3.9. All values were well within the specification. The average release was 61.4 psig, and the standard deviation was 1.8 All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 141.4 psig, and the standard deviation was 6.6. All values were well within the specification. The average release was 63.6, and the standard deviation was 6.1. All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

TI-NHTSA 018691

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

Voltage Drop Post-test Results: Statistics not calculated . All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

All six switches met the acceptance criteria in the Ford ES specification.

2.8.4 Salt Spray (#49 through 54)

Calibration Pre-test Results: The average actuation was 131.7 psig, and the standard deviation was 3.8. All values were well within the specification. The average release was 57.9 psig, and the standard deviation was 5.3 All values were well within the 20 psig minimum specification.

Calibration Post-test Results: The average actuation was 136.9 psig, and the standard deviation was 8.6. All values were well within the specification. The average release was 58.0, and the standard deviation was 5.9. All values were well within the 20 psig minimum specification.

Voltage Drop Pre-test Results: Statistics not calculated. All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: Statistics not calculated . All values were well within the specification of 200 millivolts maximum.

Current Leakage Pre-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Current Leakage Post-test Results. Statistics not calculated. All values were well below the specification of 100 microamps.

Proof Pre-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

Proof Post-test Results: No evidence of fluid leakage and no drop in test pressure observed on any device.

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

All six switches met the acceptance criteria in the Ford ES specification.

Pre-test and post-test actual switch test results are attached at the end of this test summary.

IN-PROCESS IP-2 TEST SUMMARY (PS 97-14)

CUSTOMER: Ford Motor Co.	TEST: IN-PROCESS IP-2 TEST SUMMARY	PAGE 10 OF 8
TESTED BY: E. Rose/ Eng Lab	TEXAS INSTRUMENTS INCORPORATED	DEVICE: 77PSL2-1
APPROVED BY: Jim Watt, QRA	MATERIALS & CONTROLS GROUP	DOC.: PS 97-14
DATE: April 04, 1997	ATTLEBORO, MASSACHUSETTS 02703	FILE NAME: IP TESTING

CC:	Tom Chambaness	TC	Charlie Douglas	TPPC
	Dave Czarn	ZAPM	Steve Major	WHI T
	Mike DeMattie	PCCM	Gary Snyder	TPPC
	Jeff DiDomenico	ELS	Jim Watt	PCC
	Steve Offiler	SBPI		

SUBJECT: Additional Information on 77PSL2-1 Pass Car ISR Failures

Jim: Per our phone conversation, the following message attempts to answer the questions posed by Bruce Maeroff (Supv. Pass Car Brake Eng.) with factual detail. I caution you to use this wisely, as this is decidedly sensitive information.

1) Describe the problem in more detail, including a description of the actual failure mode.

Answer: This is limited to Pass Car product which is crimped on the automatic assembly equipment. Light Truck product does not have this problem regardless of assembly technique, nor does Pass Car product which is crimped on the manual equipment. The problem is ruptured Kapton diaphragms during Impulse testing at Ford spec. parameters (temperature, pressure, and time) which significantly exceed actual conditions: Five brake applications per mile for 100,000 miles to a pressure of 1450 psi at a fluid temp. of 135 C. Ruptured diaphragms result in brake-fluid leakage, as the diaphragm is the fundamental design element (along with the gasket) which contains and separates the brake fluid from the pressure-sensing elements. The rupture occurs in the area which experiences maximum strain. The type and location of the rupture we are seeing is very normal for diaphragms cycled to the end of their life. The problem may be viewed as diaphragms which have a characteristic life which falls short of Ford's conservative specification.

2) Specifically, how many cycles to failure ?

Answer: Eight of 12 virgin devices originally undergoing ES testing failed due to leakage at the following points: one at 270K, at 290K, at 325K, at 350K, four at 388K, and four surviving removed from test at 388K. The other 12 devices, which subsequently returned from the Fluid Resistance test, were placed under quarantine, where they remain.

(Trying to Keep Things in Perspective: Weibull failure analysis of this data shows that Ford's specified reliability and probability (P90-.90, see ES, page 3) gives a minimum value of 214K cycles, which seems logical in light of the first failure occuring at 270K. 214K is only 43% of the spec, and is meaningless to Ford regardless because it is based on failure testing, whereas the spec assumes success testing throughout: "For PV... all samples tested must pass" (ES, page 12, section IV. A.) It is, nonetheless, two extremely hard brake applications per mile for 100,000-plus miles.)

3) Why is this happening ?

Answer: We are still investigating a number of hypotheses, and at this point none has clearly emerged as most probable. These include: crimp parameters (pressure/time relationship in air cylinders), possible geometrical differences in crimp dies, slight plastic deformation of internal components due to crimp which is undetectable on disassembled devices, bad lot of Kapton, damage to Kapton or its Teflon layer on the automatic equipment, etc. We [illegible]

TI-NHTSA 018695

1

present with high priority.

4) What are our interim corrective actions?

Answer: Build pressure-sensing subassemblies with manual crimp. This is the configuration we Impulse tested successfully (albeit that Fluid Resistance) for this ISR.

5) What are our long-term corrective actions and plans?

Answer: We must first complete the analysis of the cause of the problem and convince ourselves that we have a thorough understanding by demonstrating that we can turn the problem on and off. At this point, whatever process controls, SPC checks, etc. that are needed to ensure permanency will be determined and implemented. Then we will be ready to rebuild parts on the automatic equipment which will undergo the Fluid Resistance test and the Impulse test per the specification, and submit these results as an addendum to the ES test report. The timetable for these actions is unfortunately open-ended, because of the amount of time required to "complete" (cycle to death) any given test-lot and we've still got a few to go.

6) Miscellaneous additional thoughts:

• Mack Scholler has told us that Bruce Pease must write an "alert" which will be good for a 90-day extension; we must re-ISR the automated crimp within 90 days. (Joe, this info comes from your FSG 1053402.) Ford cannot dictate our production process. It is our prerogative to choose our process and ISR it as such. At this point we have done exactly that - we've chosen the manual sensor asm. and submitted the ISR for it (with the slight deviation regarding Fluid Resistance). Of course, from a profit standpoint it is in our own best interests to get the automatic sensor asm. equip. on-line and ISR'ed ASAP, but as far as I can tell they have no grounds to hold us to the stated 90 days.

• Diaphragm life will improve significantly with reduction in either pressure or temperature. We have cycled 34 Pass Car devices built on the automatic equipment to 500K with no failures using 800 (3A) psi at 121 C, and we've cycled another 10 devices to 500K with no failures using the full 1450 psi but at roughly 35-40 C. (unpowered, 10.5 Hz)

• QC cycles a sampling of devices from every lot, to the full 500K, which ensures that once we get our corrective actions in place that we'll be able to hold the gains.

Regards,
Steve D

TI-NHTSA 019898

-MSG M#= 277944 FR=SBO1 TO=ZARN SENT=09/10/91 01:27 PM
R#=002 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/10/91 01:27 PM

Dave Czarn	ZARN	CC:	Tom Burke	MFPC
Jeff DiDomenico	ELB		Tom Charbonneau	TC
Charlie Douglas	CPPC		Mike DeMattia	PCQA
Stan Hamol	SH2		Dick Gariepy	MFPC
Bob Robichaud	RHRO		John Kourtesis	MDES
Matt Sellers	PCME		Bill Sweet	PCME
			Jim Watt	PCQA

FR: Steve Offiler SBO1

SJ: Early Kapton Failures on AMI#2 Sensors

As most of you are aware, Production Validation of the 77PSL2-1 has been significantly impacted by failure during the Impulse test. This test runs 500K pressure cycles from 0 to 1450 psi at 2 Hz, in 121 deg. C ambient. The failure mode was leakage, caused by ruptured Kapton, beginning at roughly 270K cycles. Sensors for this test were built on AMI#2 on 91-07-19.

We have placed the highest priority on solving this problem. Several test lots have been created to test a number of possible causes. These test lots, typically 6 devices per lot, have been cycled to failure and Weibull techniques employed. Results are presented as follows:

Sorted by: Theta

Build dt	Beta	Theta	Rel@500K	Cup	Crimp	PreCr	OP psi
910828	3.5	1469	97.73	27713	AMI	no	1300
901019	3.7	1371	97.63	MB	HL	no	3000
910828	6.9	1208	99.77	27713	AMI	yes	1300
910822	6.0	1133	99.26	27713	HL	no	800
910828	9.3	1005	99.85	27713	HL	yes	0
910822	7.0	760	94.81	MB	AMI	yes	1300
910719	12.8	722	99.10	27288	AMI	yes	4000
910719	5.7	446	14.69	27713	AMI	yes	3000

Sorted by: Beta

Build dt	Beta	Theta	Rel@500K	Cup	Crimp	PreCr	OP psi
910719	12.8	722	99.10	27288	AMI	yes	4000
910828	9.3	1005	99.85	27713	HL	yes	0
910822	7.0	760	94.81	MB	AMI	yes	1300
910828	6.9	1208	99.77	27713	AMI	yes	1300
910822	6.0	1133	99.26	27713	HL	no	800
910719	5.7	446	14.69	27713	AMI	yes	3000
901019	3.7	1371	97.63	MB	HL	no	3000
910828	3.5	1469	97.73	27713	AMI	no	1300

TI-NHTSA 018697

In Weibull terminology, Beta is the slope of the curve plotting cumulative percentage of failures versus # cycles, and Theta is the characteristic life, the number of cycles at which 63.2% of the devices have failed. A large Beta number means all failures occur in a relatively short timespan, which is good because relatively accurate life [illegible] the percentage of failures at any given number of cycles is possible.

Scrutinizing the data above, sorted by Theta, shows devices built for Validation (both 77PBL2-1 and 77PBL2-3) on 91-07-19 are at the very bottom of the list. However, the attempt to reproduce the very worst lot on 91-08-28 produced drastically different results (third best). It has come to our attention that certain upgrades to AMI#2 to increase speed were underway in the July timeframe. While more details are needed, it is possible that something related to these modifications may be the root cause of the observed failures from 91-07-19.

Results sorted by Beta are also presented above. The only interesting point to be made here is that the larger Beta's seem to correlate rather well with the presence of AMI pre-crimp.

Other tools and techniques are also being employed to help solve this problem, including: cross-sectioning of devices to expose any issues related to internal geometries; pressure-sensitive film which helps show location of peak forces applied during crimp, etc. Please contact me for more details.

Regards,
Steve O.

TI-NHTSA 018698

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 160-03-36

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PS	9/10/91	Steve Offiler	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeffrey DiDomenico	9/11/91		

PROJECT TITLE: Ford '94 '92 Electronic Speed Control Deactivate PS

CUSTOMER:

PURPOSE OF TEST: Improve Kapton life in Poss-Cor parts

PROCEDURE: Impulse test – standard parameters

1 – 12 : Started at 0 cycles BANK 4 & 5
43 – 60 : Started with 591 K cycles complete BANK 1, 2, 3
81 – 96 : started with 500 K cycles complete BANK 6
* all devices AMI crimp, no precrimp, unless otherwise stated under origin

Device #	ORIGIN			Trip Act/Rel		Fail			
160-03-01	Special Hexport: .002"								
-02	relief in modify								
-03	Kapton clamp					402K			
-04	chassis/switches					263K			
-05						748K			
-06									
160-03-07	Control group for								
-08	1-6. All standard								
-09	parts								
-10									
-11						913K			
-12						536K			
160-03-43	Control lot for			137 / 66					
-44	49-60. All standard			139 / 60					
-45	parts. Are 591K			133 / 65		Leak @	799K		
-46	on test 159-03-24			138 / 62					
-47				149 / 67		Leak	459K		
-48				149 / 62		Leak @	751K		
160-03-49	washer thickness reduced			133 / 47		Leak @	477K		
-50	by .001". Higher rate.			140 / 52					
-51	Are 591K in test			119 / 48		Leak	711K		
-52	= 159-03-24			121 / 54					
-53				133 / 47		Leak @	751K		
-54				171 / 49					

TI-NHTSA 018699

Device #	ORIGIN	Init. Act/Rel		Fail			
[illegible]-55	.005" step in washer/	43 / 49			999K		
-56	[illegible] metal disc.	45 / 49					
-57	[illegible] 591 K in test	[illegible] / 49		LEAK@	610K		
-58	4159-43-24	40 / 49					
-59		47 / 51		Leak @	951 K		
-60		40 / 51		999 K			
[illegible]-91	Crimped on [illegible]-[illegible]			929K			
-92	[illegible] validation						
-93	parts. Successfully			999K			
-94	[illegible] 500K in						
-95	val test			1045K			
-96				1003K			

TI-NHTSA 016700

Next page.

SALE AUG '91
NO CHG

BUILD AUG '91

APP. BUILD JULY '91
NO CHG

BUILD NOV '90

BUILT AUG '9[illegible]

CONTROL GROUP

JEFF -
PICK UP 1/EA.
JULY AMI NEO &
AUG AMI NEO
PARTS ?

ATTEMPT REBUILD
OF VAL PARTS —
"SAME" ISSUE AS
[illegible] --
W/ SEALS FAIL?

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 115-03-10

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSL3-1	9/4/91	Steve Offiler	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey DiDomenico	9/4/91		

PROJECT TITLE: Ford MY'91 Electronic speed control deactivate PS

CUSTOMER:

PURPOSE OF TEST: Impulse devices to failure and obtain Weibull data

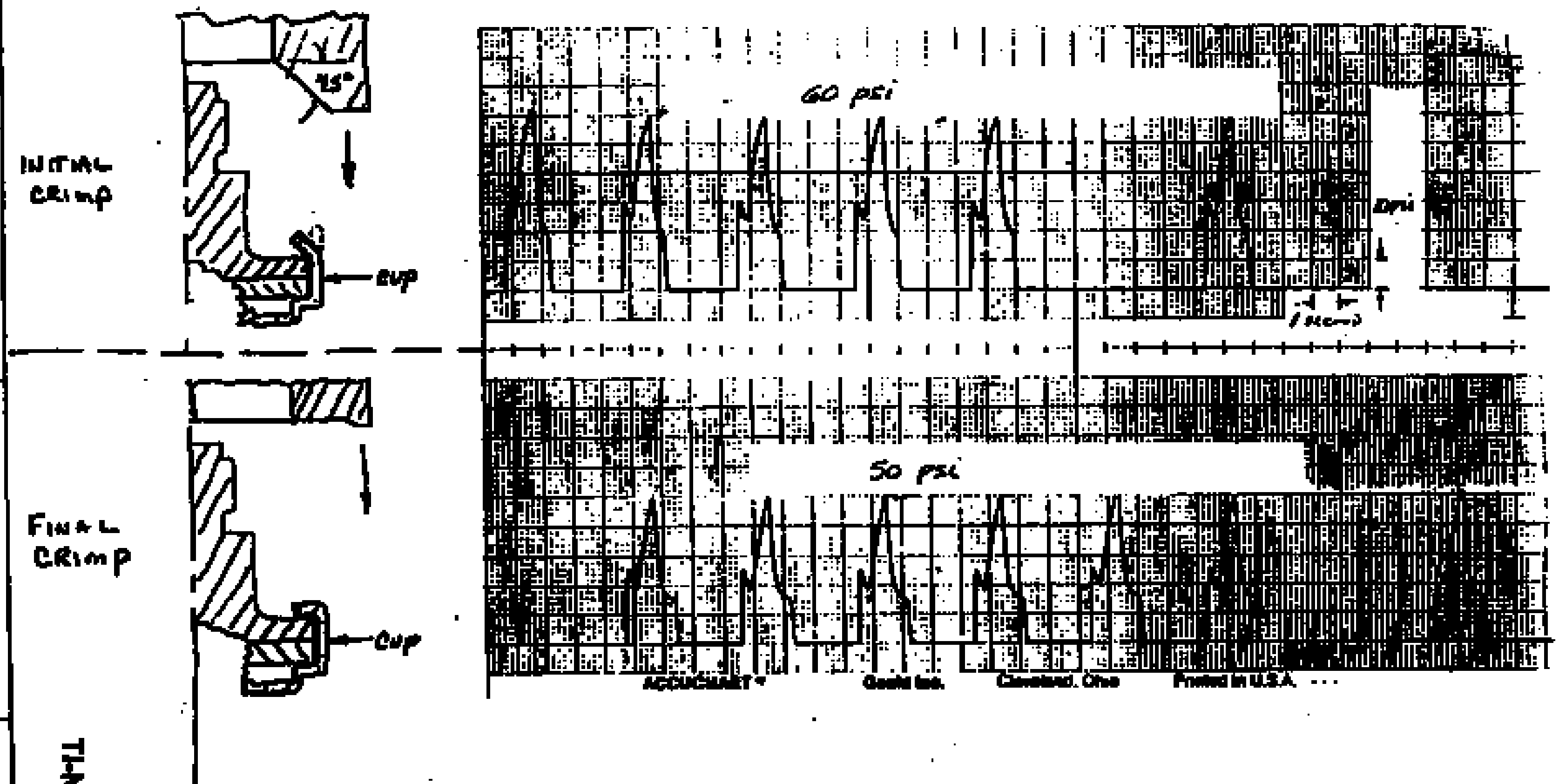
PROCEDURE: Return parts from validation testing to impulse test and cycle to failure

1-6 : no cycles yet.
13,14,15,17 : 394K cycles before this test

Device #	ORIGIN				Total Cycles to failure				
115-03-01	From the same lot as								
-02	the parts cycled on								
-03	proof testing and don't								
-04	cycles of reduced pressure								
-05	used according								
-06	ANI Comp. as previous								
115-01-13	original validation								
-14	parts								
-15									
-17									

TI-NHTSA 018703

CRIMP PRESSURES — SEMI AUTOMATED

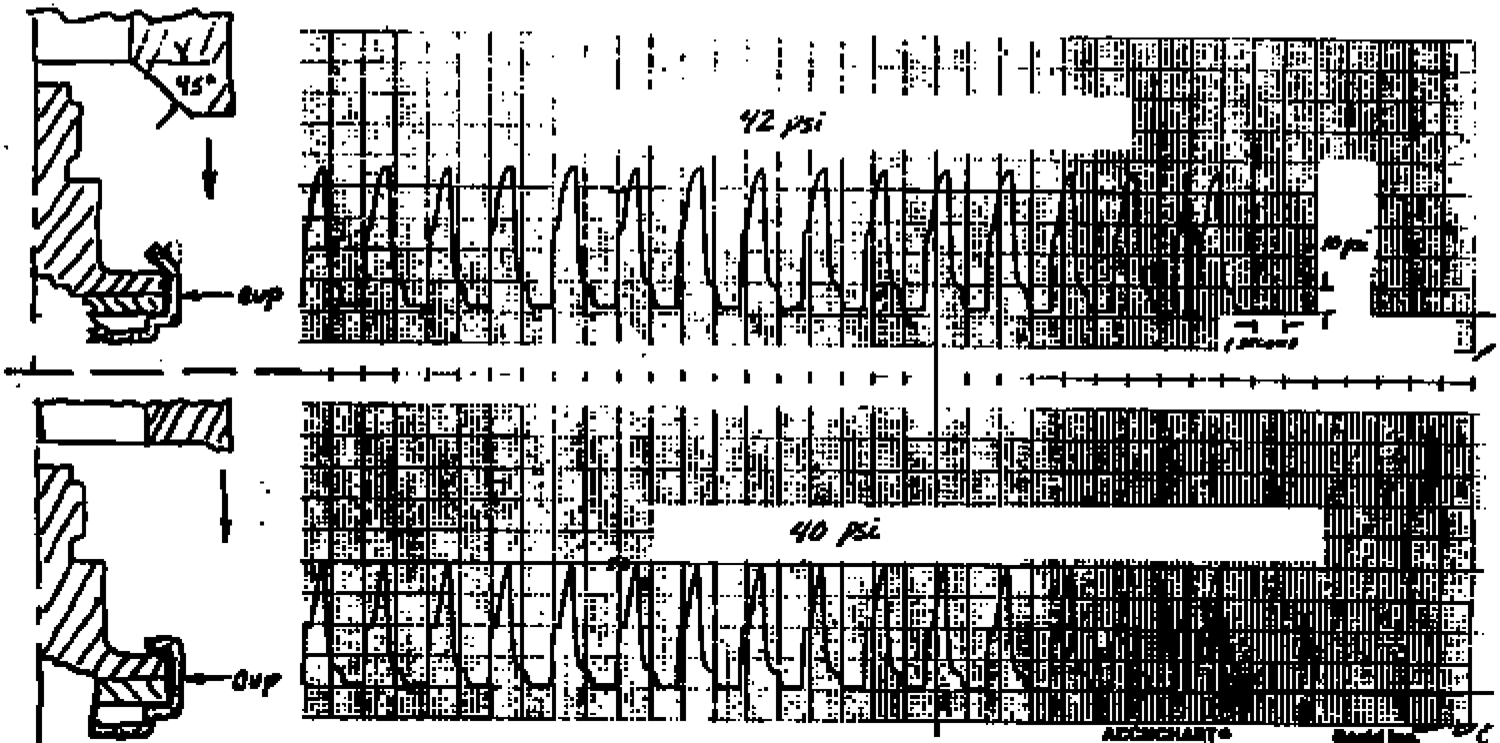


TI-NHTSA 018704

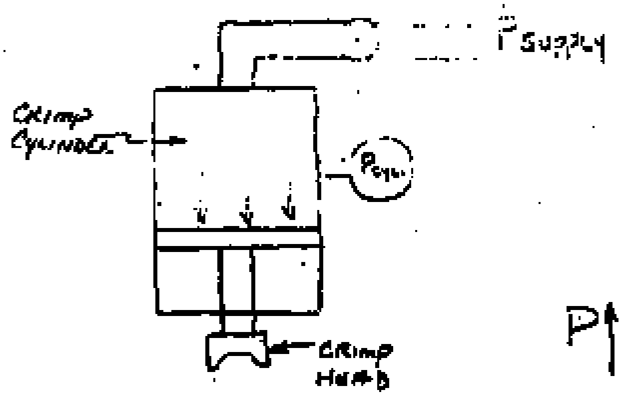
CRIMP PRESSURES - FULLY AUTOMATED (A.M.I.)

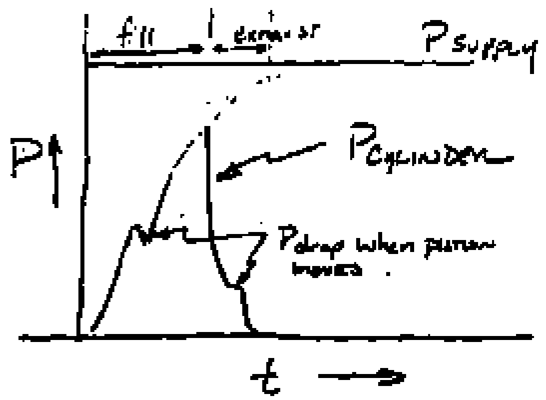
INITIAL CRIMP

FINAL CRIMP



TI-NHTSA 015705





Cont'd

275 psi/sec

$$\frac{1 \text{ cycle}}{1.2 \text{ sec}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 50 \text{ cpm}$$

P/C SEMI-AUTOMATED PROCESS

Spec: 500 K cycles
0-1430 ±50 psi

fluid = 135 ± 14 °C
Amb = 107 °C min

Bld	Test	Qty		
10/90	10/90	24	passed 500 K cycles	(57PS PV TESTING)
		6	Weibull	θ = 1371 K; 1st fail = 790 K
8/91	9/91	6	Weibull	θ = 1179 K; 1st fail = 830 K
8/91	9/91	6	Weibull	θ = 1005 K; 1st fail = 819 K
9/91	9/91	24	passed 500 K cycles	(77PS PV TESTING RE-TEST)
		6	Weibull	θ = ; 1st fail = 790 K

also, lot chk on 57 side lot control.

P/C AUTOMATED PROCESS

BLD	TEST	QTY		
7/91	9/91	12	θ = 446 K; 1st fail = 250 K	(77PS ORIG. PV TESTING)
8/91	9/91	6	Weibull θ = 760 K; 1st fail = 541 K	
8/91	9/91	6	Weibull θ = 1409 K; 1st fail = 718 K	
8/91	9/91	6	Weibull θ = 1209 K; 1st fail = 786 K	

Epstein, Sally

From:	Sullivan, Martha [m-sullivan@email.mc.ti.com]
Sent:	Thursday, February 11, 1999 11:11 AM
To:	Beringhause, Steven
Cc:	McGuirk, Andy; Rahman, Aziz; Baumann, Russ
Subject:	Dateline Show

Attorney-client privileged communication

NEW YORK (Reuters) - Internal Ford documents show the automaker has known for years about potential wiring problems in its cruise control systems that one mechanic believed may have caused some of its cars to accelerate suddenly, NBC News said on Tuesday. But the automaker said no connection between cruise control and sudden acceleration has ever been proved, and blasted NBC.

Andy has the video of this over here of this show. Points to shorts in the cruise control module. I wonder if this could cause current to pass through our switch after key off?

TI-NHTSA 018708

Epstein, Sally

From: McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent: Thursday, February 11, 1999 12:05 PM
To: Beringhause, Steven; Sullivan, Martha
Cc: Rahman, Aziz; 'Baumann, Russ'
Subject: RE: Dateline Show

Attorney-client privileged communication

very good point.

if i understood the article, the demonstrations showed that the cruise system was always 'hot' even with cruise control switch off....and that a short between either of two different specific wires of the harness of the cruise control electrical 'module' wire board to electrical ground could cause the cruise system to engage to wide-open-throttle position.

so, assume we see these sneak circuits and what might happen in our switch application ?

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Sullivan, Martha
Sent: Thursday, February 11, 1999 12:11 PM
To: Beringhause, Steven
Cc: McGuirk, Andy; Rahman, Aziz; Baumann, Russ
Subject: Dateline Show

Attorney-client privileged communication

NEW YORK (Reuters) - Internal Ford documents show the automaker has known for years about potential wiring problems in its cruise control systems that one mechanic belived may have caused some of its cars to accelerate suddenly, NBC News said on Tuesday. But the automaker said no connection between cruise control and sudden acceleration has ever been proved, and blasted NBC.

Andy has the video of this over here of this show. Points to shorts in the cruise control module. I wonder if this could cause current to pass through our switch after key off?

Graveline, Dora

From: McGuirk, Andy
Sent: Thursday, February 11, 1999 1:08 PM
To: Rahman, Aziz; Baumann, Russ
Subject: RE: 77PS Overview

Attorney-client privileged communication

same.... we want to go on record again that we have given further consideration and still believe that the use of a normally open relay upstream would be a good way to resolve the concern. we want to see us taken out of the always powered circuit as we think that would be a good basic design practice

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 23-08
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 494-3044

From: Rahman, Aziz
Sent: Thursday, February 11, 1999 12:51 PM
To: McGuirk, Andy
Subject: RE: 77PS Overview

If you are talking about the normally open relay upstream of the switch, I already reviewed that with Fred on Day 1. Is the de-electric circuit you are talking about the same relay approach, or something new?

From: McGuirk, Andy
Sent: Thursday, February 11, 1999 11:09 AM
To: Rahman, Aziz
Subject: RE: 77PS Overview
Importance: High

lets talk ASAP about delivery of a new letter about the switch de-electric circuit proposal we sent earlier
AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 23-08
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 494-3044

From: Rahman, Aziz
Sent: Thursday, February 11, 1999 11:03 AM
To: Baumann, Russ; Beringhause, Steven; McGuirk, Andy; Dague, Bryan
Subject: RE: 77PS Overview

Team,

Thanks for the info below. I have reviewed test report 99/14 with them and will review this info at the next opportune time. I will let you know if I need a hard copy.

From: Dague, Bryan

Sent: Thursday, February 11, 1999 8:46 AM
To: Baumann, Russell; Beringhause, Steven; Aslam, Aziz; McGuirk, Andrew
Subject: 77PS Overview

Guys,

Here is the final draft. Aziz to deliver to the customer??

Please advise if I need to fax it to someone.

I am having copies of the appendix made today.

Regards,
Bry

****

Proprietary Information

77PS Overview
2/10/99

TI's 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid pressure and transmit pressure and movement to the sensing portion of the switch over the life as defined in Ford ES -F2VC-9F924-AA.

Background:
The pressure cavity is composed of the hexport, gasket, and three Kapton™ diaphragms (called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and the diaphragms. The purpose of the Kapton™ diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore, the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity (brake line pressure) is varied.

Two known ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity are i. brake fluid could leak past an impaired gasket seal, or ii. brake fluid could leak through a damaged or 'worn out' Kapton™ diaphragm.

The Gasket:
In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the elastomer to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid.

Fluid compatibility is typically established by the use of published tables. These tables list fluid groups and general material types. Lab testing is always done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Ethylene Propylene is used in the 77PS and is standard throughout the industry for seal gasket materials. TI has been using this material in brake applications since 19[illegible].

The gasket compression target was obtained from published industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24% was selected. The depth of the hexport gland shown on attachment #2 controls this attribute. This gland dimension is cut into the hexport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimped together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled and restrained. This

design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specific details of these tests and the results can be seen in the PV test report numbers listed below: (copies can be provided on request).

Test Report #	TI Switch Part number	Year Tested
1. PS/91/48	77PSL2-3	1991
2. PS/91/49	77PSL2-1	1991
3. PS/92/49	77PSL3-1	1992
4. PS/92/80	77PSL5-2	1992
5. PS/92/82	77PSL3-1	1992
6. PS/93/11	77PSL6-1	1993
7. PS/93/44	77PSL4-1	1993

Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket or sealing surfaces, and as a result, may cause leaks early in life. In order to protect TI's customer supply chain from gasket-manufacturing issues there are several preventive actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment. TI's customer return rates indicated by past return and analysis records are less than 1 ppm (one leaker return in 5 years from master cylinder leak testing).

Kapton ™ Diaphragm:

A pressure switch diaphragm must seal the pressure cavity, transmit pressure forces to the converter, and follow the converter motion without significantly affecting the switch calibration points. In addition, the diaphragm material must be resistant to chemical attack by the brake fluid.

Basically, a single piece of Kapton ™ in this design consists of a 0.003-inch thick polyimide film laminated on both sides with a 0.001-inch thick FEP Teflon film. The polyimide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton ™ was selected for its mechanical and chemical properties. Moreover, TI has been using this material in pressure switch applications since 1981. In this application three stacked Kapton ™ layers were used as the diaphragm seal.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's ™ ability to meet the specified requirements (PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton ™ diaphragm, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch can vary, but typically is around 1 million cycles which is well above the 500,000 cycles specified in the Ford specification (ES-F2VC-9F924-AA). (See Life Testing to Failure (PS/96/14))

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time and that the design intent is consistently being achieved. See attached IP reports which confirm 100% successful passing of all tests defined in the specification.

Manufacturing & PV anomalies such as pinched Kapton ™ can affect the Kapton ™ diaphragm seal performance (see PFMEA Document # 503831). Material/chemical compatibility and stress/strain concentrations can also cause the Kapton ™ diaphragms to fatigue. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton ™ fatigue occurs well over 0.5 million full-scale pressure cycles in our history of simulated and accelerated life testing. When Kapton ™ fatigue does occur, there are visual signs of de-lamination, cracking, and embrittlement. The Kapton ™ diaphragms break down first in the areas of highest stress and or strain. Typically, the first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure. The above mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions.

Water has been shown to accelerate the aging of the base polymide. Water can be introduced in two known ways:

1) By entering the contact cavity via the electrical connector
2) By being in solution in the brake fluid and entering the switch via the pressure port.

When water enters the connector it will "age" the Kapton ™ diaphragms and make them appear as though they have reached the end of life. This condition leaves visual clues. Classic signs of chemical attack of the Kapton ™ include de-lamination of the Teflon from the base polymide base, embrittlement, and cracking of the base polymer. See Endurance Test (report PS/98/53).

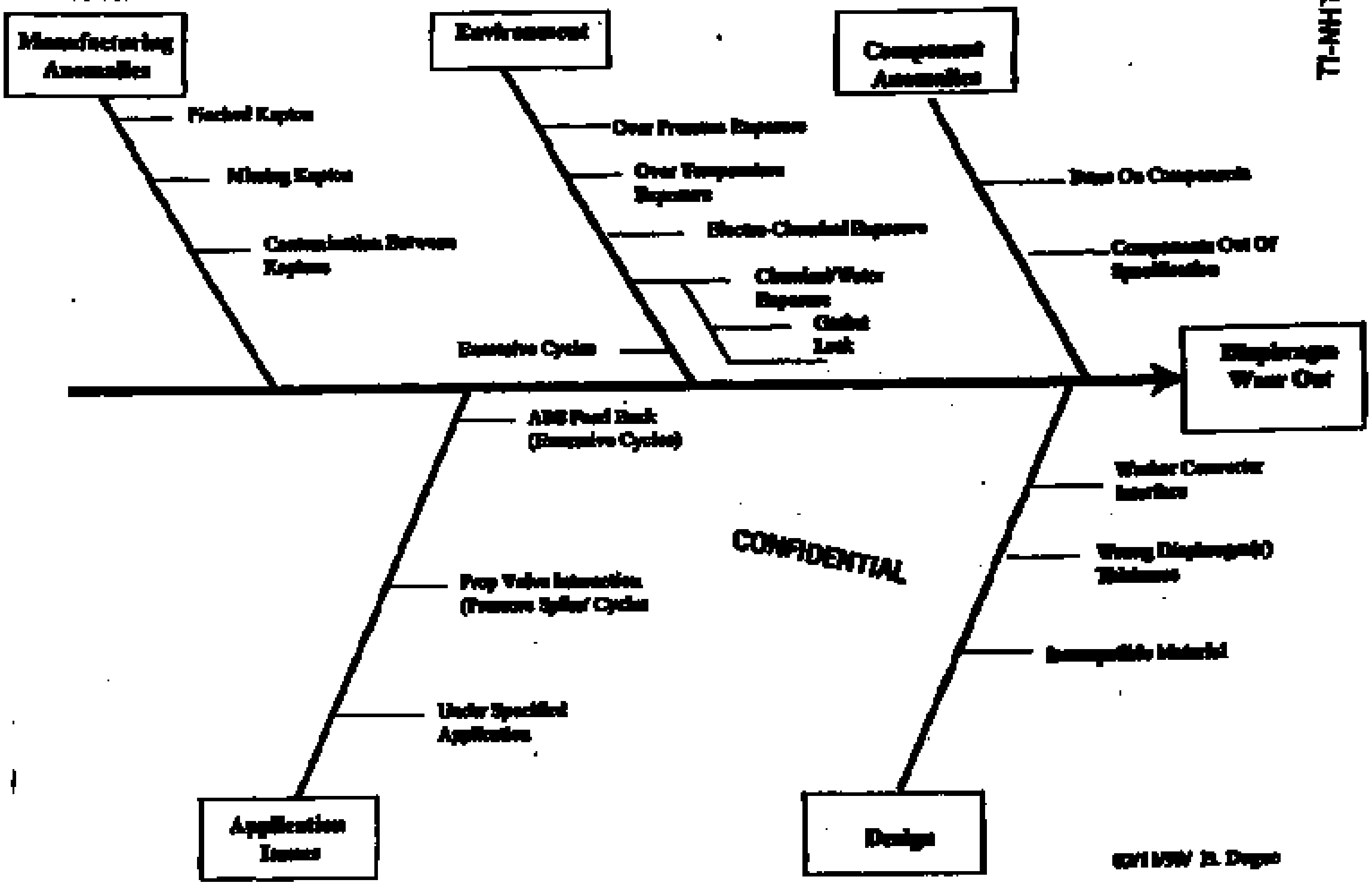
Authored by Bryan Dague. Call Andy Mcguirk or Bryan Dague with questions.

77PS Overview Appendix

1. **Pressure Switch Cross Section**
2. **Hexport Print (TI # 36900)**
3. **Gasket Print (TI# 74353)**
4. **DFMEA for Gasket and Kapton Seal**
5. **Life Test to Failure Test Report (Weibull Analysis)**
6. **Customer Specification (ES-F2VC-9F924_AA)**
7. **PFMEA**
8. **IP Test Reports**
9. **Endurance Test Report**

Texas Instruments

Ford Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series
Wear Out Fishbone



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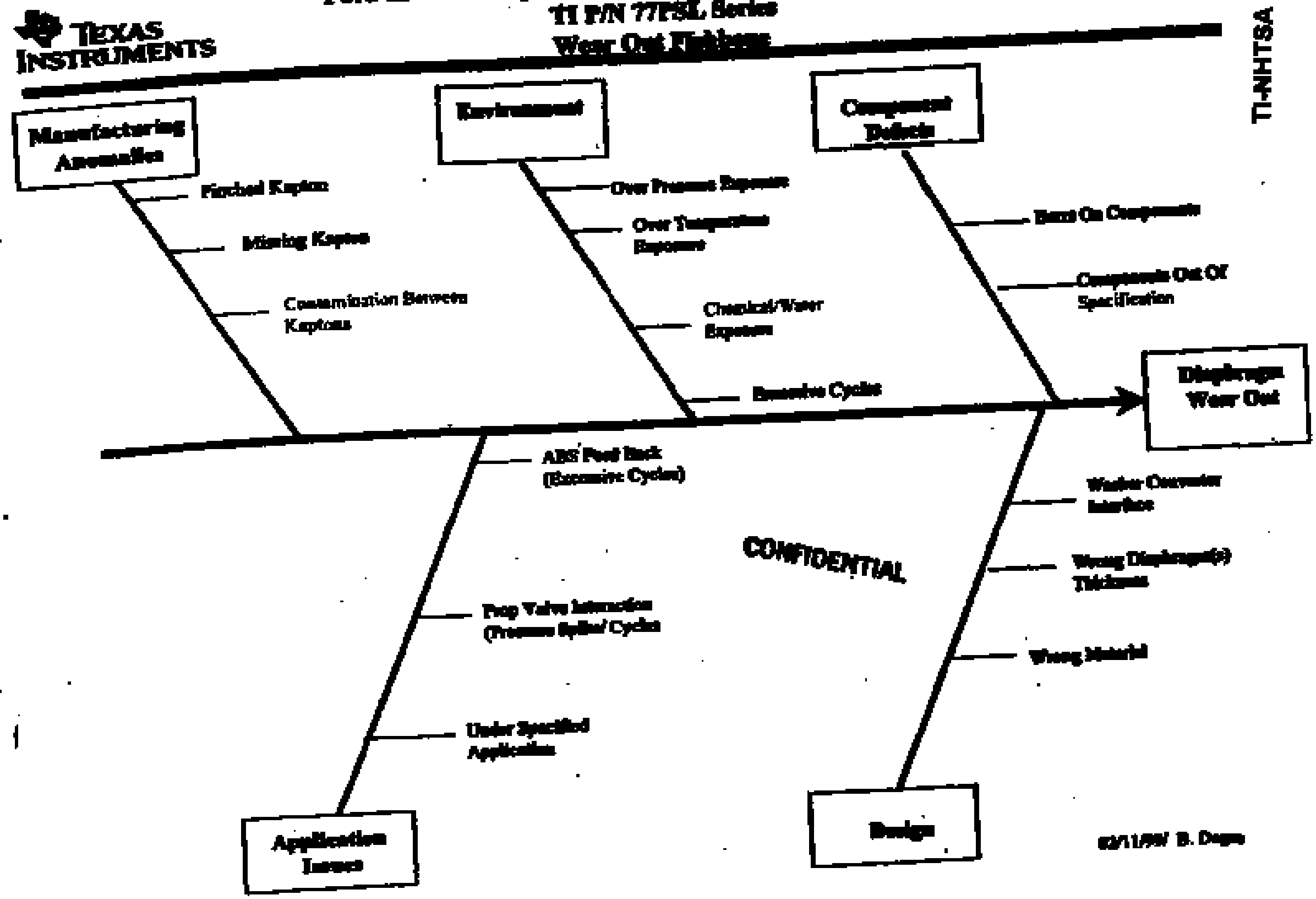
TI-NHTSA 018714

FEB-11-00 THU 17:00

P.02

TI-NHTSA 018716

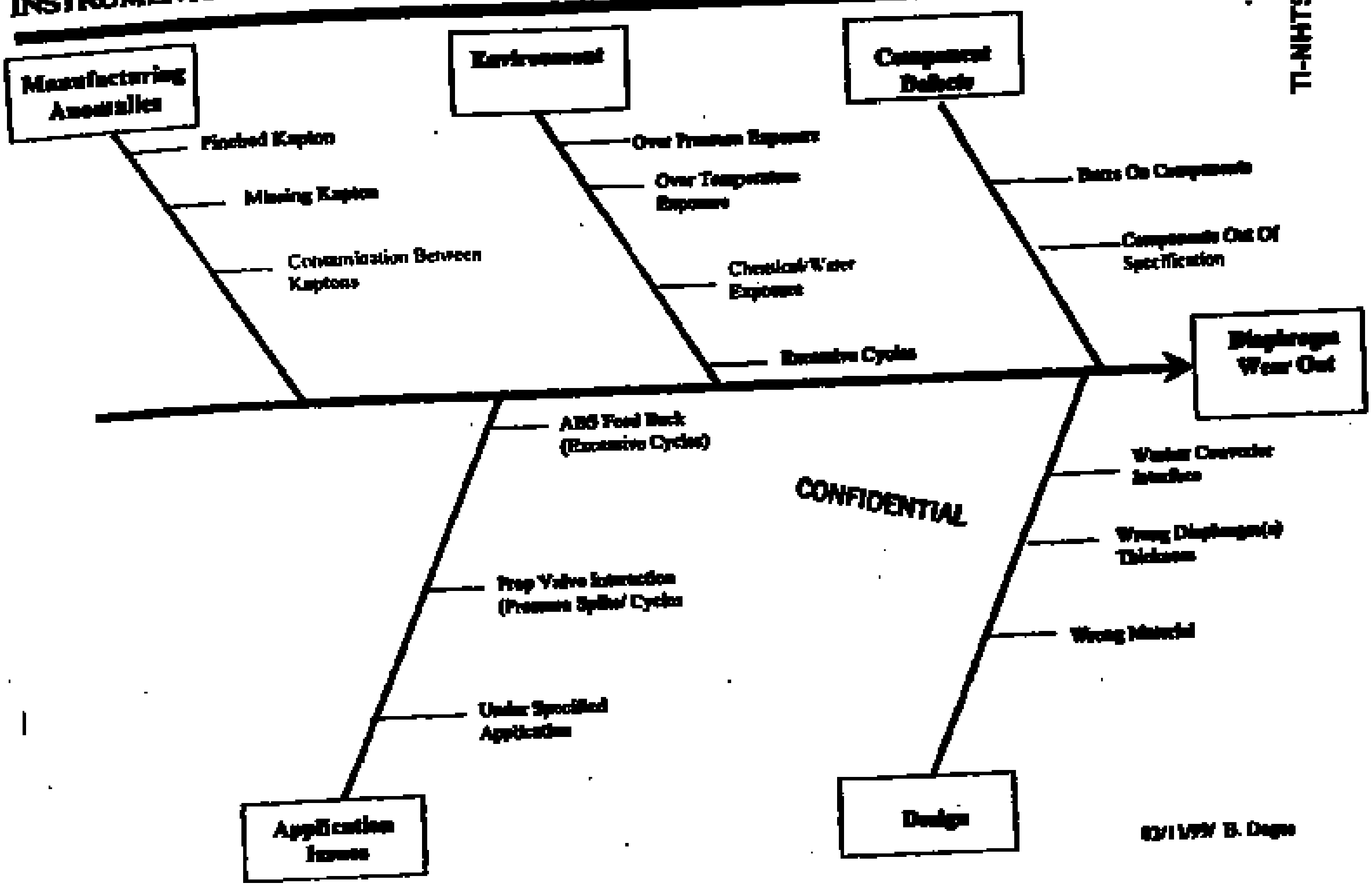
Ford Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series
Wear Out Fishbone



02/11/99/ B. Dague

TEXAS INSTRUMENTS

Ford Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series
Wear Out Fishbone



03/11/99 B. Dague

Epstein, Sally

From: McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent: Thursday, February 11, 1999 12:08 PM
To: Rahman, Aziz; Baumann, Russ
Subject: RE: 77PS Overview

Attorney-client privileged communication

same.... we want to go on record again that we have given further consideration and still believe that the use of a normally open relay upstream would be a good way to resolve the concern. we want to see us taken out of the always powered circuit as we think that would be a good basic design practice

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Rahman, Aziz
Sent: Thursday, February 11, 1999 12:31 PM
To: McGuirk, Andy
Subject: RE: 77PS Overview

If you are talking about the normally open relay upstream of the switch, I already reviewed that with Fred on Day 1. Is the de-electric circuit you are talking about the same relay approach, or something new?

From: McGuirk, Andy
Sent: Thursday, February 11, 1999 11:09 AM
To: Rahman, Aziz
Subject: RE: 77PS Overview
Importance: High

lets talk ASAP about delivery of a new letter about the switch de-electric circuit proposal we sent earlier
AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Rahman, Aziz
Sent: Thursday, February 11, 1999 11:02 AM
To: Baumann, Russ; Beringhause, Steven; McGuirk, Andy; Dague, Bryan
Subject: RE: 77PS Overview

Team,

Thanks for the info below. I have reviewed test report 98/14 with them and will review this info at the next opportune time. I will let you know if I need a hard copy.

From: Dague, Bryan
Sent: Thursday, February 11, 1999 8:48 AM
To: Baumann, Russell; Beringhause, Steven; Rahman, Aziz; McGuirk, Andrew
Subject: 77PS Overview

Guys,

Here is the finial draft. Aziz to deliver to the customer??

Please advise if I need to fax it to somone.

I am having copies of the appendix made today.

Regards,
Bry

****

Proprietary Information

77PS Overview
2/10/99

TI's 77PS switch family has been specifically designed to operate in an automotive braking system. The pressure cavity of the switch has been designed to seal brake fluid pressure and transmit pressure and movement to the sensing portion of the switch over the life as defined in Ford ES -F2VC-9F924-AA.

Background:
The pressure cavity is composed of the hexport, gasket, and three Kapton TM diaphragms (called out as "seal" on attachment 1.). The purpose of the gasket is to provide a fluid tight seal between the hexport and the diaphragms. The purpose of the Kapton TM diaphragms is to provide a flexible fluid tight seal between the pressure cavity and the internal components of the switch. Furthermore, the diaphragms are intended to transfer pressure to the converter, and follow the movement of the converter as pressure in the pressure cavity (brake line pressure) is varied.

Two known ways that brake fluid may enter the contact cavity of TI's brake switches from the pressure cavity are i. brake fluid could leak past an impaired gasket seal, or ii. brake fluid could leak through a damaged or 'worn out' Kapton TM diaphragm.

The Gasket:
In order to create a fluid tight elastomeric seal, there must be proper compression of the elastomer, sufficient backing of the elatomer to prevent movement when pressure is applied, and finally the elastomer must be compatible with the working fluid.

Fluid compatibility is typically established by the use of published tables. These tables list fluid groups and general material types. Lab testing is always done with the specific fluid that the customer has specified for the application along with the specific compound formulated by the selected gasket supplier. Ethylene Propylene is used in the 77PS and is standard throughout the industry for seal gasket materials. TI has been using this material in brake applications since 1988.

The gasket compression target was obtained from published industry standards (see Parker O-ring Handbook). In this particular design a nominal gasket compression of 24%was selected. The depth of the hexport gland shown on attachment #2 controls this attribute. This gland dimension is cut into the hexport at the time of manufacturing. As a result, this dimension in combination with the gasket dimensions determines the final gasket compression when the assembly is crimped together.

Lastly, the movement/position of the gasket when pressure is applied must be controlled and restrained. This design accomplishes this by selecting the outer diameter of the gasket to be slightly smaller than the inner diameter of the gasket gland of the steel plated hexport. Therefore, the hexport gland prevents the gasket from moving outwards when high pressure is applied to the switch.

The DFMEA outlines the types of tests that were selected and run to confirm that all of these parameters are selected correctly. The resulting design was exposed to test conditions that were intended to duplicate actual application conditions, and in some cases go beyond the intended limits to failure. See the DFMEA Document number 503794 and customer specification ES-F2VC-9F924-AA . Specifically, burst testing, impulse testing, and thermal cycle tests were performed to confirm that the gasket performed as intended. The specific details of these tests and the results can be seen in the PV test report numbers listed below: (copies can be provided on request).

Test Report #	TI Switch Part number	Year Tested
1. PS/91/48	77PSL2-3	1991
2. PS/91/49	77PSL2-1	1991
3. PS/92/49	77PSL3-1	1992
4. PS/92/80	77PSL5-2	1992
5. PS/92/82	77PSL3-1	1992
6. PS/93/11	77PSL6-1	1993
7. PS/93/44	77PSL4-1	1993

Gasket-manufacturing anomalies can be produced from out of spec gaskets, contamination of the gasket or sealing surfaces, and as a result, may cause leaks early in life. In order to protect TI's customer supply chain from gasket-manufacturing issues there are several preventative actions in place. These actions include: hair nets, protective smocks, and cleaning procedures for the equipment. TI's customer return rates indicated by past return and analysis records are less than 1 ppm (one leaker return in 5 years from master cylinder leak testing).

Kapton TM Diaphragms:

A pressure switch diaphragm must seal the pressure cavity, transmit pressure forces to the converter, and follow the converter motion without significantly affecting the switch calibration points. In addition, the diaphragm material must be resistant to chemical attack by the brake fluid.

Basically, a single piece of Kapton TM in this design consists of a 0.003-inch thick polyimide film laminated on both sides with a 0.001-inch thick FEP Teflon film. The polyimide film has the ability to stretch without breaking (strains on the order of 70% before rupture), and the Teflon film is compatible with a wide range of chemicals. As a result of this layered construction, Kapton TM was selected for its mechanical and chemical properties. Moreover, TI has been using this material in pressure switch applications since 1981. In this application three stacked Kapton TM layers were used as the diaphragm seal.

To confirm the correct material was selected for this application we refer to the DFMEA. Specifically, this document identifies burst testing, impulse testing, and thermal cycle testing. These tests confirmed the Kapton's TM ability to meet the specified requirements (PV reports listed above). Since temperature, chemical exposure, and stress levels all affect the life expectancy of the Kapton TM diaphragms, additional testing is commonly done. A typical impulse test would include pressure cycles to 1450 psi, constant temperature of 135 C, and a cycle rate of 120 cycles/minute. Depending on the factors listed above, the life expectancy of a TI brake pressure switch can vary, but typically is around 1 million cycles which is well above the 500,000 cycles specified in the Ford specification (ES-F2VC-9F924-AA). (See Life Testing to Failure (PS/98/14))

In addition, continued conformance testing has been ongoing for many years at TI. The purpose of this testing is to confirm that the components, materials, and processes have remained stable over time and that the design intent is consistently being achieved. See attached IP reports which confirm 100% successful passing of all tests defined in the specification.

Manufacturing & PV anomalies such as pinched Kapton TM can affect the Kapton TM diaphragm seal performance (see PFMEA Document # 503831). Material/chemical compatibility and stress/strain concentrations can also cause the Kapton TM diaphragms to fatigue. See DFMEA Document number 503796. In order to verify the correct design parameters were selected, the switch was subjected to a number of tests designed to simulate accelerated life testing of the application. See PS reports called out above. Life testing per the customer specification (ES-F2VC-9F924-AA) has shown acceptable performance.

Typically, Kapton TM fatigue occurs well over 0.5 million full-scale pressure cycles in our history of simulated and accelerated life testing. When Kapton TM fatigue does occur, there are visual signs of de-lamination, cracking, and embrittement. The Kapton TM diaphragms break down first in the areas of highest stress and or strain. Typically, the first region to show break down is the circumferential area surrounding the converter button. See Endurance Test (report # PS/98/53). Again, diaphragm life depends on stress levels (pressure magnitude applied), temperature, and chemical exposure. The above mentioned tests were conducted in TI's Life Test lab with relatively controlled conditions.

Water has been shown to accelerate the aging of the base polymide. Water can be introduced in two known ways:

1) By entering the contact cavity via the electrical connector
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When water enters the connector it will "age" the Kapton TM diaphragms and make them appear as though they have reached the end of life. This condition leaves visual clues. Classic signs of chemical attack of the Kapton TM include de-lamination of the Teflon from the base polymide base, embrittlement, and cracking of the base polymer. See Endurance Test (report PS/98/53).

Authored by Bryan Dague. Call Andy Mcguirk or Bryan Dague with questions.

77PS Overview Appendix

1. Pressure Switch Cross Section
2. Support Print (TI # 36900)
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7. PFMEA
8. IP Test Reports
9. Endurance Test Report

TI-NHTSA 018720

TI-NHTSA 018721

Gravelina, Dora

From: McGuirk, Andy
Sent: Thursday, February 11, 1999 2:04 PM
To: Baumann, Russ; Murphy, Rich
Subject: FW: 77PS Day 2, 2/10/99 Summary

attorney-client privileged communication

Rich, we have deployed a regular status Tier to Ford to assist in their work...Aziz Rahman.

this is his report from day2

a
[illegible]
[illegible]
ATTLEBORO, MA [illegible]
TEL : [illegible]
FAX : [illegible]
PAGER: [illegible]

From: Rahman, Aziz
Sent: Thursday, February 11, 1999 11:08 AM
To: McGuirk, Andy; Beringhause, Steven; Baumann, Russ; Dague, Bryan; Douglas, Charles; Sharpe, Robert; Sullivan, Martha; Rowland, Thomas; Baker, Gary
Subject: 77PS Day 2, 2/10/99 Summary

Day 2, 2/10/99 Highlights

Main event of the day was a team meeting to prep for the Executive Technical Review on 2/11. Joe Nami of Large Vehicle Safety Group led the meeting. There were a lot of participants, including Fred Porter, Tom Masters from Engineering, Norm LaPointe AVT Design Analysis, Steve LaRouche from CRL, Ford legal folks, wiring, connector etc. TI was the only supplier represented.

TI is not invited to the Tech Rev. (whew?!)
Tech Rev will be a high level, broad overview of Town Car Underhood Fires
Numbers Joe has thus far:
149 Underhood Fires, Thermal Anomalies, Thermal Events
39 with engine off, 8 with engine on, no information on the rest
6 possible related to the Brake Pressure Switch (BPS), 17 potential other root causes, no information on the rest
Other root causes from above line : 42 way connector, EEC wire harness, Relay pack.
At this point NHTSA response required on BPS, F2VC part only. Others may follow
Lengthy discussion on approach for the review. General consensus that presentation from technical side should be broad based, since sufficient info is not available for any deep dive.
General consensus that we need a lot more parts back from the field that were involved in these events.Oasis message discussed.
Someone inquired about TI answers to questions from last meeting. I responded that I had provided the information to Fred and Steve Reimers, and they acknowledged. Two other questions for TI:
Does TI sell the switch directly to aftermarket, like auto part stores. I replied that most probably not. We would go through Ford Service Parts for service parts. Is that accurate Charlie?

Does TI have fire experts on site who can determine origin of fires, as in experts who work on structural fires. I replied in the negative, but said I would follow up. Any inputs? Intent was to answer repeatedly asked question: Do we know where the fire originated. Outside - in, inside - out, what burned first, brake fluid, or plastic base??

Joe's meeting was followed by a vigorous brainstorming session with Fred, Tom, Norm, Steve & Len. This was all technical and I actively participated.

I reviewed TI report PS/98/14 on weibull life of quiet switch showing first leaker at 900k+ cycles. Gave copy to Norm. Bryan, need weibull data quickly on pass-car snap switch.

I reviewed our finding that the 92 through 97 Town Car, Grand Marquis, Crown Vic platforms had prop valve mounted switches and that in vehicles with ABS option, the prop valve is located downstream of the ABS module.

There was considerable discussion on pressure profile at such a location with Len saying that the switch probably sees full pressure reversals. We agreed that I would contact Teves for more info.

We discussed formation of electrolytic cell with Brake Fluid in the base cavity, and how a low resistance path to ground could be formed. Discussed the wattage available with a 15A fuse and 14Vdc system. Is that sufficient to generate enough heat through the ground path.

Discussed CRL analysis of Memphis part, and gave copy of Al's report to Norm. Bryan, per Norm, Al retained "spoonfuls" of the corrosion residue. Do you know if Al has done any compositional analysis (IR) as opposed to elemental only?

Kept getting back to source of fire. Ford has not yet been able to create a fire in a switch. Team decided that pulling in Dow Chemical was key to understand if we can create a fire with given constraints.

I will start exposing the resistivity test here to temperature 2/11.

No phone yet. Andy has arranged for a cellular phone and pager. On the positive side, received invitation from Fred to join his team for a Section Lunch at the Hawaiian Cafe. Should be fun!

More tomorrow.

Regards
Aziz

Epstein, Sally

From:	Parikh, Tushar [tparikh@email.mc.ti.com]
Sent:	Friday, February 12, 1999 10:12 AM
To:	Watt, Jim
Cc:	McGuirk, Andy
Subject:	FW: Impulse Test: Reliability Demonstration

Jim,

We just collected the Impulse Test Data since January of 1999 for 77PS.

Number of Pieces 180
Number of Cycles 500,000

This sample is much larger than what we need to demonstrate the mean life of the lot. As per my note below, I just need six samples @ 4500 cycles without any failure to demonstrate that the lot is acceptable and would have minimum mean life of 500,000 cycles. Hence we can make the statement that "the lot would have minimum mean life of 500,000 cycles." Producer's risk is still same at 5% level.

Any question, please give me a call.

Thanks.

Tushar Parikh

From: Parikh, Tushar
Sent: Thursday, February 11, 1999 8:41 AM
To: Watt, Jim
Cc: McGuirk, Andy
Subject: Impulse Test: Reliability Demonstration

Jim,

After talking to you and Andy yesterday, I have done my literature research last night. The following is my findings:

This test falls into reliability demonstration category as reliability life tests terminated at prearranged time.

Brief Description of the test:

It is based on DOD Handbook H108. This kind of life test is stopped upon reaching a computed termination time (number of operation, cycles , etc) T provided the specified number of failures (in this case 1) did not occur before. The test is also stopped if the specified number of failures is reached before time T. This procedure is applicable to testing with or without replacement of failed parts.

The acceptability of a lot is determined by the time required for a predetermined number of failures, rf (in this case 1), to occur in a sample size n (in this case 6), and a comparison of this time with the test termination time T multiplied by a constant k. The value of constant k with .05 % producer's risk , for a sample size of 6 is .009. A lot is accepted if the predetermined number of failures rf (One) has not yet occurred before termination time T is reached.

T= K * mean life specified as acceptable

TI-NHTSA 018724

Mean life (specified Ford)= 500,000

T= .009 * 500,000=4500 Cycles

From the data provided to me yesterday, if the product does not fail before 4500 cycles during impulse Test, then we can make the statement that " the lot is acceptable and would have minimum mean life of 500,000 cycles." In our case, We need six samples that would have gone through at least 4500 Cycles without any failure. The number Andy gave me has six samples about twenty five times and fifty cycles. That is about 1250 cycles so far, for six samples, far short of 4500 cycles. If we have ninety times of fifty cycle test with six number of samples without any failure, than our statement would be valid.

I will talk to Rick to find out whether we could find all the data to support our calculation.

Let me know if this makes any sense to you.

Thanks.

Best Regards,

Tushar Parikh

Morris, Irene

From: McGuirk, Andy
Sent: Friday, February 12, 1999 10:38 AM
To: Dague, Bryan; Beringhause, Steven; Baumann, Russ
Subject: FW: 77PS Diaphragm Wear Out Cause & Effect Diagram - Updated a/o 5:00pm
Importance: High
Sensitivity: Confidential

attorney - client privileged communication

lets agree to wording ASAP so Aziz can deliver

a
AUTOMOTIVE SENSORS AND CONTROLS QRA MANAGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-1060
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 504-2044

From: Watt, Jim
Sent: Thursday, February 11, 1999 4:56 PM
To: 'Baumann, Russ RUSB'; Dague, Bryan; McGuirk, Andy; Beringhause, Steven
Subject: RE: 77PS Diaphragm Wear Out Cause & Effect Diagram - Updated a/o 5:00pm
Sensitivity: Confidential

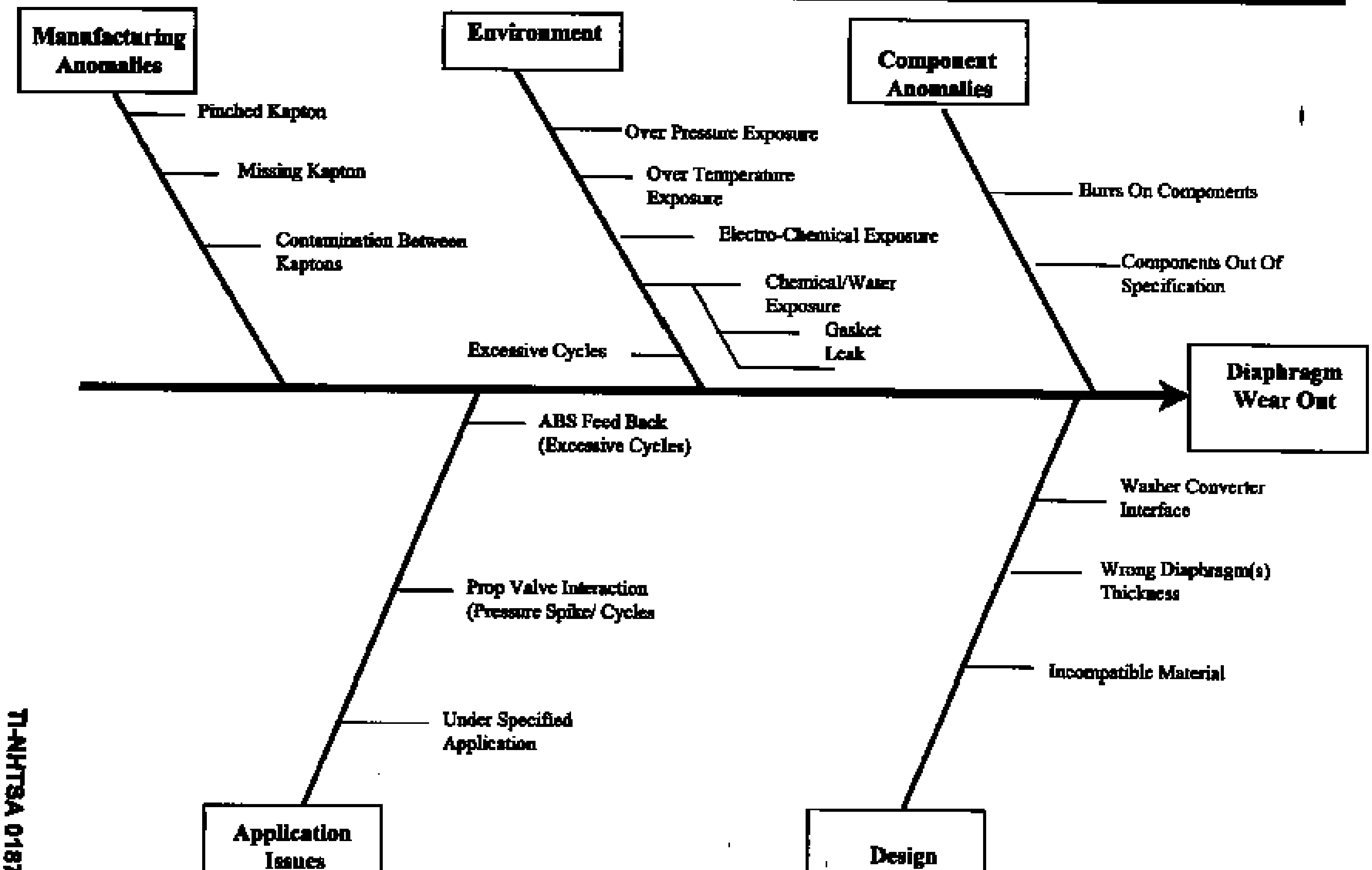
Ford
77PS(diaphragm).ppt

Jim Watt, QRA, magid: jw02; mail station 12-33; page (508)236-1010, no. (0696)
ph (508) 236-1719;
fax (508)236-3153

TI-NHTSA 018726

Texas Instruments

Ford Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series
Wear Out Fishbone



02/11/99/ B. Dague

[illegible]

From: Baker, Gary [[illegible]]
Sent: Friday, February 12, 1999 12:26 PM
To: Rahman, Aziz
Cc: McGuirk, Andy; Beringhause, Steven; Dague, Bryan; Baumann, Russ; Sharpe, Robert; Douglas, Charles; Rowland, Thomas
Subject: RE: 77PS, 2/11/99

Aziz,

Thanks for the update.

On the point that "Having the switch hot at all times is not a good practice", has Ford given us any reaction to our proposal to adding a relay in series with the pressure switch?

It may be important to get Ford on the record on this point.

Best regards,
Gary

From: Rahman, Aziz
Sent: Friday, February 12, 1999 11:28 AM
To: McGuirk, Andy; Beringhause, Steven; Dague, Bryan; Baumann, Russ; Sharpe, Robert; Douglas, Charles; Baker, Gary; Rowland, Thomas
Subject: 77PS, 2/11/99

Main event of the day was the Technical Review. Highlights:

Key participants were: Jack Pasques Chief Engineer, Luxury VC
Chuck Parks Program Engineer, Town Car
Ann O'Neill Quality Directory, Luxury VC
Sam Cole Manager Large Vehicles Electrical Systems

Next Tech Review: Every Thursday, implies core team prep meeting every Wednesday.

- There is a need to have the ability to implement, whatever solution is decided, in two months max.
- Next meeting with NHTSA is next week, as part of their regular quaterly meetings. Town Car underhood fires will be high on the discussion list, and the expectation (hope?) is that Ford will be able to get 2 months time to implement a solution.
- There is a very urgent need to re-create ignition in the lab. They kept coming back to this again and again.
- There was considerable concern that the field data set is not complete, and Joe Nemi has been tasked to get a clearer picture of the events breakdown.
- There were strong feelings of "got to do more".
- Fred's statement that "TI Engineering is resident here" elicited a "Good" response.

I met with Fred 2/12 morning to capture his thoughts on follow up actions:
- Need a "raft" of experiments to accelerate kapton wear. Need to design and execute a DOE with temperature, moisture, disc energy, contaminants (soap, detergent), # of kapton layers etc as factors. I will close with Bryan on this. We need a plan with timing by next Wednesday.
- Looks like we may need 2 - 3x life. Will need to establish real application requirement for 10yr/150k miles. 500k is not enough. What solutions can TI evaluate and put into place in 2 months.
- No potential solution should be eliminated for cost reasons.
- Having the switch hot at all times is not a good practice, and Ford will be internally working on a solution for this. I did not get a feeling that this is going to happen in the 2 month time frame established earlier.
- I have the formal workplan that Steve Reimers is coordinating. I will fax it to Andy today. Quite a few of the TI actions have been completed, but are open on the list. I will work with Steve to close these out.

I have a meeting with Central Labs folks at 1.00 today to look at kapton from non-fire. non-leak switches with varying mileage. This will be key in trying to correlate kapton aging in the field as opposed to lab tests. Bryan, can we do this with the switches we pulled from the field with known mileage. Can we swap parts in used cars, say at Tasca? Today PM, we will meet with Greg Stevens, materials guy at AVT who has been tasked with getting Dow in the loop.

With Fred out next week, Steve Reimers will be main TI liason. I do plan to continue my field assignment for another week, and will evaluate need for further extensions at the end of next week.

FYI, I have a phone & pager now. Thanks Andy. I felt like "Far From the Maddening Crowd " (Thomas Hardy) without the comm-link!
Phone: 508-208-6119
Pager: 1800-946-4646, pin 604-2042

Regards
Aziz.

Costein, Kelly —

From: Rahman, Aziz [arahman@email.mc.ti.com]
Sent: Monday, February 15, 1999 7:31 PM
To: Degue, Bryan; Benninghaus, Steven; McGuirk, Andy; Sharpe, Robert; Baker, Gary; Baumann, Russ
Subject: FW: Brake Pressure Switch Log

Brake Pressure Switch Log

Received second wave of parts from Texas junkyards. All F2VC parts. Most o
them with connector attached. Some of them with prop valves & servos. 2 from underhood
fires. Analysis will start tomorrow PM. Please let me know if there are any specifics to
look at, before we disassemble these. I was thinking of doing some quick voltage drops,
insulation resistance checks. Obviously lots of pictures. Any quick way to test these
parts for leaks, prior to disassembly?

By the way, Steve R. did mention that the Electrical System folks were looking into usi
a Brake Pedal Position Sensor as a replacement for the Brake Pressure Switch as a
corrective /containment action. Have we determined what they use in the 99 Town Car?

From: Rahman, Aziz
Sent: Monday, February 15, 1999 8:22 PM
To: 'Fred Porter (Ford)'; 'Norm LaPointe (Ford)'; 'Steve LaRouche (Ford)'; 'Ste
Reimers (Ford)'
Subject: Brake Pressure Switch Log

Attached is a log file with information on the devices under review. It also contains
switches received today from John McInerney.In addition to Steve L's analysis summary
file, I will be using this log to track incoming parts. Please advise if I have missed a
data.

<<Brake Pressure Switch Log>>

Please let me know if you cannot open the file. Steve/Norm, can you please e-mail me the
last update on your analysis summary file? Thanks.

Regards
Aziz,

TI-NHTSA 016730

Log Updated 2/15/199[illegible]

Sw #	Sw Date Code	Vehicle	VIN	Event	Mileage	Leaker?
Memphis		Town Car		Sw. Fire		
A		Town Car		Underhood Fire		
B		Town Car		Underhood Fire		
C		Town Car		Underhood Fire		
D		Crown Vic Police Car		Cruise Insp		
E		Town Car		Reference		
F		Town Car		Cruise Insp		
1	2008	Town Car	NX762858	Reference	79164	
3	3015	Town Car	PY724043	Reference	71337	
4	2046	Town Car	PY628170	Reference	86087	
5		Town Car		Reference	95348	
6		Town Car		Reference	47325	
7	2058	Town Car	NX725430	Reference	88222	
8	3025	Town Car	PX160229	Reference	88814	
9	2280	Town Car	PX837756	Reference	??	
10	2281	Town Car	PY[illegible]375	Reference	82224	
11	3028	Town Car	PY72[illegible]	Reference	91358	
From TX trip of 2/10 to 2/12						
1	2028	Town Car	PY[illegible]	Reference		
2	3083	Crown Vic Police Car	PX1[illegible]	Reference	1[illegible]	
3	3288	Grand Marquis	RX841585	Reference	??	
4	3028	Crown Vic	PX168812	Reference	40842	
5	2083	Town Car	PY610384	Reference	73115	
6	??	Town Car	NY724[illegible]	Underhood Fire	??	
7	3081	Town Car	PY780172	Reference	??	
8	2048	Town Car	NY733191	Underhood Fire	10[illegible]10	
9	3088	Town Car	PY788[illegible]	Reference	??	
10	2272	Crown Vic	PX161140	Reference	72[illegible]14	
11	2115	Town Car	NY757408	Reference	??	
12	3085	Town Car	PY742[illegible]	Reference	??	
13	3088	Town Car	PY7432413	Reference	100048	

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Kapton #1	Kapton #2	Kapton #3	Term-Heater/ Resistance	Present Location of Sw.	Present Status	Comments
Tear	Tear	Tear		Central Lab		
				Central Lab	Analysis in Progress	
				N/A	Sw. not available	
				Central Lab	Analysis in Progress	
Tear?	Tear?	Tear?		Central Lab	Analysis in Progress	
				Central Lab	Analysis in Progress	
Tear?	Tear?	Tear?		Central Lab	Analysis in Progress	
				AVT		
				AVT		
				AVT		
				Central Lab	Analysis in Progress	
				Central Lab	Analysis in Progress	
				AVT		
				AVT		
				AVT		
				AVT		
				AVT		
				AVT		With Connector and servo
				AVT		With Connector and servo
				AVT		With Connector and servo
				AVT		With Connector
				AVT		With Connector
				AVT		
				AVT		With Connector
				AVT		With Servo, Prop Valve
				AVT		With Connector, Prop Valve, Servo
				AVT		With Connector, Prop Valve, Servo
				AVT		With Connector
				AVT		With Connector
				AVT		With Connector and Servo

Epstein, Sally

From:	McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent:	Tuesday, February 16, 1999 7:15 AM
To:	Rowland, Thomas
Cc:	Sharpe, Robert; Dodd, Bob; Pechonis, John; Baker, Gary; Beringhause, Steven; Santosh, Bob
Subject:	FW: Brake Pressure Switch Log
Importance:	High

tom, by copy of this note we will look to gary baker and bob dodd and steve beringhause for information about the '99 town car today which reportedly was launched without a p/s in the brake system for cruise system.

we will also determine our analysis protocols for these texas return units before noon today, tuesday.

a

AUTOMOTIVE SENSORS AND CONTROLS QRA MANGER
34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745
PAGE: (800) 467-3700 PIN 604-2044

From: Rahman, Aziz
Sent: Monday, February 15, 1999 6:30 PM
To: Dague, Bryan; Beringhause, Steven; McGuirk, Andy; Sharpe, Robert; Baker, Gary; Baumann, Russ
Subject: FW: Brake Pressure Switch Log

Received second wave of parts from Texas junkyards. All F2VC parts. Most of them with connector attached. Some of them with prop valves & servos. 2 from underhood fires. Analysis will start tomorrow PM. Please let me know if there are any specifics to look at before we disassemble these. I was thinking of doing some quick voltage drops, insulation resistance checks. Obviously lots of pictures. Any quick way to test these parts for leaks, prior to disassembly?

By the way, Steve R. did mention that the Electrical System folks were looking into using a Brake Pedal Position Sensor as a replacement for the Brake Pressure Switch as a corrective /containment action. Have we determined what they use in the 99 Town Car?

From: Rahman, Aziz
Sent: Monday, February 15, 1999 1:22 PM
To: 'Fred Porter (Ford)'; 'Norm LaPointe (Ford)'; 'Steve LaRouche (Ford)'; 'Steve Reimers (Ford)'
Subject: Brake Pressure Switch Log

Attached is a log file with information on the devices under review. It also contains switches received today from John McInerney.In addition to Steve L's analysis summary file, I will be using this log to track incoming parts. Please advise if I have missed ar data.

i disabled file to conserve space and e-mail time.....

Please let me know if you cannot open the file. Steve/Norm, can you please e-mail me the last update on your Analysis summary file? Thanks.

Regards
Aziz,

TI-NHTSA 018734

Epstein, Sally

From: McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent: Tuesday, February 16, 1999 7:41 AM
To: Watt, Jim; Parikh, Tushar
Subject: RE: Impulse Test: Reliability Demonstration

no. the thing 'wears out' at about 1 million cycles

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From: Parikh, Tushar
Sent: Tuesday, February 16, 1999 8:24 AM
To: McGuirk, Andy; Watt, Jim
Subject: RE: Impulse Test: Reliability Demonstration

Thanks for clearing it up. with the new information, I have come up with the following answer.

Number of Units * Cycles the product went through impulse testing =1250*500,000=625,000,000

In order to use DOD H108 tables, I will normalize the data for a sample of twenty pieces.

Normalized Data without any failure=31,250,000 Cycles

With Producer's Risk at 50% (very high i.e. we are not taking practically any chance for sending any lot that would not meet the requirements of mean life of 500,000), estimated mean life would be=

31,250,000/ .035=892,857,000 i.e. about 1785 times the required minimum life of 500,000.

Please let me know whether this makes sense.

Thanks.

Tushar Parikh

From: McGuirk, Andy
Sent: Monday, February 15, 1999 4:19 PM
To: Parikh, Tushar
Subject: RE: Impulse Test: Reliability Demonstration

you misunderstood.

i had 50 sheets of data with 25 lines each sheet and each line was 6 pieces tested to 500,000 cycles with zero leak failure.

the number then is 1250 pieces tested to 500,000 cycles with zero failure. what we all wanted to 'claim' was some 'astronomical

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reliability' based on this testing history.

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PAGE: (800) 467-3700 PIN 504-2044

From: Parikh, Tushar
Sent: Thursday, February 11, 1999 8:41 AM
To: Watt, Jim
Cc: McGuirk, Andy
Subject: Impulse Test: Reliability Demonstration

Jim,

After talking to you and Andy yesterday, I have done my literature research last night. The following is my findings:

This test falls into reliability demonstration category as reliability life tests terminated at prearranged time.

Brief Description of the test:

It is based on DOD Handbook H108. This kind of life test is stopped upon reaching a computed termination time (number of operation, cycles , etc) T provided the specified number of failures (in this case 1) did not occur before. The test is also stopped if the specified number of failures is reached before time T. This procedure is applicable to testing with or without replacement of failed parts.

The acceptability of a lot is determined by the time required for a predetermined number of failures, rf (in this case 1), to occur in a sample size n (in this case 6), and a comparison of this time with the test termination time T multiplied by a constant k. The value of constant k with .05 % producer's risk , for a sample size of 6 is .009. A lot is accepted if the predetermined number of failures rf (One) has not yet occurred before termination time T is reached.

T= K * mean life specified as acceptable

Mean life (specified Ford)= 500,000

T= .009 * 500,000=4500 Cycles

From the data provided to me yesterday, if the product does not fail before 4500 cycles during impulse Test, then we can make the statement that " the lot is acceptable and would have minimum mean life of 500,000 cycles." In our case, we need six samples that would have gone through at least 4500 Cycles without any failure. The number Andy gave me has six samples about twenty five times and fifty cycles. That is about 1250 cycles so far, for six samples, far short of 4500 cycles. If we have ninety times of fifty cycle test with six number of samples without any failure, then our statement would be valid.

I will talk to Rick to find out whether we could find all the data to support our calculation.

Let me know if this makes any sense to you.

Thanks.

Best Regards,

Tushar Parikh

Eggers, Sally

From: Rahman, Aziz [illegible]
Sent: Tuesday, February 16, 1999 12:04 PM
To: Beringhause, Steven; Dague, Bryan; McGuirk, Andy; Baumann, Rusk; Sharpe, Robert
Subject: Analysis workplan

File RTRN_XM.XLS_PC   File RTRN_XM.DOC_PC

<<File RTRN_XM.XLS_PC>> <<File RTRN_XM.DOC_PC>>

Proposed flow chart for return device analysis, published by S. Reimers, Ford.

Dague, Bryan

From:	Dague, Bryan
Sent:	Tuesday, February 16, 1999 6:03 AM
To:	Rahman, Aziz
Subject:	RE: Brake Pressure Switch Log

Aziz,

I did get your phone MSG last night, and it sounds like you are on the right track. Although I don't know what kind of environment you are working in, you might try to get some of the following measurements:

1) Calibration (actuation and release)? Not sure if you have the equipment there. At the same time you will see if there is a gross leaker.

2) Leak down test. Go up pretty high in pressure 200 to 3000 psi. If the kapton is cracked and there is a leak path filled with brake fluid, the brake fluid will seal the leak path at low pressures (5 to 10 psi).

3) Resistance from each terminal to the hexport. If the contact cavity is filled with brake fluid you will probably not get a stable reading. The voltage and current supplied by the meter is enough to start moving ions around in the solution. The electrodes start charging and the resistance reading starts changing. The right way to do measure impedance. This is done with a fancy meter, and with an AC voltage and current. This is why we were unable to get good readings on our brake fluid resistance experiment.

4) The real information will come when you dissect the switches. Paying close attention to the following:
   a) wear on the bumps (arm, converter, and cup)
   b) wear between the converter and washer
   c) Kapton degradation
   d) wear between the pin and the cup.

That is pretty much all I can think of.

Good luck and let me know what you find.

Regards,
Bry

From:	Rahman, Aziz
Sent:	Monday, February 15, 1999 8:30 PM
To:	Dague, Bryan; Beringhause, Steven; McGuirk, Andy; Sharpe, Robert; Baker, Gary; Baumann, Russ
Subject:	FW: Brake Pressure Switch Log

Received second wave of parts from Texas junkyards. All F2VC parts. Most of them with connector attached. Some of them with prop valves & servos. 2 from underhood fires. Analysis will start tomorrow PM. Please let me know if there are any specifics to look at, before we disassemble these. I was thinking of doing some quick voltage drops, insulation resistance checks. Obviously lots of pictures. Any quick way to test these parts for leaks, prior to disassembly?

By the way, Steve R. did mention that the Electrical System folks were looking into using a Brake Pedal Position Sensor as a replacement for the Brake Pressure Switch as a corrective /containment action. Have we determined what they use in the 99 Town Car?

From:	Rahman, Aziz
Sent:	Monday, February 15, 1999 8:22 PM
To:	'Fred Porter (Ford)'; 'Norm LaPointe (Ford)'; 'Steve LaRouche (Ford)'; 'Steve Reimers (Ford)'

TI-NHTSA 018739

Epstein, Sally

From: Beringhause, Steven [sberinghause@email.mc.ti.com]
Sent: Tuesday, February 16, 1999 2:13 PM
To: Rahman, Aziz

Aziz,
One comment on the switch testing, the plan looks good for junk yard parts. I would not run as aggressive a test plan on parts that were in a vehicle fire because we do not know what shape the seal is in from the fire and leakage might disrupt clues. My guess is that this matches the plan.

Steve

Morris, Irene

From: Sharpe, Robert
Sent: Tuesday, February 16, 1999 10:13 AM
To: McGuirk, Andy; Rowland, Thomas
Cc: Dodd, Bob; Pechonis, John; Baker, Gary; Beringhause, Steven; Bartosh, Bob; Douglas, Charles
Subject: RE: Brake Pressure Switch Log

Last spring I reported to Marketing that the TI brake switch application on the Town Car had been converted to a "plunger type" switch (normally closed) application, mounted on the brake pedal, sometime in MY98. This is why you do not see the Town Car, Crwn Vic, and Gran Marq in Charlie's application listing for MY98, sent to Fred Porter. In fact, my predecessor (Norm Frede) also indicated this in his forecasts from June'97.

I have a call into Ford, Mr. Dale Stolztimer (sp?) for further confirmation, however, his voice mail is full. Dale is the Core/AVT Engineer for switches within the Ford Chasis Group.

Aziz, let's try to confirm/qualify Ford's potential containment action. Would this be across the board as a replacement for all TI brake switch applications, or only for the Town Car. Also, I would like to confirm if Ford is looking at using the same "plunger" type switch or are they looking at a different "position" sensor in regards to their potential containment action. Any feedback regarding our proposal to rewire (remove battery feed) the switch for containment action ?? I will see you later this afternoon.

Best Regards,

Rob Sharpe
Texas Instruments
Phone (248) 305-5729
Fax (248) 305-5734
rsharpe@ti.com

-----Original Message-----
From: McGuirk, Andy
Sent: Tuesday, February 16, 1999 8:16 AM
To: Rowland, Thomas
Cc: Sharpe, Robert; Dodd, Bob; Pechonis, John; Baker, Gary; Beringhause, Steven; Bartosh, Bob
Subject: FW: Brake Pressure Switch Log
Importance: High

tom, by copy of this note we will look to gary baker and bob dodd and steve beringhause for information about the '99 town car today which reportedly was launched without a p/s in the brake system for cruise system.

we will also determine our analysis protocols for these texas return units before noon today, tuesday.

a

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34 FOREST ST M/S 23-05
ATTLEBORO, MA 02703
TEL : (508) 236-3080
FAX : (508) 236-3745

From:	Rahman, Aziz
Sent:	Monday, February 15, 1999 6:30 PM
To:	Dague, Bryan; Beringhause, Steven; McGuirk, Andy; Sharpe, Robert; Baker, Gary; Baumann, Russ
Subject:	FW: Brake Pressure Switch Log

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By the way, Steve R. did mention that the **Electrical System folks were looking into using a Brake Pedal Position Sensor as a replacement for the Brake Pressure Switch as a corrective /containment action.** Have we determined what they use in the 99 Town Car?

From:	Rahman, Aziz
Sent:	Monday, February 15, 1999 6:22 PM
To:	'Fred Porter (Ford)'; 'Norm LaPointe (Ford)'; 'Steve LaRouche (Ford)'; 'Steve Reimers (Ford)'
Subject:	Brake Pressure Switch Log

Attached is a log file with information on the devices under review. It also contains switches received today from John McInerney.In addition to Steve L's analysis summary file, I will be using this log to track incoming parts. Please advise if I have missed any data.

I disabled file to conserve space and e-mail time.....

Please let me know if you cannot open the file. Steve/Norm, can you please e-mail me the last update on your analysis summary file? Thanks.

Regards
Aziz,

Epstein, Sally

From:	Beringhause, Steven [sberinghause@email.mc.ti.com]
Sent:	Wednesday, February 17, 1999 6:48 AM
To:	Rahman, Aziz
Subject:	FW: 99-003: PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWI TCH FROM 77P9 FROM LINCOLN TOWN CAR

Aziz,
Here was Al's first pass proposal. I am not sure if the final process changed. I will find out today, but I do not think it did. Bryan is not in yet, my guess is he is still sick. I will follow up with Al or Bryan at home.

Steve

PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

* Review Ford's Analysis data that they are bringing in.
* Examine threads and determine if it is OK to just chase the threads to get a good seal or should we remove material for analysis.
* Pressure Leak Test the device (15 minute static-hold, air-pressurized test).
* Decide if we should remove any material or try any other analysis before we start disassembling the device.
* Do a practice decap using the below procedure on a deliberately fractured part (to mimic the condition that the returned device will be in) before performing it on the real sample. Bryan, you and I could do this now.
* Procedure to remove aluminum crimp ring
* Use aluminum foil (or plastic if Ford prefers) to mask the analysis surface.
* Also create a paper/tape shield to further reduce chance of contamination during cutting of crimp ring.
* Place a piece of tape over the area to be cut.
* Cut crimp ring using jewelers saw or Dremel cutoff wheel in one of the two areas indicated on optical photo.
* Cut corners of ring at 180 degree orientation
* Unfold crimp ring
* Optically examine revealed surfaces. Take optical photographs (Digital camera with macro lens plus instant microphotography) and document observations where appropriate. Examine the following areas
    * Inside surface of crimp ring.
    * Seal area and underside of base
    * Top of cap
* Start SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis on the inside of the ring and on various surfaces of the plastic base.
* Reprotect the top surface and remove the cap. Bryan had originally suggested just using an end mill to remove the cap. I wouldn't, however, go all the way through with the end mill. I would leave some material behind as a shield. I would suggest then bending the cap off.
* Optically document all revealed surfaces starting with cap.
* Meanwhile, start SEM-EDX analysis on top side of cap. Particularly focus in on the edges of the ceramic pin guide and on the indented ring that lines up with interior wall of the switch cavity. Particularly look for evidence of corrosion or arcing.
* Decide if we should try to flake off any of the overlaying debris to try to examine the underlying metal surface.
* Proceed to perform SEM-EDX analysis on other component surfaces revealed by removal of cap.
* Non-destructively probe inside of the grommet to determine its resilience which will give us an indication of the temperature that it saw. Another indication might be the depth of the indentations left by the grommet seal rings in the wire.
* Decide if it makes sense to further examine the mating connector or grommet seal.

Regards,

Al

Currey, Pat

From:	Rahman, Aziz [arahman@email.mc.ti.com]
Sent:	Wednesday, February 17, 1999 11:00 AM
To:	Beringhause, Steven; Dague, Bryan; McGuirk, Andy; Baumann, Russ; Sharpe, Robert; Baker, Gary; Sullivan, Martha; Douglas, Charles
Subject:	FW: 77PS Ford Central Lab Findings

Findings.doc

From: LaRouche, Steve (S.)[SMTP:slarouch@ford.com]
Sent: Wednesday, February 17, 1999 11:54 AM
To: 'A. Rahman'

<<Findings.doc>>
Aziz: Here is a copy of the spread sheet summarizing our findings to date.
Sorry I didn't get it to you sooner, but I wanted Norm to review it first.

<<Findings.doc>>

Steve LaRouche (SLAROUCH)
Metallurgy Section, Central Laboratory, Room N410
(313) 845-4876 (313) 322-1614 FAX

DRAWINGS AVAILABLE UPON REQUEST

[illegible]

From:	McGuirk, Andy [a-mcguirk@email.mc.ti.com]
Sent:	Wednesday, February 17, 1999 2:44 PM
To:	Baker, Gary; Baumann, Russ; Beringhause, Steven; Dague, Bryan; Hopkins, Al
Cc:	Douglas, Charles; Rahman, Asiz; Rowland, Thomas; Sharpe, Robert; Sullivan, Martha
Subject:	77PS UPDATE

When: Thursday, February 18, 1999, 2:00 PM - 3:00 PM, (GMT-05:00) Eastern Time (US & Canada)
Where: 23A

~~*~*~*~*~*~*~*~*

I WANT TO REVIEW FORD'S ANALYSIS SPREADSHEET (ALL, LED BY STEVE WITH THEORIES), OUR UPDATED CAUSE AND EFFECT DIAGRAM (BRYAN), OUR 'SCIENCE FAIR' EXPERIMENTS RESULTS(STEVE AND BRYAN), AND REVIEW A PROPOSAL FOR OUR RESPONSE TO FORD'S POSSIBLE QUESTION POSED FROM ASIZ ABOUT TI POSITION (ANDY).

ALSO, I WANT TO UNDERSTAND FORD'S DATA ABOUT ABS (C/O ASIZ FROM TEVES) AND PROP VALVE PRESSURE TRACES, AS WELL AS DATA FROM DOW C/O FORD ABOUT BRAKE FLUID AS IT RELATES TO FIRES AS WELL AS KAPTON (C/O ASIZ FROM FORD).

FINALLY, WE SHOULD UNDERSTAND BRAKE SWITCH AND KAPTON WEAROUT WITH ANOTHER FORD PLATFORM...STEVE DID WE COLLECT ANY SAMPLES FROM SIMILAR AGE VEHICLES?

WE SHOULD ALSO DISCUSS THE POTENTIAL BRAKE PEDAL POSITION 'SOLUTION' (CHARLIE AND ROB...BRIEF GARY SO HE CAN DELIVER) AND BE PREPARED TO HELP FORD UNDERSTAND THEIR RISKS IN THAT PATH.

A

TI-NHTSA 016748

Epstein, Sally

From: Hopkins, AL [ahopkins@email.mc.ti.com]
Sent: Wednesday, February 17, 1999 5:09 PM
To: Beringhause, Steven
Cc: Douglas, Charles; Rahman, Aziz; Baker, Gary; Baumann, Russ; Dague, Bryan; McGuirk, Andy
Subject: Corrosivity of Brake Fluid/Water Mixtures on Brass

Attorney-client privileged communication

Has anybody talked to Dow from our end on the corrosivity of Brake Fluid/Water Mixtures on Brass both in the stressed and unstressed condition? Also, has anybody from our side talked to them about flammability? In particular, you had raised a good issue about the flammability/evaporation interaction. They might be able to suggest the best temperature to do your tests at.

Al

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PAGE: (800) 467-3700 PIN 601-2011

From: Rahman, Aziz
Sent: Wednesday, February 17, 1999 6:16 PM
To: Beringhause, Steven; Dague, Bryan; McGuirk, Andy; Baumann, Russ; Sharpe, Robert
Subject: 2/17 Update

Main event: 2PM core team meeting. Highlights:

- Manager Len Brown agitated that Dow has not shown up yet. Will probably get them on board tomorrow or Friday.
- Exec. meeting at 4.pm Friday. TI not invited. Will present test plan (copy with Steve B.).
- Ford team in DC today at NHTSA, asking for two months for public action.
- People surprised that on-vehicle characterization has not yet occurred. Leads provided on expediting this.
- Increasing tempo on getting more parts back for analysis.
- Re-emphasized need to study warranty data more closely for trending, and special causes.
- Increasing speculation that pure heat is not sufficient to ignite. Need spark.
- Will present brake pedal position sensor to execs as possible containment.

Two tests conducted today at AVT labs:

- Passed about 54 Amps at about 1V, through switch terminals, no fluid. Temp in connector area increased to about 182 F before system went open circuit. Dissection revealed spring arm deformed and twisted away from stationary. Will have pictures tomorrow.

- Passed about 50 Amps at about 1V through switch terminals, with switch based filled with approx 50% Brake Fluid, 50% salt water. Temp in connector area increased to about 270 F and stayed there. No smoke or ignition. Dissection revealed spring arm deformed. Pictures tomorrow.

-Will set up calibration station in Central Lab tomorrow.

- Will be returning to MA Friday 2pm flight.Later flights not available because of vacation week. Per Steve B.'s input, will plan to return next week

Regards
Aziz