# EA02-025

9/10/03
REQUEST NO. 7
BOX 9
PART A – R
PART C

# Epstein, Saity

From:

Bent:

To:

Cc;

Prois, Stephen (s-prois@emell.mo.tl.com) Tuesday, May 18, 1999 3:35 PM Beringhause, Steven Pechanis, John; McGuirk, Andy; Degue, Sryan 77PSL2\_1.xds

Subject:



Revised version of spreadsheet.

<<7798L2\_1.xla>>

Recards,

Steve

Dete:

18-May-99

TI I/N:

77P\$L2-1

Ford P/N:

F2VC-9F924-AB

		Qty	
	Let	Lagradee	QΦ
Date	Since.	Tested	Lank
26-Nov-91	4,000	jo	-
26-Nov-91	4,000	Į0	-
5-Dag-91	4,000	10	-
5-Dec-91	4,000	ĮO	-
9-Dec-91	4,000	10	•
9-Dec-91	2,000	5	•
11-Dec-91	4,000	10	•
11-Dec-91	4,000	10	•
13-Dec-91	4,000	LO	•
14-Dec-91	4,000	IQ.	•
16-Dec-91	4,000	IQ.	•
16-Dec-91	4,000	IO.	•
2-Jun-92	4,000	10	•
6-Jun-92	4,000	10	•
7-Jan-92	2,000	5	•
8-Jan-92	4,000	10	•
8-Jun-92	4,000	10	•
14-Jan-92	4,000	10	•
4-Jan-92	4,000	10	•
15-Jan-92	4,000	(O	•
28-Jen-92	2,000	5	•
31-Jen-92	4,000	10	•
2-Peb-92	1,650	5	•
4-Feb-92	4,000	Į0	•
5-Feb-92	4,000	10	•
6-Peb-92	4,000	10	•
10-Feb-92	4,000	10 10	•
11-Feb-92	4,000		•
12-Feb-92	4,000	10 10	•
12-Feb-92	4,000	10	•
14-Fub-92	4,000	10	•
14-Feb-92	4,000 4,000	10	•
14-Peb-92 15-Feb-92	4,000	10	•
			•
24-Peb-92 26-Peb-92	4,000	10 10	•
26-Feb-92	4,000	10	-
28-Feb-92	4,000	10	
25-Feb-92	4,000	10	•
28-Feb-92	4,000	10	•
6-Mar-92	4,000	10	•
10-Mar-92	4,000	10	:
11-Mar-92	4,000	10	:
12-Mar-92	4,000	10	- :
T-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	4,000	'n	•

TI-NHT&A 013668

77P9L2-1: Impulse Date Results 11/91 - 12/92

10 34 00		••	
18-Mar-92	4,000	10	•
23-Apr-92	1,000	5	-
2-May-92	2,000	5	•
5-May-92	2,000	5	-
6-May-92	2,000	5	-
14-Sep-92	2,000	5	•
22-Sep-92	4,000	10	-
30-Sep-92	4,000	10	-
7-Oct-92	4,000	10	•
7-Oct-92	4,000	10	-
16-Oct-92	4,000	10	•
21-Oct-92	2,000	3	-
20-Oct-92	4,000	10	•
29-Oct-92	4,000	10	•
29-Oct-92	4,000	ίο	•
30-Qct-92	4,000	10	-
4-Nov-92	4,000	10	-
10-Nov-92	4,000	10	_
10-Nov-92	4,000	. 10	_
11-Nov-92	4,000	10	
17-Nov-92	2,000		·
20-Nov-92	4,000	10	
			-
4-Dec-92	2,009	3	•
9-Dec-92	2,000	5	-
14-Dec-92	2,000	5	•
16-Dec-92	4,000	10	•
16-Dec-92	4,080	10	•
16-Dep-92	4,000	10	•
21-Dec-92	2,000	5	•
21-Dec-92	4,000	LQ .	-
	-		

268,650

Totals

TI-NHT8A 013569

# Plastic Generation Matrix (FOR REFERENCE ONLY)

FORD Part Number	Texas instruments Part Number	Generation Of Plantic Material	UL Designation
F2VC-8P924-AB F9LC-8P924-AA			UL (HB) UL (HB)
A (1000) 0.000 (100)	######################################	Odvoronenananovanan (sp. 1911)	٠.
FELC-OF024-AA	77PBL2-5	Cellenex 4300 Cellenex 4300	ul (HB) ul (HB)
t Same	puerrenance concentrate de la concentrate del la concentrate del la concentrate de la concentrate de la concentrate de la concentrate del la concentrate de		
fiag- <b>aps</b> 34-aa 94da- <b>0</b> F924-aa F3DG- <b>0</b> F824-aa	77P8L5-1 77P8L5-2	GE Noryl GTX 830 GE Noryl GTX 830 GE Noryl GTX 830	UL (HB) UL (HB) UL (HB)
	er en	·	
F3AC-8P834-AA F3VO-8P834-AB F3DC-9F824-AA F3TA-9F824-CA	77PGL3-1 77PGL3-1 77PGL3-2 77PGL3-3	GE Noryt GTX 830 Cellenex 4300 GE Noryl GTX 630 GE Noryl GTX 630	以 (HB) 以 (HB) 以 (HB) 以 (HB)
e in the Stoward	i. Pohod <b>aloko adaloko adalok</b> a pakoa interakula 1905 berili.	ecocustica de como de	
F55A-87924-AA	77PBL2-2	GE Noryl GTX 850	* UL (HB)

 $x_{ij}$  , the mass  $x_{ij}$  is represented by  $\delta_{ij}$  . The  $x_{ij}$  ,  $y_{ij}$  is

<sup>\*</sup> UL(HB)= Horizontal Burn

## Currey, Pat

From:

Prois, Stephen [s-prois@sensil.mc.ti.com] Tussday, May 18, 1999 3:21 PM

Sent:

Toı

Beringhause, Steven

Ce:

McGuirk, Andy; Pechonis, John; Degue, Bryen

Subject:

77P\$L2\_1.xis



<<7785L2\_1.xla>>

Steve,

I've summarised the data per our discussion. I have also reviewed the files in marketing without success. Please let me know if you need anything else.

Regards,

Steve

TI-NHTSA 013571

Date: 19-May-99
TI record search flacings of May 14-17 '99
TI PRY: 778-3-1
Ford P/N: FZVC-4P924-AB

1 b 5 1614	VC-9P924	AB.	
Ford P/N: F. Touted at 'coord an	48' ME 1111	electoring ES	and representative con-
TORKER SE TORKE IN	Th. Ba	Qt7	
	Lot	mpeter.	G4
B-4-	Sim	Testal	Legit
<u>Deta</u>	4,000	10	•
26-Nov-91	4,000	10	•
26-Nov-91	4,000	10	•
5-Dec-91	A,000	10	•
5-Dec-91	4,000	10	-
9-Dec-91	2,000	5	• .
9-Dec-91	4,000	10	•
11-Dec-91	4,000	10	•
11-Dec-91	4,000	10	•
13-Dec-91	4,000	10	-
14-Dec-91	4,000	10	-
16-Dec-91	4,000	10	-
16-Dec-91	4,000	10	•
2-192	4,000	10	•
6-J <del>ee-9</del> 2	2,000	5	•
7-Jan-92	4,000	70	•
8-jm-92			•
8-Jap-92			-
(4-Jan-92	4,000		- 2
14-Jan-92			•
15-Jan-92	4,000		•
28-Jan-97	2,000		-
31-Jan-97	4,000	•	
2-Fdb-%	2 1,656	•	
4-Feb-9	2 4,00	•	
5-Feb-9	2 4,00	•	
6-Pdb-9	2 4,00	•	
10-Feb-9	2 4,00		
11-Pob-5		~	
12-Feb-			, į
12-Feb-	4,00	~	<u>.</u>
14-Feb	92 4,0	-	
14-Feb	92 4.0	<del></del>	. ·
14-740-	92 40	••	D -
15-7-4-	92 40		
24-Pe	<b>92 4</b> 0		10 -
26.74b	.gg 4,9		10 -
26-Feb	. <b>4</b> 2 4.0	~~	w
21-Feb	∟92 4√		56
28-Feb	<b>. 22</b> 4.	000	10 -
25-Pd	-02 4	000	10
6-349	-22 4	000	10 .
10-148	,	000	10 -
11-144	.02	200	10 -
12-14	-92	,000	10 -
120-1900		-	

77PSL2-1: Impulse Data Regults 11/91 - 12/92

18-Mar-92	4,000	10	-
23-Apr-92	2,000	5	
2-May-92	2,000	5	
5-May-92	2,000	5	•
6-May-92	2,000	5	
14-Sep-92	2,000	5	_
22-Sep-92	4,000	10	
30-Sep-92	4,000	10	
7-Oct-92	4,000	10	
7-Oct-92	4,000	10	
16-Oct-92	4,000	10	
21-Oct-92	2,000	3	
20-0 <del>0-9</del> 2	4,000	10	
29-Oct-92	4,000	10	
29-Oct-97	4,000	10	
30-Oct-92	4,000	10	
4-Nov-92	4,000	· 10	
10-Nov-92	4,000	LO	•
10-Nov-92	4,000	10	
11-Nov-92	4,000	10	_
17-Nov-92	2,000	š	
20-Nov-92	4,000	10	_
4-Dec-92	2,000	š	
9-Dec-92	2,000	•	•
14-Dec-92	2,000	į	:
16-Dec-92	4,000	10	•
16-Dac-92	4,000	10	:
16-Dec-92	4,000	16	•
21-Dac-92	2,000		•
21-Dec-92		.5	•
21-040-92	4,000	10	-

Totals exits	 	
LOCKE COM		
	 	-

preliminary draft summary of TX record search fludings of May 14-17 1999

summary by Stave Beringhame & Andy McGukrk May 19th 1999

TT P/N:

77PSL2-1

Ford P/N:

F2VC-9F924-AB

Tosted at 'room temp' per anisuffictering ES requirements

	and her an	Qty	on refere
	Lot	impulse.	Ğά
Date	Size	Tested	Look
26-Nov-91	4,000	10	
26-Nov-91	4,000	10	-
5-Dec-91	4,000	10	•
5-Dec-91	4,000	10	•
9-Dec-91	4,000	10	•
9-Dec-91	2,000	5	-
11-Dec-91	4,000	10	•
11-Dec-91	4,000	10	-
13-Dec-91	4,000	10	•
14-Dec-91	4,000	. 10	•
16-Dec-91	4,000	10	•
16-Dec-91	4,000	10	-
2-Jun-92	4,000	10	-
6-Jan-92	4,000	10	-
7-Jan-92	2,000	5	-
8-Jan-92 8-Jan-92	4,000	10	-
6-Jan-92	4,000	10	•
14-Jim-92	4,000 4,000	10	•
15-Jan-92	4,000	10 10	-
28-Jan-92	2,000	5	. •
31-Jan-92	4,000	10	•
2-Fqb-92	1,650	5	
4-P46-92	4,000	10	
5-Feb-92	4,000	10	
6-Feb-92	4,000	10	
10-Feb-92	4,000	10	
11-Feb-92	4,000	10	
12-Feb-92	4,000	10	-
12-Feb-92	4,000	10	-
14-Fdb-92	4,000	10	-
14-Fab-92	4,000	10	-
14-Feb-92	4,000	10	
15 <del>-Feb-9</del> 2	4,000	10	-
24-Pdb-92	4,000	10	•
26-Pab-92	4,000	10	•
26-Feb-92	4,000	10	•
28-Peb-92	4,000	10	-
28 <del>-Fab-9</del> 2	4,000	10	-
28-Peb-92	4,000	10	•
6-Mar-92	4,000	10	•
10-Mar-92	4,000	10	-
11-Mar-92	4,000	10	-
12-Mar-92	4,000	10	•

TI-NHTSA 013574

77P6L2-1: Impulse Date Results 11/91 - 12/92

18-Mar-92	4,000	10	•
23-Apr-92	2,000	5	-
2-May-92	2,000	5	•
5-May-92	2,000	5	-
6-May-92	2,000	5	-
14-Sep-92	2,000	•	
22-Sep-92	4,000	10	
30-8cp-92	4,000	10	-
7-004-92	4,000	10	-
7-Oct-92	4,000	10	-
16-Og-92	4.000	10	
21-Oot-92	2,000	5	_
20-Oct-92	4,000	10	
29-Oct-92	4,000	10	
29-Oct-92	4,000	10	
30-Oct-92	4,000	10	
4-Nov-92	4,000	10	-
10-Nov-92	4,000	10	-
10-Nov-92	4,000	10	
11-Nov-92			•
	4,000	10	•
17-Nov-92	2,000	5	•
20-Nov-92	4,000	10	-
4-Dec-92	2,000	. 5	-
.9-Dec-92	2,000	5	-
14 <b>-D</b> qq-92	2,000	5	-
16-Dec-92	4,000	· 10	-
16-Dec-92	4,000	10	•
16-Dec-92	4,000	10	•
21-Dec-92	2,000	5	-
21-Dec-92	4,000	10	•
	-		

Totals units 265,650 665 -

ئىرىر 190<sub>0-</sub>يىر

# proliminary dust summary of TI record march findings of May 14-17 (999-

summitty by Steve Buringhause & Andy McGuirk May 19th 1999

TI P/N:

77PSL2-1

Ford P/N: F2VC-9F924-AB

Tested at 'room temp' per respelacturing ES requirements

		Qty	-
	Lot	(mpd/s	Qty
Onte	مجلك	Tested	Leek
26-Nov-91	1,000	, 10	-
26-Nov-91	4,000	10	-
5-Dec-91	4,000	lo	-
5-Dec-91	4,000	LO	•
9-Dec-91	4,000	LO	•
9-Dec-91	2.000	5	-
tt-Dec-91	4,000	. 10	•
11-Dec-91	4,000	ΙĐ	-
13-Dec-91	4,000	10	•
14-Dec-91	4,000	10	•
16-Dec-91	4,000	10	-
16-Dec-91	4,000	10	•
2-Jan-92	4,000	10	•
6-Jan-92	1,000	10	•
7-Jan-92	2,000	5	•
8-Jen-91	1.000	10	-
8-√ <del>92</del> 14-192	1,000	10	-
	4,000	10	•
14-Jan-92 15-Jan-92	4.000	10	•
13- <b>165-91</b> 28-Jan-92	4.000 2.000	ro	•
20-Jan-92 31-Jan-92	4,000	5	•
2-Feb-92	1,650	to 5	•
1-Feb-97	4,000	10	:
5-Feb-92	+,000	10	:
6-Feb-92	1,000	10	
10-F-6-92	1,000	10	
11-Feb-92	4,000	10	:
12-Feb-92	4.000	10	
12-Feb-92	1.000	10	
14-Feb-92	4,000	10	
14-Feb-92	1,000	10	
14-Feb-92	4.000	10	
15-Peb-92	4,000	LO	
24-Feb-92	4,000	LO	2
26-Peb-92	4.000	Į0	
16-Feb-92	4,000	10	-
28-7-03-92	4,000	10	•
28-Feb-91	4,000	10	
28-Feb-92	4,000	10	
6-Mar-92	4.000	10	•
10-Mar-92	1,000	10	

TI-NHTSA 013576

77P&L2-1: Impulse Deta Results 11/91 - 12/92

[ (- <del>Max</del> -92	4,000 ,	10	-
12-Mar-92	1.000	lΟ	
18-Mar-92	4.000	LO	
23-Apr-92	2,000	3	
2-May-92	2,000	5	
5-May-92	2.000	•	
6-May-92	2.000	5	
14-Sep-92	2.000	5	
22-Sep-92	4.000	10	•
30- <b>Sep-92</b>	4.000	10	
7-Oct-92	4.000	10	
7-Oct-92	4.000	10	
16-Oct-92	4.000	10	•
21-Oct-92	2.000	3	
20-Oct-92	4,000	10	
29-Oct-92	4.000	IO	
29-Oct-92	4.000	10	
30-Oct-92	4.000	10	_
1-Nov-92	4,000	70	_
IO-Nov-92	4.000	ĬŌ	
10-Nov-92	4.000	LO	
11-Nov-92	4,000	10	
17-Nov-92	2,000	5	
20-Nov-92	4.000	10	
+-Dec-92	2.000	3	
9-Dec-92	2.000	3	
14-Dec-92	2,000	•	
16-Dec-92	4,000	10	
16-Dec-92	4,000	10	
16-Dec-92	4.000	10	-
21-Dec-92	2,000	5	-
21-Dec-92	7,000	tō	-
	71444	14	-

Disappointed their get on so off.

Asia monor can univertical and asia monor constructed when rece

Totals mits 165,650 665 -

Greg Stevens

Finding Profits

suitch only 92-93 timeframe
tields
spc
change History
Timprovements
built a fence -> after Tom 1 siek/ Warry no claim

TI-NHT8A 01357

# Currey, Pat

From:

McGuirk, Andy [a-mcgulrk@email.mc.tl.com] Wednesday, May 19, 1999 11:46 AM

Seatt

To:

Sharpe, Robert Baumann, Russ

Ca Subject:

my first draft 77PSL2\_1.xis



AUTOMOTIVE SENSORS AND CONTROLS GRA MARAGER 34 FOREST ST M/S 23-05 ATTLEBORG, MA 02703 TEL: (508) 236-3080 FAX: (508) 236-3745 MOBILE: (508) 208-6119 PAGE: (800) 467-3700 PIN 604-2044

<<77PSL2\_1.xls>>

Regards.

andy

TI P/N: 77PSL2-1 Forg P/N: F2VC-9F924-AB

		Qty			
	Lot	League la c	Qty	Qė	
Date	Street	Tested	Page 1	Lesk	Consumite
26-Nov-91	4,000	LO	10		<del></del> -
26-Nov-91	4,000	10	10	•	
5-Dec-91	4,000	10	10	-	
5-Dec-91	4,000	10	LO	•	
9-Dec-91	4,000	10	10	•	
9-Dec-91	2,000	5	5	•	
11-Dec-91	4,000	10	LQ	•	
11-Dec-91	4,000	10	LO	•	
13-Dec-91	4,000	10	10	•	
14-Dec-91	4,000	10	10	•	
16-Dec-91	4,000	10	LQ.	•	
16-Dec-91	4,000	10	10	•	•
2-Jan-92	4,000	10	LÓ	•	
6-Jan-92	4,000	10	10	•	
7-Japa-92	2,000	5	5	•	
8-Jan-92	4,000	10	10	-	
8-Jap-92	4,000	10	10	•	
14-lan-92	4,000	10	10	-	
14-Jan-92	4,000	10	10	-	
15-Jun-92	4,000	10	10		
28-Jen-92	2,000	5	5	•	•
31-Jan-92	4,000	10	10	-	
2-Feb-92	1,650	5	4	•	Dookse spring
4-Feb-92	4,000	10	10		7.7.
5-Feb-92	4,000	ιō	10	-	
6-Feb-92	4,000	10	10	•	
10-Feb-92	4,000	10	10		
11-Feb-92	4,000	10	10	-	
12-Feb-92	4,000	10	10	-	
12-Pab-92	4,000	10	10		
14-Pab-92	4,000	10	10	•	
14-Peb-92	4,000	10	10		
14-Feb-92	4,000	10	10		
15-Peb-92	4,000	10	10	•	
24-P-6-92	4,000	10	10	•	
25-Peb-92	4,000	10	10	-	
26-Peb-92	4,000	10	10		
28-Peb-92	4,000	10	10	-	
25-Feb-92	4,000	10	10	•	
28-F92	4,000	10	9		Continuity failure, terminal inside of
	-1++-		-		bean is not staked, Date code 2057.
					Sorted lot 100%.
6-Man-92	4,000	10	10	•	

Totals	344,634	-44	40	•
21-Dec-92	4,000	10	10	•
21-Dec-92	2,000	3	5	
16-Dec-92	4.000	iõ	10	-
16-Dec-92	4,000	10	10	-
16-Dec-92	4,000	10 .	IÉ	
14-Dec-92	2,000	;	3	
9-Dec-92	2,000	5	Š	-
4-Dec-92	2.000	Š	5	-
20-Nov-92	4,000	10	10	-
17-Nov-92	2.000	5	•	
11-Nev-92	4,000	10	10	-
10-Nov-92	4,000	10	10	-
10-Nov-92	4,000	10	10	•
30-Ocs-92 4-Nov-92	4.000	10	10	-
	4,000	10	10	•
29-Oct-92 29-Oct-92	4,000 4,000	10 10	10	₹.
20-Oct-92	4,000	10	10 10	•
21-Oct-92	2,000	.5	,	•
16-Oct-92	4,000	10	10	. •
7-Oct-92	4,000	10	10	-
7-Oct-92	4.000	10	10	•
30-8 <del>ep-9</del> 2	4,000	10	10	•
22-Sep-92	4,000	10	10	•
14-Sep-92	2.000	5	9	-
6-May-92	2,000	5	5	•
5-May-92	2.000	5	5	•
2-May-92	2,000	5	5	•
23-Apr-92	2,000	5	5	-
18-Mm-92	4,000	LÓ	10	-
12-Mar-92	4,000	ΙQ	10	-
11-Mar-92	4,000	. 10	10	-
10-Mm-92	4,000	10	LO	•

Currey, Pat

From:

Dague, Bryan [bdague@email.mc.ti.com] Wednesday, May 19, 1999 10:48 AM McGuirk, Andy

Sent:

To:

Importance

High

777012\_1.04

Andy,

Here are both revs.

Bry <<77P8L2\_1.xls>> <<77P8L2\_1.xls>>

# Carrey, Pat

From:

Prois, Stephen [s-prois@email.mc.ti.com] Tuesday, May 18, 1999 3:35 PM

Sent:

To:

Ces

Beringhause, Steven Pechenia, John; McGuirk, Andy; Dague, Bryan

Subject:

77PSL2\_1.xls



Revised version of apreadaheet.

<<77FSL2\_1.xl=>>

Regards,

Stevs

## preliminary dealt summary of TI record search findings of May 14-17 1999

ememory by Stove Beringhause & Andy McGuirk May 19th 1999 TI P/N: 77PSL2-1

Ford P/N:

F2VC-9F924-AB

Toront at 'room ump' per manufacearing ES requirements

	,	Qty	-
	Let	Impules	Qty
Date	âbe _	Intel	Leek
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26-Nov-91	4,000	10	•
5-Dec-91 5-Dec-91	4,000 4,000	10 10	-
3-Dec-91	4,000	10	•
9-Dec-91	2,000	. 5	:
11-Dec-91	4,000	LÕ	
11-Dec-91	4,000	10	•
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14-Dec-91	4,000	LQ	
16-Dec-91	4,000	10	•
16-Dec-91	4,000	10	•
2-Jan-92	4,000	10	-
6-J <del>an-9</del> 2	4,000	10	•
7-Jan-92	2,000		-
8-Jan-92	4,000	10	•
\$-Jep-92	4,000	10	•
14-Jm-92	4,000	IQ	•
14-Jan-92 15-Jan-92	4,000 4,000	· 10	•
28-Jan-92	2,000	5	•
31-Jan-92	4,000	10	
2-F92	1,650	5	
4-Peb-92	4,000	. 10	•
5-Feb-92	4,000	10	•
6-Pab-92	4,000	10	-
10-Feb-92	4,000	10	-
11 <del>-Feb-92</del>	4,000	10	-
12-Feb-92	4,000	10	-
12-Feb-92	4,000	, 10	-
14-Feb-92	4,000	10	-
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15-Feb-92 24-Feb-92	4,000	10	•
26-Feb-92	4,000 4,000	10 10	•
26-Peb-92	4.000	· 10	:
28-Feb-92	4,000	10	:
28-Feb-92	4,000	10	:
28-Feb-92	4,000	10	
6-Mar-92	4,000	10	•
10-Mar-92	4,000	10	-
11-Mar-92	4,000	10	-
12-Mar-92	4,000	10	-

TI-NHTSA 013584

77PSL2-1: impulse Data Results 11/91 - 12/92

18-Mar-92	4,000	10	-
23-Apr-92	2,000	5	-
2-May-92	2,000	5	-
5-May-92	2,000	5	-
6-May-92	2,000	5	-
14-Sep-92	2.000	5	-
22-Sep-92	4,000	10	•
30-Sep-92	4,000	10	-
7-Oct-92	4,000	10	
7-Oct-92	4,000	10	
16-Oct-92	4,000	10	-
21-Oct-92	2,000	5	
20-Oat-92	4,000	10	
29-Oct-92	4,000	10	
29-Oct-92	4,000	10	-
30-Oct-92	4,000	10	-
4-Nov-92	4,000	10	•
10-Nov-92	4,000	10	-
10-Nov-92	4,000	10	-
11-Nov-92	4,000	10	-
17-Nov-92	2,000	5	-
20-Nov-92	4,000	10	-
4-Dec-92	2,000	5	-
9-Dec-92	2,000	5	-
14-Dec-92	2,000	5	•
16-Dec-92	4,000	10	•
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16-Dec-92	4,000	ĮŪ	•
21-Dec-92	2,000	-5	-
21-Dec-92	4,000	10	-

70-4-I I		444	
	750.00		_
Totals units		•	-

# Currey, Pat

From

Prois, Stephen (s-prois@email.mc.ti.com)

Sent:

Tuesday, May 18, 1999 3:21 PM

To:

Beringhauso, Steven

Ce:

į

McGuirk, Andy, Pechonis, John; Dague, Bryan

Subjects

77PSL2\_1.xls



77962,120

<<77PBL2\_1.xla>>

Stave,

I've summarized the data per our discussion. I have also reviewed the files in marketing without success. Please let me know if you need anything else.

1

Regards,

Steve

19-May-90

TT record search flustings of May 14-17 '99 TT P/N: 77PSL2-1

Pord P/N:

P2VC-9F924-AB

Tested at 'courts turny' per menufacturing ES requirements

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16-Das-91 4,000 10	-
16-Dec-91 4,000 10	-
2-Jan-92 4,000 10	-
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2-Fab-92 1,650 5	-
4-Pep-92 4,000 10	•
5-Pai-92 4,000 10	-
6-7-6-92 4,000 10	-
10-Peb-92 4,000 10 11-Peb-92 4,000 10	:
12-Feb-92 4,000 10	:
12-Feb-92 4,000 10	
14-Pag-92 4,000 10	
14-Peb-92 4,000 10	
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15-Feb-92 4,000 10	-
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TI-NHTSA 013587

# REDACTED

From: Mulligan, Sean

Sent: Thursday, May 20, 1999 9:12 AM To: McGuirk, Andy; Beringhause, Steven Subject: Test Report Synopsis and testlog.

Please review the latest version of the Test synopsis and Test log. <<synopsis.doc>> <<TESTLOG9.xls>> Revised items on the Test Synopsis are highlighted in red. There have been minor changes throughout the document so it is worth skimming the entire document (esp. in light of recent developments).

The following items have been updated on the test log: Test 14, 15a and 17.

Awaiting your faedback,

All the best,

Sean P. Mulligan

Texas Instruments Automotive Sensors & Controls Mechanical Design Phone (508) 236-2835 Fax (508) 236-3586

# TI 77PS Test Synopsis

This document is a synopsis of tests conducted by Texas Instruments during the 77PS investigation. The intent of this document is to highlight test findings which drove the investigation to its current state. Throughout the investigation, several tests were conducted with the same objective. When each objective was met, efforts were refocused to obtain a new level of understanding and to establish a new set of objectives. As such, tests have been categorized into (5) levels, representing the level of knowledge obtained from the group of tests conducted. Each level is listed below with a short description of the objective:

- Level 1: Create a laboratory switch ignition without any restrictions on methods.
- Level 2: Create a laboratory switch ignition using only conditions found in the switch operating environment.
- Level 3: Understand the laboratory ignition mechanism.
- Level 4: Compare factors contributing to laboratory ignition.
- Level 5: Evaluate recommendations.

## Refer to Brake Pressure Switch Test Log.

Level 1 Objective: Determine if a switch ignition can be created in the laboratory.

#### Test 1

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact cavity flooded with brake fluid mixed with varying amounts of %  $H_20$ .

14 volts applied to one terminal, second terminal electrically floating. (No electrical load across switch terminals). Switch hexport electrically grounded.

#### Results:

- (8) samples were tested total:
- (2) with 4% H<sub>2</sub>0 in brake fluid.
- (2) with 6% H<sub>2</sub>0 in brake fluid.
- (2) with 10% H<sub>2</sub>0 in brake fluid.
- (2) with 75% H<sub>2</sub>0 in brake fluid.

No ignition occurred. No significant temperature rise observed in all samples. Current draw ranged from 0.5 mAmps to 5 mAmps over a period greater than (250) hours.

#### Test 2

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact flooded with brake fluid. 14 volts applied to one terminal, second terminal connected to a 14  $\Omega$  register which is tied to ground. (1 Amp load across switch terminals). Switch hexport electrically grounded.

Results: (2) samples were tested. No ignition occurred. No significant temperature rise observed for a period over (250) hours.

Conclusion: A (1) Amp load through switch terminals cannot ignite brake fluid in the contact cavity of switches.

#### Test 6

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Henter element installed in contact cavity of the switch.

Power applied to the heater element until plastic base melts.

Spark generated in contact cavity of switch.

Brake fluid present in the contact cavity (wet device) and absent in the contact cavity (dry device).

Results: (2) dry devices were tested and (1) wet device was tested. Ignition occurred in all devices.

<u>Wet device:</u> The internal temperature of a wet device reached 660°F. A hole burned through the base of the switch (close to the heating element). The applied spark ignited the fumes in the contact cavity of the switch and engulfed the base material of the switch.

<u>Dry device:</u> The internal temperature of a dry switch reached over 1000°F. The switch base flopped over. The applied spark ignited the fumes in the contact cavity of the switch and engulfed the base material of the switch.

Conclusion: A switch ignition can occur under the following laboratory conditions:

Heater element installed in the switch contact cavity. 5 watts of power dissipated in heating element. Spark generated in the contact cavity of the switch.

Brake fluid did not contribute to the ignition process.

TI-NHTSA 013591

Level 2: Objective: Determine if a laboratory ignition can occur using only switch components and elements found in the switch environment.

#### Test óa

Objective: Determine if corresive degradation of switch electrical components can cause an increase in electrical resistance (and thus a source of heat) in the switch, which may lead to an ignition.

Results: (1) out of (15) samples tested increased resistance to 5 Ωs. A solution of 5 wt. % NaCl in H<sub>2</sub>0 can corrode the electrical components of the switch and cause an increase in electrical resistance. Repeated injections of the solution of 5 wt. % NaCl in H<sub>2</sub>0 into the contact cavity of a switch, with the switch continuously powered at 14 Volts, can cause an ignition.

Conclusion: A switch ignition can occur under the following laboratory conditions:

A solution of 5% NaCl in H<sub>2</sub>0 is injected into contact cavity of a switch. Continuous 14 Volt power applied to the switch. Hexport is grounded.

Current is limited at 15 Amps.

#### Test 6c

Objective: Determine if brake fluid with metal shavings is conductive enough to create an ignition.

Results: (3) devices with various size metal particles were tested. No significant current increase detected.

Conclusion: Metal shavings did not significantly increase conductivity brake fluid. Current levels measured were well below levels necessary to create an ignition.

#### Test 7

Objective: Determine if switch meets cycle life specification.

Results: Tests conducted during the first quarter of 1999 show that switches exceed cycle life specification.

In the first quarter of 1999, a total of (42) 77PSL2-1 snap switches were impulse tested to over 1,000,000 cycles with only (1) leak below 1,000,000 cycles, which

occurred at 728,000 cycles. A Weibull analysis showed 99.9% reliability at 500,000 cycles at 95% confidence level.

Conclusions: Switches meet cycle life specification. First quarter, 1999 tests confirm impulse test findings made during the period between 1991 and 1992. During that period, (6) impulse tests on 144 devices of 57PS and 77PS construction, had no leaks when tested to 500,000 cycles. A Weibull analysis of first quarter, 1999 tests, showed 99.9% reliability at 500,000 cycles at 95% confidence level.

#### Test 15a.

Objective: Determine the long term corrosive effects of brake fluid on the electrical components of switches which are continuously powered at 14 Volts.

Results: Test was suspended after 550 hours of testing. (6) samples were tested with continuous 14 Volts power. The contact cavity of (4) switches contained new brake fluid and (2) switches contained old brake fluid. Switches with old brake fluid drew very little hexport current and showed a decrease in hexport current over time to less than 1/10 mAmp. Samples with new brake fluid showed an increase in hexport current to over 20 mAmps toward the end of the 550 hours of testing. Analyses of (1) sample with new brake fluid and (1) sample with old brake fluid revealed electrolytic corrosion of the contact arm of both switches. There was a much lower level of corrosion in the sample with used brake fluid than the sample with new brake fluid.

Conclusion: Brake fluid in the contact cavity of switches, which are at 14 Volts continuous power for over 500 hours, can cause electrolytic corrosion of the switch contact arm. It is unknown if this corrosion, under continuous power conditions, can eventually lead to sufficient current draw to drive an ignition.

### Test 17

Objective: Quantify the long term corrosive effects of new brake fluid on the electrical components of switches under the following laboratory conditions:

Contact cavity of switch flooded with new brake fluid. Switches at continuous 14 Volts power.

Switches subjected to vibration for (1) hour per day.

Switches subjected to 100°C for (1) hour per day.

Results: Test suspended after (312) hours. (50) samples tested. The average hexport current draw after (312) hours is 1.9 mAmps with a standard deviation of 1.8 mAmps. There has been no increase in hexport current. These results are consistent with results previously found in Test 15a.

Conclusion: New brake fluid in the contact cavity of switches, has not caused an increase in hexport current after (312) hours at continuous 14 Volta power.

Level 3: Objective: Understand the laboratory ignition process, determine the current path and establish a repeatable ignition method.

#### Test 6b

Objective: Understand the ignition process, determine the current path and establish a repeatable ignition method.

Results: Multiple attempts at laboratory ignition, via injection of a solution of 5 wt. % NaCl in  $H_20$  into the contact cavity of switches, has resulted in a repeatability rate of approximately 50%. Plots of hexport current verses time show an increase in current until the point of ignition.

Conclusion: A repeatable laboratory method for switch ignition was established. Based on hexport current measurements, the current path is from switch terminals to hexport body.

When a solution of 5 wt. % NaCl in H<sub>2</sub>0 is repeatedly injected into the contact cavity of powered switches, electrolytic corrosion of the switch terminal results in an increase in terminal resistance. When sufficient power is drawn through the corrosive resistance, switch elements heat up and begin to glow red hot. A hole burns through the switch base and ignition occurs. There is arcing visible throughout the corrosion process which may provide the spark necessary for ignition.

Level 4: Objective: Compare and contrast variables influencing ignition using the established leboratory ignition method.

#### Test 13a

Objective: Compare various fluids in the established ignition method.

Results: The following fluids were tested.

- (1) NaCl in H<sub>2</sub>0.
- (1) tap water
- (1) rain water
- used brake fluid.
- used brake fluid with 5 wt. % H<sub>2</sub>0
- (1) new brake fluid
- new brake fluid with 5 wt, % H<sub>2</sub>0

The switch filled with 5 wt. % NaCl in H<sub>2</sub>0 resulted in an ignition when average hexport current exceeded 2.5 Amps. Switches that were filled with tap water and rain water draw less than 10 mAmps over a (3) hour test and showed little signs of

corrosion. Switches filled with a matrix of new and used brake fluids, with water and without water, all drew less than 3 mAmps hexport current draw and showed no signs of corrosion over the (24) hour test.

Conclusion: Brake fluid is not conductive enough to cause the electrolytic corrosion and necessary current draw to create an ignition. Because of its' significantly higher conductivity, an ionic rich fluid such as NaCl in H<sub>2</sub>0 is necessary to cause an ignition.

#### Test 15

Objective: Compare the ignition characteristics of various plastics as switch base material.

Results: When 5 wt. % NaCl in H<sub>2</sub>0 was injected into switches with different base materials, the following results were obtained: Cellanex 4300 ignited 3 out of 5 attempts. Noryl ignited 2 out of 5 attempts. Zytel ignited 1 out of 5 attempts.

Conclusions: All plastics tested can ignite using the established laboratory ignition method.

#### Test 15b

Objective: Determine if switch ignition can occur in the vertical position and 45° orientation. Determine if switch ignition can occur and at different rotational angles in the 45° orientation.

Results: Switch ignitions can occur in both the vertical and 45° orientation using the established laboratory ignition method.

Conclusion: Switch ignition does not appear to be sensitive to vertical orientation verses 45° orientation nor to rotational angle in the 45° orientation.

## Level 5 Objective:

Test 16

Objective: Test proposed relay circuit.

Results: (1) switch was injected with a solution of 5 wt. % Nacl in H<sub>2</sub>0 and placed in the proposed current limiting circuit for (48) hours. The current draw remained constant at 180 mAmps throughout the test. There was no activity observed and the contact arm remained mostly integt.

(1) switch was brought to an impending burn condition using the established burn method. An impending burn is a condition where a corresive resistance has built

up in the switch and an ignition is imminent. The switch was then placed in the proposed relay circuit for(18) hours where it drew 160 mAmps, showed no visible activity and did not result in an ignition.

1

Because the proposed relay circuit acts as a resistor which limits current to the switch, the maximum power to the switch is limited to .75 Watts. A resistive wire was wrapped around the base of (1) switch and 0.75 Watts of power was dissipated in the wire. The wire became warm to the touch but had no effect on the switch.

Conclusion: 0.75 Watts, the maximum power in the proposed circuit design, is insufficient to cause substantial electrolytic corrosion or significant switch terminal heating, which is necessary to create an ignition. In previous tests, using a resistor as the heating element (see Test 6), approximately 5 Watts of power was necessary to create an ignition. There is not enough power in the proposed circuit to create ignition.

# Brake Pressure Sulich Test Log, Updated 7/12/99

Category	Test	Location	Test Paracetiges	Resulta Lipdala
ab Shrudalion	1	11	Vary water concentrations to near Brake Fluid	260+ hours, Current draw in the 0.5mA to 5mA range
Polyatki igailan	-1		1494tic to one terrolisal, heaport grounded	Field has decolored
Switch			Water Conc. 4%, 6%, 10%, 75%	No Significant Temperature Riss. Text Suspended.
				Saternal Analysis suspended.
	3		How Brake Fluid	290+ hours. Constant temperature.
			1 App Strough malich terminals	No significant temperature (see with since
	<del></del>		14Vdc to one terminal, heaport grounded	Test Suspended.
	$-\bot$ 1			
		ĀVT	new Brate Fluid in Switch, 24 VDC to one	> 300 hours into test, may current 700A
			Streinel, Hesport Groundesi	No significant change with tions. Test suspended
	41	ÁVT	new Brake Fluid in Sedich, 24 VDC to one	16 hours into test must custant SmA
			terreinal. Hesport Grounded, Ambient at 100 C	No significant temperature rise with time. Test suspended.
				The second secon
	- 5	TVA	mane' Broke Fluid in Selich, 16 Amps	Temperature rise of 20 C shows room temp.
			Through solick terminals	Onlin T renched shedy state at 20 C. Test suspended.
	5a	AVI	nany Banko Fluid in Switch approx. 50 Atops	Temperature rose to approx. 270 F. No smoke. No ligition
			Through Switch Terminals	Test superided.
		ַ װ	Build header elements but Spligh.	3 touled. Statios observed, ignition observed an part wheeler
			Heat III fallure, include specifing.	See allecheers
	$\neg$	•	(1) w/solution of Busine Fluid and 6 at. % Hy0	Test complete
				Brains field in cavity slows down heat build-up
				Sunde charged at 675 F, Been mails and falls off at 800 F
			<del></del>	Annual residence of the party of the second
	8m	<del> п</del> -	Creeks heater by correcting spring sean	One and of 48 desires because of making and
			Salt vision existion, 14V between spring	One out of 16 devices increased resistance to 5 ohms. Others either very low resistance or magazinus.
			and hosport	Located spins 450 print to him him to him
	<del>-   </del>			it took about 100 hours to reach the 5 ohus stage.
	<del></del> -		<del> </del>	This 5 ofen devices ignited smaler conditions similar to test 6.
	- 60	Ťì	Re-nin Ignition tout to understand	
THE	<del>"   <del>"  </del></del>	<del></del>	reports billy and current justs.	Switch ignition with repeated 5% water solution into extich
Ž	<del></del>	<del></del>		Current pells is through therport.
`⇒ ———	<del>-                                    </del>		<del></del>	See plots and video.
· · · · · · · · · · · · · · · · · · ·	-   -		Pure 'new' trains fluid with motel shoulings	Attributed fast include top water, old SF, new BF and other.
· <del></del>	<del></del> -	<del></del> -	1	Maini showings do not contribute significantly to basics third

# Brake Pressure Switch Test Log, Updated 7/12/99

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o pi	<u>.                                    </u>			
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	·		The state of the s	
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Secting Displaces Wear	1		12 step + 12 quiet suitches of 5 % units in BF	Samp semples supported at 1.3 million cycles with 2 leaks.
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g		<u> </u>	used brake fluid	Chartaical arriyate in process.

# Brake Pressure Switch Test Log, Updated 7/12/99

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,	I		used brake fluid w/ 5% H <sub>2</sub> O	
	7		new brake this	
	$\neg$		new bruke fluid w/ 6% H <sub>2</sub> O	
	,		Stranger Committee Committ	
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Evaluation of Pleatic	15	П	Assess properties and moldability of different	Test suspended.
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			(1) Boar nock at 1021 day C per day	

REDACTED

From: Sent

Muligan, Seen

Ta: . Bublect: Thursday, May 20, 1996 9:12 AM McGuirk, Andy; Beringhause, Sheven

Test Report Synopsis and testing.

Please review the latest version of the Test synopsis and Test log.





Revised items on the Test Synopsis are highlighted in red. There have been minor changes throughout the document so it is worth sidmining the entire document (esp. in light of recent developments).

The following items have been updated on the test log: Test 14, 15e and 17.

Awaiting your feedback,

# & I.J.

Lan P. Multigan

Texas Instruments
Automotive Sensors & Controls
Mechanical Design
Phone (508) 236-2535
Fax (508) 236-3586

# TI 77PS Test Synopsis

This document is a synopsis of tests conducted by Texes Instruments during the 77PS investigation. The intent of this document is to highlight test findings which drove the investigation to its current state. Throughout the investigation, several tests were conducted with the same objective. When each objective was mot, efforts were refocused to obtain a new level of understanding and to establish a new set of objectives. As such, tests have been categorized into (5) levels, representing the level of knowledge obtained from the group of tests conducted. Each level is listed below with a short description of the objective:

- Level 1: Create a laboratory switch ignition without any restrictions on methods.
- Level 2: Create a laboratory switch ignition using only conditions found in the switch operating environment.
- Level 3: Understand the laboratory ignition mechanism.
- Level 4: Compare factors contributing to laboratory ignition.
- Level 5: Evaluate recommendations.

# Refer to Brake Pressure Switch Test Log.

Level 1 Objective: Determine if a switch ignition can be created in the laboratory.

#### • Test I

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact cavity flooded with brake fluid mixed with varying amounts of % H<sub>2</sub>0.

14 volts applied to one terminal, second terminal electrically floating. (No electrical load across switch terminals).

Switch hexport electrically grounded.

#### Results:

- (8) samples were tested total:
- (2) with 4% H<sub>2</sub>0 in brake fluid.
- (2) with 6% H<sub>2</sub>0 in brake fluid.
- (2) with 10% H<sub>2</sub>0 in breke fluid.
- (2) with 75% H<sub>2</sub>0 in brake fluid.

No ignition occurred. No significant temperature rise observed in all samples. Current draw ranged from 0.5 mAmps to 5 mAmps over a period greater than (250) hours.

#### Test 2

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact flooded with brake fluid. 14 volts applied to one terminal, second terminal connected to a 14  $\Omega$  resistor which is tied to ground. (1 Amp load across switch terminals). Switch hexport electrically grounded.

Results: (2) samples were tested. No ignition occurred. No significant temperature rise observed for a period over (250) hours.

Conclusion: A (1) Amp load through switch terminals cannot ignite brake fluid in the contact cavity of switches.

#### Test 6

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Heater element installed in contact cavity of the switch.

Power applied to the heater element until plastic base malts.

Spark generated in contact cavity of switch.

Brake fluid present in the contact cavity (wet device) and absent in the contact cavity (dry device).

Results: (2) dry devices were tested and (1) wet device was tested. Ignition occurred in all devices.

<u>Wet daylor</u>: The internal temperature of a wet device reached 660°F. A hole burned through the base of the switch (close to the heating element). The applied spark ignited the fluxes in the contact cavity of the switch and engulfed the base material of the switch.

Dry davice: The internal temperature of a dry switch reached over 1000°F. The switch base flopped over. The applied spack ignited the fumes in the contact cavity of the switch and engulied the base material of the switch.

Conclusion: A switch ignition can occur under the following laboratory conditions:

Heater element installed in the switch contact cavity. 5 waits of power dissipated in heating element.

Spark generated in the contact cavity of the switch.

Brake fluid did not contribute to the ignition process.

Level 2: Objective: Determine if a laboratory ignition can occur using only switch components and elements found in the switch environment.

### Test 6a.

Objective: Determine if corrosive degradation of switch electrical components can cause an increase in electrical resistance (and thus a source of heat) in the switch, which may lead to an ignition.

Results: (1) out of (15) samples tested increased resistance to 5 Ωs. A solution of 5 wt. % NsCl in H<sub>2</sub>0 can corrode the electrical components of the switch and cause an increase in electrical resistance. Repeated injections of the solution of 5 wt. % NsCl in H<sub>2</sub>0 into the contact cavity of a switch, with the switch continuously powered at 14 Volts, can cause an ignition.

Conclusion: A switch ignition can occur under the following laboratory conditions:

A solution of 5% NaCl in H<sub>2</sub>0 is injected into contact cavity of a switch. Continuous 14 Volt power applied to the switch. Hexport is grounded.

Current is limited at 15 Amps.

#### Test 6c

Objective: Determine if brake fluid with metal shavings is conductive enough to create an ignition.

Results: (3) devices with various size metal particles were tested. No significant current increase detected.

Conclusion: Metal shavings did not significantly increase conductivity brake fluid. Current levels measured were well below levels necessary to create an ignition.

#### Test 7

Objective: Determine if switch meets cycle life specification.

Results: Tests conducted during the first quarter of 1999 show that switches exceed cycle life specification.

In the first quarter of 1999, a total of (42) 77PSL2-1 snap switches were impulse tested to over 1,000,000 cycles with only (1) leak below 1,000,000 cycles, which

occurred at 728,000 cycles. A Weibull analysis showed 99.9% reliability at 500,000 cycles at 95% confidence level.

Conclusions: Switches meet cycle life specification. First quarter, 1999 tests confirm impulse test findings made during the period between 1991 and 1992. During that period, (6) impulse tests on 144 devices of 57PS and 77PS construction, had no leaks when tested to 500,000 cycles. A Weibuil analysis of first quarter, 1999 tests, showed 99.9% reliability at 500,000 cycles at 95% confidence level.

#### Test 15a

Objective: Determine the long term corrosive effects of brake fluid on the electrical components of switches which are continuously powered at 14 Volts.

Results: Test was suspended after 550 hours of testing. (6) samples were tested with continuous 14 Volts power. The contact cavity of (4) switches contained new brake fluid and (2) switches contained old brake fluid. Switches with old brake fluid drew very little hexport current and showed a decrease in hexport current over time to less than 1/10 mAmp. Samples with new brake fluid showed an increase in hexport current to over 20 mAmps toward the end of the 550 hours of testing. Analyses of (1) sample with new brake fluid and (1) sample with old brake fluid revealed electrolytic corresion of the contact arm of both switches. There was a much lower level of corresion in the sample with used brake fluid than the sample with new brake fluid.

Conclusion: Brake fluid in the contact cavity of switches, which are at 14 Volts continuous power for over 500 hours, can cause electrolytic corresion of the switch contact arm. It is unknown if this corresion, under continuous power conditions, can eventually lead to sufficient current draw to drive an ignition.

#### Test 17

Objective: Quantify the long term corrosive effects of new brake fluid on the electrical components of switches under the following laboratory conditions:

Contact cavity of switch flooded with new brake fluid. Switches at continuous 14 Volts power.

Switches subjected to vibration for (1) hour per day.

Switches subjected to 100°C for (1) hour per day.

Results: Test suspended after (312) hours. (30) samples tested. The average hexport current draw after (312) hours is 1.9 mAmps with a standard deviation of 1.8 mAmps. There has been no increase in hexport current. These results are consistent with results previously found in Test 15a.

Conclusion: New brake fluid in the contact cavity of switches, has not caused an increase in hexport current after (312) hours at continuous 14 Volts power.

Level 3: Objective: Understand the laboratory ignition process, determine the current path and establish a repeatable ignition method.

### Test 6b

Objective: Understand the ignition process, determine the current path and establish a repeatable ignition method.

Results: Multiple attempts at laboratory ignition, via injection of a solution of 5 wt. % NaCl in H<sub>2</sub>0 into the contact cavity of switches, has resulted in a repeatability rate of approximately 50%. Plots of hexport current verses time show an increase in current until the point of ignition.

Conclusion: A repeatable laboratory method for switch ignition was established. Based on hexport current measurements, the current path is from switch terminals to hexport body.

When a solution of 5 wt. % NaCl in H<sub>2</sub>0 is repeatedly injected into the contact cavity of powered switches, electrolytic corresion of the switch terminal results in an increase in terminal resistance. When sufficient power is drawn through the corresive resistance, switch elements heat up and begin to glow red hot. A hole burns through the switch base and ignition occurs. There is aroing visible throughout the corresion process which may provide the spark necessary for ignition.

Level 4: Objective: Compare and contrast variables influencing ignition using the established laboratory ignition method.

#### Test 13a.

Objective: Compare various fluids in the established ignition method.

Results: The following fluids were tested.

- NaCl in H<sub>2</sub>O.
- (1) tap water
- (1) rain water
- (1) used brake fluid
- (1) used brake fluid with 5 wt. % H<sub>2</sub>0
- (1) now brake fluid
- (1) new brake fluid with 5 wt. % H<sub>2</sub>0

The switch filled with 5 wt. % NsCl in  $H_20$  resulted in an ignition when average hexport current exceeded 2.5 Amps. Switches that were filled with tap water and rain water drew less than 10 mAmps over a (3) hour test and showed little signs of

corrosion. Switches filled with a matrix of new and used brake fluids, with water and without water, all drew less than 3 mAmps hexport current draw and showed no signs of corrosion over the (24) hour test.

Conclusion: Brake fluid is not conductive enough to cause the electrolytic corrosion and necessary current draw to create an ignition. Because of its significantly higher conductivity, an ionic rich fluid such as NaCl in H<sub>2</sub>0 is necessary to cause an ignition.

#### Test 15

Objective: Compare the ignition characteristics of various plastics as switch base material.

Results: When 5 wt. % NaCl in H<sub>2</sub>0 was injected into switches with different base materials, the following results were obtained: Cellanex 4300 ignited 3 out of 5 attempts. Noryl ignited 2 out of 5 attempts. Zytel ignited 1 out of 5 attempts.

Conclusions: All plastics tested can ignite using the established laboratory ignition method.

#### Test I5b

Objective: Determine if switch ignition can occur in the vertical position and 45° orientation. Determine if switch ignition can occur and at different rotational angles in the 45° orientation.

Results: Switch ignitions can occur in both the vertical and 45° orientation using the established laboratory ignition method.

Conclusion: Switch ignition does not appear to be sensitive to vertical orientation verses 45° orientation per to rotational angle in the 45° orientation.

### Level 5 Objective:

#### Test 16

Objective: Test proposed relay circuit.

Results: (1) switch was injected with a solution of 5 wt. % Nacl in H<sub>2</sub>0 and placed in the proposed current limiting circuit for (48) hours. The current draw remained constant at 180 mAmps throughout the test. There was no activity observed and the contact arm remained mostly intact.

(1) switch was brought to an impending burn condition using the established burn method. An impending burn is a condition where a corrosive resistence has built

up in the switch and an ignition is imminent. The switch was then placed in the proposed relay circuit for (18) hours where it drew 160 mAmps, showed no visible activity and did not result in an ignition.

Because the proposed relay circuit acts as a resistor which limits current to the switch, the maximum power to the switch is limited to .75 Watts. A resistive wire was wrapped around the base of (1) switch and 0.75 Watts of power was dissipated in the wire. The wire became warm to the touch but had no effect on the switch.

Conclusion: 0.75 Watta, the maximum power in the proposed circuit design, is insufficient to cause substantial electrolytic corrosion or significant switch terminal heating, which is necessary to create an ignition. In previous tests, using a resistor as the heating element (see Test 6), approximately 5 Watta of power was necessary to create an ignition. There is not enough power in the proposed circuit to create ignition.

# Brake Pressure Switch Test Log. Updated 08/10/1999

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			14V4c to one terminal, impost grounded	No significant temperature due with time Test Suspended.		
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		4	L	Annual and the section		
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		<u>.                                    </u>	terrelisal. Herport Grounded, Ambiert at 100 C	No significant temperature rise with time. Test suspended.		
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	5	AVT	new Grake Fluid in Switch, 16 Augus	Temperature day of 20 C along sport time		
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# Brake Pressure Switch Test Log, Updated 08/10/1999

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— z ——	<u>.                                    </u>		HARRING BING	Chemical aniyals in process.

# Brake Pressure Switch Test Log, Updated 06/10/1999

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	<u> </u>		(1) hour sock at 100 dag C per day	

### Currey. Pat

From:

Mulligan, Sean [smulligan@email.mc.tl.com]

Sent: To: \*Thursday, May 20, 1999 8:13 AM McGuirk, Andy; Beringhause, Steven

Subject:

Test Report Synopsis and testing.





Please review the latest version of the Test synopsis and Test

log. 
<<synopsis.doc>> <<TESTLOG9.xls>> 
Revised items on the Test Synopsis are highlighted in red. There have been 
minor changes throughout the document so it is worth skimming the entire 
document (sep. in light of recent developments).

The following items have been updated on the test log: Test 14, 15a and 17.

Awaiting your feedback.

All the best,

Sean P. Mulligan

Texts Instruments Automotive Sensors & Controls Mechanical Design Phone (508) 236-2535 Fax (508) 236-3586

### TI 77PS Test Synopsis Draft 7/12/99

This document is a synopsis of tests conducted by Texas Instruments during the 77PS investigation. The intent of this document is to highlight test findings which drove the investigation to its current state. Throughout the investigation, several tests were conducted with the same objective. When each objective was met, efforts were refocused to obtain a new level of understanding and to establish a new set of objectives. As such, tests have been estagorized into (5) levels, representing the level of knowledge obtained from the group of tests conducted. Each level is listed below with a short description of the objective:

Level 1: Create a laboratory switch ignition without any matrictions on methods.

Level 2: Create a laboratory switch ignition using only conditions found in the switch concreting environment.

Level 3: Understand the laboratory ignition mechanism.

Level 4: Compare factors contributing to laboratory ignition.

Level 5: Evaluate recommendations.

#### Rofer to Brake Pressure Switch Test Log.

Level I Objective: Determine if a switch ignition can be created in the laboratory.

#### • Text 1

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact cavity flooded with brake fluid mixed with varying amounts of % HaD.

14 voits applied to one terminal, second terminal electrically floating. (No electrical load across switch terminals).
Switch hexport electrically grounded.

#### Results: +

- (8) annulus were tested total:
- (2) with 4% EleO in brake fluid.
- (2) with 6% H<sub>2</sub>O in brake fluid.
- (2) with 10% H<sub>2</sub>0 in brake fluid.
- (2) with 75% H<sub>2</sub>0 in brake fluid.

No ignition occurred. No significant temperature rise observed in all samples. Current draw ranged from 0.5 mAmps to 5 mAmps over a period greater than (250) hours.

TI-NHT8A 013613

TI 7776 Test Synapsis Dest 07/12/49

#### Test 2

Objective: Determine if switch ignition can occur under the following inhomory conditions:

Switch contact flooded with brake fluid. 14 volts applied to one terminal, second terminal connected to a 14  $\Omega$  resistor which is tied to ground. (1 Amp load across switch terminals). Switch hexport electrically grounded.

Results: (2) samples were tested. No ignition occurred. No significant temperature rise observed for a period over (250) hours.

Conclusion: A (1) Amp load through switch terminals cannot ignite brake fluid in the contact quvity of switches.

#### Tost 6

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Henter element installed in contact cavity of the switch.

Power applied to the beater element until plastic base melts.

Spark generated in contact cavity of switch.

Brake fluid present in the contact cavity (wat device) and absent in the contact cavity (dry device).

Results: (2) dry devices were tested and (1) wet device was tested. Ignition occurred in all devices.

<u>Wet device</u>: The internal temperature of a wet device reached 660°F. A hole burned through the base of the switch (close to the heating element). The applied spack ignited the finnes in the contact cavity of the switch and engulsed the base material of the switch.

<u>Ory device:</u> The internal temperature of a dry switch reached over 1000°F. The switch base flopped over. The applied spark ignited the fumes in the contact cavity of the switch and ensulfed the base material of the switch.

Conclusion: A switch ignition can occur under the following laboratory conditions:

Heater element installed in the switch contact cavity.

5 watts of power discipaned in heating element.

Spark generated in the contact cavity of the switch.

Brake fluid did not contribute to the ignition process.

**THNHTSA 013814** 

Level 2: Objective: Determine if a laboratory ignition can occur using only switch components and elements found in the switch environment.

#### Test és.

Objective: Determine if convolve degradation of switch electrical components can cause an increase in electrical resistance (and thus a source of heat) in the switch, which may lead to an ignition.

Results: (1) out of (15) samples tested increased resistance to 5 Ωs. A solution of 5 wt. % NaCl in H<sub>2</sub>0 can corrode the electrical components of the switch and cause an increase in electrical resistance. Repeated injections of the solution of 5 wt. % NaCl in H<sub>2</sub>0 into the contact cavity of a switch, with the switch continuously powered at 14 Volts, can occur an ignition.

Conclusion: A switch ignition can occur under the following laboratory conditions:

A solution of 5% NeCl in H<sub>2</sub>0 is injected into contact cavity of a switch. Continuous 14 Volt power applied to the switch. Hexport is grounded.

Current is limited at 15 Amps.

#### Test 6c

Objective: Determine if brake fluid with metal shavings is conductive enough to create an ignition.

Results: (3) devices with various size metal particles were tested. No significant current increase detected.

Conclusion: Metal shavings did not significantly increase conductivity brake fluid. Current levels measured were well below levels necessary to create an ignition.

#### • Test 7

Objective: Determine if switch meets cycle life specification.

Results: Tests conducted during the first quarter of 1999 show that switches exceed cycle life specification.

In the first quarter of 1999, a total of (42) 77PSL2-1 susp switches were impulse tested to over 1,000,000 cycles with only (1) leak below 1,000,000 cycles. which

TI-NHT&A 013815

occurred at 728,000 cycles. A Welbull analysis showed 99,9% reliability at 500,000 cycles at 95% confidence level.

Conclusions: Switches meet cycle life specification. First quarter, 1999 tests confirm impulse test findings made during the period between 1991 and 1992. During that period, (6) impulse tests on 144 devices of 57PS and 77PS construction, had no leaks when tested to 500,000 cycles. A Welbull analysis of first quarter, 1999 tests, showed 99,9% reliability at 500,000 cycles at 95% confidence level.

#### Test 15a

Objective: Determine the long term corrosive effects of brake fluid on the electrical components of switches which are continuously powered at 14 Volts.

Results: Test was suspended after 550 hours of testing. (6) samples were tested with continuous 14 Volts power. The contact cavity of (4) switches contained new brake fluid and (2) switches contained old brake fluid. Switches with old brake fluid frew very little hexport current and showed a decrease in hexport current over time to less than 1/10 mAmp. Samples with new brake fluid showed an increase in hexport current to over 20 mAmps toward the end of the 550 hours of testing. Analyses of (1) sample with new brake fluid and (1) sample with old brake fluid revealed electrolytic corrosion of the contact arm of both switches. There was a much lower level of corrosion in the sample with used brake fluid than the sample with new brake fluid.

Conclusion: Brake fluid in the contact cavity of switches, which are at 14 Volts continuous power for over 500 hours, can cause electrolytic corrosion of the switch contact arm. It is unknown if this corrosion, under continuous power conditions, can eventually lead to sufficient current draw to drive an ignition.

#### Test 17

Objective: Quantify the long term corrosive effects of new brake fluid on the electrical components of switches under the following laboratory conditions:

Contact cavity of switch flooded with new brake fluid. Switches at continuous 14 Voius power. Switches subjected to vibration for (1) hour per day. Switches subjected to 100°C for (1) hour per day.

Results: Test suspended after (312) hours. (50) samples tested. The average hexport current draw after (312) hours is 1.9 mAmps with a standard deviation of 1.8 mAmps. There has been no increase in hexport current. These results are consistent with results previously found is Test 15a.

TI-NHTBA 013816

TI 77FE Test Synapsis Dech (7/1244)

Conclusion: New braits fluid in the contact cavity of switches, has not esused an increase in hexport current after (312) hours at continuous 14 Volts power.

Level 3: Objective: Understand the laboratory ignition process, determine the current path and establish a repeatable ignition method.

#### Test 6b

Objective: Understand the ignition process, determine the current path and establish a repeatable ignition method.

Results: Multiple attempts at laboratory ignition, via injection of a solution of 5 wt. % NaCl in H<sub>2</sub>0 into the contact cavity of switches, has resulted in a repeatability rate of approximately 50%. Flots of bexport current verses time show an increase in current until the point of ignition.

Conclusion: A repeatable laboratory method for switch ignition was established. Bused on hexport current measurements, the current path is from switch terminals to between body.

When a solution of 5 wt. 6 NuCl in H<sub>2</sub>0 is repeatedly injected into the contact cavity of powered switches, electrolytic corrosion of the switch terminal results in an increase in terminal resistance. When sufficient power is drawn through the corrosive resistance, switch elements heat up and begin to glow red hot. A hole burns through the switch base and ignition occurs. There is arcing viable throughout the corrosion process which may provide the spark necessary for ignition.

Lavel 4: Objective: Compare and contrast variables influencing ignition using the established laboratory ignition method.

#### Test 13a

Objective: Compare various finids in the astablished ignition method.

Results: The following fluids were tested.

- (1) NaCl to Ha0.
- (1) tup water
- (1) rate water
- (1) used brake fluid
- (1) used brake finid with 5 wt. % H<sub>2</sub>O
- (1) new brake fluid
- (1) new brake fluid with 5 wt. % H<sub>2</sub>O

The switch filled with 5 wt. % NaCl in H<sub>2</sub>0 resulted in an ignition when average hexport current exceeded 2.5 Amps. Switches that were filled with tap water and rain water drew less than 10 mAmps over a (3) hour test and showed little signs of

TI-NHTSA 013617

corresion. Switches filled with a matrix of new and used braits finids, with water and without water, all drew less than 3 mAmps hexport current draw and showed no signs of corresion over the (24) hour test.

Conclusion: Brake fluid is not conductive enough to cause the electrolytic correctors and necessary current draw to create an ignition. Because of har significantly higher conductivity, an ionic rich fluid such as NaCl in H<sub>2</sub>O is accessary to cause an inteltion.

#### Test 15

Objective: Compare the ignition characteristics of various plantics as switch best material.

Results: When 5 wt. % NaCt in H<sub>2</sub>0 was injected into swhehes with different base materials, the following results were obtained: Collanex 4300 ignited 3 out of 5 attempts. Noryl ignited 2 out of 5 attempts. Zytel ignited 1 out of 5 attempts.

Conclusions: All planties tested can ignite using the established laboratory ignition method.

#### Test 15b

Objective: Determine if switch ignition can occur in the vertical position and 45° orientation. Determine if switch ignition can occur and at different rotational angles in the 45° orientation.

Results: Switch ignitions can occur in both the vertical and 45° orientation using the established laboratory ignition method.

Conclusion: Switch ignition does not appear to be sensitive to vertical orientation verses 45° orientation age to rotational angle in the 45° orientation.

#### Lavel 5 Objectives

Test 16

Objective: Test proposes relay circuit.

Results: (1) switch was injected with a solution of 5 wt. % Neel in H<sub>2</sub>0 and placed in the proposed current limiting circuit for (48) hours. The current draw remained constant at 180 mAmps throughout the test. There was no activity observed and the contact arm remained mostly intact.

 switch was brought to as impending born condition using the established burn method. An impending burn is a condition where a corrective resistance has built

TI-NHTSA 013618

up in the switch and en ignition is imminent. The switch was time placed in the proposed relay circuit for(18) hours where it drew 160 mAmps, showed so visible activity and did not result in an ignition.

Because the proposed relay circuit acts as a resistor which limits current to the switch, the maximum power to the switch is limited to .75 Watts. A resistive wire was wrapped around the base of (1) switch and 0.75 Watts of power was dissipated in the wire. The wire became warm to the touch but had no effect on the switch.

Conclusion: 0.75 Watts, the maximum power in the proposed circuit design, is insufficient to cause substantial electrolytic corrotion or significant switch terminal heating, which is necessary to create an ignition. In previous tests, using a resistor as the heating element (see Test 6), approximately 5 Watts of power was necessary to create an ignition. There is not enough power in the proposed circuit to greate ignition.

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#### Carrey, Pat

Prom:

McGuirk, Andy [a-mcguirk@smail.mc.tl.com]

Seat:

Thursday, May 20, 1999 1:07 PM

To:

Warner, Pam

Subject:

FW: Test Report Synopsis and testlog.





AUTOMOTIVE SENSORS AND CONTROLS ORA MANAGER

34 FOREST ST M/S 23-05 ATTLEBORO, MA 02703 TEL : (508) 236-3080 FAX : (508) 236-3745 MOBILE: (508) 208-6119

PAGE: (800) 467-3700 PIN 604-2044

From:

Mulligan, Sean Thursday, May 20, 1999 9:12 AM Sent: McGuirk, Andy: Beringhause, Steven To:

Subject:

Test Report Synopsis and testleg.

Please review the latest version of the Test synopsis and Test log. <<synopsis.doc>> <<TESTLOG9.xls>> Revised items on the Test Synopsis are highlighted in red. There have been minor changes throughout the document so it is worth skimming the entire document (esp. in light of recent developments).

The following items have been updated on the test log: Tust 14, 15s and 17.

Awaiting your feedback,

All the best,

Sean P. Mulligan

Texas Instruments Automotive Sensors & Controls Mechanical Design Phone (508) 236-2535 Fax (508) 236-3586

## TI 77PS Test Synopsis Draft 7/12/99

This document is a synopsis of tests conducted by Texas Instruments during the 77PS investigation. The intent of this document is to highlight test findings which drove the investigation to its current state. Throughout the investigation, several tests were conducted with the same objective. When each objective was met, efforts were refocused to obtain a new level of understanding and to establish a new set of objectives. As such, tests have been categorized into (5) Isvals, representing the level of knowledge obtained from the group of tests conducted. Each level is listed below with a short description of the objective:

Level 1: Create a laboratory switch ignition without any restrictions on methods.

Level 2: Create a laboratory switch ignition using only conditions found in the switch operating environment.

Level 3: Understand the laboratory ignition mechanism.

Level 4: Compare factors contributing to laboratory ignition.

Level 5: Evaluate recommandations.

#### Refer to Brake Pressure Switch Test Log.

Level 1 Objective: Determine if a switch ignition can be created in the laboratory.

#### Test 1

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact cavity flooded with brake fluid mixed with varying amounts of %  $H_2$ 0.

14 volts applied to one terminal, second terminal electrically floating. (No electrical load across switch terminals).

Switch hexport electrically grounded.

#### Results:

- (8) samples were tested total:
- (2) with 4% H<sub>2</sub>0 in brake fluid.
- (2) with 6% H<sub>2</sub>0 in brake fluid.
- (2) with 10% H<sub>2</sub>0 in brake fluid.
- (2) with 75% H<sub>2</sub>0 in brake fluid.

No ignition occurred. No significant temperature rise observed in all samples. Current draw ranged from 0.5 mAmps to 5 mAmps over a period greater than (250) hours.

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#### Test 2

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact flooded with brake fluid. 14 volts applied to one terminal, second terminal connected to a 14  $\Omega$  resistor which is tied to ground. (1 Amp load across switch terminals). Switch hexport electrically grounded.

Results: (2) samples were tested. No ignition occurred. No significant temperature rise observed for a period over (250) hours.

Conclusion: A (1) Amp load through switch terminals cannot ignite brake fluid in the contact cavity of switches.

#### o Text6

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Heater element installed in contact cavity of the switch.

Power applied to the heater element until plastic base meits.

Spark generated in contact cavity of switch.

Brake fluid present in the contact cavity (wet device) and absent in the contact cavity (dry device).

Results: (2) dry devices were tested and (1) wet devices was tested. Ignition occurred in all devices.

Wet device: The internal temperature of a wet device reached 660°F. A hole burned through the base of the switch (close to the heating element). The applied spark ignited the fumes in the contact cavity of the switch and engulfied the base material of the switch.

<u>Dry device:</u> The internal temperature of a dry switch reached over 1000°F. The switch base flopped over. The applied spark ignited the fumes in the contact cavity of the switch and engulfed the base material of the switch.

Conclusion: A switch ignition can occur under the following laboratory conditions:

Heater element installed in the switch contact cavity.

5 watts of power dissipated in heating element.

Spark generated in the contact cavity of the switch.

Brake fluid did not contribute to the ignition process.

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Level 2: Objective: Determine if a laboratory ignition can occur using only switch components and elements found in the switch environment.

#### Test 6a.

Objective: Determine if corrosive degradation of switch electrical components can cause an increase in electrical resistance (and thus a source of heat) in the switch, which may lead to an ignition.

Results: (1) out of (15) samples tested increased resistance to 5  $\Omega_B$ . A solution of 5 wt. % NeCl in H<sub>2</sub>0 can corrode the electrical components of the switch and cause an increase in electrical resistance. Repeated injections of the solution of 5 wt. % NaCl in H<sub>2</sub>0 into the contact cavity of a switch, with the switch continuously powered at 14 Volts, can cause an ignition.

Conclusion: A switch ignition can occur under the following laboratory conditions:

A solution of 5% NaCl in H<sub>2</sub>0 is injected into contact cavity of a switch. Continuous 14 Volt power applied to the switch. Hexport is grounded.

Current is limited at 15 Amps.

#### Test 6c

Objective: Determine if brake fluid with metal shavings is conductive enough to create an ignition.

Results: (3) devices with various size metal particles were tested. No significant current increase detected.

Conclusion: Metal shavings did not significantly increase conductivity brake fluid. Current levels measured were well below levels necessary to create an ignition.

#### Test 7

Objective: Determine if switch meets cycle life specification.

Results: Tests conducted during the first quarter of 1999 show that switches exceed cycle life specification.

In the first quarter of 1999, a total of (42) 77PSL2-1 snap switches were impulse tested to over 1,000,000 cycles with only (1) leak below 1,000,000 cycles, which

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occurred at 728,000 cycles. A Welbull analysis showed 99.9% reliability at 500,000 cycles at 95% confidence level.

Conclusions: Switches meet cycle life specification. First quarter, 1999 tests confirm impulse test findings made during the period between 1991 and 1992. During that period, (6) impulse tests on 144 devices of 57PS and 77PS construction, had no leaks when tested to 500,000 cycles. A Weibuli analysis of first quarter, 1999 tests, showed 99.9% reliability at 500,000 cycles at 95% confidence level.

#### Test 15a

Objective: Determine the long term corrosive effects of brake fluid on the electrical components of switches which are continuously powered at 14 Volts.

Results: Test was suspended after 550 hours of testing. (6) samples were tested with continuous 14 Volts power. The contact cavity of (4) switches contained new brake fluid and (2) switches contained old brake fluid. Switches with old brake fluid drew very little hexport current and showed a decrease in hexport current over time to less than 1/10 mAmp. Samples with new brake fluid showed an increase in hexport current to over 20 mAmps toward the end of the 550 hours of testing. Analyses of (1) sample with new brake fluid and (1) sample with old brake fluid revealed electrolytic corrosion of the contact arm of both switches. There was a much lower level of corrosion in the sample with used brake fluid than the sample with new brake fluid.

Conclusion: Brake fluid in the contact cavity of switches, which are at 14 Volts continuous power for over 500 hours, can cause electrolytic corrosion of the switch contact arm. It is unknown if this corrosion, under continuous power conditions, can eventually lead to sufficient current draw to drive an ignition.

#### Test 17

Objective: Quantify the long term corrosive effects of new brake fluid on the electrical components of switches under the following laboratory conditions:

Contact cavity of switch flooded with new brake fluid. Switches at continuous 14 Volts power.

Switches subjected to vibration for (1) hour per day.

Switches subjected to 100°C for (1) hour per day.

Results: Test suspended after (312) hours. (50) samples tested. The average hexport current draw after (312) hours is 1.9 mAmps with a standard deviation of 1.8 mAmps. These has been no increase in hexport current. These results are consistent with results previously found in Test 15s.

Conclusion: New brake fluid in the contact cavity of switches, has not caused an increase in hexport current after (312) hours at continuous 14 Volta power.

Level 3: Objective: Understand the laboratory ignition process, determine the current path and establish a repeatable ignition method.

#### Test 6b

Objective: Understand the ignition process, determine the current path and establish a repeatable ignition method.

Results: Multiple attempts at laboratory ignition, via injection of a solution of 5 wt. % NaCl in H<sub>2</sub>0 into the contact cavity of switches, has resulted in a repeatability rate of approximately 50%. Plots of hexport current verses time show an increase in current until the point of ignition.

Conclusion: A repeatable laboratory method for switch ignition was established. Based on hexport current measurements, the current path is from switch terminals to hexport body.

When a solution of 5 wt. % NaCl in H<sub>2</sub>0 is repeatedly injected into the contact cavity of powered switches, electrolytic corrosion of the switch terminal results in an increase in terminal resistance. When sufficient power is drawn through the corrosive resistance, switch elements heat up and begin to glow red hot. A hole burns through the switch base and ignition occurs. There is aroing visible throughout the corrosion process which may provide the spark necessary for ignition.

Level 4: Objective: Compare and contrast variables influencing ignition using the established laboratory ignition method.

#### Test 13a

Objective: Compare various fluids in the established ignition method.

Results: The following fluids were tested.

- (1) NaCl in H<sub>2</sub>0.
- (1) tap water
- (1) rain water
- (1) used brake fluid
- used brake fluid with 5 wt. % H<sub>2</sub>O
- (1) new brake fluid
- (1) new brake fluid with 5 wt. % H<sub>2</sub>O

The switch filled with 5 wt. % NaCl in H<sub>2</sub>0 resulted in an ignition when average hexport current exceeded 2.5 Amps. Switches that were filled with tap water and rain water drew less than 10 mAmps over a (3) hour test and showed little sizes of

corresion. Switches filled with a matrix of new and used brake fluids, with water and without water, all drew less than 3 mAmps hexport current draw and showed no signs of corresion over the (24) hour test.

Conclusion: Brake fluid is not conductive enough to cause the electrolytic corrosion and necessary current draw to create an ignition. Because of its significantly higher conductivity, an ionic rich fluid such as NaCl in  $H_2O$  is necessary to cause an ignition.

#### e Test 15

Objective: Compare the ignition characteristics of various plastics as switch base material.

Results: When 5 wt. % NaCl in H<sub>2</sub>0 was injected into switches with different base materials, the following results were obtained: Cellanex 4300 ignited 3 out of 5 attempts. Noryl ignited 2 out of 5 attempts. Zytel ignited 1 out of 5 attempts.

Conclusions: All plastics tested can ignite using the established laboratory ignition method.

#### Test 15b

Objective: Determine if switch ignition can occur in the vertical position and 45° orientation. Determine if switch ignition can occur and at different rotational angles in the 45° orientation.

Results: Switch ignitions can occur in both the vertical and 45° orientation using the established laboratory ignition method.

Conclusion: Switch ignition does not appear to be sensitive to vertical orientation verses 45° orientation nor to rotational angle in the 45° orientation.

#### Level 5 Objective:

#### Test 16

Objective: Test proposed relay circuit.

Results: (1) switch was injected with a solution of 5 wt. % Necl in H<sub>2</sub>0 and placed in the proposed current limiting circuit for (48) hours. The current draw remained constant at 180 mAmps throughout the test. There was no activity observed and the contact arm remained mostly intact.

(1) switch was brought to an impending burn condition using the established burn method. An impending burn is a condition where a corresive resistance has built

TI-NHT8A 013627

up in the switch and an ignition is imminent. The switch was then placed in the proposed relay circuit for (18) hours where it drew 160 mAmps, showed no visible activity and did not result in an ignition.

Because the proposed relay circuit acts as a resistor which limits current to the switch, the maximum power to the switch is limited to .75 Watts. A resistive wire was wrapped around the base of (1) switch and 0.75 Watts of power was dissipated in the wire. The wire became warm to the touch but had no effect on the switch.

Conclusion: 0.75 Watts, the maximum power in the proposed circuit design, is insufficient to cause substantial electrolytic corresion or significant switch terminal heating, which is necessary to create an ignition. In previous tests, using a resistor as the heating element (see Test 6), approximately 5 Watts of power was necessary to create an ignition. There is not enough power in the proposed circuit to create ignition.

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# CELTUY, Pat

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# **Brake Pressure Switch** Institutions Potential Thermal Event Theory Profile 5/20/99



# **NA Hydraulic Switch History**

Time Period:	'83	<b>'87</b>	<b>'90</b>	<b>'91</b>	<b>'98</b>	<b>'99</b>
Application:	Power Steering	Power Steering Suspension	Power Steering Suspension Transmission	} •	Cruise	Power Steering Suspension Transmission Cruise Clutch
Fluid:						

- Ti has some 16 years and 130 million units accumulated experience in hydraulic applications using multiple fluids
- Ti has some 12 years of brake system application experience working with brake fluids