EA02-025

TEXAS INSTRUMENTS, INC.'S 9/10/03 ATTACHMENT

REQUEST NO. 7

BOX 8

PART A-U

PART A

Ford Motor Company
of Australia Limited
A.C.N. 004 116 283

Rapifax Transmission

OUR REF. ....
PAGE 1 OF 1
FROM JOHN PECK
DEPT. CAPRI ENGRG
RAPIFAX No.: (052) 788109
DATE: 4/8/92

TO: DANNY O'DRISCOLL - TEXAS INSTRUMENTS
cc P. SAWYER/C. CAREY - BCIA AUST.
FAX: cc V. STOIOS/P. WILLIAMS - SUPPLY H/O
cc T. WORTHINGTON

DELIVERY: ☐ NORMAL ☐ RUSH-CALL FOR PICKUP

SUBJECT - SWITCH ASY - SPEED CONTROL DEACTIVATE (94JA-9F924-AB)

TESTS CONDUCTED ON THE EVACUATE AND FILL EQUIPMENT IN BROADMEADOWS PLANT 2, CONFIRMS THAT VACUUMS AS LOW AS 0·4 MILLIBARS ARE ACHIEVED, WITH A RANGE OF 0·4 - 1·0 MILLIBARS OVER THE VEHICLE POPULATION. THESE LOW PRESSURES HAVE BEEN ESTABLISHED TO MINIMISE THE 'SOFT PEDAL' CONCERN WHICH IS INHERENT IN CAPRI.

SINCE ABOVE SWITCH ASY IS DESIGNED TO COMPLY WITH ES-E2VC-9F924-AA, WHICH REQUIRES A VACUUM CAPABILITY OF 3-6 MM Hg, THERE IS DOUBT AS TO THE ABILITY OF 94JA-9F924-AB TO COPE WITH OUR BROON EVAC AND FILL EQUIPMENT REQUIREMENTS.

WOULD YOU PLEASE INITIATE AND PREPARE A WORK PLAN TO

A) EVALUATE EFFECTIVENESS OF SEALS IN 94JA-9F924-AB AT VACUUM LEVELS OF 0·4 MILLIBARS.

B) IF NECESSARY, TO DETERMINE DESIGN CHANGES REQD TO SWITCH TO COPE WITH A VACUUM OF 0·4 MILLIBARS

C) ESTABLISH COST AND TIMING IMPLICATIONS OF REQUIRED CHANGES (TOOLING AND PIECE). OUR PROGRAM INTENT IS FOR AN OTS SUBMISSION TO SUPPORT PPB BUILD WITH STOCK IN B/M PLANT (MRD DATE) BY 1/11/92 (NOV). LATEST POSSIBLE OTS SUBMISSION WOULD BE APRIL 14 93 TO SUPPORT PCB BUILD.

WOULD YOU PLEASE TREAT THIS AS EXTREMELY URGENT, AND ADVISE YOUR TIMING FOR PREPARATION OF A) B) C) ABOVE BY 7/8/92.

REGARDS

[signature]

Ford Motor Company of Australia Limited
A.C.N. [illegible]

Rapifax Transmission

OUR REF.

PAGE 1 OF 2

FROM JOHN BECK

DEPT. CAPRI ENGRG

RAPIFAX No.: (052) 788109

TO: DANNY O'DRISCOLL – TEXAS INSTRUMENTS.
PATRICK SAWYER / CATHY CAREY – BCIA.

7785 L61
Spec change

RAPID CC. V. STOIOS / T. WORTHINGTON / P. ROBERTS / P. WILLIAMS.

DELIVERY: ☐ NORMAL ☐ RUSH-CALL FOR PICKUP

SIG:

DATE: 6/4/92

SUBJECT – SWITCH ASY – SPEED CONTROL DEACTIVATE 94JA-9F924-AB.

FOLLOWING DISCUSSIONS WITH DANNY O'DRISCOLL RE REQUIREMENTS OUTLINED IN MY RAPIFAX TO PATRICK SAWYER, DATED 30/10/92, IT IS APPARENT THAT THE [redacted] REPRESENTS A MARGINAL PERFORMANCE REQUIREMENT, WHICH IS NOT ACCEPTABLE TO TEXAS INSTRUMENTS.

REVIEW OF THE HMO IMPULSE TEST (III.K.) SHOWS THE REQUIREMENTS FOR PRESSURE PULSE (1450 PSI), AND TEST FLUID TEMPERATURE (135°C) TO BE FAR MORE SEVERE THAN CAPRI FIELD REQUIREMENTS, AND OF THE REQUIREMENTS OF S84 DA-2140-AA CYLINDER ASY - BRAKE MASTER, AS APPLIED TO THE CAPRI BRAKE MASTER CYLINDER (1000 PSI AND AT ROOM TEMPERATURE RESPECTIVELY).

I AM THEREFORE PROPOSING THAT THE DRAWING 94JA-9F924-AB BE REVISED TO INCLUDE THE NOTE – "REQUIREMENTS OF ES-F2VC-9F924-AA REVISED TO DELETE SECTIONS III.E (IMPULSE TEST) AND III.K (VACUUM TEST) [redacted] ALL OTHER TEST CONDITIONS AND ACCEPTANCE CRITERIA INCLUDED IN III.E/III.K ARE TO BE APPLIED".

INTENT IS THAT THE CURRENTLY RELEASED SWITCH ASY – 94JA-9F924-AB BE RETAINED, AND THAT ALL VENDOR RIG TESTING BE COMPLETED TO SUPPORT A FOTS SUBMISSION OF T-ASY, BRAKE MASTER CYL TUBE 94JA-2C247-AB, TO FORD, PRIOR

OUR REF.:
PAGE 2 of 2
FROM:
DEPT.:
RAPIFAX No.:
TO:
FAX:
DELIVERY: ☐ NORMAL ☐ RUSH-CALL FOR PICKUP
B/O: DATE:

TO PCB MRD (14/4/93). WHERE APPLICABLE IT IS ANTICIPATED THAT TESTING ALREADY CONDUCTED AND ACCEPTED FOR NAAO PRESSURE SWITCH WILL BE CARRIED OVER INTO 94JA-9F924-AB, AND THAT THE ONLY UNIQUE FOA REQUIREMENTS WILL APPLY TO ABOVE TEST REQUIREMENTS, AND TO DIMENSIONAL CHARACTERISTICS OF EXTERNAL (IMPERIAL) THREAD AND TO 'O'-RING 3.903.

WOULD ABOVE ADDRESSEES PLEASE ADVISE CONCURRENCE WITH ABOVE TO ENABLE DRAWING TO BE REVISED ACCORDINGLY.

REGARDS.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 299-15-96

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
Ass Car 7725	9/20/24	Steve Offerle	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeffrey DiDomenico	9/20/25		

PROJECT TITLE: Fd Speed Control PS

CUSTOMER: -

PURPOSE OF TEST: To test our Ford Australia Switch to a more powerful vacuum.

PROCEDURE:
- 3 devices, 3 sensors
- char devices
- x cycles to lowest attainable vacuum @ 10.0 psia
- re char devices
- cut hex's off sensors and examine

[illegible]	act	rel	V	act	rel
[illegible]	[illegible]	77	A	139	89
[illegible]	[illegible]	85	A	133	94
[illegible]	127	99	C	129	96

[illegible] Kapton is ... beginning to be ... [illegible]

TI-NHTSA 011211

(OVER)

-MSG M#= 68675 FR=SBO1 TO=ZARN SENT=06/29/92 02:00 PM
R#=142 ST=C DIV=0050 CC=00101 BY=SBO1 AT=06/29/92 02:00 PM

TO: Danny O'Driscoll DOD

CC: Peter Surner SAGT
Dave Czarn ZARN
Jeff DiDomenico DIDO
Charlie Douglas CMP1

FR: Steve Offiler SBO1

SJ: Ford of Australia Vacuum Spec.

We have attempted to test six 77PS devices on a vacuum manifold to the levels requested by Ford of A (0.4 to 1.1 mBar). After several minutes, we were able to attain a vacuum level which fluctuated between 1.3 and 1.45 mBar. I believe this represents the true limits of our equipment in its present form. We cycled five times between atmospheric and vacuum, as called out in the Ford of USA spec (ES-F2VC-9F924-AA). Three devices were characterized before and after, and showed no apparent performance degradation as a result of the vacuum exposure. The other three devices were disassembled in such a way as to allow inspection of the diaphragm/fluid seal in the assembled state. Unfortunately, the diaphragms showed obvious signs of being sucked significantly out of place on two of the three devices. I have a concern that this could lead to shortened diaphragm life. This has raised a number of questions:

* How is the diaphragm life affected, and at what vacuum level?
* Is five cycles needed, based on the factory-fill vacuum procedure, and will our device look better if only cycled once to these vacuum levels?
* Is the out-of-place diaphragm pushed back into place once the device is pressurized in fluid?

This is going to require additional effort and testing on my end to answer these questions, which presents some difficulty since both time and cycler capacity are in relatively short supply.

As far as Ford of A is concerned, can we get an answer on why they say they need a vacuum level (0.4 to 1.1 mBar) which exceeds the Ford of USA level by more than an order of magnitude? Is this realistic? What is their feeling on the number of vacuum cycles?
Regards,
Steve O.

MSG-NR= 371117 FR=SB01 TO=ZARN SENT=07/10/92 09:24 AM
R=024 ST=C DIV=0050 CD=00:01 BY=SB01 AT=07/10/92 09:24 AM

TO: Danny O'Driscoll DOD

CC: [redacted] ZARN
Charlie Douglas IMP1

FR: Steve Oeller SB01

SJ: Vacuum & Samples

===

Danny, glad to hear that Ford is proceeding with the measurements of the true vacuum levels in their system. Since we discovered that extreme vacuum tends to displace our diaphragm, I am maintaining my plan to better understand the effect (if any) of vacuum on diaphragm life; however, I'll be lowering the priority.

For the record, here are the vacuum unit conversions I've been using:

1 bar = 14.504 psi = 1000 mBar
1 mm Hg = 0.01934 psi
1 mBar = 0.750 mm Hg

Ford (USA) spec of 3 to 6 mm Hg equals 4 to 8 mBar.

One other point: we have settled upon dark gray as the color for Capri (77PSL6-1). In your message #2340878 you mention that the color change will take weeks, not days, to come through. We are intending to use dark gray for the 330 OTS samples, since this is indeed production-intent. We thought we'd better check to make sure that it's okay to ship parts in dark gray.

Regards,
Steve O.

TI-NHTSA 011213

-MSG M#= 00504507 FR=SBO1 TO=SBO1 SENT=08/06/92 01:29 PM
S#=194 ST=C DIV=0050 CC=00101 BY=SBO1 AT=08/06/92 01:29 PM

TO: Danny O'Driscoll DOD

CC: Dave Czarn ZARN
Jeff DiDomenico DIDO
Charlie Douglas CMP1

FR: Steve Offiler SBO1

SJ: Ford of Australia Vacuum Spec

TI-NHTSA 011214

Thanks for the fax and MSG, Danny. (For future reference, my fax number is 508-699-3153.) We in Attleboro share your surprise that Ford is truly maintaining this rather extreme vacuum level, 0.4 mBar (=0.3 mm Hg or Torr, =0.006 psia). I've mentioned before that this is about one order of magnitude higher than the Ford US spec; although to be honest, we don't know where the US spec of 3-6 mm Hg came from and how accurate it is. In response to John Peck's request:

A) Evaluate the effectiveness of seals at vacuum level of 0.4 mBar.

We have found that the "diaphragm" (a polymer film material which serves to separate the fluid from the internal workings of the switch) is literally sucked out of place at a vacuum of about 1.3 mBar. I expect this condition to worsen down at 0.4 mBar. Although it still provides an effective seal initially, when sucked out of place the diaphragm becomes wrinkled, and these wrinkles give rise to stress concentrations during pressure cycling which will result in ruptures/tears and leakage long-term.

To evaluate the situation, I plan to first conduct a controlled experiment of diaphragm life versus vacuum. I'll need to come up with vacuum equipment capable of 0.4 mBar, but I don't think this will present a major problem. Eighteen test devices will be built. Twelve of these will be subject to vacuum, with 6 destined for life-cycling, 3 opened for visual inspection, and 3 subject to a 3000 psi proof pressure test then opened for visual inspection. (The proof parts will tell me what happens to the diaphragm with application of positive pressure). The remaining 6 of 18 will be the control group for life-cycling, not subject to vacuum. We'll run the cycle test at ES parameters of pressure and temperature, however all parts will be run to failure and analyzed using Weibull techniques to see if the vacuum causes a significant reduction in diaphragm life.

Scheduling the above is a bit touchy. This test must run in my brake-fluid running now which will complete about 13/08/92, and I've got Capri validation which must be started approx. 04/09/92 in order to deliver the finished report to Australia as promised by end-September. I'll be running the vacuum test in the 3-week window between these two tests. So, results should be available roughly the first week of September.

B) Determine design changes required, if necessary.

This is purely speculation at this point. We really need to know the results of the testing in A) above before any direction can be determined. Initial ideas at this point include: an additional mechanical element to hold the diaphragm against the forces which displace it; more robust (thicker, stiffer) diaphragm materials; alternate diaphragm materials (such as EPDM rubber); features (such as knurling) to hold the diaphragm tighter; even wilder ideas like a check-valve which closes upon vacuum application, etc etc.

C) Cost and timing implications.

A 1/11/92 OTS submission for PPB build would mean a production-tooled solution by mid-October. The window for cycling testing to validate the proposed solution(s) starts with completion of the normal Capri validation in mid-September. It is flatly impossible to identify the solution, prototype it, prove it out, tool it, and validate using the production-tooled parts, in one month's time. Unless, of course, we hit upon something which requires no tooling (such as a material change). Therefore, it's likely that we'll be forced to work off of the 14/04/93 OTS submission for PCB build. (Question: are either of these builds producing cars for sale to customers?)

A couple of other points, Danny. I'm updating the envelope drawing to include a note pointing to the O-ring. We've noticed an error in the overall length of the device, presently given as 57.15 max. This number is correct on other devices which use a different hexport and was accidentally carried over on the Capri drawing. The O-ring hexport used on Capri is an off-the-shelf item also used on European power steering switches, and is longer in the hex-flat area by about 1 mm. Simple math says 58.15 would be correct, but we figured we'd take the opportunity to build in a little slack and would propose 58.5 mm.

Also, our ES testing strategy for Capri is to perform only the Impulse and Thermal Cycle tests, and claim similarity to 77PSL3-1 (the silent US Pass-Car device) for all the rest of the tests. To the best of my knowledge, this is an internally generated strategy, and really should be concurred by the customer. The rationale for running only these two tests is because the Capri device uses the same pressure-sensing components as L3-1, and the same electrical elements including the base material. The only real difference is the hydraulic seal, which is O-ring on Capri versus SAE J512 metal-to-metal on L3-1. The Impulse test exercises this seal at elevated temperature over a large number of cycles, and Thermal Cycle includes thermal expansion effects and rubber durometer changes with temperature. Please make sure our customer is aware that the ES test report will be structured as such.

Regards,
Steve O.

-MSG M#= 2217727 FR=DOD TO=ZARN SENT=08/11/92 03:54 AM
R#=054 ST=C DIV=0071 CC=00260 BY=DOD AT=08/11/92 03:37 AM

To: STEPHEN B. OFFILER SBO1

Copy: DAVID CIARN ZARN
CHARLIE DOUGLAS CMP1

From: DANNY O'DRISCOLL DOD

Subj: FORD CAPRI VACUUM SPEC

STEVE, THANKS FOR THE FAIRLY COMPREHENSIVE SUMMARY OF THE VAC. SPEC SITUATION. FORD HAVE REQUESTED THAT WE DEVELOP A PRESS SWITCH THAT CAN WITHSTAND THE VACUUM LEVEL AND SUPPLY PRODUCTION INTENT PROTOTYPES FOR THE FPB BUILD DATE OF 1/11/92.
FORD ACCEPT THAT THE VALIDATION PROCESS IS LENGTHY AND AS SUCH WE WOULD VALIDATE [illegible] AND ANYTHING ELSE THAT WE CAN PRACTICALLY DO WITHIN [illegible] THEN BE EXPECTED TO SUPPLY THE VALIDATION DATA [illegible]

[illegible]

[illegible] THE VACUUM AT [illegible] ABOUT FORCE [illegible] VACUUM. IF SAY OUR [illegible] CYCLES COULD WE [illegible] BY SPEC. [illegible]

[illegible] AIR [illegible] INTO THE BRAKE SYSTEM [illegible] THE LEVEL OF VACUUM. [illegible]

[illegible] FORD DO NOT SELL ANY PROTOTYPED [illegible] ALL [illegible] ARE USED [illegible] COMPANY FLEET [illegible]
[illegible] LEVEL MAY BE USED BY THE [illegible] AND THEN SOLD OFF AT A LATER DATE.

[illegible] CAPRI [illegible] BRAKE SYSTEM [illegible] HAVE A JOINT VENTURE [illegible] HAS BEEN A PROBLEM FOR NEARLY A DECADE [illegible] HAD MANAGED TO SOLVE IT.

[illegible]

-MSG M## 16934 FR=SB01 TO=ZARN SENT=08/11/92 03:47 PM
RM=061 ST=C DIV=0050 CC=00101 BY=SB01 AT=08/11/92 03:47 PM

TO: Danny O'Driscoll -- DOD

CC: Dave Czarn ZARN
Jeff DiDomenico DIDO
Charlie Douglas CMP1
Jim Watt JW02

FR: Steve Offiler SB01

SJ: Vacuum - Capri 77PBL6-1

TI-NHTSA 011217

Danny: I'm trying to lay out a schedule that will allow us to meet the MRD of 1/11/92. Thanks for clarifying that these can be production-intent PROTOTYPES. Previously, I was under the impression that "off-tool" (OTS) PRODUCTION parts were needed.

I have a key question that significantly impacts my schedule: do we still need to submit a complete ISR package by the end of September as previously planned? I am assuming the answer is no. Instead, one possibility is to submit a partial ISR in the late September timeframe, which contains no ES testing report. It makes no sense to test a soon-to-be-modified design (assuming we do indeed have a problem with the present design!), and I'll need my cycler for development testing and evaluation of the high-vacuum design modifications instead of performing ES testing on the "old" L6-1. A complete ES report on the new design will be planned for late December/early '93 per your inputs. Please close with Ford on this. Do they even need/want the partial in Sept, or do we just send the complete package in Dec ?

I'm presently revamping my plans for diaphragm life testing of the present design under high vacuum conditions. Instead of spending time simply evaluating the present design, instead I'll be including several prototype ideas in this same test. Regarding your question on the number of cycles of vacuum: This is a good point. We'll structure the evaluation to include checks of the present design at one and five vacuum cycles to characterize this. Maybe we'll discover the problem can be handled by spec'smanship. All other proto's will be at five cycles.

Danny, I'd like to make sure you understand a seeming inconsistency in the ES. My evaluation work is to characterize diaphragm life after application of vacuum. This is because I've noted visually that, after vacuum, the diaphragm looks like there might be a long-term life problem. The inconsistency is that nowhere in the ES does any device undergo a diaphragm life test after vacuum! So it may seem that, purely from a spec standpoint, I am performing superflous work - when in fact this is a very fundamental test. On the other hand, we don't necessarily wish to rewrite the spec to include this type of test either, because it adds a lot of extra work. I'm trying to sensitize you to this because I suspect it may come up with Ford when we discuss our ES testing plans for validation with them. If I were Ford, I'd insist upon this addition.

Do we allow air to leak into the brake system? I really don't know, but I doubt it. If we can plumb up a nice tight vacuum test system, that doesn't leak when dead-ended, then we can try a leakdown test on our device.

I think your comments on the soft pedal issue are pretty interesting - no one has been able to solve it in a decade! So: does super vacuum actually make a difference ? And if so, what happens later on when the brake system is serviced ?

[illegible] did you [illegible] my question regarding [illegible] in the overall length spec from 57.15mm max to 58.5 mm max? [illegible] going ahead with the print change? I'm hoping we don't blind-side Ford with it.

Regards,
Steve O.

-MSG MS= 00018734 FR=SS01 TO=SS01   SENT=08/11/92 03:47 PM
SS=196 ST=C DIV=0050 CC=00101 BY=SS01 AT=08/11/92 03:47 PM

TO: Danny O'Driscoll DOD

CC: Dave Czarn[redacted] ZARN
Jeff DiDomenico DIDO
Charlie Douglas CHP1
Jim Watt JW02

FR: Steve Offiler SS01

SJ: Vacuum - Capri 77PSL6-1   TI [illegible]

Danny: I'm trying to lay out a schedule that will allow us to meet the MRD of 1/11/92. Thanks for clarifying that these can be production-intent PROTOTYPES. Previously, I was under the impression that "off-tool" (OTS) PRODUCTION parts were needed.

I have a key question that significantly impacts my schedule: do we still need to submit a complete IBR package by the end of September as previously planned? I am assuming the answer is no. Instead, one possibility is to submit a partial IBR in the late September timeframe, which contains no ES testing report. It makes no sense to test a soon-to-be-modified design (assuming we do indeed have a problem with the present design!), and I'll need my cycler for development testing and evaluation of the high-vacuum design modifications instead of performing ES testing on the "old" L6-1. A complete ES report on the new design will be planned for late December/early '93 per your inputs. Please close with Ford on this. Do they even need/want the partial in Sept, or do we just send the complete package in Dec ?

I'm presently revamping my plans for diaphragm life testing of the present design under high vacuum conditions. Instead of spending time simply evaluating the present design, instead I'll be including several prototype ideas in this same test. Regarding your question on the number of cycles of vacuum: This is a good point. We'll structure the evaluation to include checks of the present design at one and five vacuum cycles to characterize this. Maybe we'll discover the problem can be handled by spec'smanship. All other proto's will be at five cycles.

Danny, I'd like to make sure you understand a seeming inconsistency in the ES. My evaluation work is to characterize diaphragm life after application of vacuum. This is because I've noted visually that, after vacuum, the diaphragm looks like there might be a long-term life problem. The inconsistency is that nowhere in the ES does any device undergo a diaphragm life test after vacuum! So it may seem that, purely from a spec standpoint, I am performing superfluous work - when in fact this is a very fundamental test. On the other hand, we don't necessarily wish to rewrite the spec to include this type of test either, because it adds a lot of extra work. I'm trying to sensitize you to this because I suspect it may come up with Ford when we discuss our ES testing plans for validation with them. If I were Ford, I'd insist upon this addition.

Do we allow air to leak into the brake system? I really don't know, but I doubt it. If we can plumb up a nice tight vacuum test system, that doesn't leak when dead-ended, then we can try a leakdown test on our device.

I think your comments on the soft pedal issue are pretty interesting - no one has been able to solve it in a decade! But does super vacuum actually [illegible]

TI-NHTSA 011219

Finally, did you note my question regarding a change in the overall length spec from 57.15mm max to 58.8 mm max ? I'm going ahead with the print changes I'm hoping we don't blind-side Ford with it.

Regards,
Steve O.

-MSG N#= 2237068 FR=DOD TO=ZARN SENT=08/12/92 03:14 AM
R#=062 ST=C DIV=0071 CC=00260 BY=DOD AT=08/12/92 02:46 AM

To: STEPHEN B. OFFILER SBO1

Copy: JEFFREY A. DIDOMENICO DIDO
CHARLIE DOUGLAS CMP1
JIM WATT JWO2
DAVID CZARN ZARN

From: DANNY O'DRISCOLL DOD

Subj: CAPRI VACUUM

I AM WORKING ON GETTING SOME ANSWERS TO YR QUESTIONS AT BCIA AND FORD BUT IT MAY TAKE A FEW DAYS.

YES - I DID COMPREHEND THE LENGTH CHANGE BUT AGAIN I AM WAITING ON BCIA.

WITH REGARD TO YR ES TEST STRATEGY: HOW SUCCESFULL DO YOU THINK WE CAN BE IN OUR EFFORTS TO CLAIM SIMILARITY TO THE L3-1 ? MY VIEW IS THAT IT MAY BE DIFFICULT TO CLAIM SIMILARITY BETWEEN A MODIFIED "LOW VACUUM" P/S AND THE L3-1.

CHARLIE - THE CAPRI WAS DESIGNED AND BUILT ON THE A PRE EXISTING FORD MODEL CALLED A "LASER". NOW, THE LASER IS A BADGED MAZDA 323. BY BADGED I MEAN THAT FORD ASSEMBLE THE MAZDA 323 (WITH SOME MINOR VARIATIONS) UNDER A LICENSING AGGREEMENT WITH MAZDA JAPAN.
FORD HAVE ALWAYS HAD A SOFT PEDAL PROBLEM WITH THE LASER AND SINCE IT USES THE SAME BRAKE SYSTEM AND COMPONENTRY - SO DOES THE CAPRI.
FORD HAVE DETERMINED THAT IT WILL COST FAR TOO MUCH TO REDESIGN THE MASTER BRAKE CYLINDER TO ELIMINATE THIS PROBLEM SO THEY USE A LOW VACUUM EVACUATION AND FILL PROCESS TO OVERCOME THIS.
THE MAIN REASON BEHIND THE LOW VACUUM LEVEL IS TO ELIMINATE THE SOFT PEDAL BUT AT THE SAME TIME FILL THE BRAKE SYSTEM WITHIN THE ALOTTED MANUFACTURING ASSEMBLY CYCLE TIME.
WHEN THE BRAKE SYSTEM IS SERVICED IN THE FIELD A DIFFERENT METHOD OF FILLING IS USED WHICH IS LONGER (TAKES ABOUT 15 MINUTES COMPARED TO 2 MINUTES IN THE FACTORY) AND CONSIDERED BY THE FORD GUYS TO BE A SUPERIOR METHOD THAN THE EVAC & FILL PROCESS.

I HOPE THIS ANSWERS YR QUESTIONS.

RGDS, DANNY

TITLE: Ford-Australia High Vacuum Testing

PURPOSE: Characterization of diaphragm life vs. vacuum and prototyping work on possible solutions if a problem is indicated.

SCOPE: This test will be conducted with emphasis on controlling variables. All devices shall be built at the same time, by the same individual, and tested simultaneously in the same cycler. Previous diaphragm life testing has produced widely varied results, so it should be recognized that the results of this test are valid only in a relative manner. This emphasizes the importance of controlling as many variables as possible and including as many test lots as possible.

Control lots and prototype lots will be constructed, and indicated devices subject to high vacuum (0.006 psia) per the attached chart. Diverging from the ES, we will subject the devices to only one cycle of vacuum, to be held for 60 seconds per the ES. Certain devices will be cycled to failure using the standard Impulse parameters; others will be cut open for diaphragm visual inspection. Weibull analysis will be employed to compare the diaphragm life in each lot. Test lots include: control lot, standard production configuration, no vacuum; standard production with high vacuum; knurled hexports to increase grip on diaphragm; full-round diaphragms; rubber diaphragms; and Tefzel (fluid-layer) diaphragms. A total of 48 parts will be built; 42 of these must be subject to vacuum; and a total of 12 will be opened.

In a separate procedure, a leakdown test will be conducted. This requires initial leak characterization of the system, dead-ended. Then, a standard production device is installed and the characterization is repeated. Initial vacuum level should be 0.006 psia; final vacuum level should be checked at intervals of 1, 5, and 10 minutes. The vacuum source is to be isolated from the test once the indicated vacuum is attained.

SBO/920819/file: VACUUM

1 DEVICE	2 VAC	3 TST	4	5	6	7	8	9
	NO	CYCLE	CONTROL LOT					
	YES	CYCLE	NO DESIGN MODIFICATION					
	YES	OPEN	NO DESIGN MOD					
	YES	PROOF & OPEN	NO DESIGN MOD			NOTE-> PROOF NOT PERFORMED		
	YES	CYCLE	KNURL HEX FLANGE					
	YES	OPEN	KNURL					
	YES	CYCLE	RUBBER DIA.					
	YES	OPEN	RUBBER DIA					
	YES	CYCLE	FULL ROUND KAPTON					
	YES	OPEN	FULL ROUND KAPTON					
	YES	CYCLE	TEFZEL					
	YES	OPEN	TEFZEL					

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	4.554
LOWER LIMIT	:	2.251 ←
UPPER LIMIT	:	9.213
SCALE(THETA) PARAMETER	:	1597.764
LOWER LIMIT	:	1362.310 ←
UPPER LIMIT	:	1873.912

HIGH VACUUM LOT
6 PIECES

DATA
846 K
1219 K
1556 K
1619 K
1601 K
1702 K

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE : 2.25
* CHARACTERISTIC LIFE : 1362.30

NO.	RELIABILITY(%)	TIME
1	90	501.3031 K

@ LO - 501 K
@ MED - 975 K
@ UPPER - 1460 K

(FULL AND 90% MIN β 5.947 θ 2092.3 90% REL @ 1373 K)

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	14.025
LOWER LIMIT	:	6.933 ←
UPPER LIMIT	:	28.372
SCALE(THETA) PARAMETER	:	1522.074
LOWER LIMIT	:	1445.282 ←
UPPER LIMIT	:	1602.945

CONTROL LOT
6 PIECES

DATA
1324 K
1352 K
1377 K
1512 K
1571 K
1659 K

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE : 6.93
* CHARACTERISTIC LIFE : 1445.28

NO.	RELIABILITY(%)	TIME
1	90	1044.6863 K

@ LO - 1045 K
@ MED - 1296 K
@ HI - 1461 K

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	4.554
LOWER LIMIT	:	2.251 ←
UPPER LIMIT	:	9.213
SCALE(THETA) PARAMETER	:	1597.764
LOWER LIMIT	:	1362.310 ←
UPPER LIMIT	:	1873.912

HIGH VACUUM LOT
6 PIECES
DATA
846 K
1219 K
1555 K
1614 K
1601 K
1702 K

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE : 2.25
* CHARACTERISTIC LIFE : 1362.30

NO.	RELIABILITY(%)	TIME
1	90	501.3031 K

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	14.025
LOWER LIMIT	:	6.933 ←
UPPER LIMIT	:	28.372
SCALE(THETA) PARAMETER	:	1522.074
LOWER LIMIT	:	1445.282 ←
UPPER LIMIT	:	1602.945

CONTROL LOT
6 PIECES
DATA
1324 K
1352 K
1377 K
1512 K
1571 K
1659 K

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE : 6.93
* CHARACTERISTIC LIFE : 1445.28

NO.	RELIABILITY(%)	TIME
1	90	1044.6863 K

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	4.554
LOWER LIMIT	:	2.251 ←
UPPER LIMIT	:	9.213
SCALE(THETA) PARAMETER	:	1597.764
LOWER LIMIT	:	1362.310 ←
UPPER LIMIT	:	1873.912

HIGH VACUUM LOT
6 PIECES

DATA
846 K
1219 K
1555 K
1619 K
1681 K
1782 K

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE : 2.25
* CHARACTERISTIC LIFE : 1362.30

NO.	RELIABILITY(%)	TIME
1	90	501.3031 K

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	14.025
LOWER LIMIT	:	6.933 ←
UPPER LIMIT	:	28.372
SCALE(THETA) PARAMETER	:	1522.074
LOWER LIMIT	:	1445.282 ←
UPPER LIMIT	:	1602.945

CONTROL LOT
6 PIECES

DATA
1324 K
1352 K
1377 K
1512 K
1571 K
1659 K

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE : 6.93
* CHARACTERISTIC LIFE : 1445.28

NO.	RELIABILITY(%)	TIME
1	90	1044.6863 K

-MSG M#- 17608 FR=SBO1 TO=JW02 SENT=09/02/92 01:35 PM
R#=148 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/02/92 01:35 PM

TO: Danny O'Driscoll DOD Jeff DiDomenico DIDO

CC: Mark Bissell AEB3 Jim Watt JW02
Dave Czarn ZARN Paul Westerlind B511
Chris Wagner CDW3

FR: Steve Offiler SBO1

SJ: High Vacuum CCPS for Ford Australia (77PS) Capri 16-1 cc= Blaisdell 94JA-9F924-AB

Danny has pointed out that we neglected to comprehend the Tier-1 supplier in meeting the PPB date of Nov. 1. BCIA (Brake and Clutch Industries of Australia) would like to receive our parts by Oct 16. I have pulled two weeks out of the previous schedule by shortening the total time available for the prototype experiment from 3 weeks to 2 weeks and eliminating the "sanity check" Impulse test (thus relying solely on the results of the experiment to give confidence in the chosen design). Also, I'm back to assuming use of black O-rings with a subsequent changeover to colored O-rings at a later date. I have not shifted the date of ES submission.

Prepare vac/dia life test proto lots	Now - Sep 08
(obtain rubber diaphragms - PURCH)	Sep 4
(obtain model shop parts)	Sep 4
Build prototype lots	Sep 08 - Sep 09
Complete vacuum work (Druck, MARK B.)	Sep 09 - Sep 10
Run dia. life proto experiment	* Sep 11 - Sep 25 (was 3wk)
Impulse on prod. intent (sanity check)	* N/A
Pigmented or striped O-rings (Obtain - CHRIS / PURCH)	* T-B-D (was Oct 14)
Build parts (PPB samples & validation)	Sep 29 - Sep 30
PPB Samples leave US	Oct 02
Val: Init char	Oct 05 - Oct 07
Val: Impulse & TC	Oct 16 - Oct 28
PPB Samples arrive Australia - BCIA	Oct 16
Val: Compl. of final char	Nov 06
Val: Draft ES report	Nov 09 - Nov 18
ES report leave USA	Nov 20
ES report arrive Australia	Nov 30

Regards, Steve O.

TI-NHTSA 011227

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 324-15-48

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
CCPS	9/1/92	Steve Offiler	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey DiDomenico	9/8/92		

PROJECT TITLE: Speed Control PS

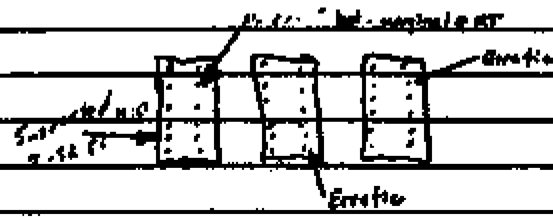
CUSTOMER:

PURPOSE OF TEST: characterization of diaphragm life vs. vacuum and prototyping various possible solutions if a problem is indicated.

PROCEDURE: Next pages

NOTE: This is the first life test to use the automatic shutdown feature on failure

\# Counter has turned over. Add 2KK to count]



Device #	Vacuum	Test	Modification	Cyc. to Failure	Remarks
324-15-01	NO	cycle	control	1377K	
-02	↓	↓	none	1658K	erratic
-03	↓	↓	↓	1352K	very slow leak
-04	↓	↓	↓	1324K	
-05	↓	↓	↓	1512K	
-06	↓	↓	↓	1371K	
324-15-07	yes	cycle	none	1619K	Erratic Switch
-08	↓	↓	↓	848K	
-09	↓	↓	↓	1984K	
-10	↓	↓	↓	1219K	T-diff?
-11	↓	↓	↓	1601K	
-12	↓	↓	↓	1555K	
324-15-13	yes	open	none		
-14	↓	↓	↓		
324-15-15	yes	Ball/spec	none		
-16	↓	↓	↓		
324-15-17	yes	cycle	Vented	870K	
-18	↓	↓	New	944K	
-19	↓	↓	Shape	952K	
-20	↓	↓	↓	1324K	
-21	↓	↓	↓	1210K	
-22	↓	↓	↓	1380K	60482!

TI-NHTSA 011228

Device #	Vacuum	Test	Material	Cycles to Failure	Remarks			
324-15-23	yes	open	Kapton					
-24	↓	↓	↓					
324-15-25	yes	cycle	Rubber	}				
-26			diaphragm					
-27								
-28					Suspended			
-29								
-30	↓	↓	↓		2690K			
324-15-31	yes	open	Rubber					
-32	↓	↓	diaphragm					
324-15-33	yes	cycle	Foil lined	2085K				
-34			Kapton	2018K				
-35				2094K				
-36				1866K				
-37				2657K				
-38	↓	↓	↓	2084K				
324-15-39	yes	open	Foil lined					
-40	↓	↓	Kapton					
324-15-41	yes	cycle	Tefzel	576K				
-42				1326K				
-43				1524K				
-44				1447K				
-45				996K				
-46	↓	↓	↓	544K				
324-15-47	yes	open	Tefzel					
-48	↓	↓						

leak down test

Time	Plug Pressure	Device Pressure
0	.005 PSIA	.006 PSIA
1 min	.016	.018
5 min	.037	.037
10 min	.053	.046

TI-NHTSA 011229

PRESSURE SWITCH DATA   Form 21605   TEST NO. 324-15-48

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
CCPS	9/4/92	Steve Offiler	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeffrey DiBenedetto	9/8/92		

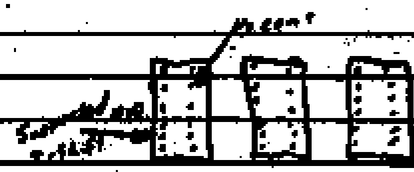
PROJECT TITLE: Speed Control PS

CUSTOMER:

PURPOSE OF TEST: characterization of diaphragm life vs. Vacuum and prototyping work on possible solutions if a problem is indicated.

PROCEDURE: Next pages

* Counter has turned over. A 1KK to Count!



Device #	Vacuum	Test	Modification	cyc. to Failure	Remarks				
324-15-01	No	Cycle	Current ✓	1377					
-02	↓	↓	Desc ✓	1659 K					96% Low
-03			✓	1552 K	2	DEAD	ST 1324K	β = 14.0	6.937
-04			✓	1324 K	very slow			α = 1522	1495.3
-05			✓	1512 K					
-06	↓	↓	↓ ✓	1471				99 : 90 →	1044.7 K
324-15-07	yes	Cycle	None ✓	1619 K	cracked				
-08			✓	846K					96% Low
-09				1702 K	2	DEAD	ST 846K	β = 4.6	2.891
-10			✓	1219 K	T-34 +			α = 1598	1362.3
-11			✓	1601 K					
-12	↓	↓	↓ ✓	1555				99 : 90 →	921.3 K
324-15-13	yes	Aged	none						
-14	↓	↓	↓						
324-15-15	yes	Aul/Heat	none						
-16	↓	↓	↓						
324-15-17	yes	Cycle	Vented ✓	870 K				β = 6.5	
-18			Mag ✓	944 K					
-19			Flange ✓	952 K	6	DEAD	ST 870	K α = 1197	
-20			✓	1324 K					
-21			✓	1210 K					
-22	↓	↓	↓ ✓	1580	Cycl				

TI-NHTSA 011230

Device #	Version	Test	Installation	Cycles to Failure	Remarks				
324-15-23	yes	open	Panel						
-24	↓	↓	↓						
324-15-25	yes	cycle	Roller						
-26			Deployment						
-27									
-28				Ø	DEAD				
-29									
-30	↓	↓	↓						
324-15-31	yes	open	Roller						
-32	↓	↓	Deployment						
324-15-33	yes	cycle	Full Anal						
-34			Kapton						
-35				Ø	DEAD				
-36									
-37									
-38	↓	↓	↓						
324-15-39	yes	open	Full Anal						
-40	↓	↓	Kapton						
324-15-41	yes	cycle	Tef Seal ✓	896K					
-42			✓	1236K				Bx 5.5	
-43			✓	1384K	5 DEAD	ST	@ 844K	B=1209	
-44				1447K					
-45			✓	976K					
-46	↓	↓	↓ ✓	844K					
324-15-47	yes	open	Tef Seal						
-48	↓	↓	↓						

144K	down	test
	Flag	Device
Time	Resistance	Resistance
0	.00275Ω	.00192Ω
1 min	.026	.016
5 min	.037	.032
15 min	.053	.041

-MSG M#= 59390 FR=VAGS TO=PCME SENT=09/03/92 02:48 PM
R#=186 ST=C DIV=0050 CC=00134 BY=VAGS AT=09/03/92 02:48 PM

TO:	DICK GARIEPY	MFPC		
CC:	ED SMITH	PCQA	BILL SWEET	PCME
	STEVE OFFILER	SBO1	ELAINE ROSE	SAMY
	DENNIS NATALE	PCME	DAVE CZARN	ZARN
	ANDY MCQUIRK	PCQA	CHARLIE DOUGLAS	CPPC
	STAN HOMOL	SH2	GARY SNYDER	GJS1
	TOM CHARBONEAU	TC	JIM WATT	PCQA
	NORM FREDA	WHLZ	TOM BURKE	MFPC
	BOB BARTOSH	PCME		

FR: MATT SELLERS PCME

SJ: IMPULSE TESTING ON 77PS

DICK,

THERE ARE OTHER THINGS BESIDES DISC ENDURANCE THAT ARE EVALUATED DURING THE IMPULSE CYCLING OF THE 77PS DEVICES IN PARTICULAR WHICH SHOULD HAVE BEEN EVALUATED PRIOR TO MAKING THE DETERMINATION THAT IMPULSE TEST FREQUENCY COULD BE REDUCED FROM EVERY LOT TO ONCE EACH WEEK. I REFER MOST STRONGLY TO SPRING LIFE ON THE 77PS PRODUCT. WE HAVE DETECTED IN THE PAST INSTANCES WHERE AN IMPROPERLY BENT SPRING ARM, WHICH PASSES ALL SPC REQUIREMENTS, WILL BREAK DURING IMPULSE CYCLING. FOR THIS REASON ALONE I WOULD ADVISE NOT REDUCING THE IMPULSE TEST CYCLING FREQUENCY ON 77/87PS AT THIS TIME. PERHAPS THERE IS A COMPROMISE FREQUENCY THAT WOULD BE MUTUALLY AGREEABLE TO THE ENTIRE MRB. ADDITIONALLY, THERE ARE OTHER CONCERNS AS FOLLOWS:

1.) THIS MAY CONSTITUTE A CHANGE TO THE MANUFACTURING CONTROL PLAN WHICH WOULD REQUIRE CUSTOMER APPROVAL.

2.) D&P FMEA'S REFER TO THESE CYCLING AUDITS AS ONE OF SEVERAL MANUFACTURING CONTROLS FOR SEVERAL PROCESSES.

3.) THE MRB TEAM MAY NEED TO REVIEW OTHER AREAS OF THE D&P FMEAS TO DETERMINE IF ANY OTHER ADVERSE IMPACTS MAY RESULT.

PLEASE CONSIDER THESE ITEMS AND RESPOND URGENTLY TO MYSELF AND THE REST OF THE MRB.

REGARDS...MATT
X1245

-MSG M#= 77135 FR=VAGS TO=COPY SENT=09/04/92 07:33 AM
ST=C DIV=0050 CC=00134 BY=VAGS AT=09/04/92 07:33 AM

TO:	1ST SHIFT SMWT	MFPC	04 SEPT, 1992
	2ND SHIFT SMWT	MFPC	
CC:	CLAIRE BALTHAZAR	PCME	
	DICK GARIEPY	MFPC	
	TOM BURKE	MFPC	
	BILL SWEET	PCME	
	STEVE OFFILER	5801	
	DAVE CZARN	ZARN	
FR:	MA[redacted]	PCME	
RE:	77PS AND 87PS IMPULSE TESTING		

===================================

77/87PS SMWT'S,

INFORMATION THAT MAY HAVE BEEN PREVIOUSLY PASSED ON TO YOU CONCERNING THE REDUCTION OF IMPULSE TESTING FROM "EVERY DISC LOT" TO "ONE LOT EACH WEEK" HAS BEEN RESCINDED. YOU HAVE BEEN, AND ARE STILL REQUIRED TO, IMPULSE TEST EVERY DISC LOT PRIOR TO RELEASING THE LOT FOR BUILD/SHIP. AT TIMES, WHEN PRODUCTION DEMAND REQUIRES, YOU MAY BE AUTHORIZED TO BUILD THE SENSOR LOT PRIOR TO RECEIVING FORMAL IMPULSE TEST ACCEPTANCE FROM Q.C. HOWEVER, NO LOT MUST EVER BE PACKED WITHOUT FIRST RECEIVING FORMAL IMPULSE TEST RESULTS FROM Q.C. AUTHORIZATION TO BUILD SENSOR LOTS PRIOR TO COMPLETION OF IMPULSE TEST CAN ONLY COME FROM ENGINEERING OR MANUFACTURING MANAGEMENT. BUILDING SENSOR LOTS WITHOUT IMPULSE TEST RESULTS IS CONSIDERED A SPECIAL SITUATION AND DOING SO WITHOUT FIRST RECEIVING AUTHORIZATION FROM ONE OF THESE SOURCES IS PROHIBITED.

REGARDS...MATT
X1245

-MSG M#= 77526 FR=RWG3 TO=[redacted] SENT=09/04/92 08:01 AM
R#=030 ST=C DIV=0050 CC=00127 BY=RWG3 AT=09/04/92 07:48 AM

To: CCPS SELF-DIRECTED TEAM MFPC

Copy: ALAN SADLER AMS2 GARY J. SNYDER GJS1
DAVID CZARN ZARN

From: DICK GARIEPY RWG3

Subj: IMPULSE TESTING

MATT SELLERS HAS RAISED A VERY IMPORTANT ISSUE RELATIVE TO THE IMPULSE TESTING DONE ON 77PS DEVICES. THAT IS, IN ADDITION TO TESTING FOR DISC PROBLEMS THE IMPULSE ALSO IS OUR ONLY METHOD OF INSURING THE CONTACT ARM WAS FORMED PROPERLY.

THEREFORE WE WILL CONTINUE THE IMPULSE TESTING ON 77PS DEVICES ACCORDING TO PREVIOUS PROCEEDURE. A NEW DEFINATION OF TEST FREQUENCY "LOT SIZE" IS BEING CONSIDERED.

DICK

-MSG M#= 00451831 FR=SRO1 TO=SRO1 SENT=09/18/92 08:09 AM
S#=033 ST=C DIV=0050 CC=00101 BY=SRO1 AT=09/18/92 08:09 AM

TO:	Jeff DiDomenico	DIDO	Danny O'Driscoll	DOD
	Charlie Douglas	CMD1	Matt Sellers	PCME
	Norm Frada	WELL	Bill Sweet	WS4
	Dick Gagnon	MFPC	Chris Wagner	CDW3
	Dennis Natale	DJN1	Jim Watt	PCQA

CC: Dave Czarn (delivered separately)

FR: Steve Offiler SRO1

SJ: Vacuum/Diaphragm Life Status Report - 52/57/77/87PS Sensor

Six lots of 6 devices each began cycling last week. The devices are 77PSL2-1's, and the lots are composed of:

* Standard diaphragm configuration, NO vacuum
* Standard diaphragm configuration, vacuum (0.4 mBar)
* Roughened hexport flange, vacuum
* Rubber diaphragm, vacuum
* Full-round Kapton, vacuum
* Tefzel (fluid layer) plus two Kapton, vacuum

The first two lots will be directly compared to determine the impact of high vacuum spec'ed by Ford Australia on diaphragm life (if any). The other four are experiments which can be compared with the second lot to determine a direction for design modifications (if required).

To-date, the test has progressed to about 1230K cycles. There have been NO failures in the lot of standard config/no vacuum, versus two in the vacuum lot (846 and 1219K). This data, while preliminary, is supporting the hypothesis that high vacuum ultimately results in shortened diaphragm life due to Kapton displacement and wrinkles. There have been four failures in the roughened hexport flange lot (870, 944, 952, and 1210K) and four failures in the Tefzel lot (844, 846, 992, and 1226K). There have been NO failures yet in the rubber diaphragm lot, or the full-round Kapton lot.

Extra test devices were built for visual analysis of the diaphragm in the as-built condition, which is done by cutting off the hex while retaining the crimp. As expected, the standard configuration parts w/ vacuum show general looseness and wrinkles across the Kapton. The roughened hexport flange lot shows some specific localized wrinkling. The rubber diaphragms, with and without vacuum, look indentical - the rubber is protruding upward in a dome shape, which seems to be caused by the compression at the edges of the diaphragm. This is apparently not due to vacuum displacement. The full-round Kapton parts look quite good -no displacement from exposure to vacuum. The Tefzel parts look similar to the standard config. parts; their relatively early failure is likely to be caused by Tefzel's highly directional properties with sharply reduced elongation in the transverse direction.

Regards, Steve O.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 324-15-48

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
CCPS	9/1/92	Steve Offiler	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeffrey DiDomenico	9/8/92		

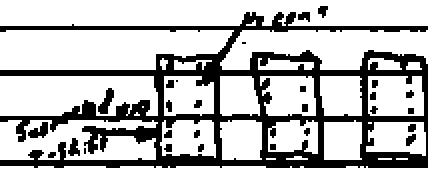
PROJECT TITLE: Speed Control PS

CUSTOMER:

PURPOSE OF TEST: characterization of diaphragm life vs. Vacuum and prototyping various possible solutions if a problem is indicated.

PROCEDURE: Next pages

[Counter has turned over. A 1kk to Count]



Device #	Vacuum	Test	Mitigation	Cyc. to Failure	Remarks				
324-15-01	No	cycle	Control ✓	1377					
-02			None ✓	1657 K					90% LOW
-03			✓	1352 K	← 2	DEAD	ST 1324K	β = 14.0	6.933
-04			✓	1324 K	very slow			θ = 1532	1405.3
-05			✓	1512 K					
-06			✓	1571				1% = 90 →	1044.7 K
324-15-07	yes	cycle	None ✓	1619 K	cracked				
-08			✓	846K					90% LOW
-09				1782 K	2	DEAD	ST 846K	β = 4.6	2251
-10			✓	1219 K	T-554			θ = 1898	1362.3
-11			✓	1601 K					
-12			✓	1555				1% = 90 →	501.3 K
324-15-13	yes	open	None						
-14									
324-15-15	yes	Pull/hold	None						
-16									
324-15-17	yes	cycle	Vented ✓	930 K					
-18			Max ✓	944 K				β = 6.5	
-19			Range ✓	952 K	6	DEAD	ST 870 K	θ = 1197	
-20			✓	1324 K					
-21			✓	1210 K					
-22			✓	1380	Review ✓				

Device #	Vacuum	Test	Mfd/Stroke	Cycs to Failure	Remarks				
324-15-23	yes	open	Kayel						
-24	↓	↓	↓						
324-15-25	yes	cycle	Roller						
-26			Kingdom						
-27									
-28				Ø	DEAD				
-29									
-30	↓	↓	↓						
324-15-31	yes	open	Roller						
-32	↓	↓	Kingdom						
324-15-33	yes	cycle	Full Band						
-34			Master						
-35				Ø	DEAD				
-36									
-37									
-38	↓	↓	↓						
324-15-39	yes	open	Full Band						
-40	↓	↓	Master						
324-15-41	yes	cycle	TelCal ✓	876K					
-42			✓	1276K				B= 5.5	
-43			✓	1324K	5 DEAD ST @ 844K			B=1209	
-44				1447K					
-45			✓	996K					
-46	↓	↓	↓ ✓	844K					
324-15-47	yes	open	TelCal						
-48	↓	↓	↓						

Leak down test

Time	Avg Antenna	Device Antenna
0	.0000SEA	.000CRA
1 min	.010	.018
5 min	.037	.037
15 min	.053	.048

-MSG M#= 506728 FR=SB01 TO=MJB2 SENT=09/21/92 10:46 AM
R#=051 ST=C DIV=0050 CC=00101 BY=SB01 AT=09/21/92 10:46 AM

TO:	Dave Czarn	ZARN	Matt Sellers	MJB2
	Jeff DiDomenico	DIDO	Bill Sweet	WB4
	Dick Gariepy	RW03	Chris Wagner	CDW3
	Dennis Natale	DJN1		
CC:	Charlie Douglas	CMP1	Danny O'Driscoll	DOD
	Mike Downey	MIKD		
FR:	Steve Offiler	SB01		

SJ: Vacuum/Diaphragm Life

The characterization test of high vacuum (for Ford Australia) combined with diaphragm life testing is reaching a point where some conclusions can begin to be made. It is imperative that we give this matter due attention ASAP, because the data suggests a diaphragm design change is in order to increase the device's resistance to high vacuum. There will, of course, be manufacturing ramifications. Furthermore, samples which MUST use the production-intent configuration will be built and shipped next week. Thus, we'll be locking ourselves into a particular design configuration very soon.

****
A meeting to discuss the interim results of ongoing testing, and the design direction, will be held in the cafeteria on Tuesday 92-09-22 at 4:00 pm.
****
Regards, Steve O.

* Base volume vs. volume which needs vacuum resist.
  Capri + Falcon.

* When were we made aware of this spec.
  Is it written into any documents for our review.

* Replace Kapton or Gasket or both.
  Gas[illegible] → yes,
  Kap[illegible] → maybe 1 or 2 eliminated short term.
  → maybe 3 eliminated if we receive cloth backed.

* Performance → Temp extremes.
  → Drift.
  → Initial

* Cost! open checkbook or all these constraints.

* Volume: 23k annually. Hard line?

* Gary Snyder input.

* [Ship] 300 OCT 1st Prod Intent.

27713-1 Cup Modification 9-22-92

Production Problem: In-sufficient preload placed on Quiet Pass Car devices. Problem manifest itself as a loose, rattling disc after sensor crimping on the AMI.

Affect: Yield loss for low pin on F.A.M. 2% to 5%.

Root Cause: General stack-up error between cup, converter, and disc. Disc envelope is too large (height) by appx .004" to .005"

Solutions Evaluated: Steped washer, bump on converter, tapered converter, spacer between washer + converter, increasing bump height on cup, lowering washer shelf on cup, increase in O.P. @ SAM. Increase in crimp pressure @ SAM

Solution Selected: Lowering washer shelf on cup. $5K tooling upgrade from Valentine.

TI-NHTSA 011240

Rubber Diaphragm 9-23-92

Preliminary Cost Analysis

Components: Add Delete

→ Rubber diap. → Internal Gasket

[redacted]

25 ¢ 2 ¢

Operations: Add

→ Manual Sensor Assy → AMI Assy

4 x 1.8 (7.2) 1 x 1.0

$10.81/hr + 67.02/k

Yields: Due to different methods of wetting the Kapton it is questionable what the impact will be on lot Sigma and $\bar{X}$ repeatability.

.60¢ each.

5% loss @ Func test = $ 30/k

Volume: 23K annually

Cost Summary

Material	.005
Labor	.07
Yields	.03
	.105

TI-NHTSA 011242

MSG NM 375258 FR=SB01 TO=ZARN SENT=09/23/92 08:32 AM
R#=171 ST=C DIV=0050 CC=00101 BY=SB01 AT=09/22/92 08:32 AM

TO:	Tom Charboneau	TC	Dennis Natale	DJN1
	[redacted]		Danny O'Driscoll	DOD
	Jeff DiDomenico	DIDO	Matt Sellers	MJS2
	Charlie Douglas	CMP1	Gary Snyder	GJS1
	Mike Downey	MIKD	Bill Sweet	WS4
	Dick Gerlapy	RWG3	Chris Wagner	CDW3
	Andy McKenna	SPRT		

FR: Steve Offiler SB01

SU: Vacuum/Diaphragm Life Testing 57/77PS Brake Sensors

A meeting was held to discuss the interim results of the combined high-vacuum / diaphragm life test, which is being run specifically to address Ford Australia's need for high vacuum withstand, and generally to explore options to improve diaphragm life.

Two lots use the standard (brake) Kapton diaphragm configuration, one exposed to 0.4 mBar vacuum, the other no vacuum. It is known that the vacuum causes diaphragm displacement and gives rise to wrinkles, which have previously been shown to have an adverse effect on life. Also previously shown is the fact that some unknown combination of design and/or process variables causes brake diaphragm life to be quite erratic, with some test lots performing very poorly (significant failures well below the customer spec. of 500K cycles) while other test lots built at a different time may show no failures until over 1KK cycles.

Two facts come out of this: one, results of a given test are only valid relative to other lots built with the same parts at the same time, and two, in general we need to have a big-picture goal of finding a more robust diaphragm configuration.

Interim results show the standard-config dia. no vac. has 5/6 failures, but please note the significant fact that the failures are tighly grouped between 1324K and 1571K cycles. Once completed, a Weibull analysis will show a high beta (steep slope) which is desirable. The vacuum parts have only 3/6 failures, but these are widely spaced from 846K to 1555K, which will produce a low beta. These results interpreted casually may suggest the vacuum-exposed parts are not all that bad. Nonetheless, given the visual observations of the wrinkles in the vacuum parts, combined with a much poorer beta, plus the fact that they began to die much sooner, confirms my hypothesis that we have a problem with vacuum exposure which is significant enough to require immediate attention. Furthermore, bear in mind that Danny has been preparing the customer for this as well, opening a window of opportunity for us to make and validate design/process changes, and gain manufacturing experience with it due to the low volumes of the Australia application.

-MSG M#= 00573252 FR=SBO1 TO=SBO1 SENT=09/23/92 08:32 AM
S#=040 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/23/92 08:32 AM

TO:	Tom Charbonneau	TC	Dennis Natale	DJN1
	Dave Czarn	ZARN	Danny O'Driscoll	DOD
	Jeff DiDomenico	DIDO	Matt Sellers	MJS2
	Charlie Douglas	CMP1	Gary Snyder	GJS1
	Mike Downey	MIND	Bill Sweet	WS4
	Dick Gariepy	RWG3	Chris Wagner	CDW3
	Andy McKenna	SPRT		

FR: Steve Offiler SBO1

SJ: Vacuum/Diaphragm Life Testing 57/77PS Brake Sensors

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Two lots use the standard (brake) Kapton diaphragm configuration, one exposed to 0.4 mBar vacuum, the other no vacuum. It is known that the vacuum causes diaphragm displacement and gives rise to wrinkles, which have previously been shown to have an adverse effect on life. Also previously shown is the fact that some unknown combination of design and/or process variables causes brake diaphragm life to be quite erratic, with some test lots performing very poorly (significant failures well below the customer spec. of 500K cycles) while other test lots built at a different time may show no failures until over 1MK cycles.

Two facts come out of this: one, results of a given test are only valid relative to other lots built with the same parts at the same time; and two, in general we need to have a big-picture goal of finding a more robust diaphragm configuration.

Interim results show the standard-config dia. no vac. has 5/6 failures, but please note the significant fact that the failures are tighly grouped between 1324K and 1571K cycles. Once completed, a Weibull analysis will show a high beta (steep slope) which is desirable. The vacuum parts have only 3/6 failures, but these are widely spaced from 848K to 1558K, which will produce a low beta. These results interpreted casually may suggest the vacuum-exposed parts are not all that bad. Nonetheless, given the visual observations of the wrinkles in the vacuum parts, combined with a much poorer beta, plus the fact that they began to die much sooner, confirms my hypothesis that we have a problem with vacuum exposure which is significant enough to require immediate attention. Furthermore, bear in mind that Danny has been preparing the customer for this as well, opening a window of opportunity for us to make and validate design/process changes, and gain manufacturing experience with it due to the low volumes of the Australia application.

Of the four experimental lots, we have 6/6 failures in both the Tefzel lot and the roughened-hexport-flange (increased friction w/ dia.) lot, all between roughly 850K and 1450K. No further efforts are planned for these lots. In comparison, we have NO failures in either the rubber diaphragm lot or the full-round Kapton lot with the test at roughly 1600K presently. These two lots will immediately be evaluated further.

Engineering concerns include:
* calibration shift at temperature extremes -40°C / 175°C

TI-NHTSA 011244

* Thermal cycling performance
* calibration drift over life
* high-temperature aging effects on calibration

Manufacturing concerns include:
* effects on lot piloting and sigma's
* cost
* viability of hand-line vs AMI assembly; req'd tooling mod's

We plan to build ASAP fairly sizable quantities of rubber diaphragm, full-round Kapton, and control lots, using the 57PS hand line. All parts will be checked using the 77PS automatic pressure tester, for calculation of piloting and sigma info. Then, parts will be subdivided into test lots to undergo each of the four items listed under engineering concerns above. Mfg. Eng, Mkt., and Field Sales will need to put some thought into the cost issues.

From a schedule/program standpoint, we must ship 300 production-intent parts on Oct 2 in order to be received in Australia at the Tier 1 (BCIA) in time for them to deliver completed brake systems to Ford for a pre-production build Nov 1. These dates are cast in stone; furthermore, the requirement that these be production-intent will serve to cast in stone whatever diaphragm configuration we choose to send.

Regards, Steve O.

* BUILD TEST LOTS — USING SILENT DISCS, NORYL BASES, CAR 3690'S

* RUN ON AUTO P.T. — DATA FOR X̄ σ

* TESTS:

1) CAL SHIFT @ TEMP (DAVE O'T) — 18 — 4 STAGES
CONVENIENT # ~6 OR SO × 3 LOTS
RT CHAR; LOW -40 HI +175°C

2) PRE-CHAR ~6 × 3 LOTS
TC CYCLE CONT. @ 0.1 Hz — 18
DOWN TO -40, SOAK ~ 30-60 min
UP TO +121°C SOAK ~ 30-60 min
POST-CHAR

3) DRIFT OVER LIFE PROD CYCLER — 66
PRE-CHAR 6 × 3 LOTS
RUN 250K 1½ LOTS; CHAR
COMPL 500K, CHAR
RUN 250K OTHER 1½ LOTS CHAR
COMPL. 500K, CHAR

4) HI TEMP AGING — MANIFOLD, PRE-FILL w/ FLUID (DIRTY)
SIT @ +150°C FOR X DAYS

VACUUM / DIA LIFE STATUS

THE 9-22 @ ~ 1.5 KK

→ BUILD ~ 30 / DIA
RANDOM
FULL AND
CTRL
→ CHARACTERIZE ALL 30
AST/REL, σ
→ TRY CHAR @ TEMP
→ TRY TC
→ TRY DRIFT
→ AGING TEST (HI TEMP)

BETTER ↑

- * RUBBER DIA } 0/6
- * FULL-AND KAPTON }
- * STD NO VAC — 4/6 @ 1.32, 1.35, 1.38, 1.51 KK
- * STD W/ VAC — 2/6 @ 0.8, 1.3 KK
- * TEFZEL } 6/6 @ 0.8 - 1.4 KK
- * ROUGH HEX FLANGE }

↓ WORSE

RUBBER DIA

MFG CONCERNS:
1. PICK-AND-PLACE
2. SMALL LIP FROM CUTOFF OPERATION
3. EFFECT ON FLOATING + σ

PERF CONCERNS:
1. EFFECT ON CHAR @ TEMP EXTR.
2. TC LIFE
3. EFFECT ON DRIFT

FULL-AND

MFG CONCERNS:
1. NEW RAND TOOLING QUICK CHG
-OR-
1. NEW AND TOOLING APPROX ON ALL 62-57-77
2. NEW PRESENCE-CHK
3. EFFECT ON FLOATING + σ

} HAND-LINE

PERF CONCERNS:
1. EFFECT ON CHAR @ TEMP EXTR.
2. DRIFT KNOWN

-MSG NO= 16807 FR=SBO1 TO=GAMY SENT=09/24/92 08:17 AM
RP=006 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/24/92 08:17 AM

TO:	Dave Czarn	ZARN	Dennis Natale	DJN1
	Jeff DiDomenico	DIDO	Danny O'Driscoll	DOD
	Charlie Douglas	CMP1	Elaine Rose	GAMY
	Mike Downey	MIKD	Matt Sellers	MJS2
	Dick Gariepy	RWG3	Chris Wagner	CDW3
	Stan Homol	SH2	Jim Watt	JW02
FR:	Steve Offiler	SBO1		

SJ: High-Vacuum CCPS for Ford Australia   77L6-1 Capri

New information received from Danny this morning indicates we've got some additional time before we need to ship the PPB samples to BCIA. We'll use this time to complete a series of tests to confirm the chosen design, and to work out many details relating to manufacturing and cost. Results of the high-vacuum experiment have pointed definitively at either the full-round Kapton or the rubber diaphragm, both of these lots having experienced NO failures thru about 1.7 million cycles; versus the standard diaphragm configuration, with or without high vacuum exposure, where all devices have died. Below is an updated schedule for sample builds and validation.

Prepare vac/dia life test proto lots	COMPL
Build prototype lots	COMPL
Complete vacuum work (Druck, MARK B.)	COMPL
Run dia. life proto experiment	Sep 11 - Sep xx ONGOING
In-house design confirmation Cal shift at temp extremes Thermal cycling Drift over life Hi temp aging	Sep xx - Oct 16
Pigmented or striped O-rings	Oct 16
Build parts (val; PPB optional)	Oct 19 - Oct 20
Val: Init char	Oct 21 - Oct 23
Val: Impulse & TC	Oct 26 - Nov 09
Build parts (PPB latest)	Oct 27 - Oct 28
PPB Samples leave US	Oct 30
Val: Compl. of final char	Nov 10 - Nov 13
PPB Samples arrive Australia - BCIA	Nov 13
Val: Draft ES report	Nov 16 - Nov 18
ES report leave USA	Nov 20
ES report arrive Australia	Nov 30

Regards, Steve O.

-MSG :N#= 25895 FR=SBO1 TO=MJS2 SENT=09/24/92 11:04 AM
R#=060 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/24/92 11:04 AM

TO: Dave Czarn	ZARN	Dennis Natale	DJN1
Jeff DiDomenico	DIDO	Danny O'Driscoll	DOD
Charlie Douglas	CMP1	Matt Sellers	MJS2
Andy McKenna	SPRT	Chris Wagner	CDW3

FR: Steve Offiler SBO1

SJ: Vacuum/Diaphragm Life Test Update

==

At this point, ALL devices have failed in four of the test lots. These are the standard dia. config with vacuum, standard config. without vacuum, the Tefzel experimental lot, and the roughened hexport flange experimental lot. THE REMAINING TWO EXPERIMENTAL LOTS (rubber diaphragm and full-round Kapton) HAVE EXPERIENCED NO FAILURES YET. The test is at 1.6KK cycles presently. A quick Weibull analysis shows the following Beta and Theta (slope and characteristic life):

Dia config	Vac	Beta	Theta
Standard	no	14.0	1522
Standard	yes	4.6	1598
rough flange	yes	6.5	1197
Tefzel	yes	5.3	1209

* 1866 Full round Failure

Note both the rough flange and the Tefzel performed poorly, comparing characteristic life with the standard config (control) lots. Also note that, comparing the two standard config's, vacuum has the effect of lowering Beta (slope) which is a measure of the predictability of the failures; the failure of the vacuum parts is much less predictable. We are continuing the test, waiting for a failure to occur in either the rubber dia. or the full-round Kapton. Previously, we've seen about 30% better characteristic life for full-round vs. standard config. We have no previous data for rubber dia.

Regards, Steve O.

* Round Kapton. 3 layers.

* Rubber dia 3 layers May be able to reduce the # of layers. Needs to be Scheduled into the test plan

TI-NHTSA 011248

-MSG M#= 00025895 FR=SBO1 TO=SBO1 SENT=09/24/92 11:04 AM
S#=049 ST=C DIV=0050 CC=00101 BY=SBO1 AT=09/24/92 11:04 AM

TO:	Dave Czarn	ZARN	Dennis Natale	DJN1
	Jeff DiDomenico	DIDO	Danny O'Driscoll	DOD
	Charlie Douglas	CMP1	Matt Sellars	MJS2
	Andy McKenna	SPRT	Chris Wagner	CDW3

FR: Steve Offiler SBO1

SJ: Vacuum/Diaphragm Life Test Update

At this point, ALL devices have failed in four of the test lots. These are the standard dia. config with vacuum, standard config. without vacuum, the Tefzel experimental lot, and the roughened baseport flange experimental lot. THE REMAINING TWO EXPERIMENTAL LOTS (rubber diaphragm and full-round Kapton) HAVE EXPERIENCED NO FAILURES YET. The test is at 1.8MK cycles presently. A quick Weibull analysis shows the following Beta and Theta (slope and characteristic life):

Dia config	Vac	Beta	Theta	
Standard	no	14.0	1522	10.6 2238
Standard	yes	4.6	1598	
rough flange	yes	6.5	1197	
Tefzel	yes	5.5	1209	

Note both the rough flange and the Tefzel performed poorly, comparing characteristic life with the standard config (control) lots. Also note that, comparing the two standard config's, vacuum has the effect of lowering Beta (slope) which is a measure of the predictability of the failures; the failure of the vacuum parts is much less predictable. We are continuing the test, waiting for a failure to occur in either the rubber dia. or the full-round Kapton. Previously, we've seen about 30% better characteristic life for full-round vs. standard config. We have no previous data for rubber dia.

Regards, Steve O.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 322-15-66

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
77PS		Steve Offiley		
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**	
Jeffrey DiDomenico	920925			

PROJECT TITLE: Speed Control Deactivate PS

CUSTOMER:

PURPOSE OF TEST: Evaluation of Rubber Diaphragms/Round Kapton

PROCEDURE:

Color Code: Black = control

Blue = Rubber Diaphragms

Red = Round Kapton

L = .004" offset

H = .009" offset

All devices subjected to .0006 PSIA vacuum for 60 sec.

Device #	Test	Seal	Offset	Init Act	Init Rel	Post Vacuum Act	Post Vacuum Rel	Final Act	Final Rel	Remarks	
322-15-01	Thermal Cycle	control	.004"	126	103	128	102	119	73	T-14-97 @	141°C;
-02	↓	↓	↓	127	97	128	100	112	91	T-14-97 @	141°C;
-03			↓	125	97	126	98	97	74	T-14-97 @	141°C;
322-15-04			.009"	156	142	160	143	133	110		
-05			↓	230	203	234	205	161	136		
-06		↓	↓	177	152	177	156	127	102		
322-15-07		Rubber Diaphragm	.004"	148	105	145	104	173	102	T-14-97 @	174°C;
-08			↓	136	105	137	108	112	87	T-14-97 @	143°C;
-09			↓	139	103	135	104	124	96	T-14-97 @	137°C;
322-15-10			.009"	175	148	176	155	126	100		
-11			↓	180	156	180	158	148	115		
-12		↓	↓	184	163	186	161	132	109		
322-15-13		Round Kapton	.004"	156	135	158	136	125	100		
-14			↓	162	129	163	130	136	104		
-15			↓	154	129	157	129	—	—	Leak: all Terminals	
322-15-16			.009"	293	260	306	274	191	156		
-17			↓	211	189	217	189	150	119		
-18	↓	↓	↓	266	239	278	242	179	124		

(OVER)

PRESSURE SWITCH DATA Form 21605 **TEST NO.**

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**	

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

High temp aging (150°C) started @ 11:00 AM 921002
Test ended 921021 @ 11:00AM. Total hrs: 456 hrs.

Device #	Test	Seal	Offset	Init Act	Init Rel	Post [illegible] Act	Post [illegible] Rel	Post Aging Act	Post Aging Rel
323-15-55	High Temp Aging	Control	.004"	131	104	132	99	158	104
-56	↓	↓	↓	126	102	129	98	150	107
323-15-57			.009"	156	132	161	135	170	140
-58		↓	↓	191	173	193	179	198	182
323-15-59		Collar Package	.009"	145	109	145	118	NG	
-60			↓	145	111	147	109	172	119
323-15-61		[illegible]	.009"	193	150	201	168	195	151
-62			↓	172	154	178	154	190	146
323-15-63		[illegible]	.004"	157	120	158	132	170	139
-64		[illegible]	↓	157	120	159	132	171	139
323-15-65			.009"	181	168	186	169	187	161
-66	↓	↓	↓	237	203	246	210	214	197

TI-NHTSA 011252

(OVER)

DIAPHRAGM REDESIGN TESTING

Results from initial testing of high-vacuum exposure combined with diaphragm life cycling have shown two candidates for improving the design of the diaphragm: the rubber diaphragm (plus 3 pc. standard square Kapton) and the full-round Kapton diaphragm (3 pc). This test compares various performance parameters of these two designs plus a control group.

Engineering tests include: thermal cycling, characterization at temp extremes, drift over life, and aging. Manufacturing tests include: statistical determination of act/rel average and standard deviation.

For engineering evaluations, build 1/2 at low preload extreme (4 mils) and the other 1/2 at high preload extreme (9 mils). To choose pin on each of these devices, measure sensor and base individually, but assume no variability in pin, and no crimp shift. For statistical evaluation, build all devices using normal production tooling and techniques, with the standard quiet pass-car preload value of 6.5 - 7.0 mils.

Perform a quick check on the eng. parts using the auto. pressure tester, to ensure functionality. Rebuild bad devices as necessary. All devices for eng. tests will ultimately be characterized using the normal manual lab technique. All devices for mfg. statistics should be checked on the auto pressure tester, collecting data for each device.

<u>EXPERIMENT SPECIFICS:</u>

Thermal Cycle

* 3 low pin/3 high pin per lot x 3 lots (=18)
* Preferred, Cycler B (auto temp ctrl); or CCPS cycler
* Pre-char act/rel
* Run cycler at approx. 0.1 Hz continuous
* Ramp from -40 C to +175 C, with soaks of 30-60 min (T-B-D, flexible) at each extreme
* Test completion point is T-B-D (based on failures ?)
* Final char act/rel, compare data for pre-post shifts, discrepancies related to preload, failures if any
* Disassemble, analyze (compr set, diaphragm condition)

SBO/920928/file DIAPHR.001

Calibration Shift at Temperature Extremes

* 3 low pin/3 high pin per lot x 3 lots (=18)
* Measure act/rel @ RT, -40 C, +175 C
* Run in any convenient oven - Delta (?)
* Compare data for shift magnitude relative to control lot, and discrepancies related to preload

Drift over life

* 3 low pin/3 high pin per lot x 3 lots (=18)
* Characterize act/rel
* Run in production cycler
* Run 1.5 lots (9) to 250K cycles, remove and char.
* Complete 500K cycles, char.
* Repeat on remaining 1.5 lots
* Draw graphs of act/rel vs. # cycles

High Temperature Aging

* 2 low pin/2 high pin per lot x 3 lots (=12)
* Run in Despatch oven
* Characterize act/rel
* Prefill devices, install on manifold and fill (optional, use fluid reservoir T-B-D, purposely entrap air, which will expand to pressurize devices slightly when heated)
* Soak at 150 C for as long as feasible
* Post-char, look for shifts
* Disassemble, examine diaphragm condition

Statistics

* Build remainder (approx. 75) from each lot, on 77 line, using all normal techniques
* Run each lot separately thru automatic pressure tester
* Collect data for each device individually -
* Bad devices should be analyzed for failure mode; if not representative of production, toss data
* Calc. avg & std, histogram for each lot
* compare lots for avg (piloting concerns) and std (device variability)

SBO/920928/file DIAPHR.001

Sensor Diameters

	Control	Rubber Diaphragm	Round Kapton
1	.0483	.0491	.0483
2	.0477	.0490	.0479
3	.0476	.0479	.0482
4	.0478	.0488	.0480
5	.0477	.0480	.0481
6	.0479	.0475	.0481
7	.0478	.0479	.0480
8	.0477	.0476	.0475
9	.0479	.0475	.0477
10	.0478	.0479	.0479
11	.0480	.0477	.0480
12	.0480	.0477	.0480
13	.0481	.0480	.0478
14	.0475	.0472	.0476
15	.0480	.0491	.0480
16	.0478	.0483	.0478
17	.0479	.0476	.0480
18	.0480	.0478	.0480
19	.0475	.0481	.0480
20	.0480	.0476	.0479
$\bar{x}$	.0478	.0478	.0479
σ	.000136	.00037	.00019

[redacted] (GILBERT CAR) 6.5 mils.

[redacted] ASSUMES ±2.5 mils (3 ...).

[redacted] MES ARE 4 AND 9 MILS

T-Cycle

- approx. 0.1 Hz continuous cycling
- Ramp -40°C to +175°C, Soak 30-60 min (flexible)

		COLD								HOT					
		Begin Cycle			End Cycle					Begin Cycle			End Cycle		
Cycle		[1] Date, Time	[2] Temp	[3] Count	[4] Date, Time	[5] Temp	[6] Count	[7]		[8] Date, Time	[9] Temp	[10] Count	[11] Date, Time	[12] Temp	[13] Count
	1	10/1 7:00P	35°C	0	10/1 4:35	-41°C	526			10/2 7:00A	30°C	526	10/2 9:35	177°C	1060
* Ramp 1:50	2	10/2 9:35A	177°C	1060	10/2 1:10	-41°C	1890			10/2 11:10A	-41°C	1890	" 12:15	177°C	2970
* Ramp 1:30	3	" 12:55	177°C	2970	" 3:35	-41°C	3300		Ramp 3:25	" 3:25	-41	3300	" 4:50P	177°C	3774
	4	" 4:50P	177°C	3774	" 9:40P	-43°C	5354			10/5 6:50A	23°C	5354	10/5 8:25A	177°C	6890
	5	10/5 9:25	177°C	5940	10/5 11:00A	-41°C	6670			" 11:00A	-41°C	6690	" 11:35P	177°C	7270
	6	" 12:45	177°C	7270	" 3:35P	-41°C	9200			" 3:35P	-41°C	8200	" 6:50P	176°C	9200
* Ramp C1:15	7	10/6 7:00A	23°C	9200	10/6 8:55A	-41°C	9930			10/6 8:55A	-41°C	9930	10/6 10:30A	177°C	10,375
	8	" 10:30A	177°C	10,375	" 1:05P	-41°C	11,290			" 1:05P	-41°C	11,290	10/6 2:35P	177°C	11,715
	9	" 2:35P	177°C	11,715	" 4:55P	-41°C	12,584			10/7 6:05A	20°C	12,584	10/7 8:00A	177°C	12,990
	10	10/7 8:00A	177°C	12,990	10/7 10:35A	-41°C	13,780			" 10:35A	-41°C	13,780	" 12:35P	177°C	14,500
	11	" 12:35P	177°C	14,500	" 5:00P	-42	15,295			" 5:00P	-42°C	15,295	" 7:30P	177°C	15,775
* Ramp 1:15	12	10/8 7:30A	22°C	15,775	10/8 7:15A	-41	16,395			10/8 9:15A	-41	16,395	10/8 1:40P	177°C	17,890
	13	" 1:40P	177°C	17,890	" 4:05P	-40°C	18,877		Ramp 7:35	10/9 7:00A	21°C	18,877	10/9 9:10A	177°C	19,470
	14	10/9 9:10A	177°C	19,470	10/9 11:55A	-41°C	20,265			10/9 11:55A	-41°C	20,265	" 12:55	177°C	20,591
	15	" 12:55	177°C	20,591	" 3:10P	-40°C	21,296			" 3:10P	-40°C	21,296	" 5:15P	177°C	21,967
	16	10/10 9:10A	20°C	21,967	10/11 11:55A	-41°C	22,555			10/11 9:55	-41°C	22,555	10/11 11:30A	176°C	23,075
	17	" 11:30A	176°C	23,075	" 2:55P	-40°C	24,175			" 3:55	-40°C	24,175	" 4:20P	176°C	24,667
	18	10/13 7:40A	20°C	24,667	10/13 10:00A	-40°C	25,450			10/13 10:00A	-40°C	25,450	10/13 1:00P	177°C	26,430
	19	" 1:00P	177°C	26,430	" 3:50P	-42	27,380			" 3:50P	-42°C	27,380	" 6:00P	177°C	27,972
	20	10/14 7:55	21°C	27,972	10/14 10:50A	-41	28,990			10/14 10:50A	-41°C	28,990	10/14 12:30P	176°C	29,535
	21	" 12:30	176°C	29,535	" 3:05P	-41	30,340			" 3:05P	-41°C	30,340	" 4:35P	177°C	30,761
	22	10/15 7:15	156°C	30,761											
	23														
	24														
	25														
	26														
	27														
	28														
	29														
	30														
	31														

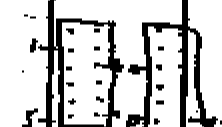
T-Sa:ft : Light #4,8,11,13,14,16 — [illegible] AFTER 20 CYCLES

Note: These are connector numbers and [illegible] match device number

Erratic: 8 < 143°C | 13 = 164°C
11 < 143°C | 14 = 174°C ?
9 < 143°C | 4 = 170°C

FL Temp

COLD → HOT 0:45 / 0:50
HOT → COLD 1:45 / 2:00
RT → HOT 0:35
RT → COLD 1:15 / 1:30

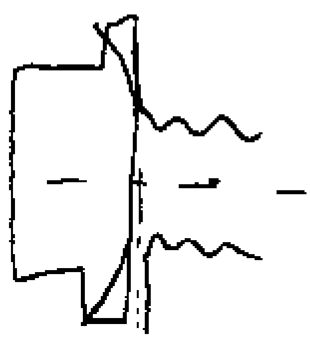


*#5 on out less on Hot cyc. #21
#5 lost on cold cyc. #22

NEW VAULT [illegible] P.M. [illegible] | OLD VAULT | NEW VAULT

GROUP: RUBBER DIAPHRAGMS

DEVICE	ACT	REL	DIF	ACTCR	RELCR
65	0.0	127.8	-127.8		
60	0.0	130.6	-130.6		
11	119.3	97.7	21.6		
19	130.8	106.5	24.3		
51	131.9	105.4	26.5		
4	134.7	111.6	23.1		
28	136.0	103.8	32.2		
12	136.4	111.4	25.0		
24	137.9	106.7	31.2		
3	138.5	110.6	27.9		
18	139.3	105.5	33.8		
21	141.0	110.4	30.6		
10	142.5	113.6	28.9		
7	143.5	109.8	33.7		
6	143.5	109.8	33.7		
25	143.5	111.1	32.4		
8	144.7	113.1	31.6		
20	145.5	115.1	30.4		
14	145.6	113.4	32.2		
23	146.2	105.4	40.8		
26	146.3	116.2	30.1		
17	147.5	117.9	29.6		
15	147.8	116.5	31.3		
13	148.0	113.3	34.7		
9	149.5	113.6	35.9		
5	149.7	111.5	38.2		
22	150.1	112.5	37.6		
AVG → 27	151.2	117.4	33.8		
43	152.0	121.0	31.0		
16	152.1	117.9	34.2		
29	152.8	114.1	38.7		
42	152.9	121.0	31.9		
2	153.3	118.2	35.1		
1	153.3	121.2	32.1		
44	153.9	120.0	33.9		
32	154.0	[illegible]	33.9		
36	154.0	121.0	33.0		
47	154.2	120.0	34.2		
39	154.4	118.7	35.7		
35	154.6	116.4	38.2		
33	154.6	117.2	37.4		
31	154.6	120.1	34.5		
40	154.6	122.7	31.9		
46	155.4	125.4	30.0		
49	156.9	122.7	34.2		
37	157.0	120.4	36.6		
41	157.2	122.9	34.3		
34	157.7	120.8	36.9		
48	157.7	123.2	34.5		
53	157.7	127.0	30.7		
63	157.8	120.8	37.0		
64	157.8	122.5	35.3		



55	158.1	119.4	38.7	
59	158.8	120.7	38.1	
62	158.8	121.7	37.1	
66	159.3	124.5	34.8	
56	159.5	119.9	39.6	
52	159.9	120.7	39.2	
38	159.9	121.1	38.8	
58	160.1	127.9	32.2	
30	160.6	119.6	41.0	
54	161.0	124.2	36.8	
45	161.3	129.7	31.6	
57	161.4	117.6	43.8	
50	162.0	127.2	34.8	
61	166.7	130.1	36.6	
avg.	150.9	117.2	33.7	Devices 60 and 65 not included
std.	9.1	6.6	4.3	

Rubber Diaphragms

Device	Act	Rel	Dens 1	Dens 2
11	117.3	97.7	.077	.076
19	130.9	106.5	.067	.067
51	134.9	105.4	.050	.051
9	139.7	111.6	.059	.058
28	136.0	113.8	.091	.090
5	149.9	116.5	.101	.100
22	150.1	112.5	.102	.102
27	151.2	117.4	.108	.107
43	152.0	121.0	.115	.115
6	152.1	112.9	.099	.099
54	161.0	124.2	.105	.105
45	162.3	128.7	.106	.105
57	164.4	117.6	.120	.121
50	163.0	132.2	.108	.109
61	166.7	130.1	.116	.116

Rubber Diaphragm, Round Kapton Evaluation

Device #	Test	Diaphragm	Offset	Initial act	Initial rel	Post Vac act	Post Vac rel	Final act	Final rel	Remarks
322-15-01	Thermal cycle	control	0.004	125	106	129	107	119	99	T-shift @ 161 deg. C.
322-15-02	Thermal cycle	control	0.004	127	97	129	100	112	91	T-shift @ 143 deg. C.
322-15-03	Thermal cycle	control	0.004	126	97	126	96	97	74	T-shift @ 143 deg. C.
322-15-04	Thermal cycle	control	0.009	159	142	160	143	139	110	
322-15-05	Thermal cycle	control	0.009	230	203	234	206	161	136	
322-15-06	Thermal cycle	control	0.009	177	152	179	166	127	162	
322-15-07	Thermal cycle	rubber	0.004	149	106	146	104	133	102	T-shift @ 174 deg. C.
322-15-08	Thermal cycle	rubber	0.004	135	105	137	106	112	87	T-shift @ 143 deg. C.
322-15-09	Thermal cycle	rubber	0.004	134	103	135	104	134	98	T-shift @ 177 deg. C.
322-15-10	Thermal cycle	rubber	0.009	178	146	176	165	136	110	
322-15-11	Thermal cycle	rubber	0.009	180	166	188	162	148	118	
322-15-12	Thermal cycle	rubber	0.009	184	169	188	161	138	108	
322-15-13	Thermal cycle	round	0.004	166	135	168	136	126	100	
322-15-14	Thermal cycle	round	0.004	168	129	168	130	125	104	
322-15-15	Thermal cycle	round	0.004	164	128	167	129	—	—	Leak: 21 T-cyc, 30,765 imp.
322-15-16	Thermal cycle	round	0.009	292	260	303	274	181	161	
322-15-17	Thermal cycle	round	0.009	211	184	217	186	160	129	
322-15-18	Thermal cycle	round	0.009	266	234	276	242	179	134	

Device #	Test	Diaphragm	Offset	Initial act	Initial rel	Post Vac act	Post Vac rel	-40 deg.C act	-40 deg.C rel	+175 deg C act	+175 deg C rel	Remarks
322-15-19	Cal. shift @ temp	control	0.004	149	110	146	128	166	135	111	83	
322-15-20	Cal. shift @ temp	control	0.004	128	106	126	107	137	106	98	72	
322-15-21	Cal. shift @ temp	control	0.004	131	109	132	106	145	122	86	68	
322-15-22	Cal. shift @ temp	control	0.009	156	137	163	136	198	175	116	92	
322-15-23	Cal. shift @ temp	control	0.009	159	184	165	186	202	183	117	89	
322-15-24	Cal. shift @ temp	control	0.009	174	149	176	146	229	202	116	89	
322-15-25	Cal. shift @ temp	rubber	0.004	145	97	147	100	176	149			no continuity at 175 deg. C
322-15-26	Cal. shift @ temp	rubber	0.004	149	112	145	112	163	127	97	71	
322-15-27	Cal. shift @ temp	rubber	0.004	129	106	131	107	145	118	70	54	
322-15-28	Cal. shift @ temp	rubber	0.009	212	189	219	191	216	264	130	98	
322-15-29	Cal. shift @ temp	rubber	0.009	196	167	199	168	273	242	134	101	
322-15-30	Cal. shift @ temp	rubber	0.009	236	200	230	206	312	376	128	99	
322-15-31	Cal. shift @ temp	round	0.004	158	127	157	128	169	145	116	97	
322-15-32	Cal. shift @ temp	round	0.004	159	129	169	133	169	147	129	106	
322-15-33	Cal. shift @ temp	round	0.004	149	119	150	119	159	131	98	79	
322-15-34	Cal. shift @ temp	round	0.009	190	174	195	172	234	205	132	107	
322-15-35	Cal. shift @ temp	round	0.009	208	179	209	184	294	217	138	110	
322-15-36	Cal. shift @ temp	round	0.009	250	234	244	216	319	260	142	118	

Device #	Test	Diaphragm	Offset	Initial act	Initial rel	Post Vac act	Post Vac rel	250K cyc act	250K cyc rel	500K cyc act	500K cyc rel	Remarks
322-15-37	Drift over life	control	0.004	130	102	130	103	123	99	122	101	
322-15-38	Drift over life	control	0.004	132	112	135	113	130	106	126	103	
322-15-39	Drift over life	control	0.004	129	101	128	103	128	103	125	102	

322-15-40	Drift over life	control	0.009	183	132	178	161	178	154	172	147	
322-15-41	Drift over life	control	0.009	196	179	207	178	206	176	200	178	
322-15-42	Drift over life	control	0.009	207	174	218	164	202	178	201	171	
322-15-43	Drift over life	rubber	0.004	136	107	144	106	129	99	130	100	
322-15-44	Drift over life	rubber	0.004	134	102	137	102	131	104	128	101	
322-15-45	Drift over life	rubber	0.004	139	109	147	116	139	113	136	109	
322-15-46	Drift over life	rubber	0.009	220	183	224	184	209	169	201	166	
322-15-47	Drift over life	rubber	0.009	184	169	193	164	169	139	171	139	
322-15-48	Drift over life	rubber	0.009	209	177	216	179	208	172	204	179	
322-15-49	Drift over life	round	0.004	159	134	166	131	160	135	146	122	
322-15-50	Drift over life	round	0.004	157	135	159	137	161	135	160	122	
322-15-51	Drift over life	round	0.004	169	131	157	134	149	134	146	120	
322-15-52	Drift over life	round	0.009	224	198	233	205	222	198	217	184	
322-15-53	Drift over life	round	0.009	233	208	242	220	247	208	220	197	
322-15-54	Drift over life	round	0.009	232	207	238	211	225	194	216	186	

Device #	Test	Diaphragm	Offset	Initial act	rel	Post Vac act	rel	458 hrs. act	rel	Remarks
322-15-55	High temp aging	control	0.004	131	104	132	99	168	104	
322-15-56	High temp aging	control	0.004	128	102	129	99	160	107	
322-15-57	High temp aging	control	0.009	159	132	161	138	180	140	
322-15-58	High temp aging	control	0.009	191	173	193	179	178	182	
322-15-59	High temp aging	rubber	0.004	146	109	146	112			device failure; not related to aging
322-15-60	High temp aging	rubber	0.004	146	111	147	109	172	119	
322-15-61	High temp aging	rubber	0.009	193	160	201	168	199	161	
322-15-62	High temp aging	rubber	0.009	172	154	178	154	180	149	
322-15-63	High temp aging	round	0.004	157	130	159	132	170	139	
322-15-64	High temp aging	round	0.004	157	130	159	132	171	138	
322-15-65	High temp aging	round	0.009	181	169	195	169	187	161	
322-15-66	High temp aging	round	0.009	238	208	240	210	218	187	

Device #	Test	Diaphragm	Offset	Room temp. act	rel	-40 deg.C act	rel	+175 deg C act	rel	Remarks
322-15-67	Char at [illegible]	control	prod.	129	93	136	112	88	66	
322-15-68	Char at [illegible]	control	prod.	135	104	144	125	97	77	
322-15-69	Char at [illegible]	control	prod.	131	99	141	117	64	49	
322-15-70	Char at [illegible]	control	prod.	135	105	139	108	40	35	
322-15-71	Char at temp.	rubber	prod.	117	84	135	100			no continuity at 175 deg. C
322-15-72	Char at temp.	rubber	prod.	140	109	150	125	74	58	
322-15-73	Char at temp.	rubber	prod.	142	109	169	122	99	79	
322-15-74	Char at temp.	rubber	prod.	140	109	162	129	77	59	
322-15-75	Char at temp.	round	prod.	154	129	165	138	100	88	
322-15-76	Char at temp.	round	prod.	148	121	163	129	104	87	
322-15-77	Char at temp.	round	prod.	150	125	163	141	116	98	
322-15-78	Char at temp.	round	prod.	149	124	178	142	109	93	