PE03-044
FORD
5/13/2005
APPENDIX I
BOOK 19 OF 28
PART 2 OF 4

[redacted]

From: Otto, Norm (N.C.)
Sent: Thursday, November 02, 2000 7:43 AM
To: Petrauskas, Lisa (L.E.)
Subject: Adjustable Pedal Data

Lisa,
This excel file contains a summary of the data I have. I don't much data on D186 and UN93, although I know they are not much better than what is out there now.

P131 adj pedals.xls

Regards,
Norm Otto
Senior Staff Technical Specialist
Body&Chassis NVH/Squeak&Rattle Prevention Department RVT
Mail Drop 22 Room 2112 AEC
Phone: 32-25698 Fax 59-47347

[redacted]

[redacted]

F250 Adjustable Pedals

Veh 149	Cycle #	Loudness	Fluct Str
Aft	1	9.64952	0.138748
	2	9.37757	0.139993
	3	9.27814	0.147151
	4	9.26539	0.154624
	5	9.71118	0.198916
		9.45636	0.155486
Fore	1	9.31852	0.093999
	2	9.37333	0.136314
	3	9.50169	0.099962
	4	9.43246	0.093119
	5	9.60915	0.125414
		9.44703	0.109766

Veh 836	Cycle #	Loudness	Fluct Str
Aft	1	9.45208	0.135674
	2	10.0719	0.163577
	3	10.1417	0.14954
	4	9.95496	0.166135
	5	10.2183	0.162017
		9.967788	0.155389
Fore	1	8.69014	0.100561
	2	8.92156	0.102212
	3	8.97556	0.097437
	4	8.98612	0.108379
	5	9.20262	0.114347
		8.9552	0.104587

[redacted]

[redacted]

Summary of Adjustable Pedal Data

Vehicle/Direction	Supplier	Loudness	Fluct Strength	Comments
P131 #149 Retract	Teleflex	9.45636	0.1554864	Average of 5 cycles
P131 #149 Extend		9.44703	0.1097655	
P131 #636 Retract		9.967786	0.1553886	
P131 #636 Extend		8.9552	0.10458716	
P225 Retract	Teleflex	6.6275	NA	Average of 12 vehicles 3 cycles/veh.
P225 Extend		6.434167	NA	
Windstar Retract	Teleflex	6.350604	0.110713647	Average of 5 pedals 3 cycles/pedal
Windstar Extend		6.285903	0.094489633	
Town Car Retract	KSR	6.308747	0.067950568	
Town Cae Extend		6.390485	0.089253146	Average Of 16 Pedals, 5 cycles/pedal

Note: Extend is towards drivers, retract is away from driver.

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[redacted]

[redacted]

From: Mango, Jack - Troy [JMango@tfxauto.com]
Sent: Thursday, July 12, 2001 8:42 AM
To: 'tmusselm@ford.com'; 'lpetraus@ford.com'
Cc: 'mgharib@ford.com'
Subject: FW: lash info from 1st batch

For your review...........

-----Original Message-----
From: Evangelista, Elio - Troy
Sent: Thursday, July 12, 2001 8:08 AM
To: Mango, Jack - Troy
Subject: lash info from 1st batch

<<lash study.xls>>

Elio Evangelista
Program Manager - Pedal Systems
Teleflex Automotive Group

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Over Size OD Diesel
Color Code Yellow
Special Parts for Lash Test

	Accelorator		Brake	
	OD (mm)	Slot (mm)	OD (mm)	Slot (mm)
1	27.744	4.52	27.741	4.52
2	27.742	4.5	27.742	4.54
3	27.748	4.53	27.75	4.51
4	27.749	4.51	27.731	4.55
5	27.74	4.55	27.739	4.52
6	27.73	4.48	27.738	4.53
7	27.757	4.51	27.743	4.53
8	27.739	4.51	27.742	4.51
9	27.738	4.48	27.743	4.52
10	27.74	4.52	27.74	4.51
11	27.747	4.49	27.742	4.52
12	27.752	4.48	27.74	4.52
13	27.747	4.51	27.742	4.52
14	27.738	4.52	27.739	4.51
15			27.741	4.51
16			27.738	4.52

Over Size OD Gas
Color Code Yellow
Special Parts for Lash Test

	Accelorator		Brake	
	OD (mm)	Slot (mm)	OD (mm)	Slot (mm)
1	27.745	4.46	27.737	4.52
2	27.742	4.51	27.738	4.52
3	27.742	4.5	27.737	4.5
4	27.74	4.51	27.746	4.52
5	27.739	4.51	27.739	4.51
6	27.738	4.5	27.738	4.51
7	27.738	4.51	27.74	4.52
8	27.731	4.51	27.74	4.51
9	27.737	4.49	27.74	4.51
10	27.74	4.51	27.74	4.51
11	27.738	4.52	27.734	4.51
12	27.735	4.51	27.744	4.51
13	27.733	4.51	27.736	4.53
14	27.739	4.5	27.72	4.52
15	27.735	4.51	27.738	4.5

[redacted]

Brake Measurements for reduced lash/improved rattle samples

	SERIAL #	SAMPLE #	OD Accel ROD (mm)	OD Brake ROD (mm)	OD ROD & NEW BUSHING (mm)	LASH WITH STD BUSHING (mm)	LASH WITH NEW BUSHING (mm)	Delta Lash	% Chg Accel	% Chg Brake	WALL THICKNESS OF NEW BUSHING (mm)
GAS BRAKE	A00	10		27.74	31.739	6.26	7.06	-0.8		-12.75%	1.9995
	A30	8		27.74	31.772	5.99	5.71	0.28		4.67%	2.016
	BO2	6		27.736	31.699	6.88	4.98	1.9		27.62%	1.9805
	A99	11		27.734	31.711	6.25	4.94	1.31		20.96%	1.9885
	A97	9		27.74	31.703	7.26	5.59	1.66		22.90%	1.9815
	A98	12		27.744	31.715	7.19	6.26	0.93		12.93%	1.9855
	B00	5		27.739	31.695	7.97	4.58	3.39		42.53%	1.976
	A92	13		27.738	31.696	5.84	4.3	1.54		26.37%	1.979
	A94	3		27.737	31.706	6.47	5.18	1.29		19.94%	1.9845
	B01	4		27.746	31.716	7.85	6.46	1.39		17.71%	1.985
	A96	7		27.74	31.722	7.28	5.13	2.15		29.53%	1.991
	Avg.			27.7378	31.720	6.886	5.385	1.50		21.18%	1.9909
	Max			27.746	31.772	7.970	7.06	3.39		42.53%	2.0160
	Min			27.72	31.695	5.840	4.3	-0.8		-12.78%	1.978
	Range			0.026	0.077	2.13	2.76	4.19			0.038
DIESEL BRAKE	A17	13		27.742	31.722	6.2	5.19	0.01		0.19%	1.99
	A13	11		27.742	31.692	5.38	4.86	0.52		9.67%	1.975
	A32	1		27.741	31.686	5.82	3.48	2.34		40.21%	1.9725
	A14	4		27.731	31.696	5.16	3.31	1.85		35.85%	1.982
	A12	5		27.739	31.71	6.55	3.85	2.7		41.22%	1.9855
	A25	7		27.743	[illegible]	6.59	2.33	[illegible]		64.64%	1.988
	A24	14		27.739	[illegible]	4.96	3.52	[illegible]		29.03%	1.9825
	A21	8		27.742	[illegible]	6.09	3.45	[illegible]		43.35%	1.9825
	A22	15		27.741	[illegible]	5.83	3.86	[illegible]		33.79%	1.976
	A23	10		27.74	[illegible]	7.96	4.48	[illegible]		43.65%	1.9795
	A19	12		27.74	[illegible]	7.56	4.18	[illegible]		44.64%	1.981
	A18	9		27.743	[illegible]	4.55	3.05	[illegible]		32.97%	1.982
	Avg.			27.7409	31.71[illegible]	5.886	3.89	2.00		32.47%	1.9850

[redacted]

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Max			27.75	31.759	7.950	5.19	4.26		64.64%	2.0095
Min			27.731	31.686	4.550	2.33	0.01		0.18%	1.9725
Range			0.019	0.073	3.4	2.86	4.25			0.037

Accelerator Measurements for reduced lash/improved rattle samples

	v	SAMPLE #	OD Accel ROD (mm)	OD Brake ROD (mm)	OD ROD & NEW BUSHING (mm)	LASH WITH STD BUSHING (mm)	LASH WITH NEW BUSHING (mm)	Delta Lash	% Chg Accel	% Chg Brake	WALL THICKNESS OF NEW BUSHING (mm)
	A66	3	27.743		31.7	7.42	4.46	2.96	39.89%		1.9765
	[redacted]										
	A61	11	27.747		31.704	8.71	5.48	3.23	37.08%		1.9785
	A57	12	27.762		31.706	7.44	5.07	2.37	31.85%		1.978
	A59	6	27.73		31.71	8.22	6.62	1.6	19.46%		1.99
	A55	15			31.705	7.05	5.75	1.3	18.44%		
	A58	10	27.74		31.696	8.62	6.67	1.96	22.62%		1.978
	A65	14	27.738		31.7	7.74	6.79	0.95	12.27%		1.981
DIESEL ACCEL	A54	8	27.739		31.7	8.11	5.62	2.49	30.70%		1.9805
	A60	1	27.744		31.683	5.67	5.13	0.54	9.52%		1.9695
	A67	5	27.74		31.738	8.18	5.59	2.59	31.66%		1.999
	A63	7	27.757		31.696	7.75	5.66	2.09	26.97%		1.9695
	A64	13	27.747		31.717	7.67	6.09	1.58	20.60%		1.985
	A56	9	27.736		31.7	8.34	6.24	2.1	25.18%		1.981
	Avg.		27.74284615		31.711	7.806	5.68	2.13	26.81%		1.9843
	Max		27.757		31.750	8.710	6.79	4.51	57.46%		2.0035
	Min		27.73		31.683	5.670	3.34	0.54	9.52%		1.9695
	Range		0.027		0.067	3.04	3.45	3.97			0.034
	A49	4	27.74		31.762	12.26	7.78	4.48	36.54%		2.011
	[redacted]										
	A40	10	27.74		31.706	12.03	7.42	4.61	38.32%		1.983
	A39	1	27.745			7.71	5.2	2.51	32.56%		

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[redacted]

GAS ACCEL.	A37	14	27.739		31.79	9.14	6.81	2.33	34.21%		1.9955
	A36	6	27.738			11.52	6.78	4.74	69.91%		
	A50	3	27.742		31.683	8.4	6.42	1.98	30.84%		1.9705
	A35	2	27.742		31.737	11.15	5.18	5.99	116.08%		1.9875
	A30	4	27.74			9.15	5.97	3.18	53.27%		
	[redacted]										
	A48	7	27.738		31.742	10.38	6	4.38	73.00%		2.002
	A41	13	27.733		31.721	7.25	5.64	1.61	28.55%		1.994
	A46	11	27.739		31.728	11.43	8.66	2.87	33.53%		1.9845
	Avg.		27.73885714		31.730	9.634	6.24	3.40	58.44%		1.9958
	Max		27.745		31.762	12.260	8.79	5.99	144.10%		2.0120
	Min		27.731		31.683	7.250	3.24	-0.65	-7.99%		1.9705
	Range		0.014		0.079	5.01	5.56	6.64			0.0415

FE85-044 22885

[redacted]

LASH CHANGE

	SERIAL #	SAMPLE #	OD Accel ROD AND BUSHING STANDARD (mm)
DIESEL BRAKE STANDARD TO NEW BUSHING	A58	1	
	A29	2	
	A85	3	
	A78	4	
	A18	5	
	A26	6	
	A94	7	
	B03	8	
	A10	9	
	A19	10	
	A24	11	
	A38	12	
	A47	13	
	A48	14	
	A47	15	
	A21	16	
	A27	17	
	A28	18	
	A03	19	
	A22	20	
	Avg.		

	A77	1	31
	A71	2	31
	A74	3	31
	A75	4	31
	A87	5	31
	A68	6	31
	A56	7	31

[redacted]

PE83-944 22869

[redacted]

DIESEL ACCEL STANDARD TO NEW BUSHING			
	A69	8	31.543
	A57	8	31.539
	A70	10	31.574

[redacted]

FROM STANDARD PARTS TO NEW BUSHING

OD Brake ROD AND BUSHING STANDARD (mm)	OD ROD & NEW BUSHING (mm)	LASH STANDARD ONLY (mm)	LASH FOR NEW BUSHING ONLY (mm)	Delta Lash	% Chg Accel	% Chg Brake	DIFF. IN WALL THICKNESS OF BUSHING (mm)
[illegible]	31.682	7.88	4.77	2.91		[illegible]	[illegible]
[illegible]	31.696	7.62	4.58	3.04		[illegible]	[illegible]
[illegible]	31.715	9.07	4.78	4.29		[illegible]	[illegible]
[illegible]	31.727	7.57	4.28	3.29		[illegible]	[illegible]
[illegible]	31.707	8.61	5.79	2.82		[illegible]	[illegible]
[illegible]	31.696	9	5.03	3.97		[illegible]	[illegible]
[illegible]	31.731	9.17	4.5	4.67		[illegible]	[illegible]
[illegible]	31.723	8.95	4.33	4.62		[illegible]	[illegible]
[illegible]	31.69	8.61	4.53	4.08		[illegible]	[illegible]
[illegible]	31.724	8.62	4.88	3.74		[illegible]	[illegible]
[illegible]	31.709	4.77	4.29	0.48		[illegible]	[illegible]
[illegible]	31.654	6.27	5.06	1.21		[illegible]	[illegible]
[illegible]	31.665	5.64	3.29	2.35		[illegible]	[illegible]
[illegible]	31.668	6.43	3.98	2.45		[illegible]	[illegible]
[illegible]	31.665	6.26	4.16	2.1		[illegible]	[illegible]
31.61	31.701	6.1	3.72	2.38		39.02%	0.0455
31.599	31.697	6.89	5.53	1.36		19.74%	0.049
31.617	31.786	6.75	4.92	1.83		27.11%	0.0845
31.61	31.7	7.06	5.12	1.94		27.48%	0.045
31.572	31.807	6.08	3.59	2.49		40.95%	0.1175
31.601	31.718	7.36	4.56	2.80		35.79%	0.0583

	[illegible]	6.3	5.72	[illegible]	[illegible]		0.0615
	[illegible]	7.03	6.16	[illegible]	[illegible]		0.0566
	[illegible]	6.63	5.74	[illegible]	[illegible]		0.059
	[illegible]	7.07	4.76	[illegible]	[illegible]		0.0485
	[illegible]	8.33	5.84	[illegible]	[illegible]		0.074
	[illegible]	6.67	5.15	[illegible]	[illegible]		0.0636
	[illegible]	6.62	5.7	[illegible]	[illegible]		0.0685

	31.687	6.61	4.84	1.77	26.78%		0.072
	31.62	8.82	6.76	2.06	23.36%		0.0405
	31.719	6.69	5.07	1.62	24.22%		0.0725

AVERAGE CHANGE FOR ACCEL 22.52%

AVERAGE CHANGE FOR BRAKE 36.79%

From: Mango, Jack - Troy (JMango@tfxauto.com)
Sent: Wednesday, July 25, 2001 7:59 PM
To: Franklin . Ben - Kendallville; 'Lisa Petrauskas (L.E.) (E-mail)'
Subject: RE: "tip in"

Greg needs to forward this info as soon as possible, we need to remove this issue from the AIMS deck this week,no later.........

-----Original Message-----
From: Franklin , Ben - Kendallville
Sent: Wednesday, July 25, 2001 11:54 AM
To: Lisa Petrauskas (L.E.) (E-mail); Mango, Jack - Troy
Subject: "tip in"

Lisa or Jack,

Can you get me some info on this issue. We really don't understand it here at the plant. We have been hearing that one part had this problem at 1PP (?) and that another one has been found since with a similar problem.. PLUS that G. Braniff is looking for some kind of info, whether from us, or Ford, or Troy, I don't know right now.. either way, we at the plant are not completely in the loop on this one, and are wondering if we need to be.. Lisa, do you need anything out of us, or is this more of a design issue. Please advise.

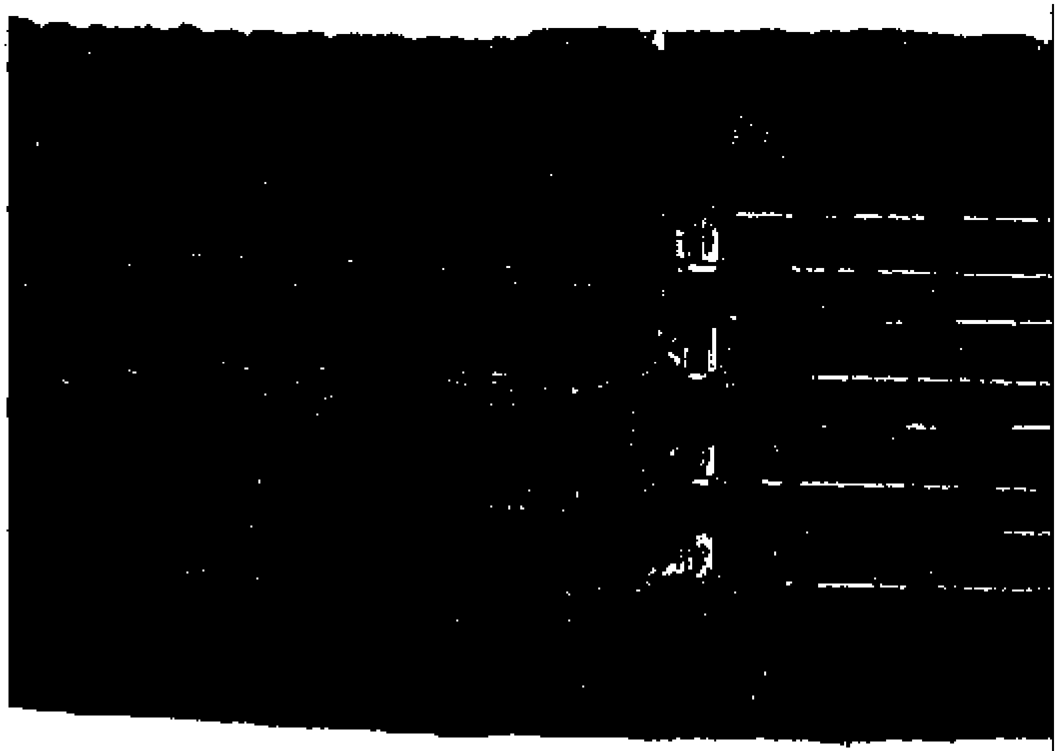
Ben Franklin
Sr. Quality Engineer
Teleflex - Kendallville
219-349-1985 x3361
fax 219-349-1983

PE03-044 22985

[redacted]

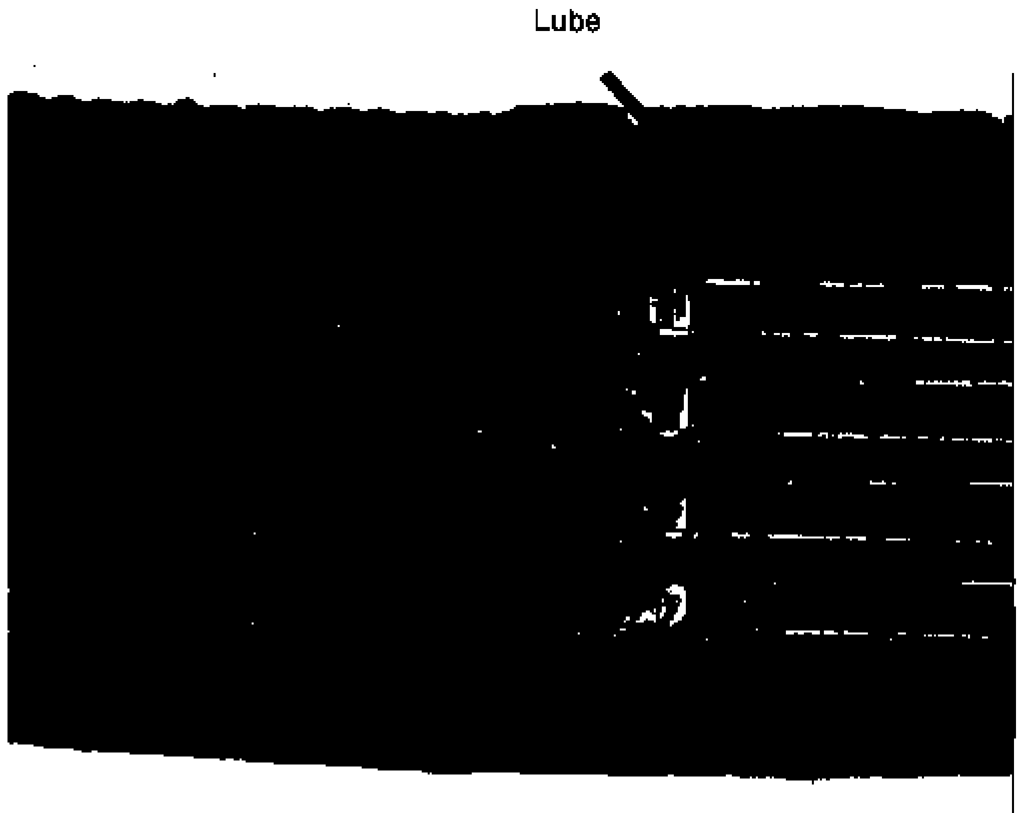
U 137 Field Failures - #111 Collector Track

- Lube on resistive ink tracks. This ink should not get lubed. The lube traps the ink particles and creates an abrasive slurry.



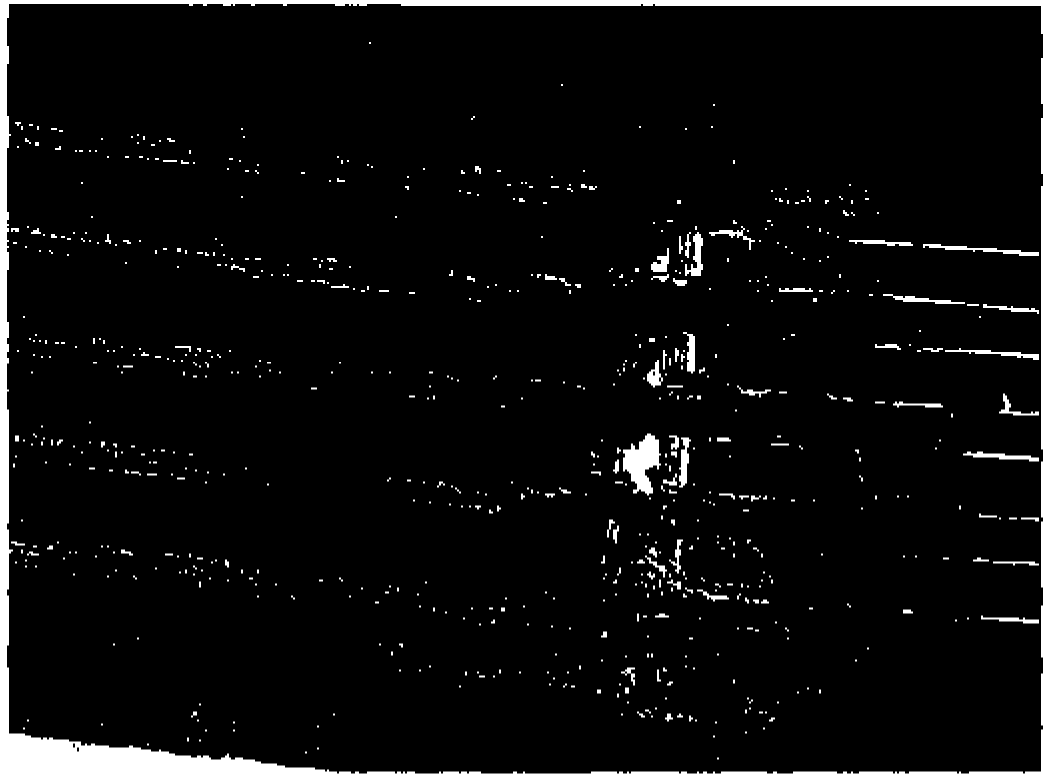
U 137 Field Failures - #111 Collector Track #2

- The lubricant looks like the same lubricant that gets applied to the switch. However, this lube does not migrate, and there is no indication of the lube present between the switch and the pot tracks.



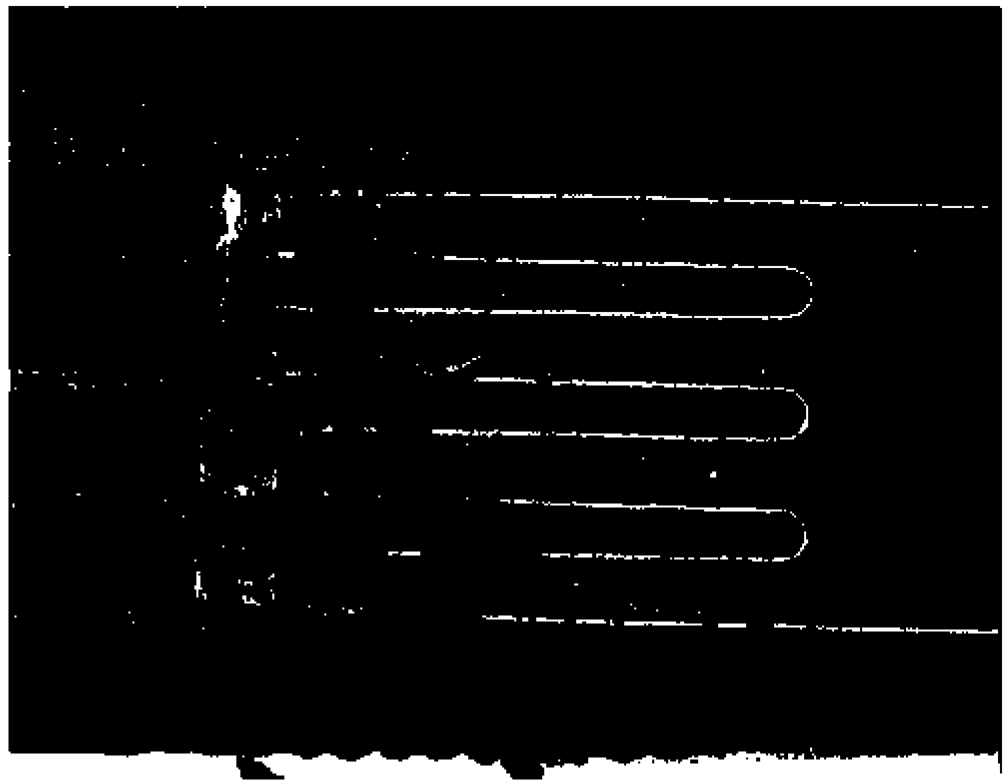
U 137 Field Failures - #111 Potentiometer Track

- Most areas of the resistive tracks appear to have had the lube applied to the tracks. The abrasive slurry wore the contact fingers off but did not significantly wear the resistive ink.



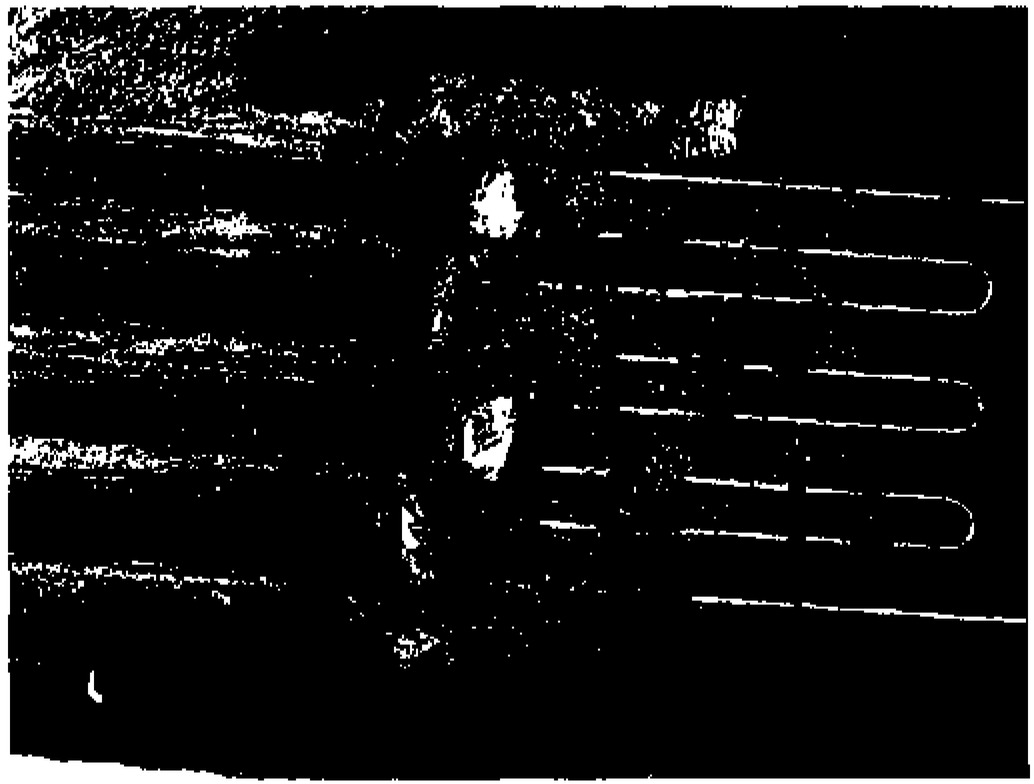
U 137 Field Failures - #95 Collector Track

- All of the contact fingers and potentiometer tracks exhibit the same condition. Lube on the pot tracks, abrasive slurry, and worn away contact fingers.



U 137 Field Failures - #95 Potentiometer Track

- Failure #95.



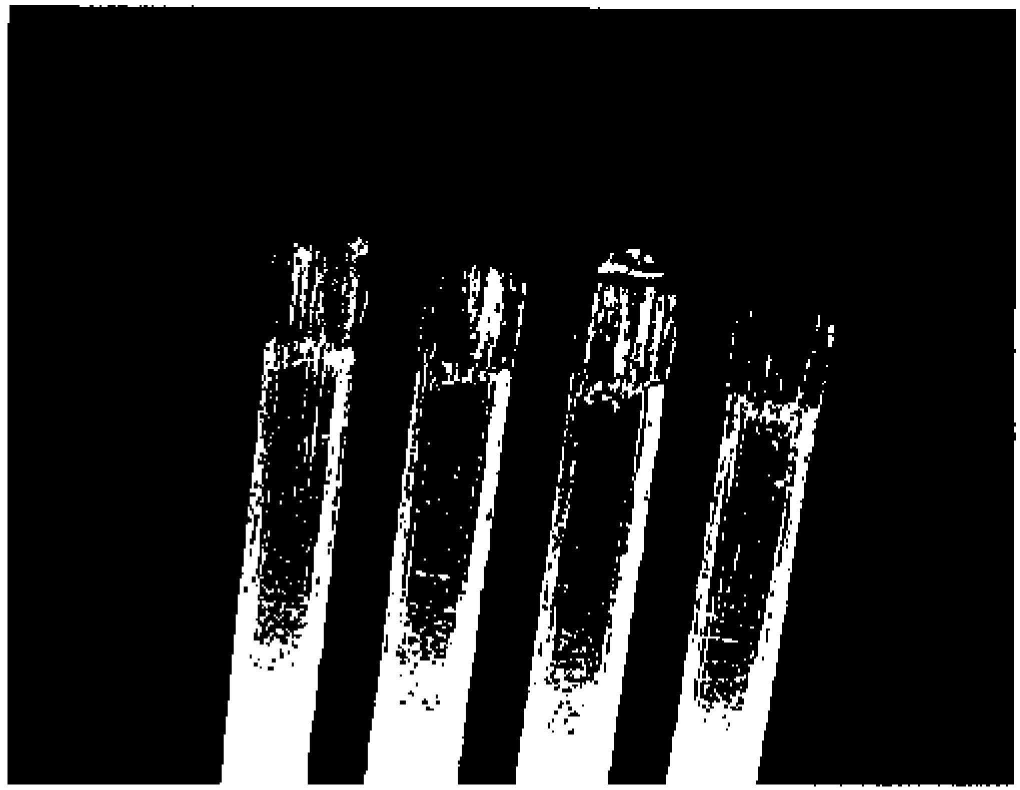
U 137 Field Failures - #95 Potentiometer Track Contacts

- All of the potentiometer contact fingers were worn off. This was the worst. Possibly due to the lowest rotor height.

PBD-944 11688

U 137 Field Failures - #111 Potentiometer Track Contacts

- This was about the least worn. Notice the pieces of the finger material loosely attached.



[redacted]

NYE INSTRUMENT GREASE 706D

Copper Corrosion Inhibited

A light viscosity, lithium soap thickened, polyolester grease for bearings, gear trains and related instrument applications.

Nye

The World Leader in Synthetic Lubricants

Recommended Service Range (°C)			-54 to 150	
Thickener			Lithium Soap	
Base Oil (Synthetic Oil 230A)	Type		Polyolester	
	Kinematic Viscosity cSt (mm²/s)	100°C	3.7	ASTM D-445
		40°C	16.5	
		-40°C	-	
	Viscosity Index		123	ASTM D-2270
	Flash Point (°C)		240	ASTM D-92
	Pour Point (°C)		-60	ASTM D-97
Color, Appearance			-	
Penetration 1/10 mm	Unworked		260	ASTM D-217
	Worked	60 X	269	
		10,000 X	-	
		100,000 X	-	
	NLGI Grade		2	
Density	gm/cc	25°C	0.96	ASTM D-1480
Dropping Point (°C)			190	ASTM D-2265
Oil Separation	24 hours	100°C	3.5 %	FTM 791B, 321.2
Evaporation	24 hours	100°C	< 0.1 %	ASTM D-972
Water Washout	60 minutes	40°C	-	ASTM D-1264
Copper Corrosion	24 hours	120°C	2E, Moderate Tarnish	ASTM D-4048
Neutralization #		mg KOH/g	0.72	ASTM D-974
Neutralization #	24 hours @ 120°C	mg KOH/g	0.53	
4 Ball Wear	60 min., 1200 RPM 40 kg. load	100°C	-	ASTM D-2266
		150°C	-	
Low Temperature Torque (-40°C) gm-cm	Starting Torque		-	ASTM D-1478
	Running Torque	10 minutes	-	
	Running Torque	60 minutes	-	
Oxidative Stability	100 hours	100°C	-	ASTM D-942
Bearing Rust Test			-	ASTM D-1743
Apparent Viscosity			-	

The typical properties shown on this product data sheet should not be used as a basis for preparing specifications. Refer to our product Material Safety Data Sheet for detailed safety information. (0101)

12 Howland Road Fairhaven MA 02719 USA Ph: 508.996.6721 Fx: 508.997.5285 www.nyelubricants.com

PE83-044 11826

[redacted]

NYE UNIFLOR™ 8511

A PTFE thickened, medium viscosity, completely fluorinated grease for use in high temperature applications exposed to fuels or aggressive chemicals. It possesses excellent thermo-oxidative stability and low vapor pressure characteristics.

The World Leader in Synthetic Lubricants

[illegible]			[illegible]	[illegible]
Recommended Service Range (°C)			- 50 to 225	
Thickener			PTFE	
Base Oil	Type		PFPE	
	Kinematic Viscosity cSt (mm²/s)	100°C	16	ASTM D-445
		40°C	65	
		-40°C	approx. 13,000	
	Viscosity Index		258	ASTM D-2270
	Flash Point (°C)		None	ASTM D-92
	Pour Point (°C)		< - 54	ASTM D-97
[illegible]			[illegible]	
Color, Appearance			White, Smooth	
Penetration 1/10 mm	Unworked		264	ASTM D-217
	Worked	60 X	279	
		10,000 X	-	
		100,000 X	-	
	NLGI Grade		2	
Density	gm/cc @ 25°C		1.94	ASTM D-1480
Dropping Point (°C)			Non-Melting	ASTM D-2265
Oil Separation	24 hours	100°C	5.4 %	FTM 791B, 321.2
Oil Separation	24 hours	25°C	0.9 % (3.4 kPa Static Pressure)	ASTM D-1742
Evaporation	24 hours	100°C	0.1 %	ASTM D-972
Water Washout	60 minutes	80°C	0.3 %	ASTM D-1264
Copper Corrosion	24 hours	100°C	1A, No Corrosion	ASTM D-4048
4 Ball Wear	60 min., 1200 RPM 40 kg. load	75°C	-	ASTM D-2266
		150°C	-	
Low Temperature Torque (-40°C) gm-cm	Starting Torque		665	ASTM D-1478
	Running Torque	10 minutes	-	
	Running Torque	60 minutes	295	
Oxidative Stability	158 hours	100°C	10 kPa (1.5 psig)	ASTM D-942
Bearing Rust Test			-	ASTM D-1743
Apparent Viscosity			-	

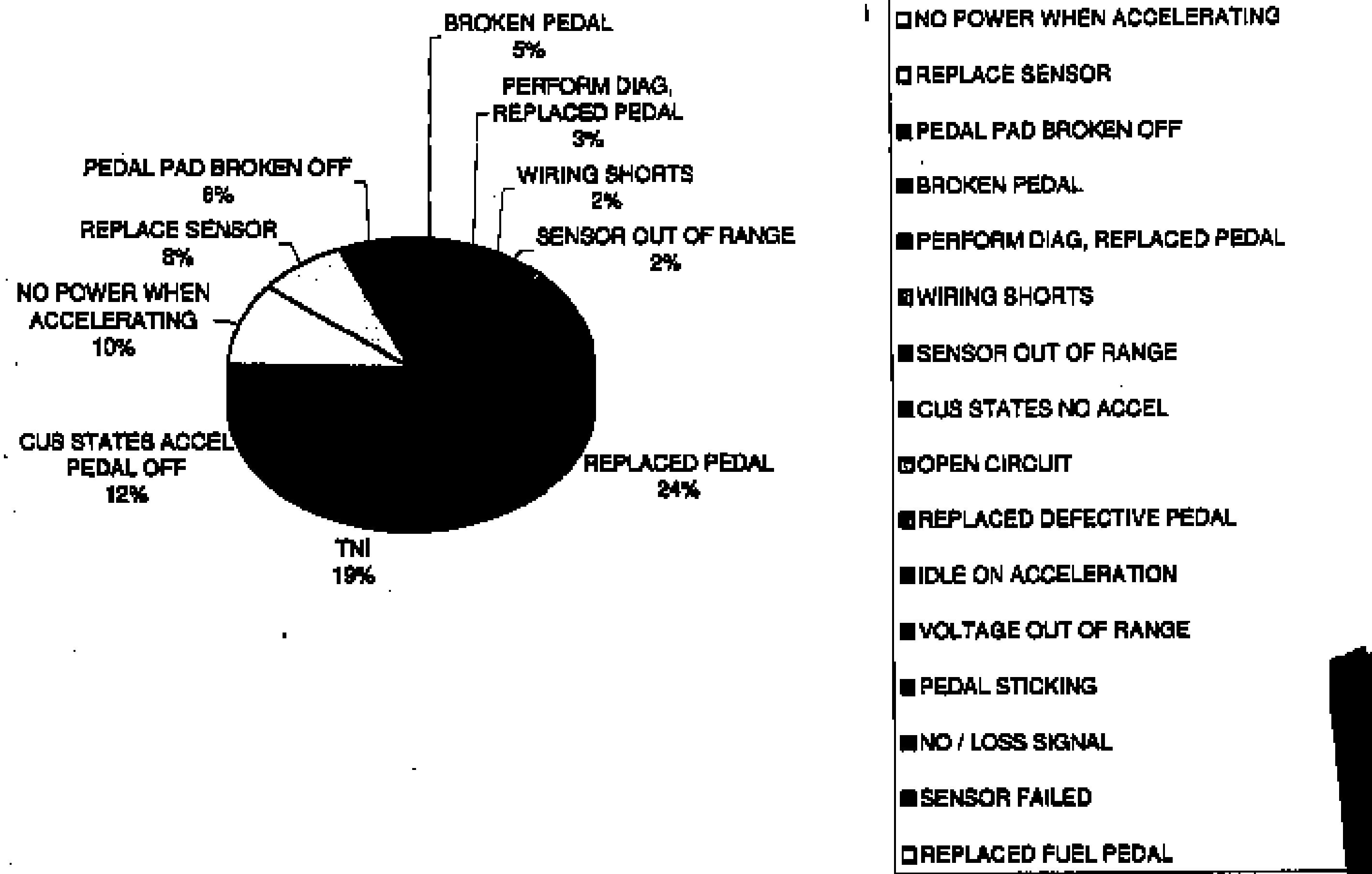
The typical properties shown on this product data sheet should not be used as a basis for preparing specifications. Refer to our product Material Safety Data Sheet for detailed safety information. (0205)

12 Howland Road Fairhaven MA 02719 USA Ph: 508.996.6721 Fx: 508.997.5285 www.nyelubricants.com

PE03-044 11627

Phenolic w/ 8511

7.3L 2001-2003 MY Super Duty F-Series / Excursion -1C3Z 9F836- Pedal Claims



[redacted]

FED3-044 11088

[redacted]

West, Gregory (G.S.)

From: Shore, John (J.)
Sent: Wednesday, January 15, 2003 4:07 PM
To: West, Gregory (G.S.)
Cc: Jaeger, Sharon (S.A.); Balint, Gary (G.S.); Hirtzel, Rich (R.J.)
Subject: RE: Sales Data

SERVICE PART: [redacted] PEDAL
ENGINEERING PART: [redacted]

MONTH	YEAR	Quantity	
01	2003	[redacted]	January forecasted sales - [redacted]
12	2002		
11	2002		
10	2002		
09	2002		
08	2002		
07	2002		
06	2002		
05	2002		
04	2002		
03	2002		

SERVICE PART: 1C3Z- 9F836-BA PEDAL
ENGINEERING PART: 1C34 9F836 BB

MONTH	YEAR	Quantity	
01	2003	323	January Forecasted sales - 750 to 790
12	2002	552	
11	2002	606	
10	2002	785	
09	2002	766	
08	2002	834	
07	2002	805	
06	2002	612	
05	2002	578	
04	2002	537	
03	2002	493	

FYI 6.0L

SERVICE PART: [redacted] PEDAL
ENGINEERING PART: [redacted]

A C	YEAR	Quantity	Replaced Part Number
[redacted]			

John Shore
Recall Parts Program Manager
Ford Customer Service Division
Office - 734 266-9780 FAX - 734 266-1166
Page - 734 797-5991 E-mail - Jshore@Ford.com
Mail Drop MD-44 1313C NPDC

-----Original Message-----
From: West, Gregory (G.S.)
Sent: Wednesday, January 15, 2003 3:54 PM
To: Shore, John (J.)

AWS Cost Per Repair TIS Model Year Matrix

2001-2003 MY 7.3L P131 / U137 [NA] [USA / CAN SOLD / REPAIR'D] - NOV 30 2002 CUTOFF

Cutoff Date : Nov 30, 2002
Result ID : 18391513
Min Divisor : 100

Cost Per Repair TIS Model Year Matrix Logic: Corporate

MIS	[illegible]	[illegible]	[illegible]
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
Repairs	[illegible]	1,104	15
Cost	[illegible]	224,045	4,166
Divisors	[illegible]	162,0[illegible]	18,244

Currency Reported: US DOLLAR Currency Requested: US DOLLAR Currency Exchange Version: v5

TOTAL = 1,280,197.

END OF REPORT

Att: Kim / Gary

[redacted]

APTEK Williams Inc.
A Williams Controls Company

FAX

[redacted] NW 12th Ave.
Deerfield Beach
Fl 33442
Ph. 954 421 8450
Fx. 954 421 8044

From : Tomás Pino cc :
To : Greg West (313-322-9265)
Date : January 30, 2001
Re. : Pedal Mixing No. of Pages : 1 of 1

Greg, we looked at the potential problems coming from the use of a pedal in the wrong truck. The results are better summarized in a table:

PEDAL	TRUCK	RESULT
'01 P131	'03 Navistar	S3=100% S1=S2=0% (All Constant)
'01 P131	'03 Caterpillar	No PWM Signal
'01 P131	'03 Cummins	S1=0% No IVS
'03 Navistar	'01 P131	Vref Short to Ground, S1=S2=S3=0%
'03 Navistar	'03 Caterpillar	No PWM Signal
'03 Navistar	'03 Cummins	S1=S2=S3=0%
'03 Caterpillar	'01 P131	S1=100% (12v), No IVS
'03 Caterpillar	'03 Navistar	S1=S2=S3=0%
'03 Caterpillar	'03 Cummins	S1=0%, No IVS
'03 Cummins	'01 P131	S1=0%, No IVS
'03 Cummins	'03 Navistar	Sort SW Supply, S1=0%
'03 Cummins	'03 Caterpillar	No PWM Signal

In short, no truck should be able to go beyond idle with any of these combinations. In some cases, damage to the sensor or the ECU will surely occur.

Thanks,

Tomás Pino

28624

Pedal Test

WILLIAMS CONTROLS INC

Version 1.0

Thursday, January 18, 2001 1:04:46 PM

P/F Limits	Low	High
Travel	[redacted]	[redacted]
V-WOT	[redacted]	[redacted]
F-WOT	[redacted]	[redacted]
V-Idle	[redacted]	[redacted]
F-Idle	[redacted]	[redacted]
Sw Pt	[redacted]	[redacted]
Hyst	[redacted]	[redacted]

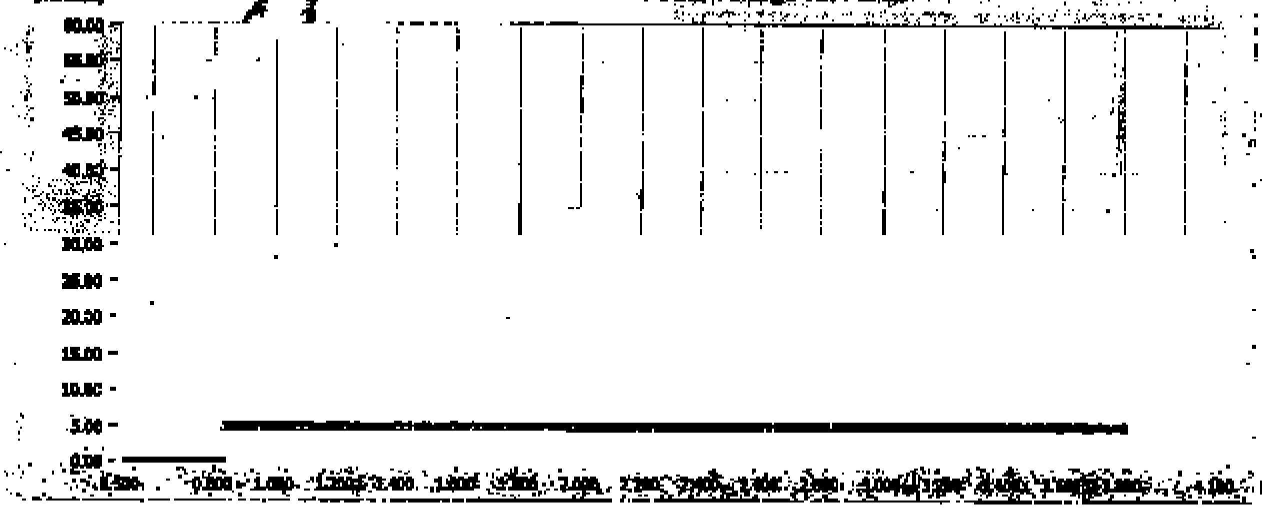
Pedal Test Results

Total Degrees	[redacted]	Deg	[redacted]
Pedal Voltage WOT	[redacted]	%	[redacted]
Pedal Force WOT	[redacted]	N	[redacted]
Pedal Voltage Idle	[redacted]	%	[redacted]
Pedal Force Idle	[redacted]	N	[redacted]
Switch Point	[redacted]	%	[redacted]
Hysteresis	41.04	%	[redacted]

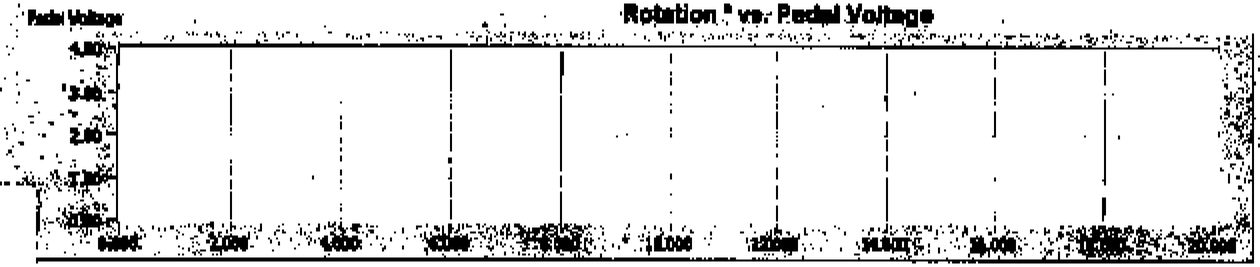
Status: Ready. Waiting for Operator Start

Barcode / Serial # 0112482

Pedal Voltage vs. Force



Rotation ° vs. Pedal Voltage



PE92-044 11884

[redacted]

[redacted]

From: Greg Braniff [gbraniff@tfxauto.com]
Sent: Wednesday, September 18, 2002 9:37 AM
To: Greg West
Subject: Fwd: 3-Track correlation

3-Track correlation

Greg, there is no statistical correlation between KV and KTP, but, just looking at the #'s they don't look to bad. Let me know what you think.

Greg Braniff
Teleflex Automotive
Ph 248-616-3107
Cell 248-840-1840
gbraniff@tfxauto.com

[redacted]

From: Mike Foreman [mforeman@tfxauto.com]
Sent: Wednesday, September 18, 2002 8:09 AM
To: gbraniff@tfxauto.com; kzolan@tfxauto.com
Subject: 3-Track correlation

3-TrkCorrelationFEU1.xls   Card for foreman@tfxauto.co

Greg / Kathy,
Greg West asked me to supply information relating to correlation between STP & Kr on the first batch of 3-track parts supplied at FEU. I had Rob Mundroff do a quick data analysis and he found the correlation to be poor. Attached is raw data, not sure how you want to break the news to Greg West.

Thanks,
Mike

[redacted]

Full Name:	Mike Foreman
Last Name:	Foreman
First Name:	Mike
Job Title:	Sr. Manufacturing Engineer
Department:	Kendallville
Company:	Teleflex
Other Address:	301 West Ohio Street Kendallville, IN 46755-2017
Business:	260-349-1985
Business Fax:	260-349-1983
E-mail:	mforeman@tfxauto.com

From:	Greg Braniff [gbraniff@tfxauto.com]
Sent:	Tuesday, September 24, 2002 2:22 PM
To:	kzolan@tfxauto.com; zkhan1@tfxauto.com; Greg West; Larry Liposky
Subject:	Fwd: FW: Wabash circuit boards

FW: Wabash circuit boards

Greg Braniff
Teleflex Automotive
Ph 248-616-3107
Cell 248-840-1840
gbraniff@tfxauto.com

[redacted]

From: Pietrzak, Bob [bpietrzak@wabashtech.com]
Sent: Tuesday, September 24, 2002 12:20 PM
To: gbraniff@tfxauto.com
Subject: FW: Wabash circuit boards

Importance: High

8511 - 2.jpg 7060 - 1.jpg 7060 - 2.jpg 8511 - 1.jpg

Greg,

Can you get these out to the applicable Ford people before our 3:00 meeting?

Bob

-----Original Message-----
From: Brian Cichoski [mailto:cichoski@atdial.net]
Sent: Tuesday, September 24, 2002 10:44 AM
To: Vitale, Joseph; Pietrzak, Bob; Brown, Todd
Subject: Fw: Wabash circuit boards
Importance: High

Gentlemen,

Sorry I was not able to attend the conference call yesterday, but I caught some kind of flu bug over the weekend and was out sick. We have another conference call today at 3 pm correct? and is it beneficial to include my applications engineer in this call if we are going to discuss the pictures? contact me please.

Attached are pictures from the latest test on the swirl designed phenolic board. Please note that picture #1 & #4 are with 8511U, and pictures 2 &3 show the oil migration with the 7060. C

regards,

Brian

----- Original Message -----
From: "Ralph Patrizio" <patrizio@nyelubricants.com>
To: "Brian Cichoski" <cichoski@atdial.net>
Sent: Monday, September 23, 2002 8:50 AM
Subject: Re: Wabash circuit boards

> Hi Brian,
>
> enclosed are the pictures with the swirl designed Wabash boards. C
> Let me know if you have any questions.
>
> Ralph
>
>
>
> Brian Cichoski wrote:
>
> > Hi Ralph,
> >
> > Wabash has asked Nye to run the heat age test again on these new design
> > boards with 7060 & 8511U. The purpose of the new design is to create a
ditch C

[redacted]

> > that will not allow the 706D base oil from migrating over onto the pot
> > tracks.
> >
> > Do you think we could have a couple of pictures for a 11am Monday
morning
> > conference call that I have with Wabash, Ford, TeleFlex?
> >
> > Brian
> > ----- Original Message -----
> > From: "Ralph Patrizio" <patrizio@nyelubricants.com>
> > To: "Brian Cichoski" <cichoski@nyelubricants.com>
> > Sent: Friday, September 20, 2002 11:40 AM
> > Subject: Wabash circuit boards
> >
> > > Hi Brian,
> > >
> > > I received some Wabash (new design) circuit boards.
> > > Do you have any plans for them ?
> > >
> > > Ralph
> > >
> > > --
> > > Ralph Patrizio
> > > Nye Lubricants, Inc.
> > > 12 Howland Road
> > > Fairhaven, MA 02719 USA
> > >
> > > Ph. 508-996-6721
> > > Fx. 508-984-7123
> > >
> > > www.nyelubricants.com
> > > email: patrizio@nyelubricants.com
> > >
> > >
> > >
> > >
>
> --
> Ralph Patrizio
> Nye Lubricants, Inc.
> 12 Howland Road
> Fairhaven, MA 02719 USA
>
> Ph. 508-996-6721
> Fx. 508-984-7123
>
> www.nyelubricants.com
> email: patrizio@nyelubricants.com
>
>

C

From: Kathy Zolan [kzolan@tfxauto.com]
Sent: Monday, September 16, 2002 8:52 AM
To: Mkramer1@ford.com; Lliposky@ford.com; Gwest2@ford.com; Jwillia5@ford.com
Cc: Zulqarnain Khan
Subject: Nye Testing

Importance: High

Phenolic Resin boards test.doc...

-----Original Message-----
From: Vitale, Joseph [mailto:jvitale@wabashtech.com]
Sent: Monday, September 16, 2002 8:04 AM
To: Braniff Greg; Brian Cichoski; Brown Todd; Dean Kuchta; Lay Pam; Martin Tom; Mike Foreman; Pentecost Gary; Pietrzak Bob; Quillin Mark; Rick Trecapelli; Scaringelli Carl; Strupp Bruce; Zolan Kathy
Subject: FW:
Importance: High

Kathy,

Please distribute to the Ford team.

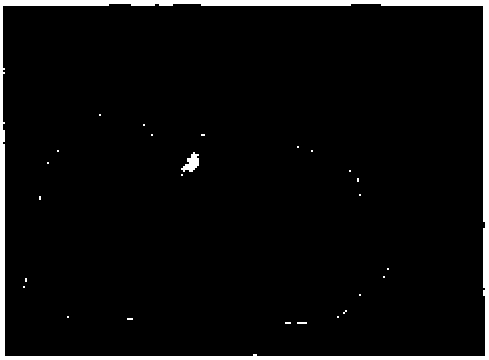
Thanks,

Attached are the pictures of the heat soak test for oil separation.

Brian
----- Original Message -----
From: "Vitale, Joseph" <jvitale@wabashtech.com>
To: "Braniff, Greg" <gbraniff@tfxauto.com>; "Brian Cichoski" <cichoski@nyelubricants.com>; "Brown, Todd" <tbrown@wabashtech.com>; "Lay, Pam" <play@wabashtech.com>; "Martin, Tom" <MARTINT@corp.optekinc.com>; "Mike Foreman" <mforeman@tfxauto.com>; "Pentecost, Gary" <gpentecost@wabashtech.com>; "Pietrzak, Bob" <bpietrzak@wabashtech.com>; "Quillin, Mark" <mquillin@wabashtech.com>; "Rick Trecapelli" <ricktrec@nyelubricants.com>; "Scaringelli, Carl" <cscaringelli@wabashtech.com>; "Strupp, Bruce" <bstrupp@wabashtech.com>; "Zolan, Kathy" <kzolan@tfxauto.com>
Sent: Wednesday, September 11, 2002 9:10 AM

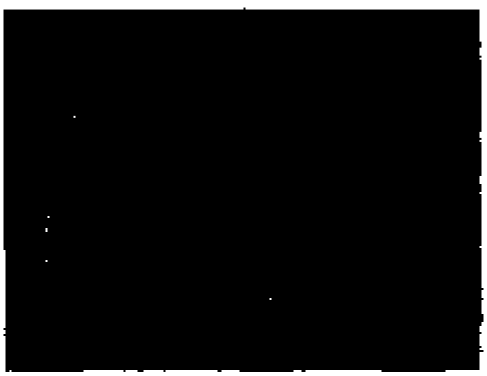
<<9-9-02 Ford-tfx-wt CCalls.doc>>

[redacted]



706D with NyeBar Q

1. Red trace indicates placement of Nyebar Q.
2. Yellow trace indicates the oil migration of 706D.



706D

1. Yellow trace Indicates oil migration of 706D.

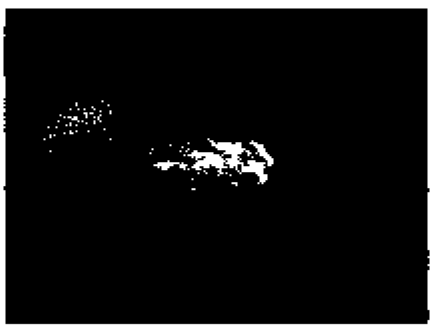
362HF w/NyebarQ

1. Red Trace indicates Nyebar Q.
2. Yellow trace indicates oil migration of 362HF.

[redacted]

362HF

1. Yellow trace indicates oil migration of 362HF.



8511 w/Nyebar Q

1. Yellow trace outline of 8511. No oil migration present.
2. Red Trace indicates Nyebar Q.

8511

1. Yellow trace outline of 8511. No oil migration present.

From: Pino, Tomas [Tpino@WMCO.com]
Sent: Tuesday, January 30, 2001 3:47 PM
To: Gregory West (G.S.) (E-mail)
Cc: Schrib, Mack
Subject: Pedal mixing

pedal mixing.doc

Greg,

Your fax was busy, so I don't know if you'll get that one. I am including the file with this message.
I thing I will be able to have all three drawings and models ready by the end of this week. Actually, I should have them by tomorrow, but we need to find out the location these files need to be sent to. Can you find out for us?

Thanks,

Tomás Pino
Aptek Williams
Ph. 954-421-8450 x370
Fx. 954-421-8044
tpino@WMCO.com

<<pedal mixing.doc>>

[redacted]

[redacted]

APTEK Williams Inc.
A Williams Controls Company

FAX

700 NW 12th Ave.
Deerfield Beach
Fl 33442
Ph. 954 421 8450
Fx. 954 421 8044

From : Tomás Pino cc :
To : Greg West (313-322-9265)
Date : January 30, 2001
Re. : Pedal Mixing No. of Pages : 1 of 1

Greg, we looked at the potential problems coming from the use of a pedal in the wrong truck. The results are better summarized in a table:

PEDAL	TRUCK	RESULT
'01 P131	'03 Navistar	S3=100% S1=S2=0% (All Constant)
'01 P131	'03 Caterpillar	No PWM Signal
'01 P131	'03 Cummins	S1=0% No IVS
'03 Navistar	'01 P131	Vref Short to Ground, S1=S2=S3=0%
'03 Navistar	'03 Caterpillar	No PWM Signal
'03 Navistar	'03 Cummins	S1=S2=S3=0%
'03 Caterpillar	'01 P131	S1=100% (12v), No IVS
'03 Caterpillar	'03 Navistar	S1=S2=S3=0%
'03 Caterpillar	'03 Cummins	S1=0%, No IVS
'03 Cummins	'01 P131	S1=0%, No IVS
'03 Cummins	'03 Navistar	Sort SW Supply, S1=0%
'03 Cummins	'03 Caterpillar	No PWM Signal

In short, no truck should be able to go beyond idle with any of these combinations. In some cases, damage to the sensor or the ECU will surely occur.

Thanks,

Tomás Pino

[redacted]

From:	Gehl, Laxman (L.D.)
Sent:	Monday, February 17, 2003 10:35 PM
To:	Boutsikakis, Georgios (G.I.)
Cc:	Hawkins, Fred (F.W.); Boal, Greg (G.); Liposky, Lawrence (L.J.); Wnuk, John (J.G.)
Subject:	Need 6-Sigma help for process improvement at Williams Controls (Pedal Supplier)

Georgios,

Today during my CQDC training, I happened to talk to Greg Beal regarding the issues we are facing with one of my suppliers, William Controls, who supplies fixed accelerator pedal for P131/U137 at KTP. When I discussed this with Fred Hawkins, he suggested me to contact you as you are a Black Belt in VPO-STA.

During 2003.25 Job1 launch at KTP, it was observed that the part was not meeting EOL requirement. Upon further investigation, it was also observed that 3 out of 10 specimen failed overload testing (Although 5 specimen tested during ES testing had passed the same test). We still do not know the cause why failure was not detected during ES testing.

Later, it was decided to "band guard" the LSL and USL with 100% testing for its electrical output to avoid job stopper situation at KTP. This has obviously resulted in to a very poor yield (only 70-75%) at the supplier's site.

I am wondering if we can assist the supplier to improve the process using 6-sigma methodology. I am Green Belt trained, and would like to get associated in this project.

During various conversation, it has been mentioned that D&R and/or buyer's activity are in favor of resourcing the fixed pedal.

If we, as a team, decide to pursue to assist supplier improve the process capability, I would like to visit the site with an appropriate Black Belt to further explore and launch the 6-Sigma process. I need your help. Please advise.

Thank you,

United We Stand

Laxman Gehi

STA Chassis Engineer

email:lgehi@ford.com

VPO 1E-436

Phone/Fax (313) 390-0771

Alternative Fax (313) 390-0793

Pager: (313) 796-7701 (Text)

Beuckelaere, Phillip (P.R.) [redacted]

From: Evangelista, Elio - Troy [eevangelist@TFXAuto.com]
Sent: Monday, April 09, 2001 3:47 PM
To: Phil Beuckelaere (E-mail)
Subject: FW: Pedal efforts - full forward vs full rearward (2003)

Elio Evangelista
Program Manager - Pedal Systems
Teleflex Automotive Group

-----Original Message-----
From: Braniff, Greg - Troy
Sent: Saturday, April 07, 2001 10:38 AM
To: Lisa Petrauskas (E-mail); 'pwill73@ford.com'
Cc: Teller, Bill - Troy; Evangelista, Elio - Troy; Kalsi, Avtar - Troy
Subject: Pedal efforts - full forward vs full rearward (2003)

Lisa and Pete, we ran 10 pedals on Saturday morning in full forward and full rearward. The data is attached. The loads jump up about 2 lbs when cycled in Full Forward position. Looks like the springs were designed to meet the spec. in the rearward position. I'm pretty sure that these parts were made from the same batch of springs as the 2002 1PP parts.

<<Pedal effort FWD vs RWD test data.xls>>

Greg Braniff
Teleflex Automotive
248-616-3107
gbraniff@tfxauto.com

[redacted]

Sample #	Full FWD (95%tile)		Full RWD (5%tile)	
	Idle (lb)	WOT (lb)	Idle (lb)	WOT (lb)
1	8.2	14.6	6.7	13.4
2	8.4	14.8	6.2	13.3
3	7.7	14.7	6	13.5
4	8.8	14.8	6.5	13.4
5	8.3	15	6.2	13.3
6	8	14.1	6.2	12.7
7	8.2	15.9	6.7	14.1
8	8.3	15.7	6.4	13.5
9	8.5	15.1	6.4	13.5
10	8.2	15.3	6.3	13
Avg	8.26	15	6.26	13.37

[redacted]

Full Name:	Mike Foreman
Last Name:	Foreman
First Name:	Mike
Job Title:	Sr. Manufacturing Engineer
Department:	Kendallville
Company:	Teleflex
Other Address:	301 West Ohio Street Kendallville, IN 46755-2017
Business:	260-349-1965
Business Fax:	260-349-1963
E-mail:	mforeman@tfxauto.com

[redacted]

RETURNED PART ANALYSIS REPORT

Report #65

SUPPLIER: CTS Automotive Products

CUSTOMER PART NUMBER: VP3M4U-9E928-AA

DATE RETURNED TO CTS: 19&20Sept 2002

#2988

Contactor tip condition and wire displacement was found to be typical for the extended mechanical cycling.
The debris found on the contactor wires was not in excess of expectations
Contactor force measurements were as follows
#2987 - 27.4 grams TPS1, 22.4 grams TPS2
#2988 - 25.0 grams TPS1 , 21.7 grams TPS2.
Both contactor assemblies were within the specification limits of 17.8 to 33.1 grams.

PE03-044 24116

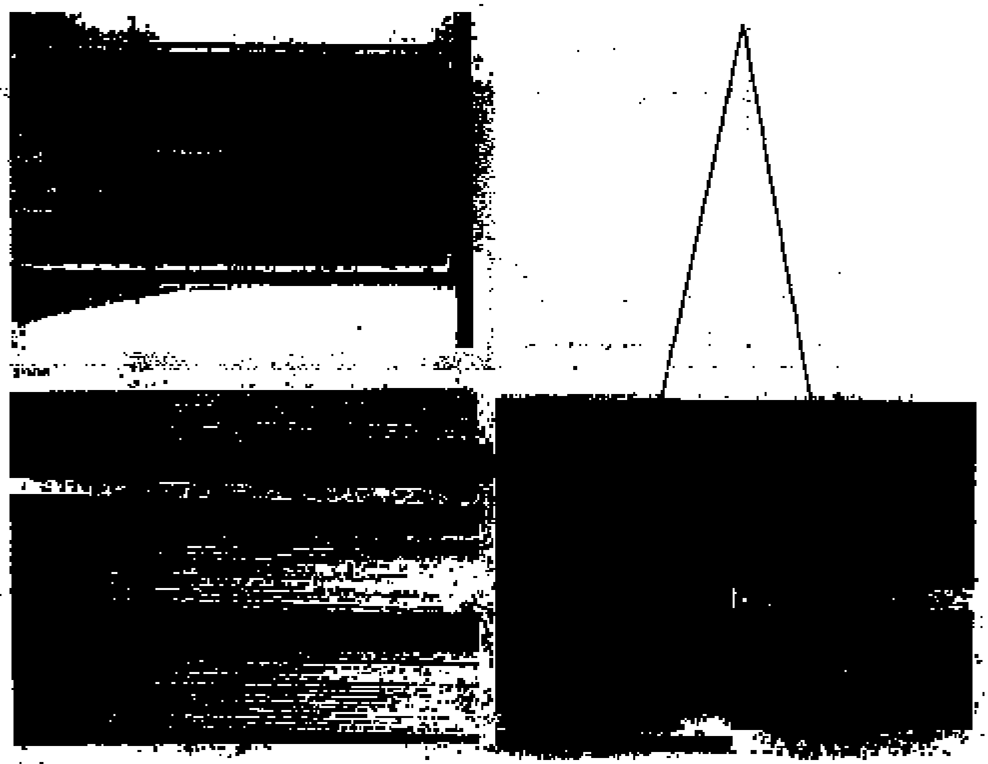
[redacted]

RETURNED PART ANALYSIS REPORT

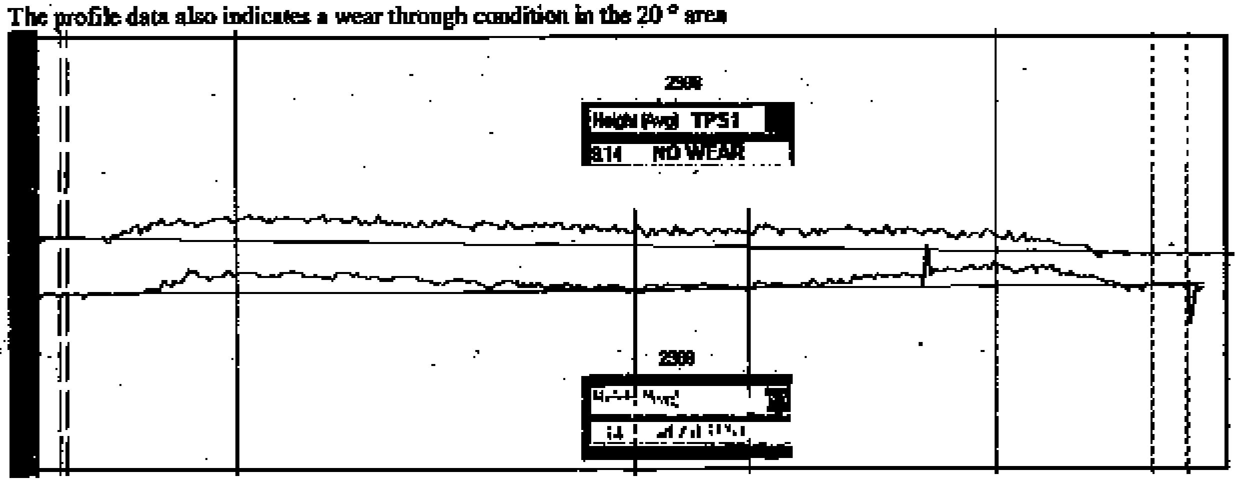
Report #65

SUPPLIER: CTS Automotive Products
CUSTOMER PART NUMBER: VP3M4U-9E928-AA
DATE RETURNED TO CTS: 19&20Sept 2002

The wear can be seen from the back light photograph: Several wear through area's are visible.



The profile data also indicates a wear through condition in the 20 ° area



#2988 SEM DATA. X 50 MAG.

PE03-044 24117

[redacted]

RETURNED PART ANALYSIS REPORT

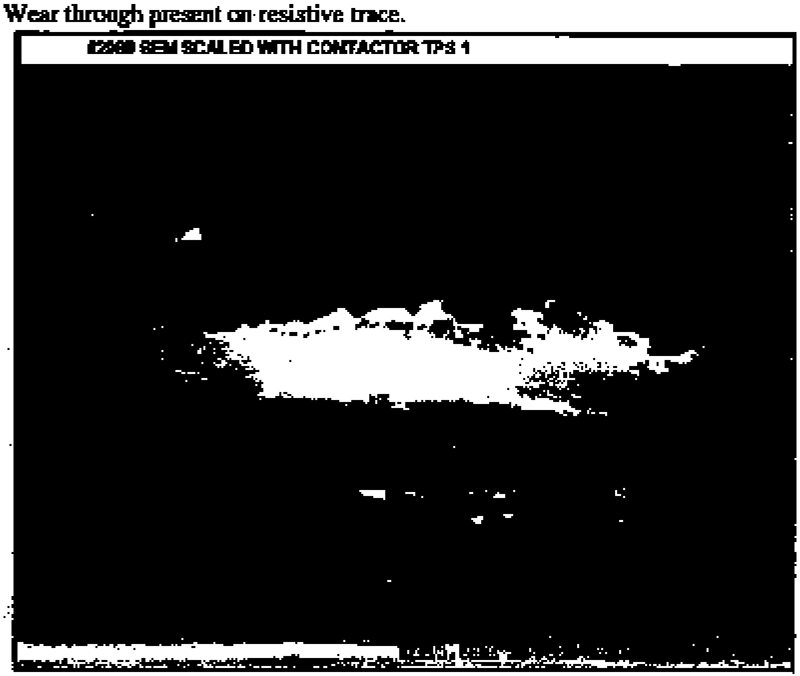
Report #65

SUPPLIER: CTS Automotive Products

CUSTOMER PART NUMBER: VP3M4U-9E928-AA

DATE RETURNED TO CTS: 19&20Sept 2002

Wear through present on resistive trace.



X 300 magnification. Contactor tips placed in position to clarify scale.

[redacted]

[redacted]

Summary Report on Rotary Sensor Wear

November 7th 2002

John G Williams
Chemistry Department
Michigan Technological University

Introduction

Here is a general summary of what we have done with respect to investigations into wear on the rotary sensor. All of our efforts have been directed toward understanding the influence variations of the resistive paint might have in determining the life of the rotary sensor.

We have received twelve sensor elements in total from various sources. All samples had been exposed to durability tests and showed wear on all four tracks. We did not examine the samples to compare wear tracks at this time. Of the twelve samples, nine arrived as assembled sensors and three arrived as isolated sensor elements. We disassembled the nine complete sensors and extracted the elements from them.

Table 1: Sensors at MTU

Number	Serial Number	LIMS Number	Source	Description
1	6371	22542	Initial 3	Good
2	119926	22796	Initial 3	Bad
3		23328	Initial 3	Wide bad
4	45978	21406	Second 6	Bad
5	9604	22305	Second 6	Marginally bad
6	9608	22305	Second 6	Severely degraded
7	9611	22305	Second 6	Good
8	97832	21406	Second 6	Bad
9			Second 6	Good
10	2984		JL	Good
11	2999		JL	Bad
12	2989		Unknown	Good

[redacted]

[redacted]

The tests we have completed are of two general types. Samples 1 and 3 were cut into two pieces approximately in half. The sample with the contact strip attached was used for the nano-indenter tests and the second was used for AFM tests.

Initial Nano-indenter Tests

We have mounted four of the sensors on 1 ¼ inch aluminum studs for testing in the MTS nano-indenter. The sample was reduced in size by moving part of the contactor strip to allow ready mounting in the instrument.

The initial tests on Samples 1 and 3 were to scratch the sample with a fine pyramidal tip (scratch motion with apex leading) with a load of 40 mN to form a scratch 500 microns long. The instrument records load and depth profiles. The initial scratch is at nominal load to record the start profile. The second scratch is under the specified load and the third scratch repeats the process at nominal load to indicate the new profile showing permanent damage to the surface. The resulting data is shown in Figures 1 to 3.

Initial AFM Tests

The strips were mounted onto glass microscope slides for examination under the Digital Instruments atomic force microscope.

Initial images were taken of the worn sections and of surfaces away from the worn tracks. Images were recorded at various magnifications and at several areas. Figures 4 and 5 show worn areas of the good and bad samples. We could not see any marked differences in the surfaces between the two samples. In the areas that had not been abraded it was possible to make out some differences in the images of the good and bad samples. These are shown in Figures 6 and 7. These show fine circular features about 0.3 micron diameter between rather large 2-3 micron complex features. Initially, it appeared that these small features were more regularly distributed in the good sample and were more 'clumped' in the bad sample. Subsequent examination of other samples, however, showed that this micro-structural feature was not consistently distributed in a way that could be related to the fate of the sample under durability testing. The feature appeared to follow the general topography of the surface and could possibly be associated with a fine dust accumulating in or associated with larger structural features.

The larger, irregular particles around three microns could be interpreted as agglomerates of finer particles and appeared similarly distributed throughout good and bad samples. It is tentatively assumed that the larger particle are the conductive carbon used as filler in the resistive paint. Smaller particles around 0.5 to 1 micron may be parts of the carbon agglomerate broken up during milling of the paint or a second filler.

Continued Nano-indenter Tests

As the nano-indenter tests seemed to be suggesting differences between the coatings which might be related to their fate in the durability testing, more tests were carried out.

[redacted]

In the second cycle of testing, the load was increased to 250mN (load needs to be confirmed) and the test was repeated five times on the same site. In these tests, the indenter was driven such that the facet of the pyramidal indenter lead the scratch (a more aggressive test).

Typical results are shown in Figures 8 and 9. Again the good and bad samples show slight but possibly significant differences. The images shown suggest that for the bad sample, successive scratches are different from preceding scratches while the good sample seems to show little difference between scratches.

The way that the images are presented by the default software package shows that the initial scratch appears deeper for the first scratch and gets successively more shallow as the test is repeated. The software package, however, subtracts some part of the topographic trace not including the local topographic detail (perhaps a linear fit to the data to remove sample slope). This subtracted data includes the plastic deformation of the previous cycle. If the data is re-plotted as produced during the indentation, each scratch lies at the same depth. A possible interpretation, therefore, is that the plastic deformation is increasing with each cycle although the sum of plastic and elastic remains the same.

In order to follow-up on this possible difference, we have mounted two more films and repeated the test. We will be interpreting the data as produced in these tests, rather than using the software package which seems to be making unacceptable assumptions about the wear process.

Observations from the Nano-indenter Data

Some significant observations concerning the indenter data might be useful.

The first is a comment on the relative loads used in the indenter and on the sensor during the durability testing. The reported loads in the durability testing are of the order of grams (approx 10 mN) on an indenter which starts spherical with a radius of about 0.76 mm diameter and wearing down to a cylinder of the same radius during the test. This means that the nano-indenter is using a much higher load as the tip is very much finer.

The indenter shows that the initial indentation is about seven microns and the plastic component is about one or two microns with the bad sample appearing a little higher. In spite of this large deformation, the five strokes of the diamond do remarkably little damage and high points which might be associated with the filler particles are largely unchanged. Some smaller particles, may be moved around or lost but not to any catastrophic extent for either film. If there is any significant difference, it lies in plastic deformation of the matrix.

Other Tests

During the investigation, discussion suggested that the wear mechanism could be a two stage mechanism. In the first stage, the indenter rides on the surface matrix film. This

[redacted]

material appears very tough and durable. However, once that film is broken, the wear rate could accelerate as filler particles are torn from the matrix leaving deep holes and unsupported matrix. In order to understand this possible process a preliminary trial was conducted to attempt to determine the distribution of the matrix particles. For this a sample of the end of a good and bad film were mounted vertically using standard metallurgical mounting procedures and a section was cut across the film normal to the direction of the contactor. This surface was then polished and examined using an optical microscope at 500X. Images are included as Figure 10 and 11. The immediate observation was that the good sample showed an immediately obvious film which appeared visually to be of constant thickness across the specimen. Each track was visible and the silver conductive traces readily distinguished. For the bad sensor, however, the resistive film was only visible for a very short part of a track near the sample edge. The silver track was visible but no sign of the resistive film could be seen at this magnification.

Both samples appeared visually to be the same prior to mounting and all tracks of resistive elements were seen and remained visible through the mounting resin. The interpretation of this observation is not clear as it implies that the film thickness on the bad sample was much smaller than the good sample. It is difficult to see how a sample with such a thin film could not have appeared different in the early parts of the durability test. Further study of the actual film thickness on the sample seems useful.

Current Plans

Current plans are to complete the analysis of two good and two bad sensor films using the 250mN scratch test to check reproducibility on each sample and from sample to sample. This is in progress.

We have mounted four more films and sectioned them and will be reporting on the observed resistive paint thickness, soon.

We plan to obtain images of the sectioned films using the AFM to check the consistency of particle distribution.

A good and a bad sensor film have been mounted for nano-indenter testing and partially abraded using 0.03 micron alumina. The intention of this is to remove the tough surface film and expose the filler particles to wear. These samples have been prepared and subjected to the high-load nano-indenter test and will be evaluated, soon.

The infrared spectra of the films will be measured using an attenuated total reflectance cell intended for use with solid samples. It is hoped that this will allow identification of the chemical composition of the binder especially in terms of the published patent describing a similar conductive paint system based on polyimide/cyanurate resin blends.

Possible Focus for Future Material Testing

[redacted]

In view of the wide temperature range that the system is exposed to during testing (-40 to 135°C), it would seem useful to ensure that the films all had similar chemistry in terms of:

(a) The composition of the blend, the way it phase separates (if incompatible)
(b) The degree of conversion to thermoset or of any reactions that may occur during 'cure' at elevated temperatures. (The patent suggests cure temperatures and cycles).
(c) The degree to which the paint solvent (N-methyl pyrolidone) is retained during 'cure' especially as a function of film thickness
(d) The glass transition temperature of the film

Suggested Instrumental Studies

(a) Dynamic mechanical analysis of the coating on the Kupton film – tensile or torsion
(b) Dynamic mechanical analysis of the film using a micro-harness probe and oscillation amplitude less than 1/5 of the film thickness
(c) SIMS study of the film surface and of freshly sectioned material looking for trapped solvent and residual monomer

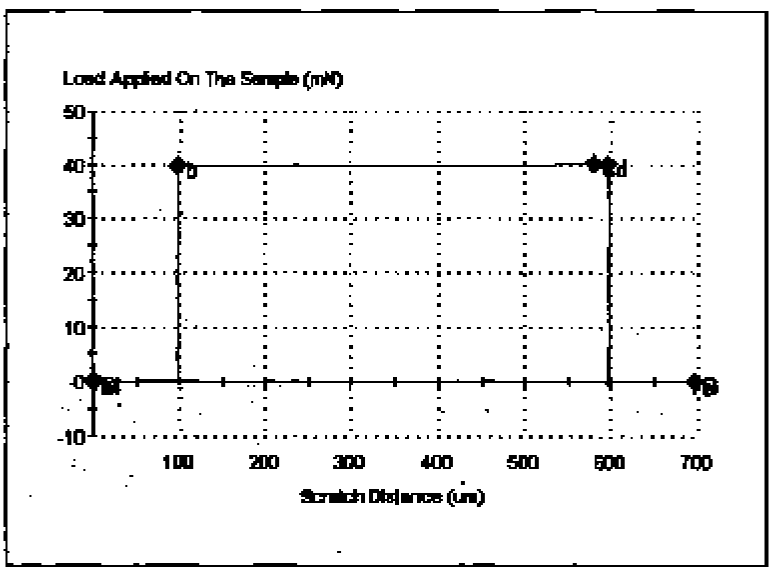


Figure 1: Load profile used during the initial scratch test

[redacted]

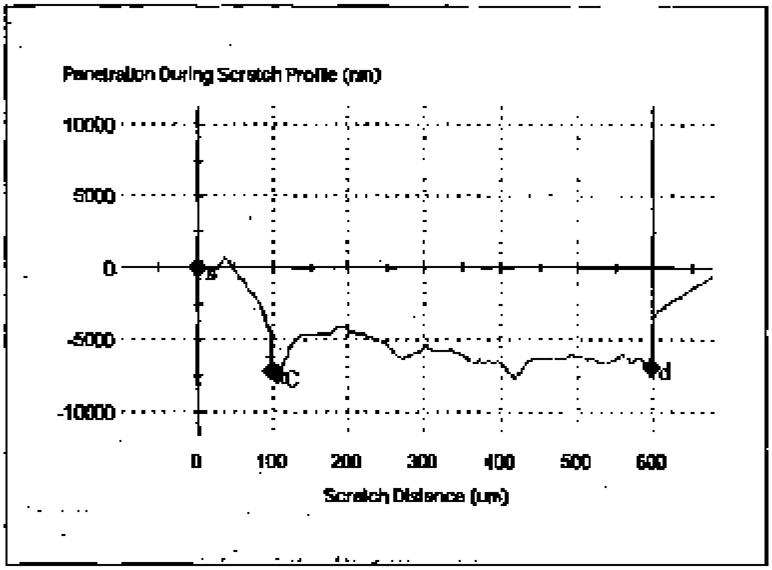


Figure 2: Penetration curve for the "good" sample

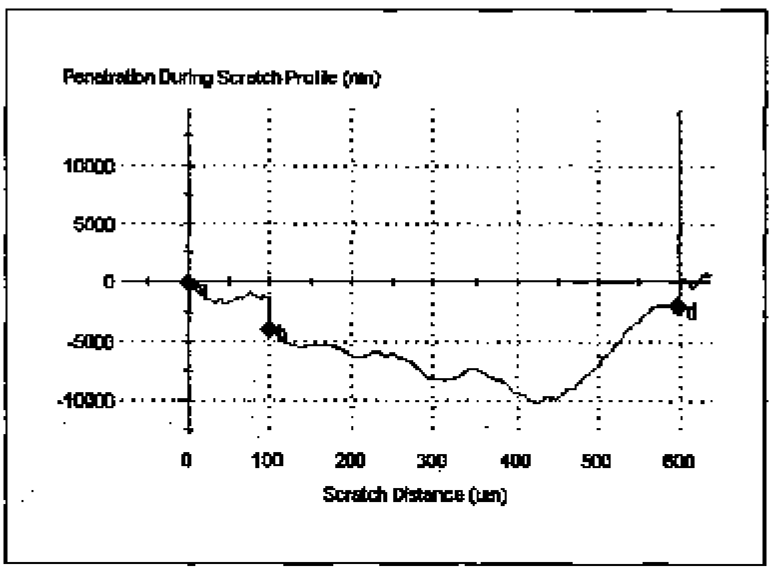


Figure 3: Penetration curve for the "bad" sample

[redacted]

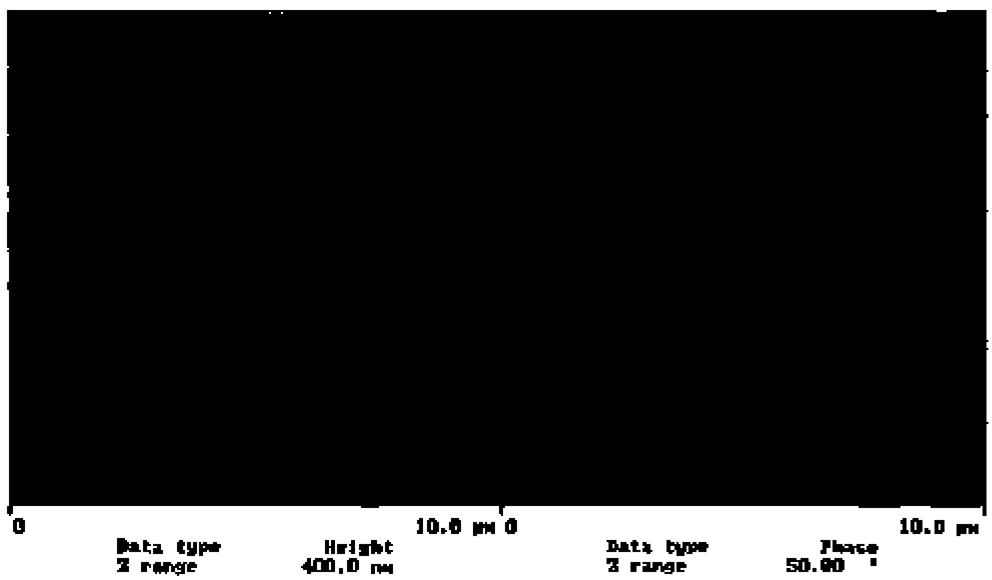


Figure 4 AFM Image of Good Sample in Woto Area

[redacted]

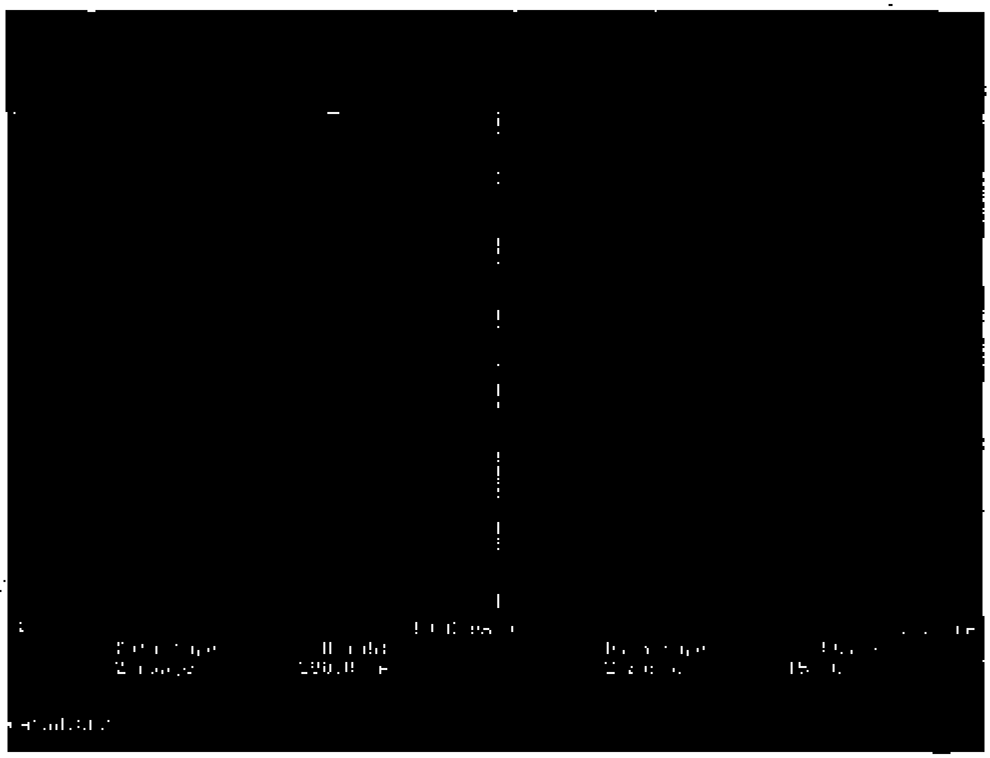


Figure 5: AFM Image of Bad Sample in Worn Area

[redacted]

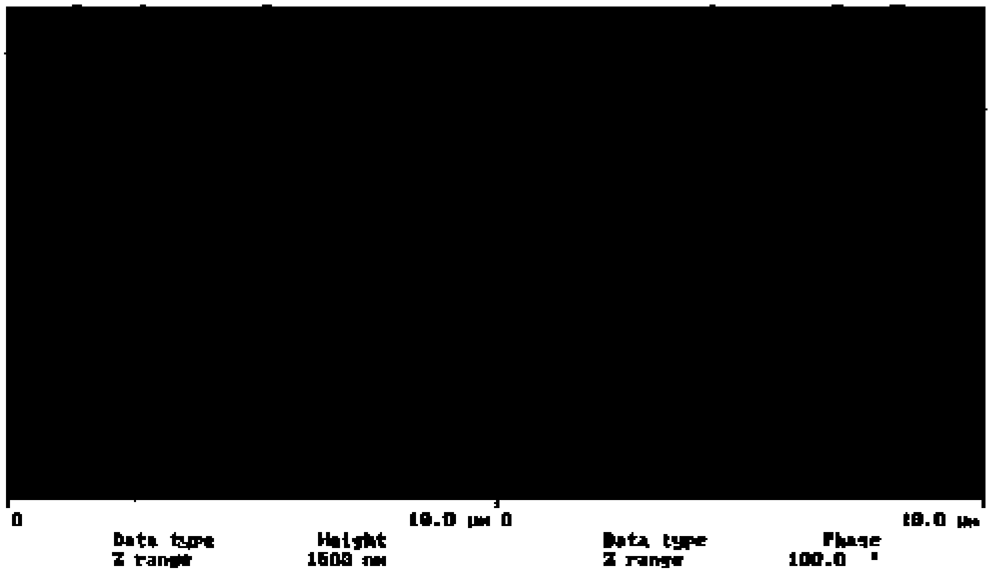


Figure 6: Good Sample in Unworn Area

[redacted]

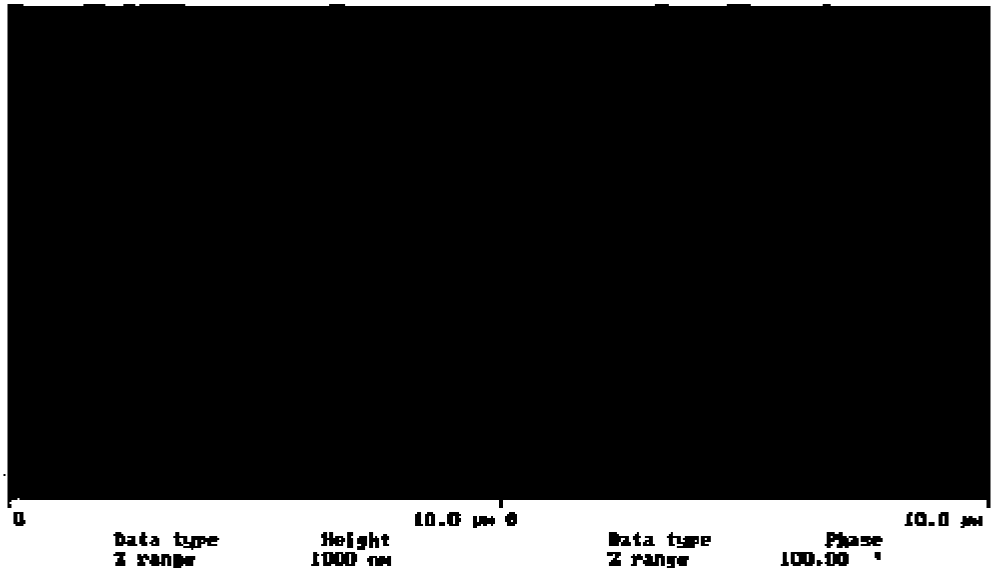


Figure 7: Bad Sample in Unworn Area

[redacted]

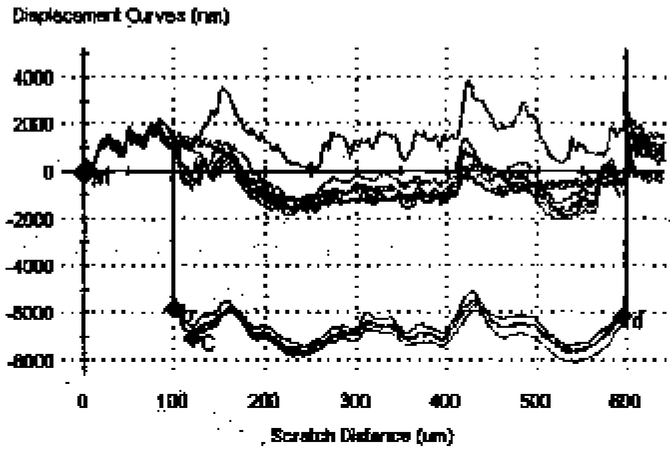


Figure 8: Good Sample 9611 -- Five scratches at the same location—This includes initial and final morphologies and the scratch displacement corrected for the slope only.

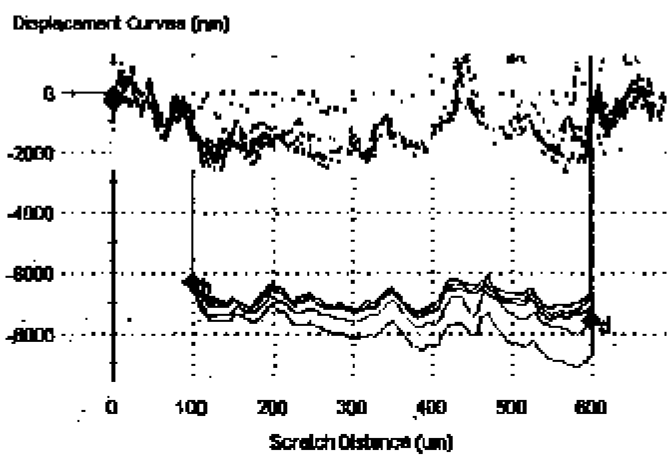


Figure 9: Bad Sample 45978 -- -- Five scratches at the same location —This includes initial and final morphologies and the scratch displacement corrected for the slope only.

[redacted]

Figure 10: Optical Micrograph of a Section of a Good Sample (500X)

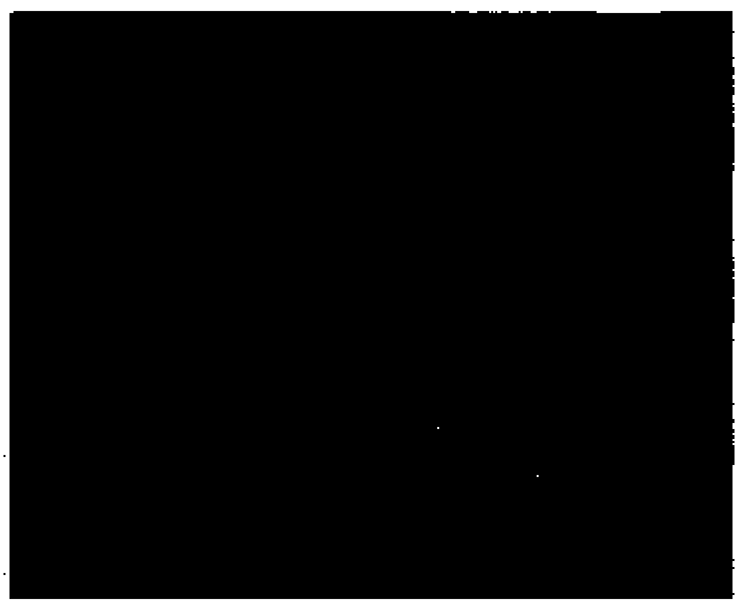


Figure 11: Photomicrograph of a Section of a Bad Sample (500X)

Subject:	Request for help on Electronic Throttle Control hardware analysis
Location:	PDC Conf Rm 1G-C13 (10)
Start:	Wed 8/14/2002 3:00 PM
End:	Wed 8/14/2002 4:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Gaw, Ron (R.M.); Gilkey, James (J.K.); Schmitz, Peter (P.J.); West, Gregory (G.S.); Simko, Steven (S.J.); Carter, Roscoe (R.O.); Nicastri, Paul (P.R.)
Categories:	ETC Systems

When: Wednesday, 8/14/02, 3-4PM

Where: PDC Conf Rm 1G-C13 (not far from the Atrium Lobby)

Purpose:
This meeting is to discuss SRL's help in conducting a chemical analysis of certain Electronic Throttle Control (ETC) hardware components. Our need is for someone to conduct a chemical analysis of the reactions between the inks used on certain circuit boards and the various grease compounds used inside the sealed circuit assemblies. Further description of the issues follow below.

Issue Details:
Due to the recent high rate of field warranty issues, we feel it is necessary to get a second, independent analysis to verify the root cause failure mode responses provided by our suppliers. We are looking for validation of the root cause currently identified as the reaction between the grease and the ink, as well as validation of the non-reaction of the circuit ink to the other greases inside the assembly.

In many of the programs using ETC pedals, there are circuit boards built into the pedals to measure pedal position. These circuit boards are sealed inside of a box, along with various greases used for NVH and durability reasons. There has been some indications that chemical reactions between these greases and the sensor circuit board inks cause the Pedal Potentiometers to wear far quicker than expected. We are also evaluating whether those same greases are conductive and capable of shorting the circuits out when they cross circuit traces. The chemical composition of the inks on the circuit boards is unique to each supplier of the ETC pedals. The greases are specifically recommended greases by the sensor board suppliers, and we will provide the grease types and and a sample pedal for evaluation. We are willing to meet further to better define the analysis requirements.

Regards,

Ron Gaw
PTSE D&R
Electronic Throttle Controls Design & Release
Ph. #: 313 390-5756 Fax. #: 313 248-2555
Pager.# 313 796-3909

-----Original Message-----
From: Schmitz, Pete (P.J.)
Sent: Wednesday, August 14, 2002 8:19 AM
To: Hass, Kenneth (K.C.)
Cc: Gandhi, Harendra (H.S.); Gilkey, James (J.K.); Gaw, Ron (R.M.); Helms, Jeffrey (J.H.); Holubka, Joe (J.W.); Lowe-Ma, Charlotte (C.K.)

PE03-044 24878

Subject: RE: Request for help on Electronic Throttle Control hardware analysis

Ken,

Joe and Charlotte are both out on vacation. I'll give Ron Gaw a call this morning and set up a meeting at FRL to review the issue and decide on how or whether we can be of assistance.

Pete

Peter J. Schmitz
Sr. Technical Specialist
Physical and Environmental Science Department
Ford Motor Company
MD3083, SRL
Dearborn, MI 48121-2053
Ph: (313) 594-1155
Fax: (313) 322-7044
e-mail: pschmit1@ford.com

-----Original Message-----
From: Hass, Kenneth (K.C.)
Sent: Tuesday, August 13, 2002 5:30 PM
To: Schmitz, Pete (P.J.)
Cc: Gandhi, Harendra (H.S.); Gilkey, James (J.K.); Gaw, Ron (R.M.); Helms, Jeffrey (J.H.); Holubka, Joe (J.W.); Lowe-Ma, Charlotte (C.K.)
Subject: RE: Request for help on Electronic Throttle Control hardware analysis

Pete,

Please work with Joe Holubka's group (in FRL's Materials Science Department, under Jeff Helms) to explore this problem further with Ron Gaw. Thanks.

Regards,

Ken Hass
Manager, Physical & Environmental Sciences
SRL MD-3083
Phone: 313/32-20098 Fax: 313/322-7044
(Dept. Office Phone: 313/32-27007)

-----Original Message-----
From: Rutkowski, Barb (B.A.) On Behalf Of Gandhi, Harendra (H.S.)
Sent: Tuesday, August 13, 2002 3:14 PM
To: Gilkey, James (J.K.); Gaw, Ron (R.M.)
Cc: Hass, Kenneth (K.C.); Gandhi, Harendra (H.S.)
Subject: RE: Request for help on Electronic Throttle Control hardware analysis

Ken Hass, manager in FRL, would be in position to look into the problem. Can you get in touch with Ken Hass. Thanks.

Haren Gandhi
Technical Fellow
Chemical Engineering Department
Ford Research Laboratory, MD3179
Phone: 313-337-2940
Fax: 313-248-5627
email: hgandhi@ford.com

-----Original Message-----
From: Gilkey, James (J.K.)
Sent: Monday, August 12, 2002 7:54 AM
To: Gaw, Ron (R.M.); Gandhi, Harendra (H.S.)

Cc: Liposky, Lawrence (L.J.); West, Gregory (G.S.)
Subject: RE: Request for help on Electronic Throttle Control hardware analysis

Ron: Greg West gave me a 1 track pedal on Friday for analysis. If you find a place to analyze it, please inform me.

-----Original Message-----
From: Gaw, Ron (R.M.)
Sent: Friday, August 09, 2002 1:35 PM
To: Gandhi, Harendra (H.S.)
Cc: Liposky, Lawrence (L.J.); West, Gregory (G.S.); Gilkey, James (J.K.)
Subject: Request for help on Electronic Throttle Control hardware analysis

Dr. Harendra Gandhi,

I am seeking your department's help in conducting a chemical analysis of certain Electronic Throttle Control (ETC) hardware components. Our need is for someone to conduct a chemical analysis of the reactions between the inks used on certain circuit boards and the various grease compounds used inside the sealed circuit assemblies. Dr. Davor Hrovat referred me to you, identifying you as the department manager of the Chemical Engineering Department at Ford SRL, and indicating your department may be able to help us. Further description of the issues follow below.

Your department's assistance in this matter would be greatly appreciated. Please contact myself (Ron Gaw, x05756) or Greg West (x59401).

Issue Details:
Due to the recent high rate of field warranty issues, we feel it is necessary to get a second, independent analysis to verify the root cause failure mode responses provided by our suppliers. We are looking for validation of the root cause currently identified as the reaction between the grease and the ink, as well as validation of the non-reaction of the circuit ink to the other greases inside the assembly.

In many of the programs using ETC pedals, there are circuit boards built into the pedals to measure pedal position. These circuit boards are sealed inside of a box, along with various greases used for NVH and durability reasons. There has been some indications that chemical reactions between these greases and the sensor circuit board inks cause the Pedal Potentiometers to wear far quicker than expected. We are also evaluating whether those same greases are conductive and capable of shorting the circuits out when they cross circuit traces. The chemical composition of the inks on the circuit boards is unique to each supplier of the ETC pedals. The greases are specifically recommended greases by the sensor board suppliers, and we will provide the grease types and and a sample pedal for evaluation. We are willing to meet further to better define the analysis requirements.

Regards,

Ron Gaw
PTSE D&R
Electronic Throttle Controls Design & Release
Ph. #: 313 390-5756 Fax. #: 313 248-2558
Pager # 313 795-3909

[redacted]

US006228288B1

(12) United States Patent
Chacko

(10) Patent No.: US 6,228,288 B1
(45) Date of Patent: May 8, 2001

(54) ELECTRICALLY CONDUCTIVE COMPOSITIONS AND FILMS FOR POSITION SENSORS

(75) Inventor: Antony P. Chacko, Granger, IN (US)

(73) Assignee: CTS Corporation, Elkhart, IN (US)

(21) Appl. No.: 09/559,851

(22) Filed: Apr. 27, 2000

(51) Int. Cl.[7] H01B 1/22; H01B 1/24

(52) U.S. Cl. 252/511; 252/512; 252/514; 428/922

(58) Field of Search 252/511, 512, 252/513, 514; 428/357, 922

(56) References Cited

U.S. PATENT DOCUMENTS

4,599,383	*	7/1986	Satoji	525/180
4,882,089	*	11/1989	Iwaskow et al.	428/242
5,250,227		10/1993	Margalit	252/511
5,840,432	*	11/1998	Hirai et al.	428/570
5,855,820		1/1999	Chan	252/511
5,897,813		4/1999	Titterle	252/511
6,010,646		1/2000	Schleifstein	252/500

* cited by examiner

Primary Examiner—Mark Kopec
(74) Attorney, Agent, or Firm—Mark P. Bourgeois; Mark W. Borgman

(57) ABSTRACT

The present invention is a polymer film conductive composition comprising, based on total composition: (a) 3–20 wt. % of polyamide-imide resin; (b) 0–10 wt. % cyanate ester resin; (c) 40–65 wt. % finely divided metallic electrically conductive particles selected from the group consisting of silver, copper, nickel, silver coated copper, silver coated nickel, carbon black, graphite and mixtures thereof, wherein all of (a), (b) and (c) are dispersed in a 20–40 wt. % organic solvent.

20 Claims, No Drawings

PE03-044 24131

[redacted]

ELECTRICALLY CONDUCTIVE COMPOSITIONS AND FILMS FOR POSITION SENSORS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention generally relates to polymer thick film conductive compositions. In particular, the invention is directed to such compositions, which are suitable for making position sensing elements.

2. Description of the Related Art

Electrically conductive polymer thick film compositions have numerous applications. Polymer thick film (PTF) conductive compositions are screenable pastes, which are used to form conductive elements in electronic applications. Such compositions contain conductive filler material dispersed in polymeric resins, which remain an integral part of the final composition after processing.

Electrically conductive compositions are used as conductive elements in variable resistors, potentiometers, and position sensor applications.

A Position sensor includes one or more voltage indicating position sensing variable resistor elements. These resistor elements are also prepared from polymer thick film materials. The resistive element is in most cases printed over a conductive element which acts as the collector element. In position sensing applications, a metallic wiper slides over the resistive element. The wiper can slide back and forth for several million cycles over the collector and resistive elements during the lifetime of the electronic component.

For accurate position sensing, the wiper should give continuous electrical output throughout the life of the sensor. The durability of these position-sensing elements depends on the mechanical properties of both the resistor and the conductive film. The polymer thick films tend to wear out after several million cycles of sliding with a metallic contactor over the elements at extreme temperature conditions typically seen in an environment such as an automotive engine compartment. Polymer resistive and conductive compositions having excellent mechanical properties are required for performance and signal output in these applications.

In addition to good mechanical properties, these materials should also have good thermal properties. Polymer thick films show a decrease in storage modulus as temperature is increased. A sharp decrease in mechanical properties is observed near the glass transition temperature. In addition to loss in modulus, these materials also tend to show an increase in coefficient of thermal expansion, which increases significantly above the glass transition temperature. A position sensor is exposed to high temperatures in under the hood applications. At these temperatures elements show a high rate of wear due to a decrease in modulus properties. In addition to the surrounding temperature, a still higher temperature is observed at the interface between the metallic wiper and the element surface due to frictional heating. In some cases these temperatures can approach the glass transition temperature (Tg) of the material and can cause loss of the mechanical properties, which adversely affect the signal output. Polymer thick film materials prepared from polymers with higher glass transition temperature would be expected to perform better for these applications.

Another important property desired of these materials is a strong adhesion to the substrate as well as to the resistive materials. A loss in adhesion can cause accelerated wear or chipping of the conductive film. In automotive applications, lubricants used in other components may come into contact with the sensor and can diffuse into the interface between the substrate and conductive film. This diffusion of the lubricant fluids can lead to a loss in adhesion of the conductive film to the substrate. A strongly bonded conductive material to the substrate can prevent this diffusion of the lubricant into the interface. For similar reasons as described above, conductive materials should have a strong interfacial bond to the resistive elements.

Substrate materials used in position sensor applications vary from polyimide, phenolic, FRP, ceramic, etc. In order to increase adhesion of the conductive materials to the substrates, some sensor manufacturers plasma treat the substrate surface to create an active surface to bond with the conductive elements. The plasma treatment is an expensive process step and an avoidance of this process step can lead to significant cost savings. Functional groups, which can create strong adhesive bonds with substrates even without a plasma treatment, are preferred for cost saving and other performance requirements.

Flexible position sensing elements such as polymer thick films on polyimide substrates undergo numerous back bending, forward bending, creasing, twisting, and other mechanically harsh process steps. A conductive material of brittle nature can fail during these operations. The cracks as a result of deformation cause a severe decrease in conductivity and other electrical and mechanical properties. A conductive element prepared from a flexible polymer is preferred for these applications.

A smooth surface of the conductive element is desired for improved electrical properties. The position sensing elements are expected to show low linearity deviation before and during the lifetime of these components. A smooth conductive surface contributes to low microgradient. Another requirement for position sensors is low linearity deviation. A highly conductive element would give low linearity deviation.

Higher molecular weight of the polymers and low average particle size of conductive particles can contribute to desired rheological properties which results in low surface roughness. Lubricants are generally applied over the resistor and collector elements and tribological properties of the lubricants are often determined by the surface roughness of the resistor and collector elements. A smooth collector surface is desired.

A good processing flexibility is desired for application of a conductive composition onto a variety of substrate materials. A low curing temperature is required for phenolic and epoxy reinforced FRP materials, where as ceramic and kapton substrates can be cured at higher temperatures. It is desirable to have a conductive composition that can be cured at a wide range of temperatures. A short cure time is desirable due to both substrate limitations and processing costs.

Another desirable property for a conductive composition is a long shelf life. A change in viscosity during storage can affect the processability and result in poor printing qualities. This can also lead to position sensing elements with widely varying performance.

A current unmet need exists for a conductive composition that can meet the above mentioned necessary attributes.

SUMMARY

The present invention is a polymer film conductive composition comprising, based on total composition:

[redacted]

a) 3–20 wt. % of polyamide-imide resin;
b) 0–10 wt. % cyanate ester resin; and
c) 40–85 wt. % finely divided metallic electrically conductive particles selected from the group consisting of silver, copper, nickel, silver coated copper, silver coated nickel, carbon black, graphite and mixtures thereof, wherein all of (a), (b) and (c) are dispersed in a 20–40 wt. % organic solvent.

DETAILED DESCRIPTION OF THE PREFFERED EMBODIMENT(S)

1. Polymer Components

The polymer components used in the present invention comprises 3–20 wt. % of a high Tg polyamide-imide polymer and 0–10 wt. % cyanate ester resin based upon total composition. The polymers are dissolved in an organic solvent.

Polyamide-imide polymers are commercially available from BP Amoco. In the electrically conductive composition of the present invention, Polyamide-imide is used in the range of 3–20 wt. % by weight of the conductive composition, with a more preferred range of 7–10 wt. %. If less than 5 wt. % resin is used, the resulting conductive composition has poor screen printing properties as well as weak mechanical properties and poor adhesion. If more than 15 wt. % is used, the resulting composition has less electrical conductive property.

Aromatic cyanate ester is a high temperature thermosetting polymer. Aromatic cyanate esters are commercially available from Lonza Chemicals. Cyanate ester resins in the range of 0–10wt. % are used. The amount of cyanate ester resin in the composition is determined by the application requirements. Increasing the amount of cyanate ester decreases flexibility, but improves temperature performance at high temperature. Depending on the amount of cyanate ester, the cured film can either behave as a molecular composite, a semi-interpenetrating network, or an immiscible blend. This versatility in morphology can be judiciously chosen for a given application.

2. Conductive Component

The electrically conductive component of the present invention comprises finely divided particles of electrically conductive materials such as silver, copper, nickel, conductive carbon, graphite or mixtures thereof. This includes mixtures of the metallic and carbon powders. Silver flakes are the preferred conductive component among all other conductive particles listed above. Silver flake particles with average particle size in the range of 0.1–10 microns are preferably used. Higher silver particle size leads to higher surface roughness. The conductive particles comprise 40–85 wt. % of the conductive composition with a preferred range of 60–70 wt. %. The preferred silver flake is commercially available from Degussa Corporation.

3. Organic Vehicle

An organic solvent of 20–40 wt. % is used to dissolve the conductive composition. The preferred solvent used in the conductive composition is N-methyl pyrrolidone. The selection of the solvent is based on the good solubility of the polymer in this solvent. This solvent also has a high boiling point. Low evaporation of the solvent is preferred for continuous printing operation where no change in viscosity of the composition due to loss of solvent is desired. The polymer is dissolved completely in prior to blending with silver particles. The preferred N-methyl pyrrolidone is commercially available from BASF Corporation.

4. Other Additives

Surfactants such as fluorinated oligomers may be added to the composition for wettability and leveling properties. Up

to 1 wt. % of a fluorinated surfactant may be used. The fluorinated oligomers are commercially available from 3M Corporation.

Rheological additives such as Thixatrol plus, Bentone 52, and others are sometimes added to tailor rheological properties for different processing applications. Typical levels of use for effective flow control range from 0–2.0 wt. % of the total composition. These rheological additives are commercially available from Rheox Inc.

5. General Composition Preparation and Printing Procedures

In the preparation of the composition of the present invention, the electrically conductive metallic particles are mixed with the a polymer solution. The polymer solution is made by mixing 3–20 wt. % of a polyamide-imide polymer and 0–10 wt. % cyanate ester resin in 20–40 wt. % N-methyl pyrrolidone based upon total composition. The polymer solution is mixed in a roller mixer for 6 hours. Electrically conductive metallic particles are mixed with polymer solution. The polymer and metallic particles are then fed to a three-roll mill to form a paste with fine particle size. At this point the surfactants and rheological additives may be added if desired to modify the properties of the conductive composition. The paste was milled for 10–30 minutes. Another method of mixing that can be used is using high-speed shear to thoroughly blend the conductive particles in the polymer binder. Three-roll mill mixing is preferred for preparing conductive composition with uniform particle size. The particle size range and viscosity of the paste is monitored to get a conductive paste suitable for application in position sensors. The milling time and milling quantity on the three roll mill determines the final particles distribution and size and resulting rheology.

The conductive paste thus prepared is applied to substrates such as polyimide, ceramic and fiber reinforced phenolic substrates by conventional screen printing processes. A preferred substrate is polyimide. The wet film thickness typically used for position sensor application is 40 microns. The wet film thickness is determined by the screen mesh and screen emulsion thickness. A preferred screen mesh of 325 is used for obtaining smooth conductive film on a polyimide substrate for position sensors. The wet film is then cured in a convection oven at a temperature range of 200–300 degrees Celsius for 10–30 minutes. Preferred curing conditions for conductive film on a phenolic substrate is 220 degrees Celsius for 15 minutes. Preferred curing conditions for conductive film on a polyimide and alumina substrate is 300 degrees Celsius for 10 minutes.

6. Test Procedures

Viscosity Measurements

The rheological properties of the conductive composition were measured using an SR-5 rheometer. The viscosity was measured as a function of shear rate using 25 mm parallel plate geometry at 25 degrees C.

Resistivity

The resistance of the conductive strip on a substrate was measured by the four point probe method. The Resistivity was calculated from the resistance, cross sectional area and length of the conductive strip.

Thermal Properties

The decomposition temperature was measured to determine the thermal stability of the conductive film under subsequent processing conditions. The weight loss in percentage was determined using a Perkin Elmer TGA.

Dynamic Thermal Properties

The changes in mechanical property of the conductive film was measured by a dynamic mechanical analysis instrument. The storage and loss modulus as a function of temperature was measured to determine glass transition temperature of the free standing film prepared from the conductive composition.

Adhesion

The adhesion of the conductive film to different substrates was measured by a cross hatch adhesion test. On the conductive strip, a series of parallel and perpendicular scribes were made using a razor blade. A Scotch Magic Tape No. 810 is affixed to the scribed area. The conductive film surface was examined after pulling the tape off from the conductive film surface. Loss of adhesion (fail) would be shown by lifting and removal of an individual square of conductive film from the cross hatches.

Mechanical Properties

Mechanical properties of the free standing film were measured by an Instron tensile tester. Free standing films from some of the example compositions could not be prepared due to brittleness of the cured film.

EXAMPLES

The present invention will be described in further detail by giving practical examples. The scope of the present invention, however, is not limited in any way by these practical examples.

Example 1

This example describes the preparation of a silver conductive composition using a fine silver flake with an average particle size of 5 microns. The components below were added to a 50-ml jar with mixing. The mixture was then roller milled in a three-roll mill for 30 minutes. The rheology of the resulting paste was a measured by a SR-5 rheometer using a parallel plate geometry. The viscosity at 1s-1 was 97,367 centipoise and 24,750 centipoise at 100s-1. The silver paste is then screen printed on alumina and polyimide substrates, dried and cured. The resulting film was tested for the following parameters Viscosity, Resistivity, Adhesion, Tensile Modulus, Strain at Break, Tensile Strength, Storage Modulus and TGA. The results of the testing for these parameters are shown in table 1.

Component	Weight (%)
Polyamide imide	7.6
Silver flake	64
N-methyl pyrrolidone	28.4

Example 2

This example describes the preparation of a silver conductive composition using a fine silver flake with an average particle size of 5 microns. The components below were added to 50 ml jar with mixing. The mixture was then roller milled in a three roll mill for 30 minutes. The rheology of the resulting paste was a measured by an SR-5 rheometer. The silver paste is then screen printed on alumina and polyimide substrate, dried and cured. The resulting film was tested for the following parameters Viscosity, Resistivity, Adhesion, Tensile Modulus, Strain at Break, Tensile Strength, Storage Modulus and TGA. The results of the testing for these parameters are shown in table 1.

Component	Weight (%)
Polyamide imide	5.86
Cyanate Ester	0.74
Silver flake	64
N-methyl pyrrolidone	29.4

Example 3

This example describes the preparation of a silver conductive composition using a fine silver flake with an average particle size of 5 microns. The components below were added to 50-ml jar with mixing. The mixture was then roller milled in a three-roll mill for 10–30 minutes. The rheology of the resulting paste was a measured by an SR-5 rheometer. The silver paste is then screen printed on alumina and polyimide substrate, dried and cured. The resulting film was tested for the following parameters Viscosity, Resistivity, Adhesion, Tensile Modulus, Strain at Break, Tensile Strength, Storage Modulus and TGA. The results of the testing for these parameters are shown in table 1.

Component	Weight (%)
Polyamide imide	3.18
Cyanate Ester	2.22
Silver flake	64
N-methyl pyrrolidone	28.6

Example 4

This example describes the preparation of a silver conductive composition using a fine silver flake with an average particle size of 5 microns. The components below were added to a 50-ml jar with mixing. The mixture was then roller milled in a three-roll mill for 10–30 minutes. The rheology of the resulting paste was measured by a SR-5 rheometer. The silver paste is then screen printed on alumina and polyimide substrate, dried and cured. The resulting film was tested for the following parameters Viscosity, Resistivity, Adhesion, Tensile Modulus, Strain at Break, Tensile Strength, Storage Modulus and TGA. The results of the testing for these parameters are shown in table 1.

Component	Weight (%)
Polyamide imide	3.7
Cyanate Ester	3.7
Silver flake	64
N-methyl pyrrolidone	28.6

TABLE 1

Properties	Example 1	Example 2	Example 3	Example 4
Viscosity, Centipoise (At shear Rate 1S^{-1})	97,367	30,221	32,161	14,427
Resistivity (milliohm.cm)	.016	.027	.036	.029
Adhesion (to Kapton, Ceramic, GR/Phenolic)	Pass	Pass	Pass	pass
Tensile Modulus(GPa)	6.00	7.77	4.63	brittle films

[redacted]

TABLE 1-continued

Properties	Example 1	Example 2	Example 3	Example 4
Strain at Break (%)	1.78	2.6	0.44	brittle films
Tensile Strength(MPa)	54.1	140	26.9	brittle films
Storage Modulus(GPa) At 1Hz, RT	4.58	7.36	3.64	4.06
Storage Modulus(GPa) At 1Hz, 250C	3.9	5.77	3.91	2.5
TGA (Weight Loss at 400C)	0.9%	0.7%	0.6%	0.7%

While the invention has been taught with specific reference to these embodiments, someone skilled in the art will recognize that changes can be made in form and detail without departing from the spirit and the scope of the invention. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A conductive composition, based on total composition, comprising:

a) 3–20 wt. % of polyamide-imide resin;

b) greater than 0 up to and including 10 wt % cyanate ester resin; and

c) 40–85 wt. % finely divided electrically conductive particles selected from the group consisting of silver, copper, nickel, silver coated copper, silver coated nickel, carbon black, graphite and mixtures thereof, wherein all of (a), (b) and (c) are dispersed in a 20–40 wt. % organic solvent.

2. The polymer film conductive composition according to claim 1, wherein the electrically conductive particles are 60–70 wt. % of the total composition and are selected from the group consisting of silver, copper, nickel, silver coated copper, silver coated nickel and mixtures thereof.

3. The polymer film conductive composition according to claim 1, wherein the organic solvent is N-methyl Pyrrolidone.

4. The polymer film conductive composition according to claim 1, further comprising 0–1 wt. % flourochemical surfactant to improve wettability.

5. The polymer film conductive composition according to claim 1, further comprising 0–2 wt. % rheological additive to modify viscosity of the conductive composition.

6. The polymer film conductive composition according to claim 2, wherein the electrically conductive particles have a particle size of 0.1–10 microns.

7. The polymer film conductive composition according to claim 3, wherein the electrically conductive particles are silver flakes.

8. The polymer film conductive composition according to claim 1, wherein the electrically conductive particles are carbon black or graphite.

9. The polymer film conductive composition according to claim 1, wherein the electrically conductive composition is applied to a substrate is chosen from the group consisting of polyimide, ceramic and fiber reinforced phenolic substrates.

10. The polymer film conductive composition according to claim 8, wherein the electrically conductive composition on the substrate is used in a position sensor.

11. The polymer film conductive composition according to claim 1, wherein the electrically conductive composition is cured at a temperature range from 200 degrees Celsius to 300 degrees Celsius.

12. The polymer film conductive composition according to claim 11, wherein the electrically conductive composition has a cure time between 10 and 30 minutes.

13. A conductive composition for coating on a substrate, based on total composition, comprising:

a) 3–20 wt. % of polyamide-imide resin;

b) greater than 0 up to and including 10 wt % cyanate ester resin;

c) 40–85 wt. % finely divided electrically conductive particles selected from the group consisting of silver, copper, nickel, silver coated copper, silver coated nickel, carbon black, graphite and mixtures thereof;

d) 20–40 wt. % organic solvent, wherein all of (a), (b), and (c) are dispersed in the organic solvent;

e) 0–1 wt. % flourochemical surfactant to improve wettability of the conductive composition; and

f) 0–2 wt. % rheological additive to modify viscosity of the conductive composition.

14. The polymer film conductive composition according to claim 13, wherein the electrically conductive particles are 60–70 wt. % of the total composition and are selected from the group consisting of silver, copper, nickel, silver coated copper, silver coated nickel and mixtures thereof.

15. The polymer film conductive composition according to claim 13 wherein the organic solvent is N-methyl Pyrrolidone.

16. The polymer film conductive composition according to claim 13, wherein the electrically conductive particles have a particle size of 0.1–10 microns.

17. The polymer film conductive composition according to claim 14, wherein the electrically conductive particles are silver flakes.

18. The polymer film conductive composition according to claim 13, wherein the substrate is chosen from the group consisting of polyimide, ceramic and fiber reinforced phenolic substrates.

19. The polymer film conductive composition according to claim 18, wherein the electrically conductive composition on the substrate is used in a position sensor.

20. The polymer film conductive composition according to claim 13, wherein the electrically conductive composition is cured at a temperature range from 200 degrees Celsius to 300 degrees Celsius for a cure time between 10 and 30 minutes.

* * * * *

PE03-844 24135

[redacted]

From: West, Gregory (G.S.)
Sent: Thursday, August 15, 2002 2:20 PM
To: Heaton, Christopher (C.E.); Carter, Roscoe (R.O.); Nicastri, Paul (P.R.); Simko, Steven (S.J.); Gaw, Ron (R.M.); Gilkey, James (J.K.); Schmitz, Pete (P.J.)
Subject: RE: Electronic Throttle Control

FYI

RTV is GE Product RTV128, RTV paste, adhesive/sealant
The rub bar lube is NYE 774.
The switch track lube is Nye 706D.
The properties of each lube can be obtained at:
http://www.nyelubricants.com/datasheets.php

I am getting samples of each one.
Also, I am trying to obtain the makeup of the inks from Wabash.

-----Original Message-----
From: Heaton, Christopher (C.E.)
Sent: Thursday, August 15, 2002 12:53 PM
To: Carter, Roscoe (R.O.); Nicastri, Paul (P.R.); Simko, Steven (S.J.); Gaw, Ron (R.M.); Gilkey, James (J.K.); Schmitz, Pete (P.J.); West, Gregory (G.S.)
Cc: Heaton, Christopher (C.E.)
Subject: Electronic Throttle Control

Team,

I have taken a few pictures of the electronic throttle control and saved them on the FRL (W) drive under the allshare folder. I'm not sure if everyone on the team has access to that drive so we may have to find another way to share the pictures. The file size of each picture might make it hard to e-mail them to all of you.

Initial observations show a couple of things: 1. There is evidence of contact heating seen in the discoloration of the rider contacts. This is evident on both sets of riders. 2. The plastic around the contact riders is melted--this may be from contact heating or it may be due to the process of attaching the contactors to the plastic pivot arm. 3. The failing track seems to have a much more gritty appearance than the passing track--this may be acting like sandpaper and wearing away the contacts on the failed riders. 4. On the failed rider contact there is a pair of contacts that each have four fingers. One has the contact points completely worn away and the other has three of four fingers warn down. The fourth finger has considerably less wear than the others. This may be due to the finger being bent or it may have had a large chunk of debris than protected it from the usual pattern of wear.

Again, it would be helpful at this point to get some information about materials used for the riders, greases, silicone, and the two different contact traces. There is definitely grease on both tracks. The failed track has a lot more debris plowed at the end of the track but this may be a combination of grit from the track and metal from the rider with only minor amounts of grease holding the clumps together and on the track.

Christopher E. Heaton
cheaton@ford.com
Research Engineer
Vehicle Electronics and Systems Dept.
Ford Research Laboratory
Phone: (313)845-4214 Fax: (313)323-6239

[redacted]

From:	Sherard, Gail (G.)
Sent:	Friday, August 23, 2002 8:22 AM
To:	Hass, Kenneth (K.C.); Helms, Jeffrey (J.H.)
Cc:	West, Gregory (G.S.); Gaw, Ron (R.M.); Liposky, Lawrence (L.J.); Simko, Steven (S.J.); Schmitz, Pete (P.J.); Carter, Roscoe (R.O.); Heaton, Christopher (C.E.); Gilkey, James (J.K.)
Subject:	ETC Pedal Assemblies

Jeff & Ken,

Several of your people have met with my engineers in an effort to help solve a current production warranty issue. The issue is as follows:

In many of the programs using ETC pedals, there are circuit boards built into the pedal assemblies to measure pedal position. These circuit boards are sealed inside of a Nylon case along with several lubricants using RTV. The supplier has indicated that chemical reactions between one of these greases and the sensor circuit board inks cause the Pedal Potentiometers to wear far quicker than expected. We would like to understand if this is the only failure mode and how exactly the lube is migrating to the ink. The chemical composition of the inks on the circuit boards is unique to each supplier of the ETC pedals and to this point we've only seen the failure on the P131/U137 programs. We have provided information about the grease and will obtain samples soon.

Warranty costs to Ford could reach as high as 6 million dollars if we see 100% failure. This could be substantially reduced if we are able to identify and contain the issue quickly. Please let me know if you are able to help us solve our issue, thanks in advance.

Gail Sherard
Manager, P/T Stationary Components - Tough Truck

PE03-044 24874

From:	Carter, Roscoe (R.O.)
Sent:	Tuesday, September 10, 2002 9:08 AM
To:	Sherard, Gail (G.); Liposky, Lawrence (L.J.); West, Gregory (G.S.); Gaw, Ron (R.M.)
Cc:	Haas, Kenneth (K.C.); Helms, Jeffrey (J.H.); Tamor, Michael (M.A.); Simko, Steven (S.J.); Schmitz, Pete (P.J.); Heaton, Christopher (C.E.); Nicastri, Paul (P.R.); Gilkey, James (J.K.)
Subject:	Report on the analysis and root cause related to the pedal sensor for electronic Throttle Control for P131/U137

The team at FRL has finished its examination of the ETC pedal position sensors as requested. After sharing our findings with the platform folks on August 28th, we have written a report to document our findings and conclusions. Due to the size of the file, I have taken the liberty of listing the report on the Physical and Environmental Sciences web site on the Lubrication Science recent report page. It can be called up using the URL given below:

http://www.srl.ford.com/pes/Trans_Fluid/ElectronicThrottleFailure.doc.

By clicking on this URL you can view and print the document if you wish.

It was interesting to find out that commercial labs had been employed to find the lubricant on the worn potentiometer tracks and that they had reported no lube when we were able to fined it on all suspect parts. One of the labs has contacted me and I have shared our findings and techniques with them. Perhaps in the future that lab will be of more assistance in solving these types of problems.

We hope this effort assist in solving the failure issue in the very near term.

On behalf of Steve Simko, Chris Heaton, Paul Nicastri, and Pete Schmitz

Roscoe "ROC" Carter
Ford Research Lab
Physical and Environmental Sciences Department
Lubricant Science and ATF Analysis Group Leader

From: Liposky, Lawrence (L.J.)
Sent: Tuesday, September 10, 2002 10:39 AM
To: Kilgoar Jr., Paul (P.G.)
Cc: Helms, Jeffrey (J.H.); Tamor, Michael (M.A.); Simko, Steven (S.J.); Schmitz, Pete (P.J.); Heaton, Christopher (C.E.); Nicastri, Paul (P.R.); Gilkey, James (J.K.); Sherard, Gail (G.); West, Gregory (G.S.); Gaw, Ron (R.M.); Carter, Roscoe (R.O.); Hass, Kenneth (K.C.); Guys, Philip (P.R.)
Subject: RE: Report on the analysis and root cause related to the pedal sensor for electronic Throttle Control for P131/U137

Outstanding job from the folks at FRL. - The expertise and information provided was key in determining root cause and resolution of this issue. We appreciate the focus and dedication . Great Job !! Thanks again.

Larry Liposky
Supervisor - Tough Truck
Accelerator/VMV Components
Phone 24-61726
Pager 796-0949

-----Original Message-----
From: Carter, Roscoe (R.O.)
Sent: Tuesday, September 10, 2002 9:08 AM
To: Sherard, Gail (G.); Liposky, Lawrence (L.J.); West, Gregory (G.S.); Gaw, Ron (R.M.)
Cc: Hass, Kenneth (K.C.); Helms, Jeffrey (J.H.); Tamor, Michael (M.A.); Simko, Steven (S.J.); Schmitz, Pete (P.J.); Heaton, Christopher (C.E.); Nicastri, Paul (P.R.); Gilkey, James (J.K.)
Subject: Report on the analysis and root cause related to the pedal sensor for electronic Throttle Control for P131/U137

The team at FRL has finished its examination of the ETC pedal position sensors as requested. After sharing our findings with the platform folks on August 28th, we have written a report to document our findings and conclusions. Due to the size of the file, I have taken the liberty of listing the report on the Physical and Environmental Sciences web site on the Lubrication Science resent report page. It can be called up using the URL given below:

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We hope this effort assist in solving the failure issue in the very near term.

On behalf of Steve Simko, Chris Heaton, Paul Nicastri, and Pete Schmitz

Roscoe "ROC" Carter
Ford Research Lab
Physical and Environmental Sciences Department
Lubricant Science and ATF Analysis Group Leader