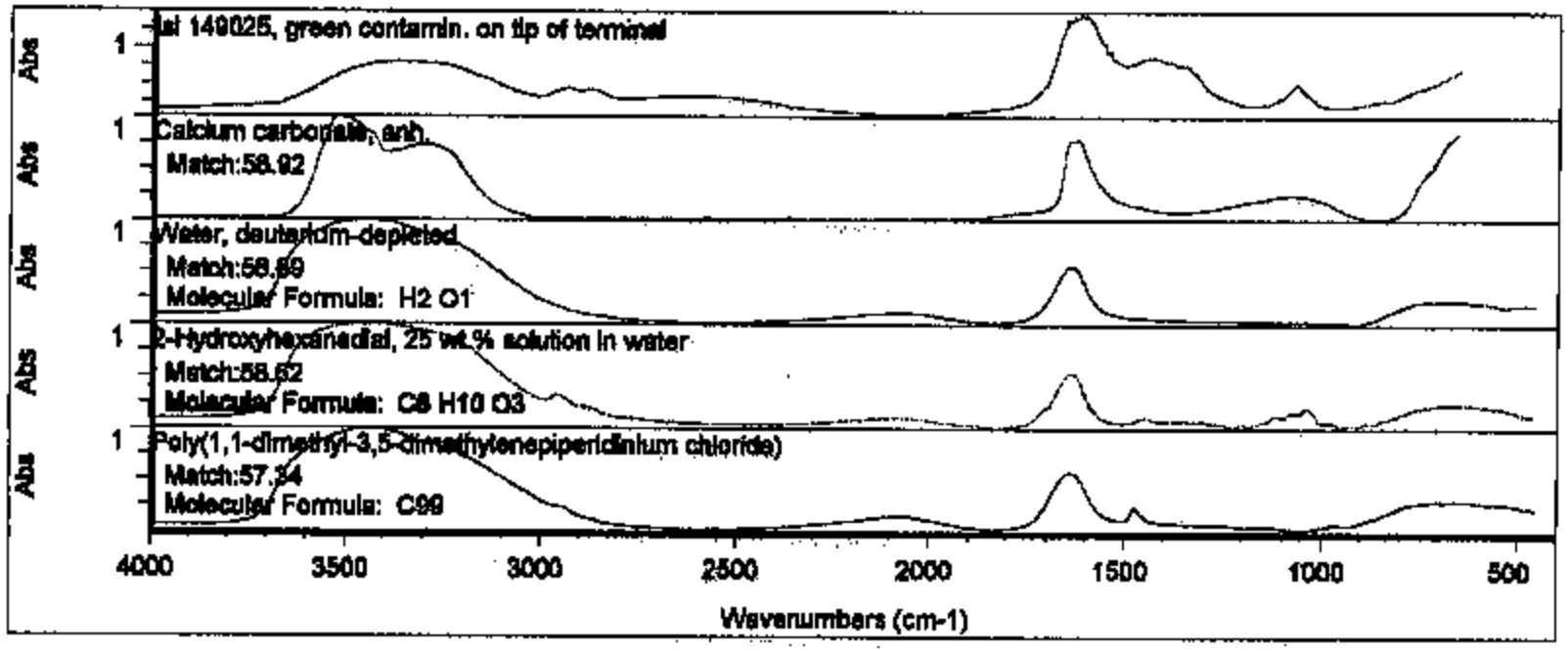
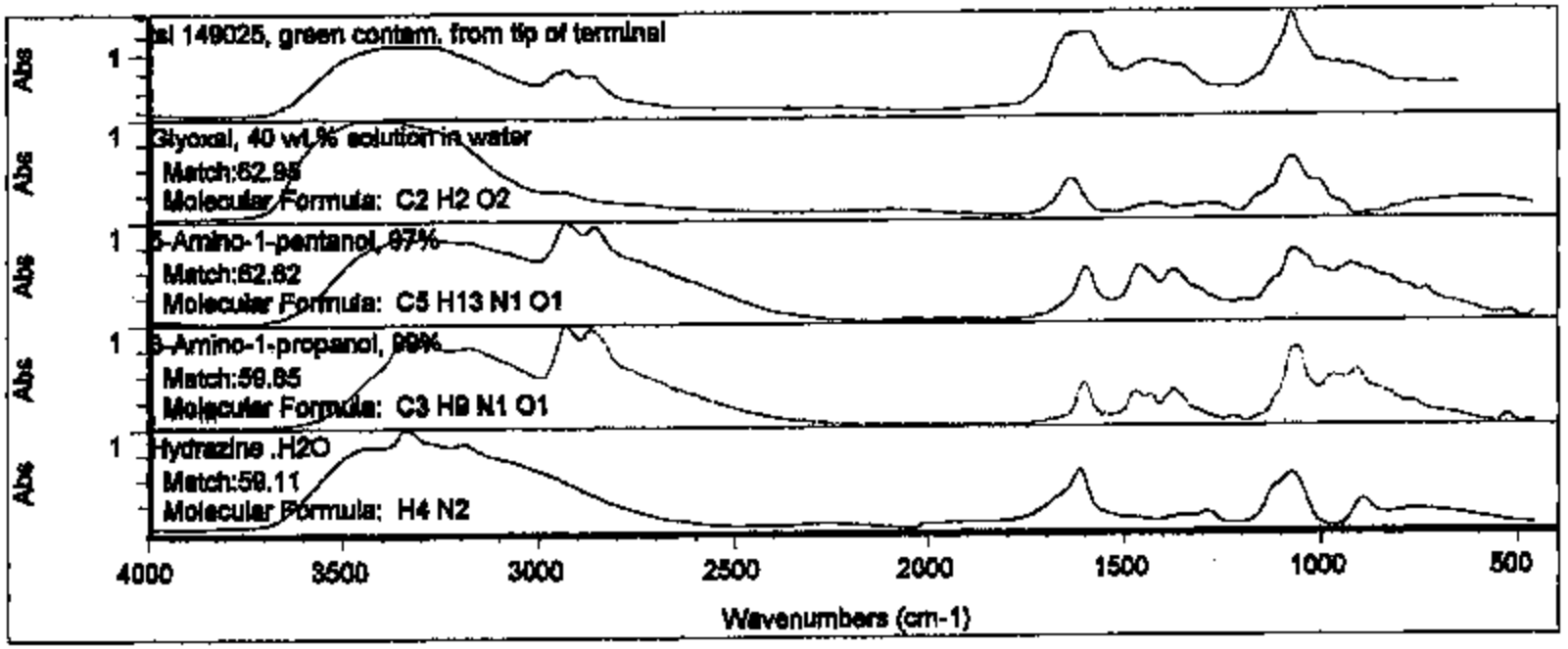
EA05-005
STEPTOE & JOHNSON
FOR TEXAS INSTRUMENTS
2/23/2006
ATTACHMENT PART 3 OF 3

OMNIC Search
Spectrum: tsl 149025, green contamin. on tip of terminal
Wed Jun 24 16:10:51 1998
Region: 3995.85 649.98
Search type: Correlation
Comment:



Index	Match	Compound name	Library
33	58.92	Calcium carbonate, anh.	TSL
840	58.69	Water, deuterium-depleted	Aldrich Condensed Phase
1923	58.62	2-Hydroxyhexanedial, 25 wt.% solution in	Aldrich Condensed Phase
10596	57.34	Poly(1,1-dimethyl-3,5-dimethylenepiperid	Aldrich Condensed Phase
89	56.71	377-55-1 Betz 1130 flocculant	Commercial Materials Polypropylene Additives
5517	55.82	1,3-Diacetylurea, 98%	Aldrich Condensed Phase
573	55.80	Poly(terephthaloyl oxamidrazone)+SrCO3	Hummel Polymer and Additives
72	53.95	Phenol resin	Hummel Polymer and Additives
1926	53.85	Glyoxal, 40 wt.% solution in water	Aldrich Condensed Phase
36	51.73	Carboxymethylcellulose, Na salt	Hummel Polymer and Additives

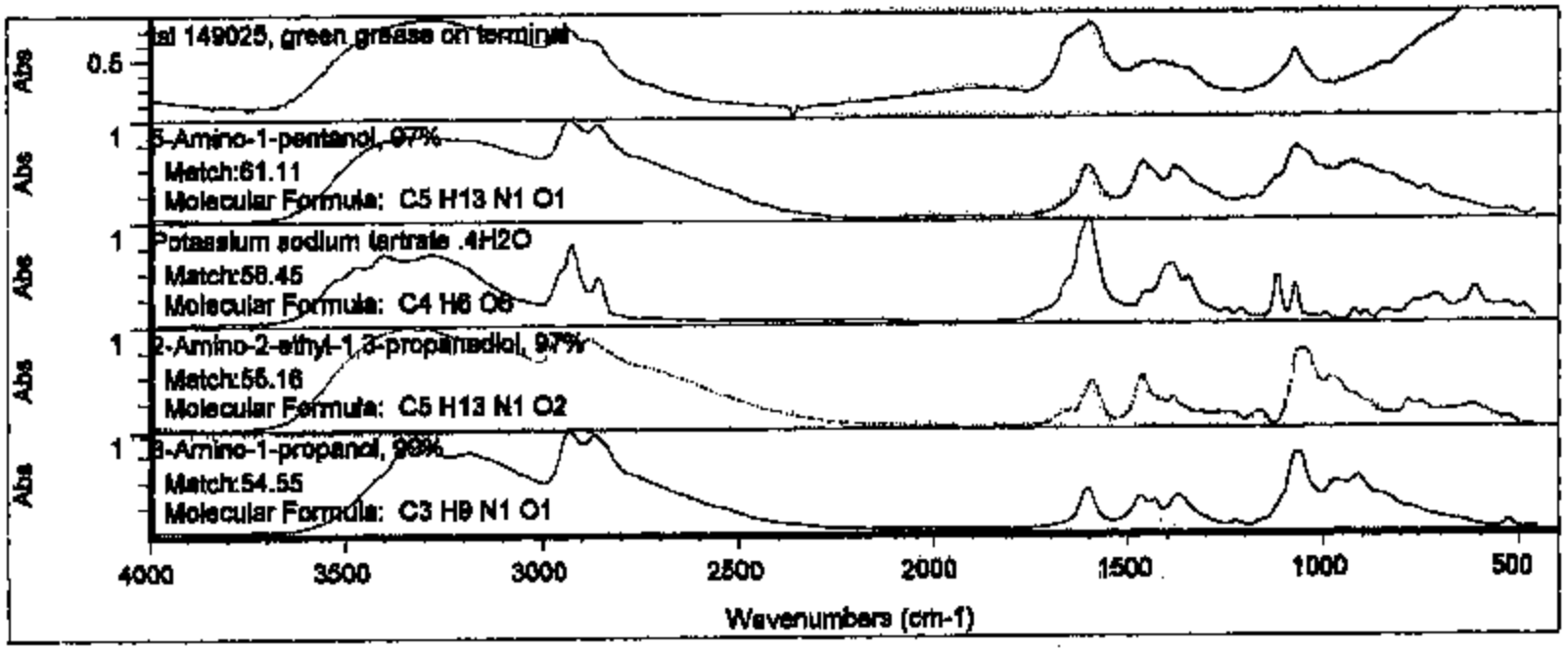
OMNIC Search
Spectrum: tsl 149025, green contam. from tip of terminal
Wed Jun 24 16:21:05 1998
Region: 3995.85 649.96
Search type: Correlation
Comment:



Index	Match	Compound name	Library
1926	62.95	Glyoxal, 40 wt.% solution in water	Aldrich Condensed Phase
2702	62.62	5-Amino-1-pentanol, 97%	Aldrich Condensed Phase
2685	59.85	3-Amino-1-propanol, 99%	Aldrich Condensed Phase
9212	59.11	Hydrazine .H2O	Aldrich Condensed Phase
9358	58.27	Magnesium sulfate .7H2O	Aldrich Condensed Phase
916	55.06	1,3-Propanediol, 98%	Aldrich Condensed Phase
1328	54.64	Diethanolamine	Hummel Polymer and Additives
2739	54.48	2-Amino-2-ethyl-1,3-propanediol, 97%	Aldrich Condensed Phase
5349	54.38	N,N-Bis(2-hydroxyethyl)formamide	Aldrich Condensed Phase
2743	53.82	1,3-Diamino-2-hydroxypropane, 95%	Aldrich Condensed Phase

TI NHT05 11844

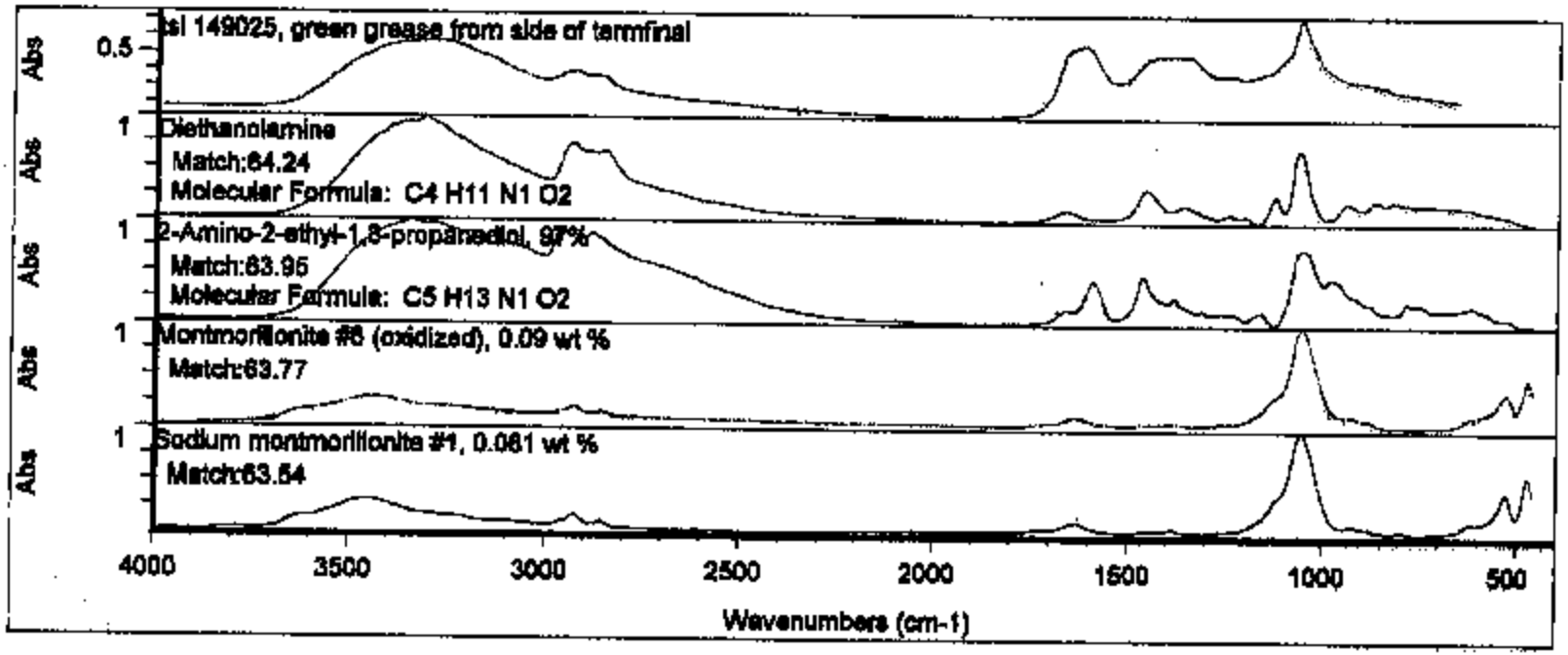
OMNIC Search
Spectrum: tal 149025, green grease on terminal
Wed Jun 24 15:51:20 1998
Region: 3995.85 649.98
Search type: Correlation
Comment:



Index	Match	Compound name	Library
2702	61.11	5-Amino-1-pentanol, 97%	Aldrich Condensed Phase
9441	58.45	Potassium sodium tartrate .4H2O	Aldrich Condensed Phase
2739	55.16	2-Amino-2-ethyl-1,3-propanediol, 97%	Aldrich Condensed Phase
2685	54.55	3-Amino-1-propanol, 99%	Aldrich Condensed Phase
2743	54.30	1,3-Diamino-2-hydroxypropane, 95%	Aldrich Condensed Phase
9212	53.87	Hydrazine .H2O	Aldrich Condensed Phase
1198	53.58	Galactan, ex gum arabic	Aldrich Condensed Phase
5517	51.61	1,3-Dimethylurea, 98%	Aldrich Condensed Phase
36	51.55	Carboxymethylcellulose, Na salt	Hummel Polymer and Additives
2710	51.43	Diethanolamine .HCl, 98%	Aldrich Condensed Phase

TI NHT05 11845

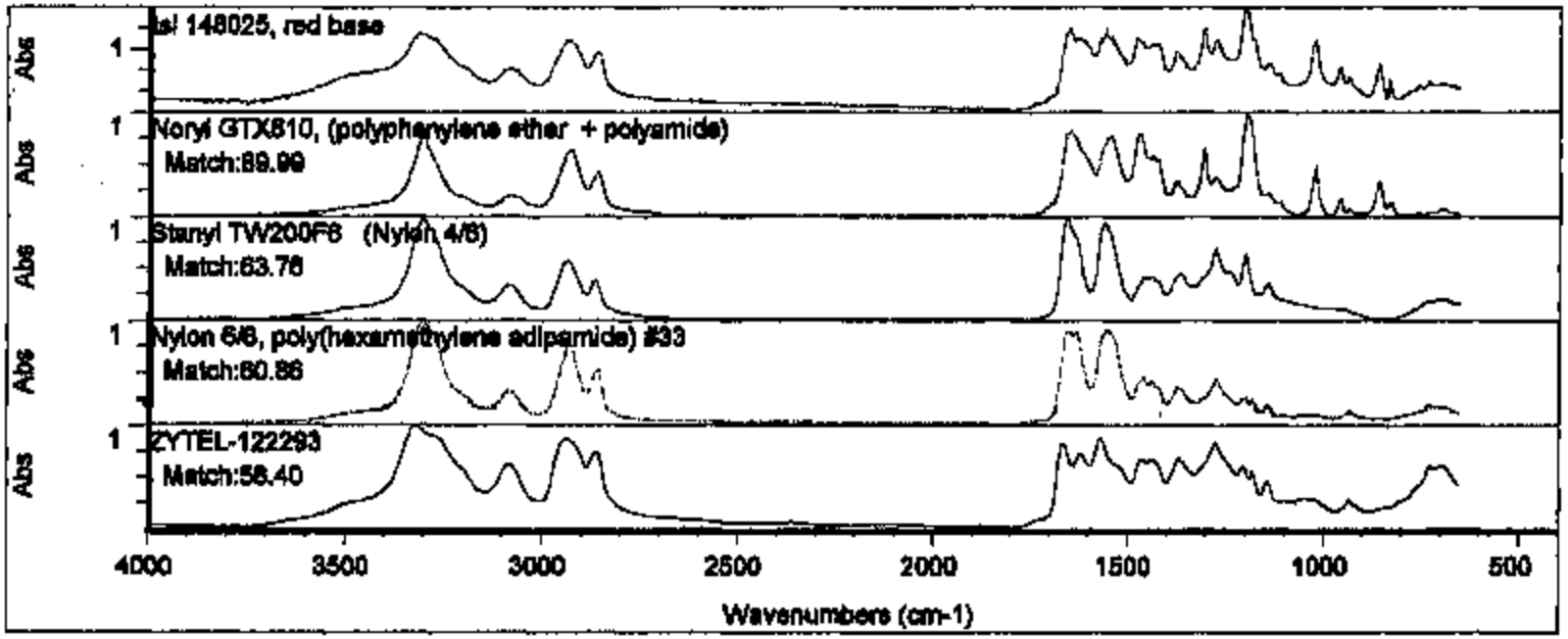
OMNIC Search
Spectrum: tsl 149025, green grease from side of termfinal
Wed Jun 24 16:01:13 1998
Region: 3995.85 649.98
Search type: Correlation
Comment:



Index	Match	Compound name	Library
1328	64.24	Diethanolamine	Hummel Polymer and Additives
2739	63.95	2-Amino-2-ethyl-1,3-propanediol, 97%	Aldrich Condensed Phase
33	63.77	Montmorillonite #6 (oxidized), 0.09 wt %	Commercial Materials Painter Minerals
28	63.54	Sodium montmorillonite #1, 0.081 wt %	Commercial Materials Painter Minerals
1787	62.96	1,2,4-Butanetriol	Hummel Polymer and Additives
2702	60.98	5-Amino-1-pentanol, 97%	Aldrich Condensed Phase
8	60.66	Montmorillonite #2, 0.101 wt %	Commercial Materials Painter Minerals
1138	60.66	1,2,4-Butanetriol, 95%	Aldrich Condensed Phase
1650	59.90	3-Hydroxypropionitrile	Hummel Polymer and Additives
82	59.85	Chipboard P40 10.7%N	Hummel Polymer and Additives

TI NHT05 11846

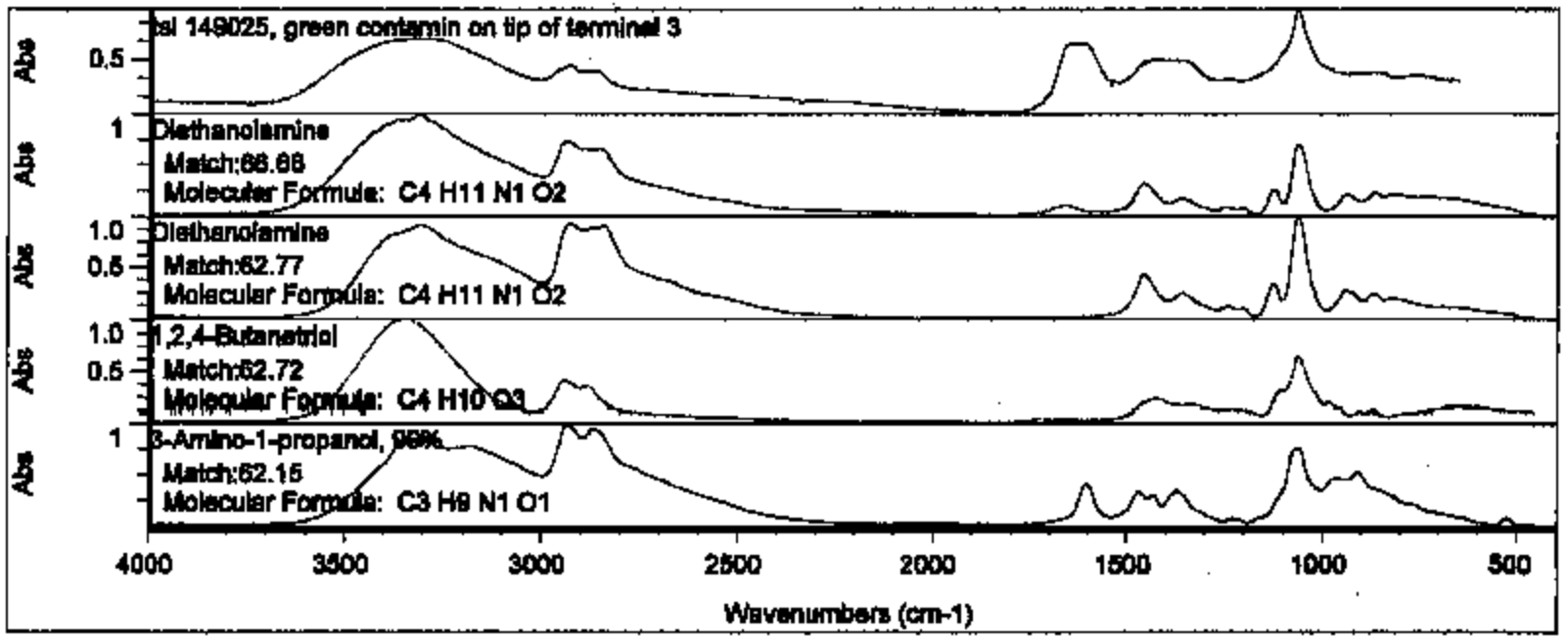
OMNIC Search
Spectrum: tsl 148025, red base
Wed Jun 24 15:44:51 1998
Region: 3995.85 649.98
Search type: Correlation
Comment:



Index	Match	Compound name	Library
86	89.99	Noryl GTX810, (polyphenylene ether + po	TSL
87	63.76	Stanyl TW200F6 (Nylon 4/6)	TSL
68	60.86	Nylon 6/6, poly(hexamethylene adipamide)	TSL
1	58.40	ZYTEL-122293	TSL
10542	54.24	Poly(2,6-dimethyl-1,4-phenylene oxide)	Aldrich Condensed Phase
7098	53.98	4,6-Diamino-2-mercaptopyrimidine, 99%	Aldrich Condensed Phase
10499	51.96	Nylon 6	Aldrich Condensed Phase
5373	51.00	Ethyl 1-piperidineglycolate, 99%	Aldrich Condensed Phase
10541	49.67	Poly(2,6-dimethyl-1,4-phenylene oxide)	Aldrich Condensed Phase
906	48.91	Poly(5-methyloxepolactam)	Hummel Polymer and Additives

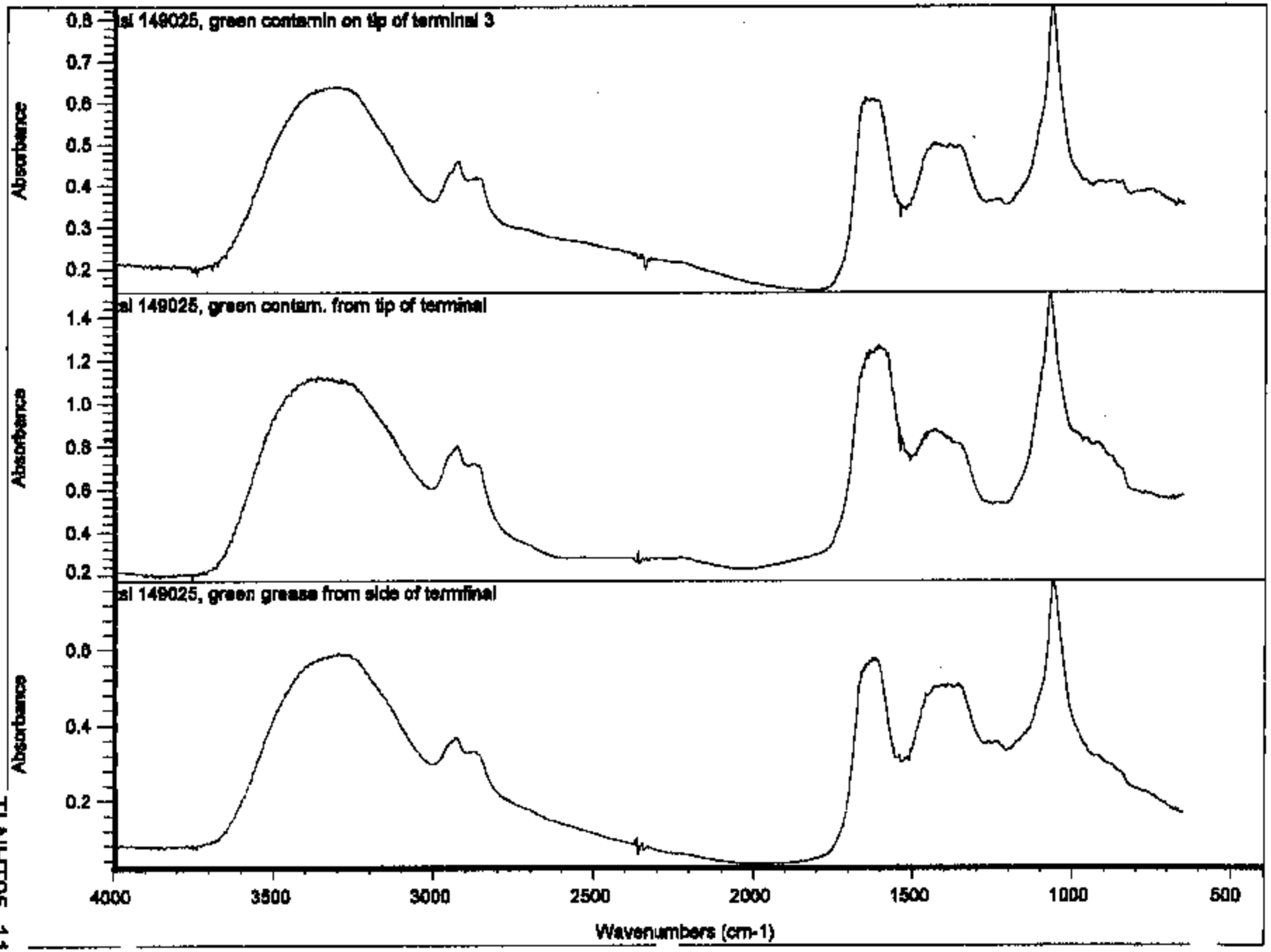
TI NHT05 11847

OMNIC Search
Spectrum: tsl 149025, green contamin on tip of terminal 3
Wed Jun 24 16:28:44 1998
Region: 3995.85 649.98
Search type: Correlation
Comment:

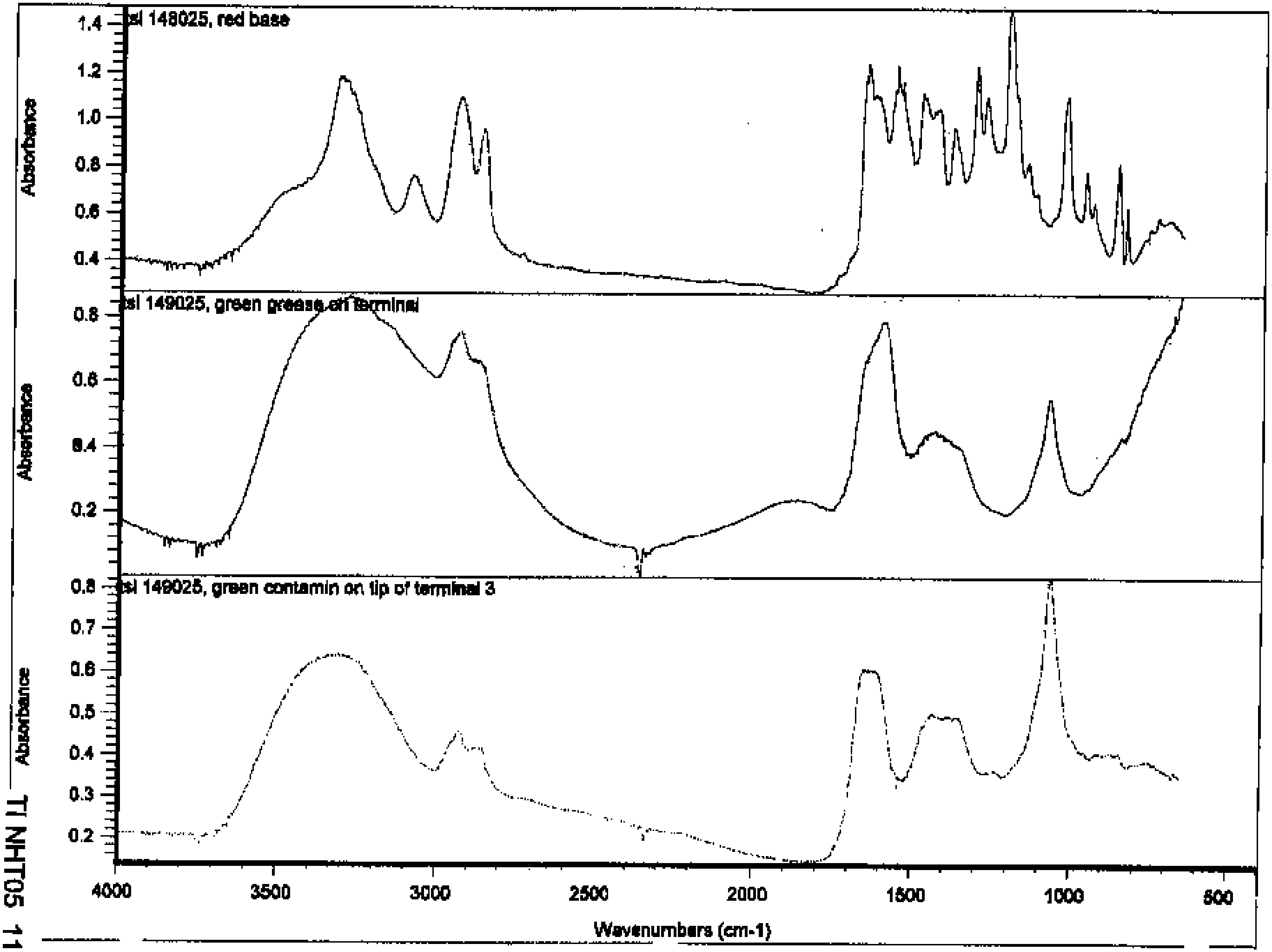


Index	Match	Compound name	Library
1328	66.68	Diethanolamine	Hummel Polymer and Additives
1896	62.77	Diethanolamine	Hummel Polymer and Additives
1787	62.72	1,2,4-Butanetriol	Hummel Polymer and Additives
2685	62.15	3-Amino-1-propanol, 99%	Aldrich Condensed Phase
2702	61.98	5-Amino-1-pentanol, 97%	Aldrich Condensed Phase
2739	61.53	2-Amino-2-ethyl-1,3-propanediol, 97%	Aldrich Condensed Phase
1926	61.40	Glyoxal, 40 wt.% solution in water	Aldrich Condensed Phase
2684	61.14	2-Hydroxyethylhydrazine, 97%	Aldrich Condensed Phase
2709	61.04	Diethanolamine, 97%	Aldrich Condensed Phase
5349	60.88	N,N-Bis(2-hydroxyethyl)formamide	Aldrich Condensed Phase

TI NHT05 11848



TI NHT05 11849



98-330: TSL # 149025: CONTAMINATION ON 77PS TERMINALS AT FORD/BOSCH

OBJECTIVE:
Determine cause of high resistance at terminals

SUMMARY:
The defect is due to the formation of a thick layer of a corrosion product containing copper, zinc, carbon, and oxygen. This layer is always thickest at the outside tip and it diminishes greatly as one approaches the plastic base. We don't see any evidence of it inside the electronics cavity.

OBSERVATIONS:
All samples, with the exception of samples #4 and 5 (Found in Gallatin by visual inspection) showed the same failure mechanism of edge-initiated corrosion. One of the contrast mechanisms in the SEM is BackScattered Electron contrast. This mode is sensitive to average atomic number and, in this material system, contamination will appear dark. The image below shows pins from three returns (6, 8 & 11). One can see that there is a great difference in extent of corrosion but that it starts at the terminal end on all samples.

PHOTO 69

The photo below shows a pin from another sample (# 1) that emphasizes the liquid-mediated nature of the corrosion mechanism. The patterns that we see aren't consistent with a vapor phase mechanism. In other words, this attack isn't simply due to humidity/temperature/time exposure.

PHOTO 1

The photo below shows an area where the corrosion deposit has partially flaked off to reveal a clean brass surface which has been pitted by the corrosion process. The full width of the area shown in the photo is about 0.002". The area with the "dried mud flats" texture is the corrosion layer that hasn't yet delaminated. The pitted appearing surface is the underlying copper. Please note that this surface texture is much different than that of the brass in uncorroded areas. These un-attacked areas are on the terminal in the cavity on all devices which we have examined and in the areas near the plastic on devices with a small total amount of corrosion. The bright areas are fragments of the corrosion deposit that have been scattered about (probably by mechanical action during mating and/or demating of the terminal/connector pair.)

PHOTO 7

Below is a spectra of the corrosion deposit. We get essentially the same spectrum regardless of whether the spectrum is taken from

- The top surface of the deposit by normal analysis

- The bottom surface of the deposit by removing it by pressing indium foil into the surface and abstracting the deposit
- Material present on the mating connector in the contact zones

SPECTRA

Dezincification of the brass isn't occurring to any major extent because we get essentially the same copper/zinc ratio whether we are examining:

- The deposit itself
- The brass surface revealed by flaking off of the corrosion deposit
- The underlying bulk brass

Copper oxide is reddish or blackish in color depending upon whether it is a cuprous or cupric species. The bulk of this deposit is neither of these colors although the material at the very end is often blackish in color. Away from the very end, the deposit is basically whitish with a greenish tint. This is best observed by glancing incidence illumination on a raised area of the deposit (from connector marks or by a deliberate scratch).

The variation in color is likely due to the amount of copper oxide present in the overall oxidation product with larger amounts of copper oxide at the dark tip. In other words, copper oxide is probably acting as a colorant in the overall product.

It isn't certain how the carbon is present in the corrosion deposit. One could visualize the following three scenarios:

- Chemically combined such as in a copper carbonate
- Mechanically combined with a carbon species that is involved in the corrosion process. An example would be a graphitic powder which could cause galvanic corrosion
- Present in a non-functional role.

We tried solvent extractions to address this issue with inconclusive results. The Chem Lab also performed FT/IR analysis. They didn't find evidence of hydrocarbon type contamination and this is a usually reliable result. The spectra was clearly inorganic in nature but the quality of the matches wasn't good enough to come to a more specific conclusion. The #12 sample has been given to Dr. Ahmed Amin for X-ray diffraction analysis to see if we can get a definitive resolution of this issue.

MAJOR UNANSWERED QUESTION:

It is my opinion that one needs two things for corrosion like this to occur with 260 brass. One is an electrolyte (aqueous solution is most

likely) and the other is a driving force. Some examples of a driving force would be

1. Corrosion accelerators such as acids, sulfur or chlorine.
2. Galvanic couple.
3. Crevice-type corrosion cell
4. Applied voltage

We currently don't know what the driving force is.

THOUGHTS ON SIMULATION TESTING

I would like the testing to be divided into two sections. One would be a screening test to evaluate the corrosion causing potential of candidate substances discovered by the audits at TI and Bosch. I would think that this would involve exposing parts to the candidate substances and them testing them under elevated temperature-humidity condtions.

The other test would be more involved and be more of a mechanistic test. The goal would be to test our hypotheses as to the possible mechanisms of failure. This testing would involve resting the parts with the terminals in contact with a wick immersed only in those solutions that would be expected to cause corrosion. The primary purpose of this testing would be to see if we can duplicate the failure rather than simply restricting ourselves to those species which have been currently discovered by an audit. Some of these species would be graphite or soot (to act as a cathode) and acidic species (pehaps a bicarbonate). I am working with Gardner Haynes of the Corrosion Lab and Steve Chura of the Environmental Lab to finalize a proposal.

ORIGINAL THREE SAMPLES:

All samples were analyzed by means of SEM-EDAX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis. This showed a thick layer of heavily oxidized brass on the terminal; more than enough to explain the in-ops failures. This layer contains oxygen, carbon, copper and zinc. We tried degreasing one of the terminals on the #1 sample with ultrasonic agitation in cyclohexane, acetone, and isopropanol. This showed some indication of lessening in the amount of carbon in some areas, but it wasn't consistent; other areas showed no lessening at all.

We didn't see much evidence of corrosion accelerators in the bulk of the corrosion deposit. So far, we have only seen two small areas with chlorine.

The deposit is very heavy at the ends of the terminals and gets lighter as you travel in to the base. This same phenomena is seen visually with the tips being darker than the terminal by the base but the SEM shows that the same phenomena is still happening in those areas. The distribution pattern strongly implies a liquid (water) mediated corrosion mechanism. There is no corrosion on the brass in the electronics cavity.

Illumination under 366nm light didn't show any evidence of fluorescent contamination on any of the three devices.

SAMPLES FROM GALLATIN:

They both had the same visual appearance. SEM-EDAX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis of sample # 5 showed a spray of particulate over the terminals and the base. These particles were actually agglomerates of much smaller particles that seemed to be held together by an organic matrix. Some of the species we saw were aluminum, silicon, magnesium, carbon and oxygen.

I feel very strongly that this problem has no relationship with the original problem; furthermore, it won't develop into the original problem.

SAMPLES FROM SUMTER
All had same optical appearance.

Analysis of samples #6 and 8 showed the same problem as originally but to a much lesser extent. In particular, sample #8 had the corrosion deposit only extending a very short distance, about 0.050". This distance is so short that it doesn't indicate the liklihood of the mating connector being involved.

SAMPLE #11
This sample had the same problem as the original three samples.

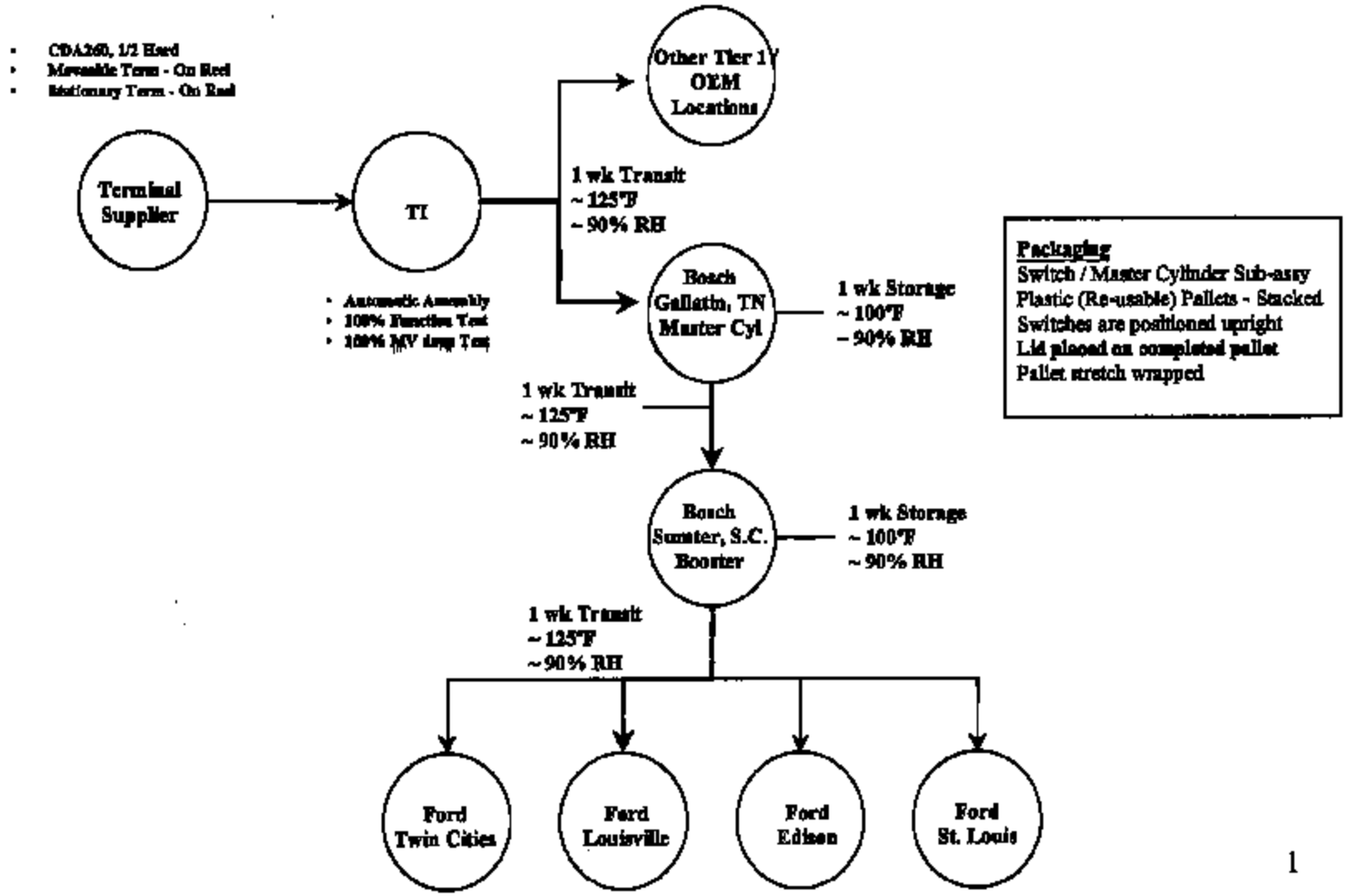
SAMPLE #12
The terminal had the same problem as the original three samples but to an even worse extent. We also found the same deposit (copper, zinc, oxygen, and carbon) on the mating areas of the mating connector. Work continues on this sample.

The data will be sent through the internal mail by Joe Pavao (2035).

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

TEXAS INSTRUMENTS

Bosch - Cruise Control PS
Bosch P/N: 2234057 , TI P/N 77PSL3-3



TI NHT05 11855

Contact List:

Bosch - Gallatin, TN

Mark Nichols	615-230-5314 P 615-452-7194 F
Mike Ross	

Bosch - Sumter, S.C.

John McCoy	803-481-6505 Phone 803-436-8531 Page
Steve Crawford	803-481-6580 Phone 803-436-8603 F
Sharon Lamb	803-481-6055 Phone
Ken Arnet	803-436-8692 Page

Actions

Date	Who	Action
6/18 @ 4:00PM	Bosch – Gallatin, TN	• Mike Ross – (Gallatin, TN) called informing TI that the Ford Louisville was experiencing failures @ vehicle roll test. Parts reported to have green/white powder . • 20 vehicles failed - Cruise Control would not set • Parts being sorted @ Ford plant by outside sorting company. • 40 of 1,620 pc shipment found to have no continuity
6/19	Ford - Louisville	• Bosch / Ford initiated inspection / rework loop prior to Vehicle Roll test. • Mating electrical connectors removed, terminals scraped, mating connector applied. • Following this step no failures were found. • Operation continued until 5:00 PM until going to continuity check. • Scrape operation maintained??
6/19	TI	• Initiated 100% continuity test on FGs Inventory followed by Green Dot on side of crimp ring. • Tested 9600 as of 6/20, 7:00 AM - No failures
6/20	TI / Bosch	• Conf. Call w/ Sumter, Gallatin & TI • Natural control group of how parts react under normal shipping/storage conditions • 1 of 800 parts inspected @ Sumter found w/no continuity • 0 of ??? parts inspected @ Gallatin found • 9:00 AM conf. Call Monday, 6/22

Actions (Continued)

Date	Who	Action
6/20	TI	• Rick Demers (TI Quality) arrives at Bosch Sumter, S.C. plant to assist in inventory sort/certification. • Recv'd (2) devices from Mike Ross (Gallatin, TN) w/ green/white powder • Recv'd (1) device from Ford – Louisville. Terminals exhibiting olive/brown color
6/20	TI	• Complete inspection of FG's Inventory via continuity test/green dot on crimp ring. Date codes 8160 – 8169. • Production as of 8170 - Initiated 10pc continuity test inspection every box following 100% function test. • Boxes passing inspection will have a "Green" dot on box label.
6/21	TI	• Rick Demers finishes Monday requirements without any findings

TEXAS INSTRUMENTS

Bosch - Cruise Control PS
Bosch P/N: 2234057 , TI P/N 77PSL3-3

Date	Who	Action
6/22	TI / Bosch	• Discussed sort findings: Gallatin – 0 / 5,100, Sumter – 1/ 6,440, TI – 0 / 20160 • 12,900 sub-assy remaining to sort at Sumter. Rick Demers and Bosch personnel to sort remaining inventory. • Discussed fact that initial 3 samples returned were from Ford – Louisville • TI to ship Friday, 6/19 shipment on 6/22 via next day delivery by 12:00 noon.
6/22	TI	• Recv'd (5) switches from Sumter, S.C. • Recv'd (2) switches from Gallatin, TN • Both groups have been recv'd in and sent to corrosion lab (Al Hopkins) • Conf call 6/24, 9:00 AM

TEXAS INSTRUMENTS

Bosch - Cruise Control PS
Bosch P/N: 2234057 , TI P/N 77PSL3-3

Description	#1	#2	#3
Fed X #	8031 8189 5661	8031 8189 5661	8012 1766 1055
Date Code	8127	8127	8127
Found @	Ford - Louisville	Ford - Louisville	Ford - Louisville
Visual Inspection	• Parts where installed • Base cavity clean • Stake looks shiny • Contamination looks green / waxy residue on both term. • Contam. Appears to only go half way down terminal	• " • " • " • "	• " • " • " • Contamination looks dark/olive brown. • Contam. Appears to end halfway down terminals.
Continuity Check	Pass	Fail / Intermittent	Pass
Function Test	Pass	Fail – ZPLF	Pass
Cut Open Parts	• Yes • Clean inside device & at entry of terminal.	• Yes • "	• Yes • "
Corrosion Lab	• Was not analyzed	• Was not analyzed	• Cut base away from terminals • Took pictures of contaminate / terminals • Contaminate shown to be half way down terminals • Element analysis shows presence of Carbon & Oxygen

TEXAS INSTRUMENTS

Bosch - Cruise Control PS
Bosch P/N: 2234057 , TI P/N 77PSL3-3

Description	#4	#5	#6
Fed X #	7901 0147 6171	7901 0147 6171	5002668900
Date Code	8140	8140	8135
Found @	Gallatin, TN Parts pulled because terminals looked different.	Gallatin, TN "	Sumter, S.C. "
Visual Inspection	• Parts were installed • Green flakes (particulate) on terminals, stake & base cavity	• Parts were installed • Green flakes (particulate) on terminals, stake & base cavity	• Parts installed • Green tint to terminals • Shiny Stake • Clean base cavity
Continuity Check	Pass	Pass	Pass
Function Test	Did not test – wanted to avoid disrupting contaminates.	Did not test – wanted to avoid disrupting contaminates.	
Cut Open Parts	• No • Same reason as above	• No • "	• No • "
Corrosion Lab	• Analysis pending	• Analysis pending	• Analysis pending

TEXAS INSTRUMENTS

Bosch - Cruise Control PS
Bosch P/N: 2234057 , TI P/N 77PSL3-3

Description	#7	#8	#9
Fed X#	5002668900	5002668900	5002668900
Date Code	8135	8131	8131
Found @	Sumter, S.C. Parts pulled because terminals looked different.	Sumter, S.C. "	Sumter, S.C. "
Visual Inspection	• Parts installed • Green tint to terminals • Shiny Stake • Clean base cavity	• Parts installed • Green tint to terminals • Shiny Stake • Clean base cavity	• Parts installed • Green tint to terminals • Shiny Stake • Clean base cavity
Continuity Check	Pass	Pass	Pass
Function Test	Did not test – wanted to avoid disrupting contaminates.	Did not test – wanted to avoid disrupting contaminates.	
Cut Open Parts	• No • Same reason as above	• No • "	• No • "
Corrosion Lab	• Analysis pending	• Analysis pending	• Analysis pending

Description	#10
Fed X #	5002668900
Date Code	8135
Found @	Sumter, S.C. Parts pulled because terminals looked different.
Visual Inspection	• Parts installed • Green tint to terminals • Shiny Stake • Clean base cavity
Continuity Check	Pass
Function Test	Did not test – wanted to avoid disrupting contaminates.
Cut Open Parts	• No • Same reason as above
Corrosion Lab	• Analysis pending

IN-PROCESS IP-2 TEST SUMMARY (PS 95-53)

1.0 GENERAL

1.1 Customer: Ford Motor Company

1.2 TI Part Number: 77PSL3-3

1.3 Customer Part Number: F3TA-9F924-CA

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

1.5 Date Of Completion: 95/06/26

1.6 Quantity Of Units Tested: 54

1.7 Disposition Of Tested Units :

Devices tested were retained by Texas Instruments.

1.8 TI test series number: #1 through #6 (Vibration completed 03/07/95)
#13 through #18 (Vacuum completed 03/07/95)
#7 through #12 (Temp Cycling completed 04/03/95)
#19 through #54 (Fluid Resistance completed 06/26/95)

2.0 TEST PROCEDURES AND RESULTS

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

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

2.1 Calibration

Procedure: Calibration was checked at room temperature (16 degrees C to 35 degrees C) using ambient air as the pressure medium. Calibration settings, as specified on the part drawing, are actuation (electrical contacts opening) at 200 - 300 psig, , and release (contacts reclosing) at 40 psig minimum. All tests were accomplished after the third cycle with the switch conducting 700 - 800 milliamps at 12.0 - 14.0 volts DC. The rate of pressure change (ramp-up, ramp down) was accomplished at 50 psig/sec.

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

2.2 Voltage Drop

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

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

2.3 Current Leakage

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

Between the switch leads with contacts open.

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

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

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

2.4 Proof

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

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

2.5 Vibration

Devices tested: TI #1 through #6.

Equipment used: Vibration table, Ling, model A395 with Hewlett-Packard model 5427 controls. Air tank with 350 psig minimum pressurized Nitrogen used to actuate devices with at least 1.1 times maximum actuation specification on part drawing; 300 psig x 1.1 = 330 psi minimum.
Switches were mounted in the test port using the currently released electrical connector before the start of the test. Switches were vibrated in all 3 planes with electrical continuity monitored during the entire test, in ambient air. Internal pressure was maintained at zero Kpa G when the switch was in the closed position, and 1.1 times max actuation pressure shown on the print when the switch was in

the open position. The switches were vibrated at 1.5mm displacement (peak to peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period, in alternate one-hour periods in the open and closed positions for a total of 8 hours in each plane, for a total test time of 24 hours.

Calibration Pre-test Results: The average actuation was 238 psig, and the standard deviation was 5.5. All values were well within the specification. The average release was 185 psig, and the standard deviation was 6.5. All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 243 psig, and the standard deviation was 6.9. All values were well within the specification. The average release was 168, and the standard deviation was 9.5. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 30 millivolts, and the standard deviation was 1.4 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 42 millivolts, and the standard deviation was 3.29

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

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

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

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

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

2.6 Vacuum

Devices tested: TI #13 through #18.

Equipment used: Kinney vacuum pump. Sensotec pressure transducer, serial no. 198033 Model Tile 727-02, range 0-25 psia calibrated quarterly, with Fluke model 8020B Digital Multimeter readout, calibrated quarterly.
Switches were mounted in the test at room temperature, ambient air as the pressure medium.
Switches were subjected to 5 cycles of vacuum from atmosphSwitches were subjected to 5 cycles of vacuum from atmosphic pressure (760mm Hg) to an absolute pressure of 3-6 mm Hg , maintaining vacuum for 60 seconds.

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

Calibration Pre-test Results: The average actuation was 251 psig, and the standard deviation was 11.3. All values were well within the specification. The average release was 173 psig, and the standard deviation was 6.8 All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 242 psig, and the standard deviation was 6.9. All values were well within the specification. The average release was 158, and the standard deviation was 6.2. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 27.2 millivolts, and the standard deviation was 0.37 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 55 millivolts, and the standard deviation was 2.77. All values were well within the specification of 200 millivolts maximum.

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

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

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

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

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

2.7 Temperature Cycle

Devices tested: TI #7 through #12.

Equipment used: Thermotron model S-4 Mini-Max environmental chamber capable of - 55 degrees C to + 200 degrees C, humidity controlled. Custom TI designed and built cycler, utilizing Enerpak Integrated hydraulic pressure source, TI315 Programmable Logic Controller, Moog servovalve and controller, Simpson signal generator, and opposing-piston fluid isolators, to produce a hydraulic-fluid flow-type primary with a brake-fluid dead-end -type secondary terminated with a 24-station manifold equipped with internal heaters. Capability to 5 hz at 0-1500 psig cycle. Custom TI designed and built 24 station Switch Monitor Circuit which automatically stops the cycler in the event of abnormal switch

action, defined as continuity change which does not track the signal from the signal generator. Thermocouple readouts calibrated quarterly.

Calibration Pre-test Results: The average actuation was 246 psig, and the standard deviation was 8.0. All values were well within the specification. The average release was 174 psig, and the standard deviation was 9.0 All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 225 psig, and the standard deviation was 4.2. All values were well within the specification. The average release was 163, and the standard deviation was 5.1. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 45.7 millivolts, and the standard deviation was 14.2 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 59 millivolts, and the standard deviation was 10.6. All values were well within the specification of 200 millivolts maximum.

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

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

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

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

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

2.8 Fluid Resistance

Devices tested: TI #19 through #54.

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

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

Impulse:	#19 through 30
Terminal Strength:	#31 through 42
Humidity:	#43 through 48

Salt Spray: #49 through 54

2.8.1 Impulse (#19 through 30)

Calibration Pre-test Results: The average actuation was 251 psig, and the standard deviation was 5.4. All values were well within the specification. The average release was 171 psig, and the standard deviation was 9.5 All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 248 psig, and the standard deviation was 4.4. All values were well within the specification. The average release was 164, and the standard deviation was 5.3. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 27.4 millivolts, and the standard deviation was .5 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 65.8 millivolts, and the standard deviation was 9.7. All values were well within the specification of 200 millivolts maximum.

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

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

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

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

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

2.8.2 Terminal Strength (#31 through 42)

Calibration Pre-test Results: The average actuation was 249 psig, and the standard deviation was 7.2. All values were well within the specification. The average release was 172 psig, and the standard deviation was 5.4 All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 248 psig, and the standard deviation was 4.4. All values were well within the specification. The average release was 164, and the standard deviation was 5.3. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 27.6 millivolts, and the standard deviation was .5 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 65.8 millivolts, and the standard deviation was 9.7. All values were well within the specification of 200 millivolts maximum.

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

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

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

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

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

2.8.3 Humidity (#43 through 48)

Calibration Pre-test Results: The average actuation was 246.8 psig, and the standard deviation was 5.2. All values were well within the specification. The average release was 168 psig, and the standard deviation was 8.2 All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 241 psig, and the standard deviation was 5.7. All values were well within the specification. The average release was 156, and the standard deviation was 6.3. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 27.6 millivolts, and the standard deviation was 1.5 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 77.5 millivolts, and the standard deviation was 4.0. All values were well within the specification of 200 millivolts maximum.

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

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

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

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

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

2.8.4 Salt Spray (#49 through 54)

Calibration Pre-test Results: The average actuation was 250.0 psig, and the standard deviation was 6.5. All values were well within the specification. The average release was 172 psig, and the standard deviation was 6.5 All values were well within the 40 psig minimum specification.

Calibration Post-test Results: The average actuation was 242.7 psig, and the standard deviation was 6.0. All values were well within the specification. The average release was 156, and the standard deviation was 4.6. All values were well within the 40 psig minimum specification.

Voltage Drop Pre-test Results: The average voltage drop was 27.0 millivolts, and the standard deviation was 0.6 All values were well within the specification of 200 millivolts maximum.

Voltage Drop Post-test Results: The average voltage drop was 77.4 millivolts, and the standard deviation was 5.9. All values were well within the specification of 200 millivolts maximum.

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

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

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

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

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

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

CUSTOMER: [redacted]	TEST: IN-PROCESS IP-2 TEST SUMMARY	PAGE 9 OF 8
TESTED BY: Elaine Rose , QRA	TEXAS INSTRUMENTS INCORPORATED	DEVICE: 77PSL3-3
APPROVED BY: Jim Watt, QRA	MATERIALS & CONTROLS GROUP	DOC. : PS 95-53
DATE: June 26, 1995	ATTLEBORO, MASSACHUSETTS 02703	FILE NAME: PS 95-53.doc

-MSG M#= 328840 FR=SB01 TO=ZARN SENT=09/15/92 07:11 AM
R#=113 ST=C DIV=0050 CC=00101 BY=SB01 AT=09/15/92 07:11 AM

TO: [redacted] ZARN
Matt Sellers MJS2

FR: Steve Offiler SB01

SJ: Disc Dim. Meas. for Cup Modifications

As a quick check on Dale's previous work, we measured the assembled height of a dozen each, quiet and snap, discs. The disc measurement was taken with a dial indicator, as-assembled, using an actual 27713 cup and converter, measuring to the converter bump. Each test lot of 12 represents 3 discs taken from 4 different lots. Each disc measurement was repeated 3 times and averaged to obtain the numbers used in the statistics.

The results track Dale's extremely well. The difference observed was 0.0011" greater for the snap disc, versus 0.0012" in Dale's study. Standard Deviations also compared well with Dale's, at 0.00030"/0.00032" (snap/quiet) versus 0.00044/0.00024 in Dale's study.

Regards, Steve O.

-MSG MS# 2293471 FR=DOD TO=ZARN SENT=08/18/92 11:36 PM
RR=116 STAT DIV=0071 CC=00240 BY=DOD AT=08/18/92 [illegible] PM

To: STEPHEN B. [illegible] SBO1

Copy: CHARLES DOUGLAS CMS1
DAVID CZARN ZARN

From: DANNY O'DRISCOLL DOD

Subj: FORD - CCPS VACUUM REQUIREMENT

I HAVE JUST RECEIVED NOTIFICATION FROM FORD THAT THE LOW VACUUM LEVEL APPLIES TO BOTH THE FALCON AND THE CAPRI. THIS MEANS, OF COURSE, THAT THE DESIGN CHANGE THAT YOU ARE DEVELOPING MUST BE APPLIED TO BOTH CCPS'S

ALSO, TONY GAGE CLAIMED THAT OUR CCPS ON THE FALCON FAILED DURABILITY TESTING. TONY WAS SHORT ON DETAILS BUT PROMISED TO COLLATE ALL THE NECESSARY INFO AND SEND THAT AND THE P/SWITCH STRAIGHT TO YOU.

TONY GAGE SUGGESTED THAT YOU CHECK WITH FORD OF EUROPE ON THE [illegible] PLATFORM, APPARENTLY THEY USE THE SAME LEVEL OF VACUUM AS AUSTRALIA FOR EVAC & FILL.

RGDS, DANNY

-MSG MW= 304596 [redacted] TT 'Y SENT=08/06/92 01:31 PM
ST=C DIV=0050 CC=00101 BY=ZARN AT=08/06/92 01:31 PM

AUGUST 6, 1992

TO:	CHARLIE DOUGLAS	CMPI	MATT SELLERS	MJS2	
	DICK GARISPY	MFPC	DALE SOSSE	JPUN	
	PAUL NOTCH	PMKI	BUDDY STRUBLE	SDSC	
	STEVE OFFILER	SBOI	BILL SWEET	WS4	
	MATT SELLERS	MJS2	JIM WATT	FCOA	
CC:	MIKE DOWNEY	MIKD	TOM CHARBONEAU	TC	
	GARY SNYDER	GJS1	RAY TOURANGEAU	RGT2	
	NORM FREDA	NHLZ	ANDY McGUIRK	JCOA	
	DANNY O'DRISCOLL	DOD	MARTHA SULLIVAN	MNS	
	BOB BARTOSH	RLB3	JOHN KOURTESIS	JKOU	
FR:	DAVE CZARN	ZARN			

SU: CCPS COORDINATION MEETING

****
8/6/92 MTG MINUTES
****

. 36900 mail Jam

NEXT MEETING:
DATE: THURSDAY 8/20
TIME: 10:00 - 11:00
PLACE: MARKETING CONFERENCE ROOM

****
KEY NEAR TERM EVENTS:

. NEW RIVETER INSTALLATION	SELLERS	9/07	
. LO-1/LS-2 IGW	WATT	8/14	
. RECV. EPDM COLORED O'RINGS	SELLERS	7/30	ORIG
(77PSL6-1)		8/28	REV
. BASE INVENT'Y-PREP. FOR RIVETER	STRUBLE	7/30	COMP
Plan is in place.			
. RDA REPORT (J. Pelkey)	OFFILER	7/27	ORIG
(77PSL2-3)		8/21	REV
. ELCO HIGH VOLUME SNUBBER QUOTE	KOTCH	8/7	

****
PROGRAM/CUSTOMER: TOWN CAR & EN53 w/ABS / Pitts
DESCRIPTION: 77PSL2-1 - standard disc - in prod'n - 160k

Pending:

RIVET APPROVAL/RIVETER INSTALLATION (champion: Sellers)

. rivet spc data to Norm	SELLERS		
. IG 6.5 TO 7 MIL PRE-LOAD RANGE	CZARN	8/04	COMP
OK FOR BASE INVENTORY BUILD ?			

FIRST CYCLE TESTING (champion: Offiler)

Issues:

DIAPHRAGM LIFE (champion: Offiler)
TERMINAL POSITION (champion: Sellers)

TI NHT05 11875

****
PROGRAM/CUSTOMER: ECONOLINE / Ford - direct
DESCRIPTION: 77PSL2-3 - standard disc - in prod'n - 80k

==> QTY SHIPPED TOWARDS 100K AMORTIZ'N : 79.1 K

****
PROGRAM/CUSTOMER: EN53 - non ABS / Dana
DESCRIPTION: 77PSL3-1 - quiet disc - in prod'n - 200k
IGW: 8/14/92

- INFO TO MACROFF FOR APPROVAL SOGGE 7/24 COMP
. MACROFF'S VEHICLE EVAL'N FREDA
- NOID RATINGS ON 6 SWITCHES FREDA 7/27 COMP
- RETRIEVE 10 SW'S FRM MACROFF FREDA 7/30 COMP
10 switches to be tested by B. Pease on DN101 Taurus/Sable.

. QU SW/RUBBER DIAPH SW'S (B. Pease) OFFILER
- PRINT TO PURCH - EXTRUDED DIAPH OFFILER 7/30 ORIG
(REQUEST SAMPLE ORDER) 8/10 REV
. QUIET SW: TOOLING EXPENDITURE/ SELLERS 8/20
PRESENT AND PROJECTED COST

Issues (items not covered above):

SENSORS W/INSUFF. PRELOAD (champion: Sogge)
. $ IMPACT IF 4 CUP P/N's REQ'D SELLERS 7/23 ORIG
8/13 REV
. HOW DO WE ID 4 P/N's ?? SOGGE/SELL 7/23 ORIG
8/13 REV
. TEST DALE'S PRE-LOAD ASSUMPTION SOGGE/SELL 8/13
W/ NO 0-PRESSURE & KAPTON W/HOLE

****
PROGRAM/CUSTOMER: F-SERIES/BRONCO / Ford - direct
DESCRIPTION: 77PSL3-3 - standard disc - in prod'n - 360K
(volume ramp-up in August/Sept)

Pending (items not covered above):

COMPLETE 600 HR. THERMAL TEST OFFILER 7/21 orig
8/07 REV
7/31 COMP
REPORT - 600 H THERMAL TEST OFFILER 8/20
FLUID RESIST/SALT/HUMIDITY REPORT OFFILER 7/31 ORIG
8/27 REV

****
PROGRAM/CUSTOMER: TAURUS SHO / Teves
DESCRIPTION: 77PSL5-2 - quiet/snubber - 3092 SOP - 20K
ISW: 8/14/92

Path to ISW:

. COMPLETE DS TESTING AND REPORT OFFILER 8/14
. SUBMIT ISW WATT 8/14

Issues (items not covered above):

FLAKING/CLEANLINESS (champion: Watt)
Teves to supply reusable totes; timing for the totes is TBD but prod'n has 1190 pcs on schedule for this month......a plan is needed ASAP.
. define Teves' packaging reqmts WATT 8/20
(establish timeline for 8/20 mtg)
. define acceptance criteria WATT

****
PROGRAM/CUSTOMER: WIN 88 / Tokico
DESCRIPTION: 77PSL3-2 - quiet disc - MY95 - 250K
ISW: est. 12/10/93

Pending (items not covered above):

. CAD PRINT OFFILER 8/28
. DEFINE EV/VP/PP REQMTS FREDA
- (RRD's, qty of switches...)

TI NHT05 11876

PROGRAM/CUSTOMER: Capri (Australia) / GCAA
DESCRIPTION: 77PSL6-1 - quiet/US:4 - MY94 - 23.4L
ISW: 10/1/92 MRD (Ship on 7/18)

Pending (items not covered above):

. VACUUM SPEC RESOLUTION D'ERRICOLL
Vacuums as low as ,4 millibar confirmed, established "to minimize the soft pedal concern which is inherent to Capri", per John Peck. Steve D. to outline best plan.
. FOAM-UP VACUUM LEVELS 777 MREDA

Path to ISW:

. IMPULSE/T-CYCLE TEST & REPORT OFFILER 9/18
. DOC'S TO ACCOMPANY FINAL ISW WATT 9/18

PROGRAM/CUSTOMER: Falcon (Australia) / Ford - direct
DESCRIPTION: 77PSL4-1 - quiet/metric J512 - MY95 - 30L
ISW: est. 12/18/93

Switch builds	Resp.	MRD	SHIP
EP - qty 50	OFFILER	9/25/92	9/15/92
VP - qty 50	OFFILER	7/23/92	7/09/92
PP - qty tbd	OFFILER	1094	TBD

PROGRAM/CUSTOMER: Ranger/Explorer / Bendix
DESCRIPTION: P/N tbd - quiet disc - MY95 - 100#
ISW: est. 12/18/93

Pending (items not covered above):

. COORDINATE CAD DATA TRANSFER CZARN 7/17 ORIG
6/10 REV

REGARDS,
DAVE
\64-FORD

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ 2

To KISH BADANI	From DAVE CRAIN
Co. FORD MOTOR Co	Co. TI
Dept.	Phone #
Fax # 313 845 3063	Fax #

KISH,

The following shows the pressure point levels of 20 switches taken at random from 2 production lots that were in-process today.

In Lot A, the values ranged from -27.0 to -70.3 psig. The values were less consistent - as you can see - than Lot B which ranged from -54.8 to -70.5. The general grouping seems to be in the -50 and below range, which is consistent with my expectation of a standard L/F switch.

We can discuss on next step tomorrow.

Regards,

Dave C