EA02-025

FORD

10/27/03

BOOK 26 OF 61

PART 4 OF 4

BOX 23 OF 28

Summary of Chemical Properties
3/2/99

The following pages were supplied by Dupont and show chemical and physical properties for Teflon and Kapton. In summary, water will degrade the mechanical properties of Kapton, but Teflon is unaffected by water. This is the reason why the Teflon-Kapton-Teflon system was selected for Texas Instruments switch diaphragm (3 mil thick Kapton layer coated with 1 mil Teflon on both sides). Page 1 (marked with "A") indicates that the Teflon is non-reactive with water. While page 2 shows Teflon has a relatively low vapor transmission rate (marked with "B"). Page 2 shows how the mechanical properties of Kapton degrade with water and temperature exposure (marked with "C").

End of document.

TEFLON

Chemical Properties

DuPont FEP fluorocarbon film is chemically inert and solvent resistant to virtually all chemicals except molten alkali metals, fluorine at elevated temperatures, and certain complex halogenated compounds such as chlorine trifluoride at elevated temperatures and pressures.

In circumstances where end-use temperatures are close to the upper service limit 205°C (400°F), 80% sodium hydroxide, metal hydrides, aluminum chloride, ammonia, and certain amines ($R\text{-}NH_2$) may attack the film in a manner similar to molten alkali metals. Special testing is required when such extreme reducing or oxidizing conditions are evident.

With these exceptions noted, DuPont FEP fluorocarbon films exhibit a very broad range of chemical and thermal serviceability.

Due to the many complex aspects of performance in severe environments, final selection should be based on functional evaluations or experience and actual end-use conditions.

The chemical substances listed in Table 5 are representative of those with which DuPont FEP film has been found to be nonreactive.

Table 5
Typical Chemicals with Which DuPont FEP Film Is Nonreactive*

Abietic acid	Cyclohexanone	Hydrofluoric acid	Phthalic acid
Acetic acid	Dibutyl phthalate	Hydrogen peroxide	Pinene
Acetic anhydride	Dibutyl sebacate	Lead	Piperidene
Acetone	Diethyl carbonate	Magnesium chloride	Polyacrylic nitrile
Acetophenone	Diethyl ether	Mercury	Potassium acetate
Acrylic anhydride	Dimethyl formamide	Methyl ethyl ketone	Potassium hydroxide
Allyl acetate	Di-isobutyl adipate	Methacrylic acid	Potassium permanganate
Allyl methacrylate	Dimethylformamide	Methanol	Pyridine
Aluminum chloride	Dimethylhydrazine, unsymmetrical	Methyl methacrylate	Soap and detergents
Ammonia, liquid	Dioxane	Naphthalene	Sodium hydroxide
Ammonium chloride	Ethyl acetate	Naphthols	Sodium hypochlorite
Aniline	Ethyl alcohol	Nitric acid	Sodium peroxide
Benzonitrile	Ethyl ether	Nitrobenzene	Solvents, aliphatic and aromatic**
Benzoyl chloride	Ethyl hexoate	2-Nitro-butanol	Stannous chloride
Benzyl alcohol	Ethylene bromide	Nitromethane	Sulfur
Borax	Ethylene glycol	Nitrogen tetroxide	Sulfuric acid
Boric acid	Ferric chloride	2-Nitro-2-methyl propanol	Tetrabromoethane
Bromine	Ferric phosphate	n-Octadecyl alcohol	Tetrachloroethylene
n-Butyl amine	Fluoronaphthalene	Oils, animal and vegetable	Trichloroacetic acid
Butyl acetate	Fluoronitrobenzene	Ozone	Trichloroethylene
Butyl methacrylate	Formaldehyde	Perchlorethylene	Tricresyl phosphate
Calcium chloride	Formic acid	Pentachloro-benzamide	Triethanolamine
Carbon disulfide	Furane	Perfluoroxylene	Vinyl methacrylate
Cetane	Gasoline	Phenol	Water
Chlorine	Hexachloroethane	Phosphoric acid	Xylene
Chloroform	Hexane	Phosphorus pentachloride	Zinc chloride
Chlorosulfonic acid	Hydrazine		
Chromic acid	Hydrochloric acid		
Cyclohexane			

*Based on experiments conducted up to the boiling points of the liquids noted. FEP resins have normal service temperatures up to 205°C (400°F). Absence of a specific chemical does not mean that it is reactive with FEP film.
**Some halogenated solvents may cause moderate swelling.

3713 7244

TEFLON FEP.

Physical Properties

Absorption

Almost all plastics absorb small quantities of certain materials with which they come in contact. Submicroscopic voids between polymer molecules provide space for the material absorbed without chemical reaction. This phenomenon is usually marked by a slight weight increase and sometimes by discoloration.

DuPont FEP fluorocarbon films have unusually low absorption compared with other thermoplastics. They absorb practically no common acids or bases at temperatures as high as 200°C (392°F) and exposures of up to one year. Even the absorption of solvents is extremely small. Weight increases are generally less than 1% when exposed at elevated temperatures for long periods. In general, aqueous solutions are absorbed very little by DuPont FEP film. *Moisture absorption is typically less than 0.01% at ambient temperature and pressure.*

Permeability

Many gases and vapors permeate FEP films at a much lower rate than for other thermoplastics (see Figure 13). In general, permeation increases with temperature, pressure, and surface contact area and decreases with increased film thickness. Table 6 lists rates at which various gases are transmitted through DuPont FEP fluorocarbon film, while Table 7 lists rates of vapor permeability for some representative substances. Note that the pressure for each material is its vapor pressure at the indicated temperature.

Table 6
Typical Gas Permeability Rates of DuPont FEP Fluorocarbon Film, 25 μm (1 mil) Thickness
(Test Method: ASTM D-1434 at 25°C (77°F))

Gas	Permeability Rate* cm³/(m²·24 h·atm)
Carbon Dioxide	25.9 × 10⁹
Hydrogen	34.1 × 10⁹
Nitrogen	5.0 × 10⁹
Oxygen	11.6 × 10⁹

*To convert to cm³/(100 in²·24 h·atm), multiply by 0.0645.

Figure 13. Water Vapor Transmission Rate of DuPont FEP Film at 40°C (104°F) per ASTM E-96 (Modified)

Notes: Values are averages only and not for specification purposes. To convert the permeation values for 100 in² to those for 1 m², multiply by 15.5.

Table 7
Typical Vapors Transmission Rates of DuPont FEP Fluorocarbon Film, 25 μm (1 mil) Thickness
(Test Method: Modified ASTM E-96)

Vapor	Temperature °C	Temperature °F	Vapor Transmission Rate SI Units g/(m²·d)	Vapor Transmission Rate English Units (g/100 in²·d)
Acetic Acid	35	95	6.3	0.41
Acetone	35	95	14.7	0.95
Benzene	35	95	9.9	0.64
Carbon Tetrachloride	35	95	4.8	0.31
Ethyl Acetate	35	95	11.7	0.76
Ethyl Alcohol	35	95	10.7	0.69
Freon® F-12	23	73	372.0	24.0
Hexane	35	95	8.7	0.56
Hydrochloric Acid	25	77	<0.2	<0.01
Nitric Acid (Red Fuming)	25	77	180.0	10.8
Sodium Hydroxide, 50%	25	77	<0.2	<0.01
Sulfuric Acid, 98%	25	77	2 × 10⁻⁴	1 × 10⁻⁵
Water	39.5	103	7.0	0.40

Page 2

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[illegible] on KAPTON

[illegible]

(1) [illegible]

(2) [illegible]

(3) [illegible]

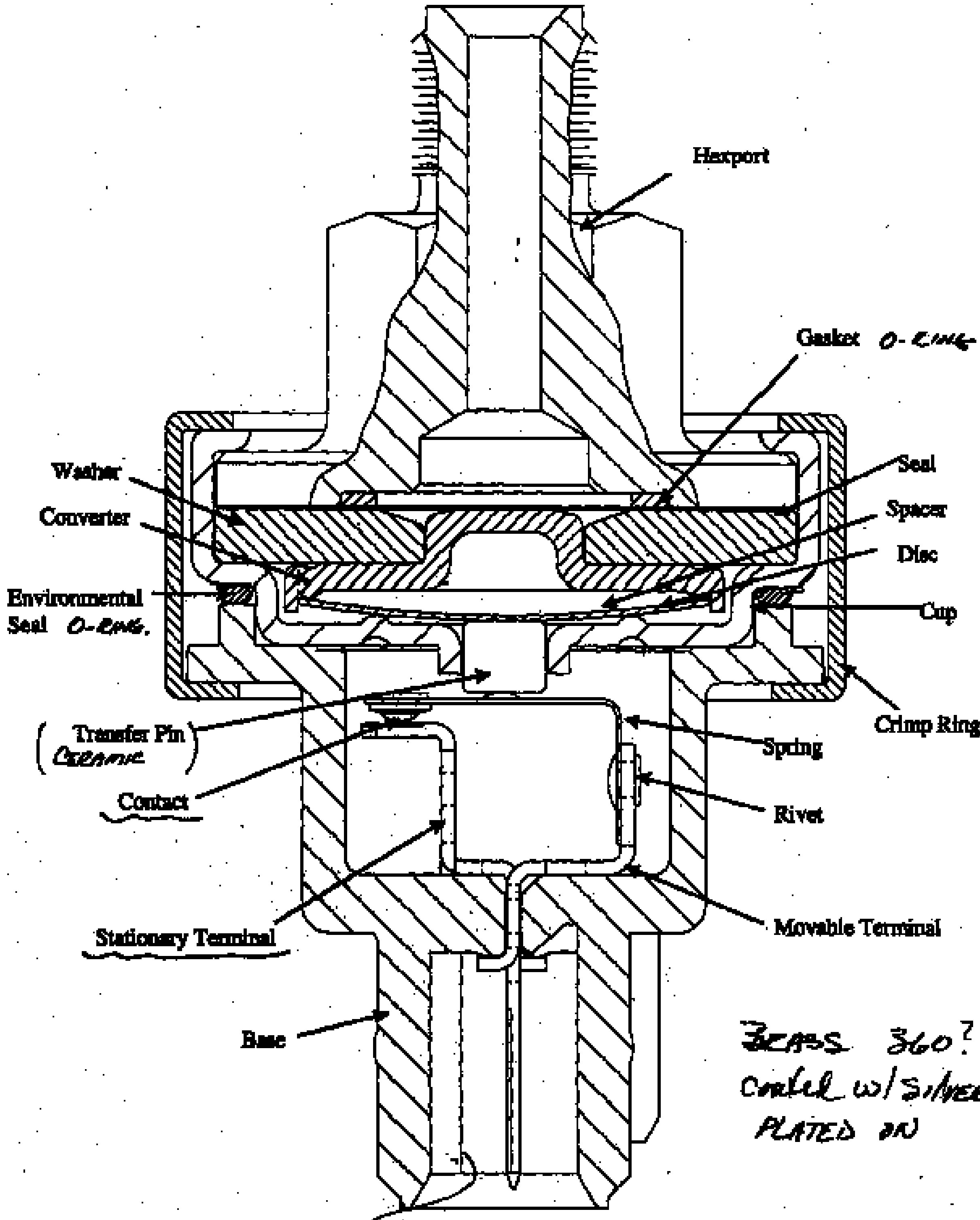
(4) [illegible]

(5) [illegible]

Page 3

3713 7246

Hydraulic Pressure Switch Cross Section



BRASS 360?
coated w/ silver
PLATED ON

(1) look for dirt & contaminants

3713 7247

TEXAS INSTRUMENTS

Materials & Controls Group
Automotive Business Unit

Low Cost Automotive Hydraulic Line Mount Pressure Switches

TI's pressure switches provide low cost, on/off controls for many automotive systems. The snap action disc reacts to changing pressure by reversing its curvature and activating electrical switch contacts.

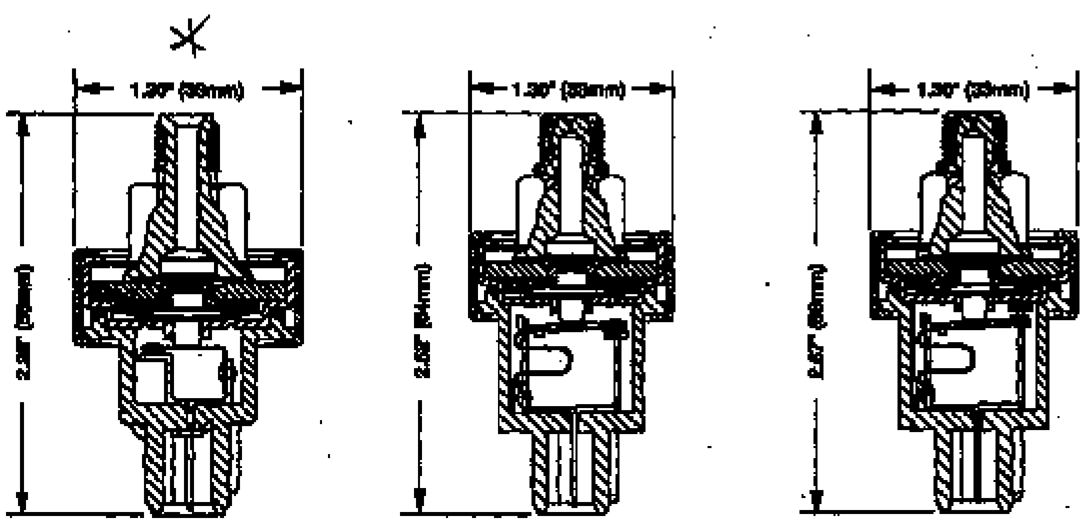
Key Features Include:

- Designed for underhood environment
- Low weight
- Custom packaging for specific application needs
- Automotive temperature range of -40 to 135°C
- Normally open and normally closed contact logic
- Industry proven since 1984

Typical Applications

- Power Steering Systems
- Cruise Control Systems
- Brake Systems
- Transmissions
- Suspension

Dimensions (typical examples, other styles available)



TEXAS INSTRUMENTS

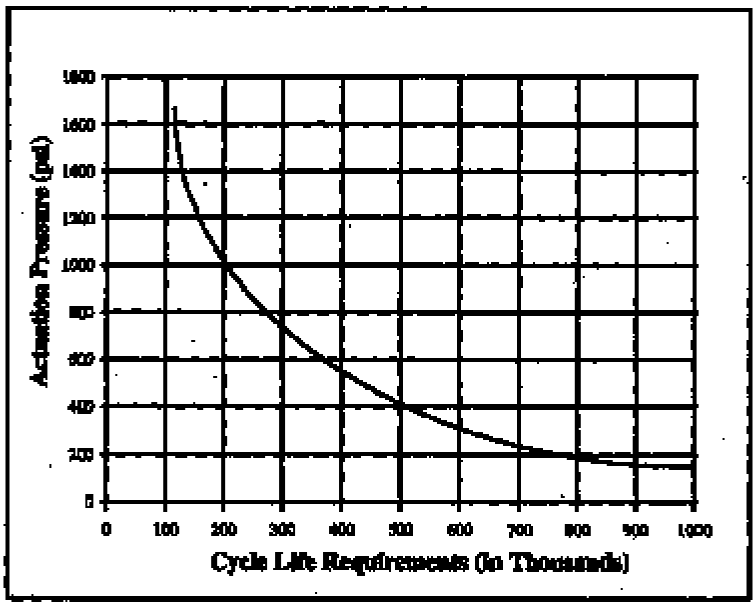
Technical Specifications

Electrical	
Supply Voltage	6 - 16 V
Supply Current	5 - 35 mA
Response Time[1]	10 ms maximum
Environmental	
Operating Temperature	-40 to 135°C
Full Scale Pressure Range	
Low Pressure Range	0 to 300 psi
Mid Pressure Range	0 to 800 psi
High Pressure Range	0 to 1600 psi

Durability	
Cycle Life	
Low/Mid Pressure Range	up to 5×10^6 cycles
High Pressure Range	up to 15×10^4 cycles
Proof Pressure	1400 to 3000 psi
Burst Pressure	
Low Pressure Range	7000 psi
Mid Pressure Range	4000 psi
High Pressure Range	2500 psi

[1]Applicable on some devices

Pressure Switch Characteristics



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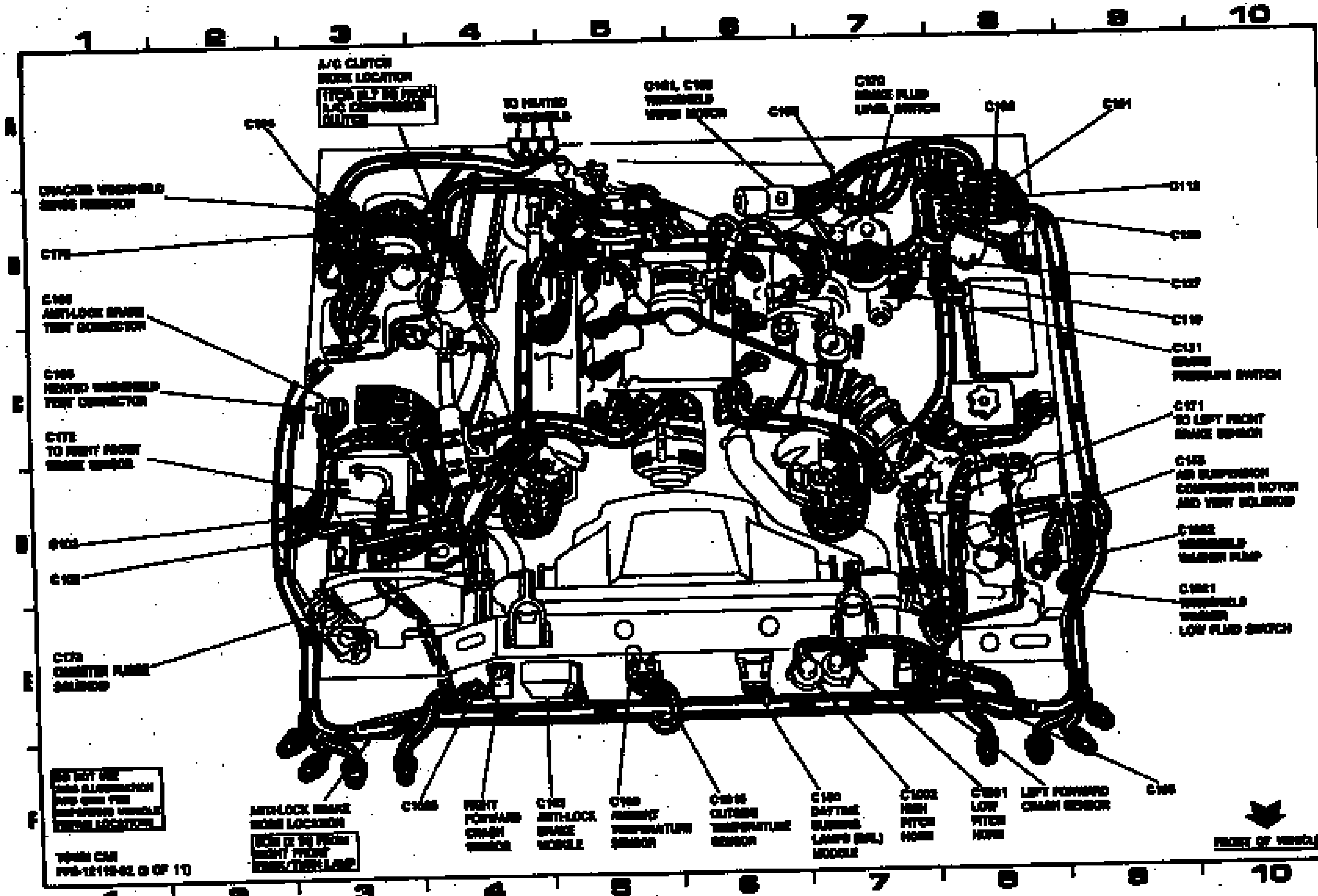
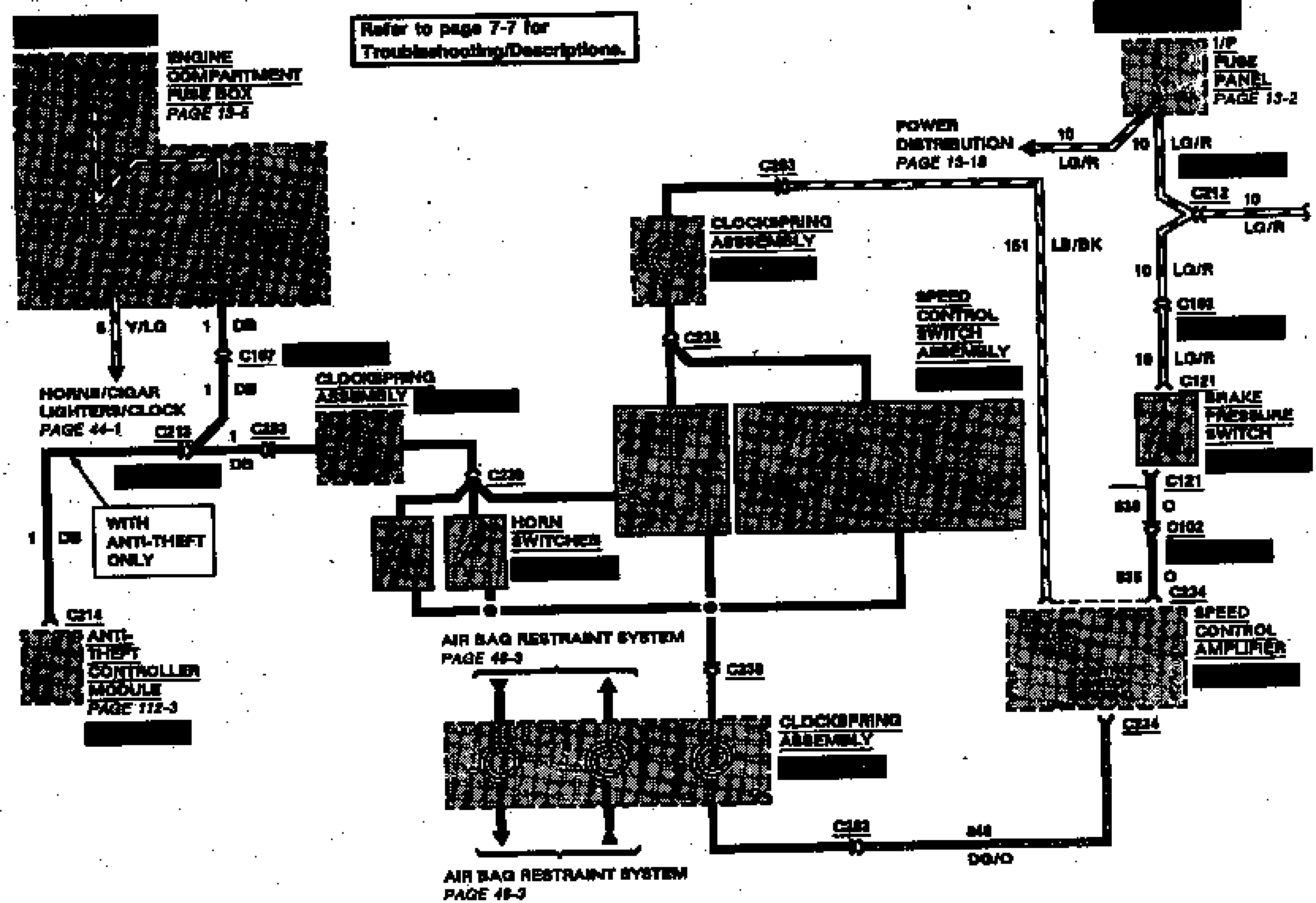


4.6L ENGINE (3 OF 3)

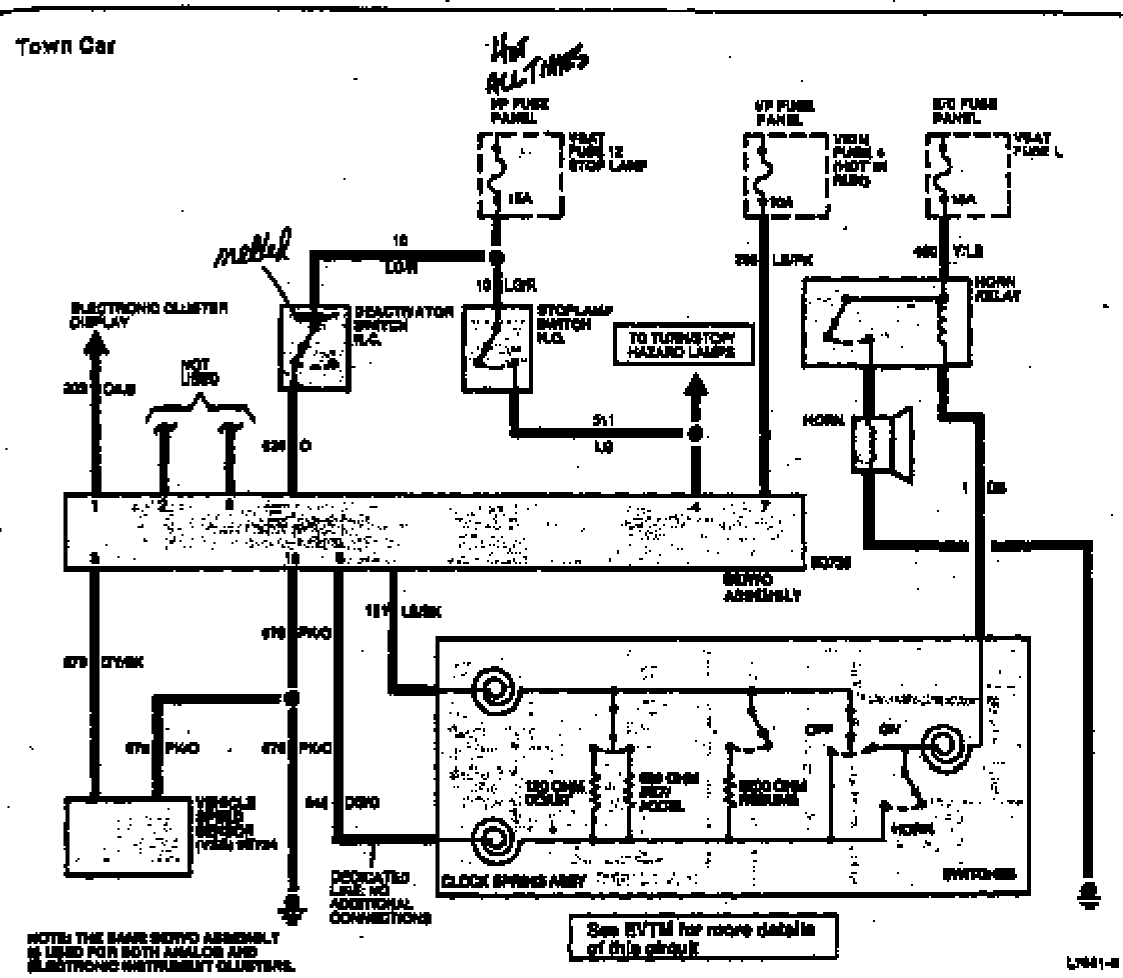
3713 7260

31-1 SPEED CONTROL



3713 7251

DIAGNOSIS AND TESTING (Continued)



Orange wire → stationary contact.

LG/R-wire → spring contact. – melted @ wall

3713 7252

DESCRIPTION (Continued)

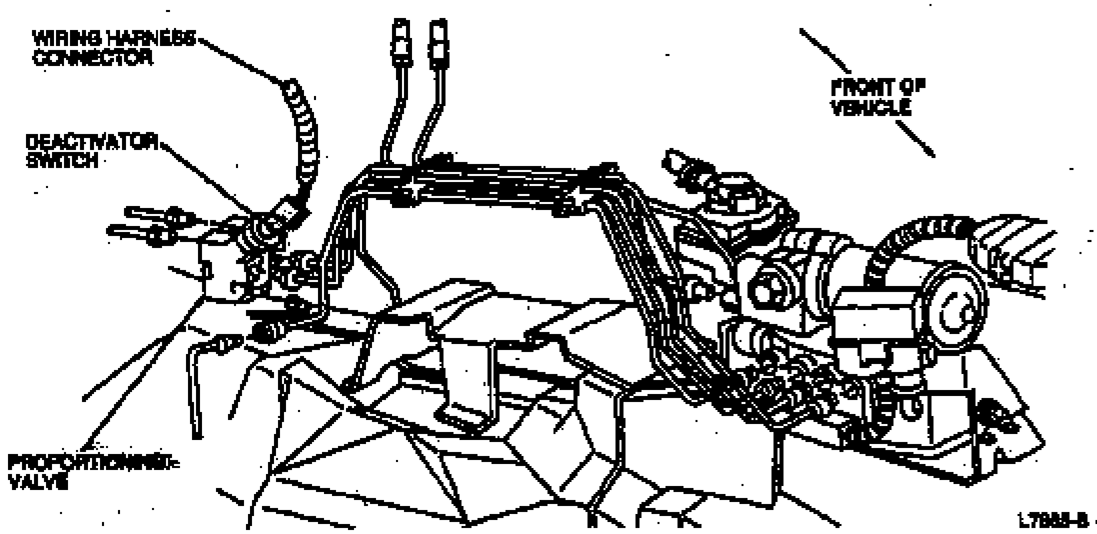
Item	Part Number	Description
1A	N610889-S58	Screw
2	—	Actuator Cable Adjuster Fitting
3	9A825	Speed Control Actuator

(Continued)

Item	Part Number	Description
4	—	Accelerator Cable
5	9C735	Speed Control Servo
6	9C809	Speed Control Bracket Plate
A		Tighten to 3-4 N·m (27-35 Lb-In)

Deactivator Switch

The deactivator switch is a normally closed switch and replaces the vacuum dump valve as a redundant safety feature in the system. Normally when the brake pedal is depressed, an electrical signal from the brakelamp circuit to the speed control servo will disengage the system. Under increased brake pedal efforts (5-10 lbs, engine running), the deactivator switch mounted in the brake line will open and remove power to the speed control servo clutch, releasing the throttle independent of the speed control servo control. The deactivator switch is located at the rear brake proportioning valve (ABS brakes) or junction block (Non-ABS brakes) below the brake booster.



L7985-B

Vehicle Speed Sensor (VSS)

The vehicle speed sensor (VSS)(9E731) is mounted to the transmission.

OPERATION

System Activation

To operate the speed control system, the engine must be running and vehicle speed must be greater than 48 km/h (30 mph). The system is activated by pressing the ON switch in the steering wheel. Then the operator must depress and release the SET/ACCEL switch. Current speed will then be maintained until a new speed is set, the brake pedal is depressed or the OFF switch is depressed.

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REMOVAL AND INSTALLATION (Continued)

3. Install three screws that retain the contact assembly and tighten to 2-3 N-m (18-26 lb-in). Remove tape from contact assembly.
4. Route the contact assembly harness down the column and connect to main wiring.

   NOTE: If a new contact assembly is installed, remove the lock mechanism after assembly is secured to column.
5. Install steering column shroud.
6. Install lower trim panel.
7. Install tilt lever if equipped.
8. Position steering wheel on steering shaft and install new steering wheel retaining bolt. Tighten to 31-45 N-m (23-33 lb-ft).

   NOTE: Route contact assembly wiring through steering wheel as wheel is being positioned.
9. Connect speed control / horn connector to clockspring contact assembly connector.

   CAUTION: Make sure wires are positioned that no interference is encountered when installing air bag module.
10. Position air bag module on steering wheel and connect clockspring contact connector.
11. Install air bag module on wheel and install four and washer assemblies. Tighten to 4-5.6 N-m (35-50 lb-in) for Town Car and 2.7-3.7 (24-32 lb-in) for Crown Victoria / Grand Marquis.
12. Connect battery ground cable and air bag backup power supply. Refer to Section 01-20B.
13. Verify air bag warning indicator.

Deactivator Switch

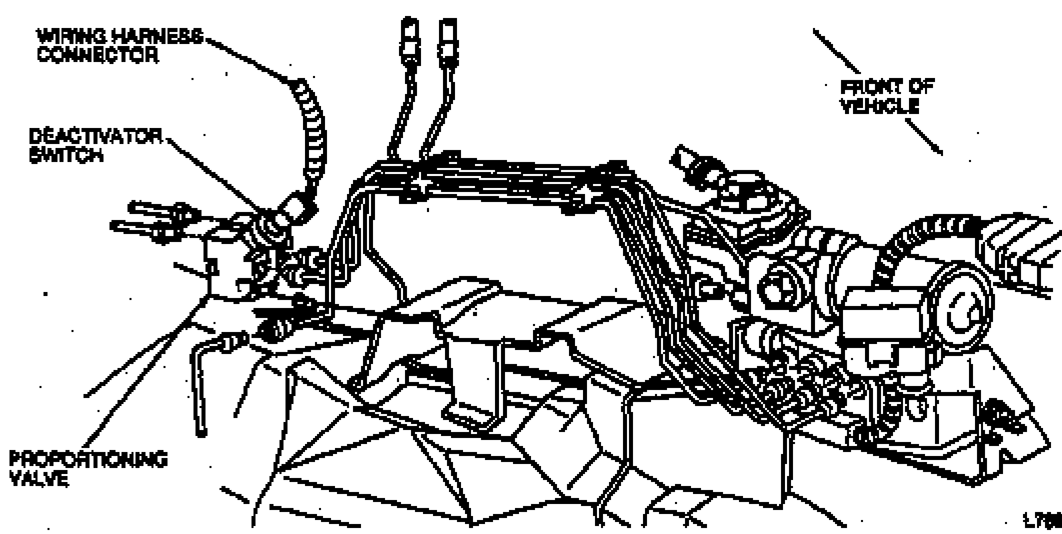
Removal

1. Remove electrical connector from switch.
2. Unscrew switch and remove from brake proportioning valve or junction block.

Installation

1. Screw switch into proportioning valve or junction block. Tighten to 15-20 N-m (12-14 lb-ft).
2. Attach electrical connector.
3. Bleed brake lines as outlined in Section 06-09 ABS brakes, or Section 06-06, non-ABS brakes.

Proportioning Valve Location



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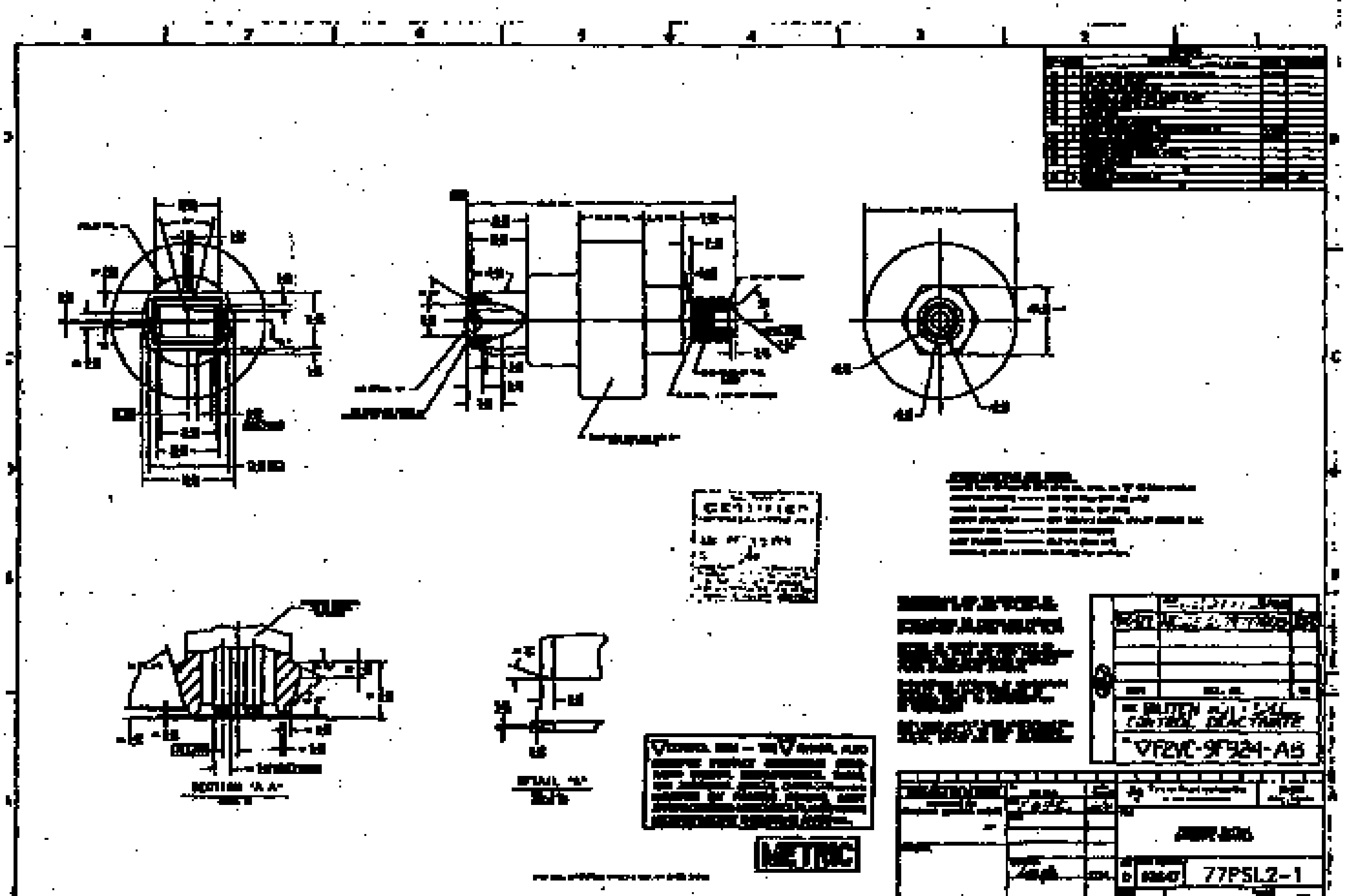


3713 7256

Engineering Specification

PART NAME	PART NUMBER
SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE	▽ ES-F2VC-9F924-AA

LET																		
FR																		
LET																		
FR																		

DATE	LET	FR	REVISIONS	DR	CK
			ADDED DATA TO COMPLETE		
			SPEC. & RETYPED		
901130			NCOLE10077779C02		[illegible]

REFERENCE

PREPARED/APPROVED BY
R.J. Pease 900910

CHECKED BY | DETAILED BY

CONCURRENCES/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR
K. Thomas 900910

ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL
[illegible]

PURCHASING

SUPPLIER QUALITY ASSISTANCE
[illegible]

ELECTRONICS DIVISION
[illegible]

▽ CONTROL ITEM — THE ▽ SYMBOL ALSO IDENTIFIES PRODUCT ENGINEERING DESIGNATED CRITICAL CHARACTERISTICS. THESE, AND ADDITIONAL CRITICAL CHARACTERISTICS IDENTIFIED BY PROCESS REVIEWS, MUST APPEAR ON THE Q-101 CONTROL PLAN(S) WHICH REQUIRE PRODUCT ENGINEERING APPROVAL.

FRAME 1 OF 18 | REV | ▽ ES-F2VC-9F924-AA

MAY 1986 PD 3947-a1 (Previous editions may NOT be used)

3713 7256

Engineering Specification

SWITCH ASSEMBLY - SPEED CONTROL, DEACTIVATE

I. General

This specification covers the test requirements for the speed control deactivate switch -9F924- used in the electronic speed control system. Design changes on the switch assembly or its components shall not be made without compliance to Section V of this specification and written approval from the releasing Production Engineering Office.

This engineering specification is a supplement to the released drawing on the above part, and all requirements herein must be met in addition to all other requirements of the part drawing. Minimum measures necessary for demonstrating compliance to these requirements are given in each section.

The engineering tests, sample sizes, and test frequencies contained within this engineering specification reflect the minimum requirements established to provide a regular evaluation of conformance to design intent. The engineering test program is intended as a supplement to normal material inspections, dimensional checking and in-process controls, and should in no way adversely influence other inspection operations.

Q1 suppliers may implement different test sample sizes and frequencies providing these changes have been included in an alternate Control Plan approved by the design responsible Product Engineering Office and concurred in by SQA.

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

- Production Validation (PV) Tests must be completed satisfactorily with parts from production tooling (and processes where possible) before ISIR approval and authorization for shipment of production parts can be effected. Parts must be revalidated completely, or per Section V whenever any change is made which could possibly affect part function or performance.

- In-Process Test Phase 1 (IP-1) - IP-1 tests are used to demonstrate process capability and must be completed using initial production parts from production tooling and processes prior to first production shipment approval. IP-1 tests are to continue in effect until process capability is demonstrated.

- In-Process Tests Phase 2 (IP-2) - IP-2 test program may be implemented only after process capability has been established. Tests must be completed with production parts on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as much as possible. In the event that any of the requirements in these tests is not met, the reaction plan specified in Ford Q101 Sect. 3.5, "Engineering Specification (ES) Test Performance Requirements" shall be invoked.

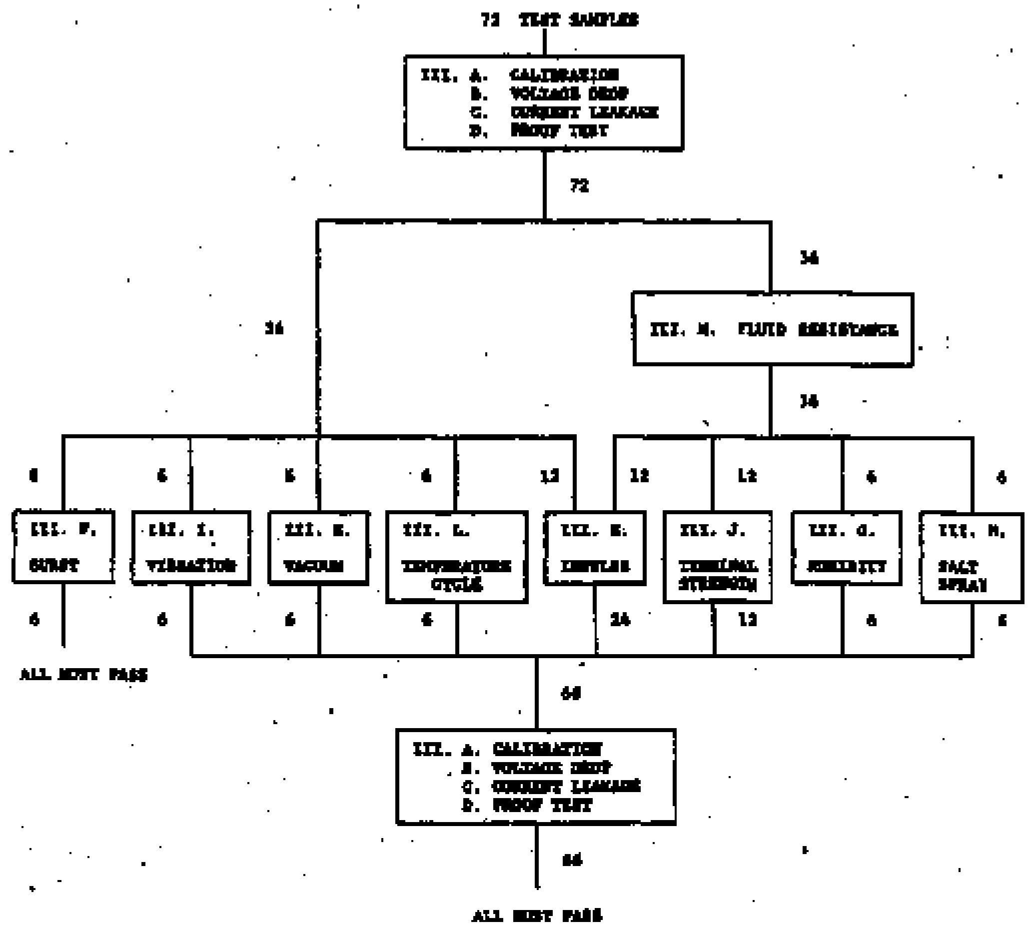
SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
M	Fluid Resistance	36	P90-.94	36/12Mo	P90-.94	36/12Mo.	P90-.94

Durability Tests

Item	Test Name	PV Minimum Sample Size	PV Criteria	IP-1 Minimum Sample Size	IP-1 Criteria	IP-2 Minimum Sample Size	IP-2 Criteria
III.							
E	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
G	Humidity	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
H	Salt Spray	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72

PRODUCTION VALIDATION FLOW CHART



III. TEST PROCEDURES AND REQUIREMENTS

▽ A. Calibration

1. Test Requirements

a. Switch calibration is to be checked at room temperature (16°C-35°C) using ambient air or equivalent.

b. Calibration settings shall be specified on the part drawing with the settings checked after 2 or more pressure cycles with ambient air, or equivalent. Pressure cycle range is to be determined by the manufacturer to insure switch calibration stability. The cut-in and differential set points are to be measured while conducting 750 ± 50 milliamperes while 13.0 ± 1.0 volts D.C. is applied. The cut-in point is to be checked with increasing pressure.

c. The cut-out point is to be checked with decreasing pressure, and the differential set point is to be calculated using the cut-in pressure minus the cut-out pressure.

2. Acceptance Requirements

a. Nonconformance is defined as any switch point which falls outside the tolerance band specified on the part drawing.

B. Voltage Drop

1. Test Requirements

a. Voltage drop is to be measured after 2 or more cycles with ambient air or equivalent from 0 to 10,000 ± 172 KPa (1450 ± 25 PSI) while conducting 750 ± 50 milliamps and 13.0 ± 1.0 volts D.C. is applied to the switch. Under these conditions with the switch closed the voltage drop is to be measured. Millivolt connection interface at terminals to be less than 10 millivolts.

2. Acceptance Requirements

a. Nonconformance is defined as a voltage drop in excess of 200 millivolts.

Engineering Specification

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

C. Current Leakage

1. Test Requirements

a. Current leakage is to be checked with 500 volts, 60 Hz alternating current.

b. Current leakage is to be checked:

(1) Between the switch leads with the contacts open.
(2) Between the lead and the switch housing with contacts closed.
(3) Between either lead and switch housing with the contacts open.

2. Acceptance Requirements

a. Nonconformance is defined as any leakage current in excess of one hundred (100) microamperes.

D. Proof Test

1. Test Requirements

a. Subject sample switches to Section A to establish their initial switching pressures.

b. Proof test is to be conducted using brake fluid or equivalent as the pressure medium. Test pressure shall be as specified on the part drawing. Test pressure shall be isolated from pressure source and held for not less than 30 seconds.

c. Recheck the switches to Section A.

2. Acceptance Requirements

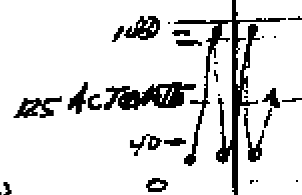
a. No evidence of fluid leakage, seepage, or drop in test pressure greater than 430 KPa.(62 PSI) is permitted.

b. A change in cut-in and cut-out pressures greater than ± 5% from the initial value is not permitted.

c. The test samples must be destroyed after testing.

Engineering Specification

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)



E. Impulse

1. Test Requirements

   a. Test the switch for a total of 500,000 cycles. Cycle pressure between (low) 0-276 KPa (0-40 psi) and (high) 10,000 ± 345 KPa (1450 ± 50 psi).

      1) 0 - 475,00 cycles: 13 ± 1 volts, trace current to monitor function.

      2) 475,001 - 500,000 cycles: 13 ± 1 volts D.C., 750 ± 50 ma., per figure 4.

   b. Brake fluid temperature to be 135 ± 14°C and ambient temperature to be 107°C min.

   c. Cycle rate is to be 110-130 cycles per minute.

   d. Switch must open and close each cycle.

2. Acceptance Requirements

   a. After impulse test check to sections A, B, C, & D using the procedure established in each section.

   b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, & D.

   c. Samples used for this test must be destroyed after all testing is completed.

F. Burst

1. Test Requirement

   a. Burst strength is to be checked using brake fluid or equivalent as the pressure medium.

   b. Pressurize the switch to 48.3 MPa (7000 PSI) minimum and hold for 30 seconds minimum.

2. Acceptance Requirements

   a. Nonconformance is defined as any evidence of fluid leakage or seepage from the switch or threads. Samples used for this test must be destroyed after testing is completed.

III. TEST PROCEDURES AND REQUIREMENTS (Cont'd)

G. Humidity

1. Test Requirements

   a. Mount the switch in the test port in a humidity chamber. Currently released mating electrical connector must be installed before start of test.

   b. Subject the switch to ten (10) continuous humidity cycles as follows:

      (1) Raise temperature to 65 +10/-2 °C over 2.5 hours; at 90-98% relative humidity.

      (2) Hold 3 hours at 65 +10/-2 °C at 90-98% relative humidity.

      (3) Lower temperature to 25 +10/-2 °C over 2.5 hours; at 80-98% relative humidity.

2. Acceptance Requirements

   a. Within 15 minutes after completion of the tenth humidity cycle check the switch to sections A, B, C, D, using the procedure established in each section.

   b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D.

H. Salt Spray

1. Test Requirements

   a. Mount the switch in the test port in a salt spray chamber. The currently released mating electrical connector and wiring must be installed prior to start of test.

   b. Expose the switch assembly to 72 hours of salt spray per ASTM B-117.

2. Acceptance Requirements

   a. After exposure, check the switch to sections A, B, C, D, using the procedure established in each section.

   b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Vibration

1. Test Requirements

a. Mount the switch in the test port and attach the currently released mating electrical connector before start of test.

b. Switches are to be vibrated in all 3 planes with electrical continuity being monitored during the entire test. See Figure 1 for switch orientation in the 3 planes. Vibration tests are to be conducted at room temperature using brake fluid, ambient air, or equivalent as the pressure medium.

c. Internal pressure shall be maintained at 0 KPa G. when the switch is in the closed position and 1.1 times max actuation pressure shown on print when the switch is in the open position.

d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

e. Vibrate the switch in alternate one-hour periods in the open and closed positions for a total of 8 hours in each plane. (Total test time is 24 hours).

2. Acceptance Requirements

a. After the entire vibration sequence check the switches to sections A, B, C, or D using the procedure established in each section.

b. Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

(1) Apply a 89 ± 9 N axial force to each terminal.

(2) With a pendulum apply a 45 ± 5 N impact force to the switch housing at the connector and, perpendicular to the centerline axis of the switch. See Figure 2 for force application point and direction.

2. Acceptance Requirements

a. Check the switch to sections A, B, C, and D using the procedures established in each section.

b. Nonconformance is defined as any terminal or housing fracture, or any switch not meeting the criteria in sections A, B, C, or D.

K. Vacuum

1. Test Requirements

a. Mount the switch in the test port. Vacuum tests are to be conducted at room temperature using ambient air as the pressure medium.

b. Subject the switch to 5 cycles of vacuum from atmospheric pressure (760 mm Hg) to an absolute pressure of 3-6 mm Hg. Maintain the vacuum for a minimum of 60 seconds.

2. Acceptance Requirements

a. Check the switch to sections A, B, C, and D using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, and D.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

L. Temperature Cycle

1. Test Requirements

a. Mount switches in test ports; test to be run using currently released brake fluid.

b. Repeat the following procedure 25 times.

(1) Lower the switch and fluid temperature to at least -40°C.

(2) Cycle the switches ten times at 10 seconds/cycles. One cycle consists of a pressure variation from 0 - 276 KPa.G (0-40 psi) to 10,000 ± 345 KPa.G (1450 ± 50 PSI).
Note: Switch must open and close each cycle.

(3) Raise switch and fluid temperature to 38°C minimum.

(4) Repeat Step 2.

c. At completion of Step b, check switches per sections A, B, C, and D.

2. Acceptance Requirements

a. Nonconformance is defined as any evidence of switch fluid leakage, seepage, or not meeting the criteria of sections A, B, C, and D.

M. Fluid Resistance

1. Test Requirements

a. Mount the switch in the test port and orient as installed in the vehicle.

b. Install the currently released mating electrical connector (with wire leads) to the switch.

c. Sequentially, immerse the switch into each of the specified fluids; at a temperature of 23 ± 2 °C, for 5 ± 1 second. Remove the switch and drain and store the switch for the specified time at room temperature, prior to immersing into the next fluid.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

Fluid	Drain Time	Storage Time
Reference Fuel C ASTM D471	60 ± 5 min.	none
10W40 Engine Oil	24 ± 1 hour	14 days
Ethylene Glycol/ Water 50/50 by Volume	24 ± 1 hour	24 ± 1 hour
Brake Fluid DOT 3	24 ± 1 hour	48 ± 1 hour
Automatic Transmission/ Power Steering Fluid (same) ESP-M2C138-CJ	24 ± 1 hour	14 days
Isopropyl Alcohol/ Water 50/50 by Volume	24 ± 1 hour	none
Reference Fuel C, ASTM D471 with Methyl Alcohol 85/15 by Volume	24 ± 1 hour	none

4. For the Flow Chart, subject the prescribed number of immersed switches to the post immersion tests specified below:

   III. E. Impulse
   III. G. Humidity
   III. H. Salt Spray
   III. J. Terminal Strength

Acceptance Requirements

a. Switches must fully meet the requirements of the specified post immersion test.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

IV. STATISTICAL ANALYSIS METHODS

A. For PV, IP-1 and IP-2 tests, all samples tested must pass. Having all the required sample size pass will provide data to support the conclusion that the switch has a minimum reliability R, at a given confidence of C. The notation Pc-R is interpreted as minimum reliability equal to R, at a confidence C; thus P90-.80 means a minimum reliability of 80% at 90% confidence.

B. All samples must pass in the statistical test acceptance criteria stated for tests with 100% frequency; or samples from lots, which could have a variable size.

V. REVALIDATION REQUIREMENTS

A. No change in design, material, process or component supplier shall be made without prior approval from the releasing Product Engineering Office. As part of approving a change, the releasing Product Engineering Office will establish the portion of the Product Validation tests required to be run to revalidate the switch. The following table is to be used as a guide in determining the type of tests required for revalidation requirements.

RUNNING CHANGE REVALIDATION

Component	Process or Material Change or New Supplier
1. Terminals, Contacts, or Connector	III, B, C, E, G, H, I, J, L, M.
2. Case or Housing	All Tests
3. Disc or Diaphragm	III, A, D, E, F, I, K, L.
4. Fitting or Fluid Connection	III, D, E, F, H, I, M.

5. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

A lot is defined as no more than eight (8) hours of production up to 4,000 pieces. If shifts extend beyond eight (8) hours, or more than 4,000 pieces are produced in a shift, the product must be separated into at least two lots.

VII. RECORD RETENTION

A. Recording and record retention shall conform with Ford Q-101.

B. Production Validation test results and analysis are to be forwarded to the releasing Product Engineering Office before approval for shipment of production parts can be granted.

C. In-Process test results shall be available at the supplier's manufacturing facility for the releasing Product Engineering Office and Ford SQA or its representatives to review on request.

VIII. INSTRUCTIONS AND NOTES

All switches are to be identified with the Ford part number, supplier identification, and a date code indicating final assembly.

All test equipment and test procedures for testing to this specification must be approved by the releasing Product Engineering Office and no change in equipment or procedure may be made without their written concurrence.

Test port configuration is shown in Figure 3.

O-rings, if used in the design, shall be free from cuts, nicks, abrasions or any other damage which would result in a fluid leak.

All switches must have a shipping cap installed over the port threads to prevent contamination. All shipping caps must be approved by the releasing Product Engineering Office prior to production incorporation.

All switches that do not pass the calibration test are to either be readjusted and rechecked, or scrapped. (Salvage of component parts permitted with 100% reinspection).

If product nonconformance occurs for test Sections III. B, C, D, E, F, and J, production shall be stopped and the problems corrected. All production lots shall be sorted 100% prior to shipment. Suspected nonconformance of any shipped parts shall be reported immediately to the releasing Product Engineering Office.

If nonconformance of the statistical acceptance criteria occurs for test Sections III. G, H, I, K, L and M, a cause to recall the subject weeks production and to stop production may result.

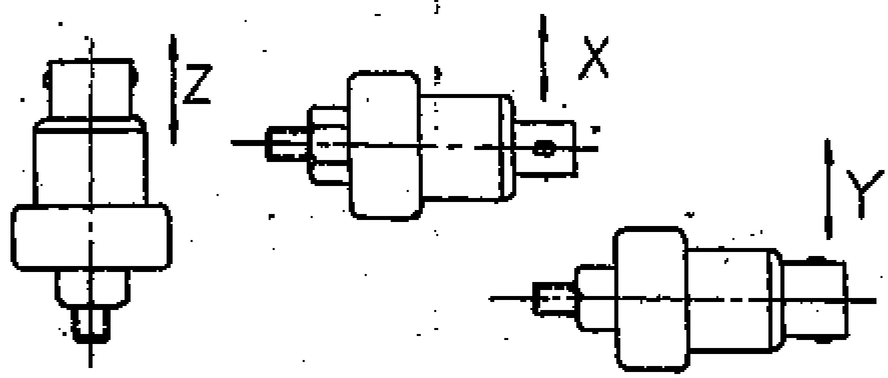
IX. <u>COMPILATION OF REFERENCE DOCUMENTS</u>

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1990 Edition

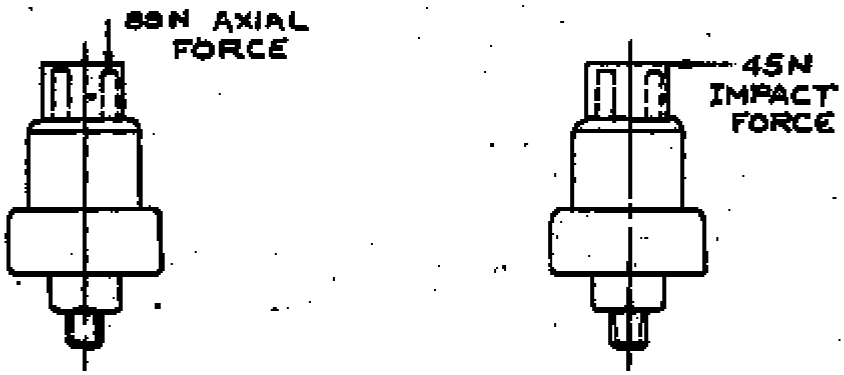
ES-FOEB-14A464-AA, Specification - SLV Assy - Wire Connector

ES-F1VF-9C735-AA, Specification - Servo Assembly Speed Control



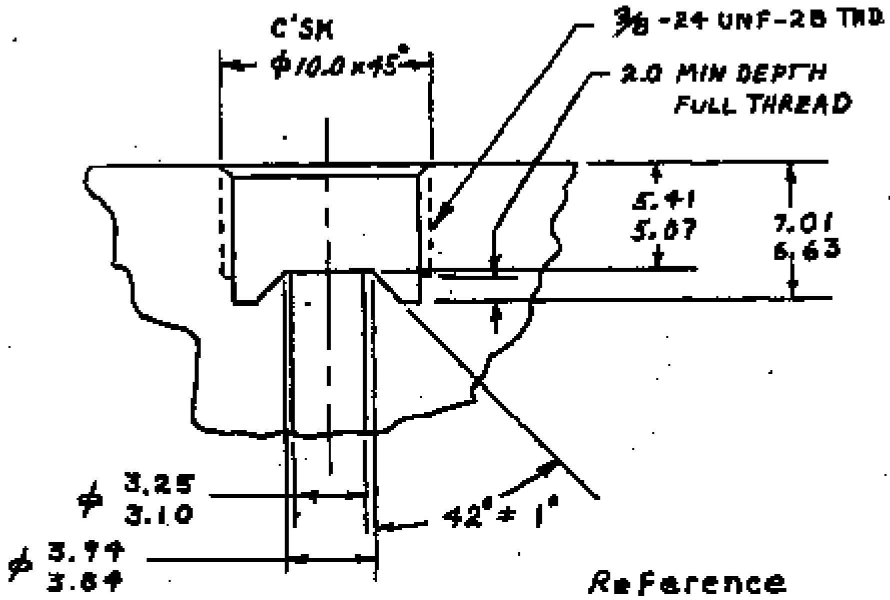
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



TERMINAL STRENGTH LOAD ORIENTATION

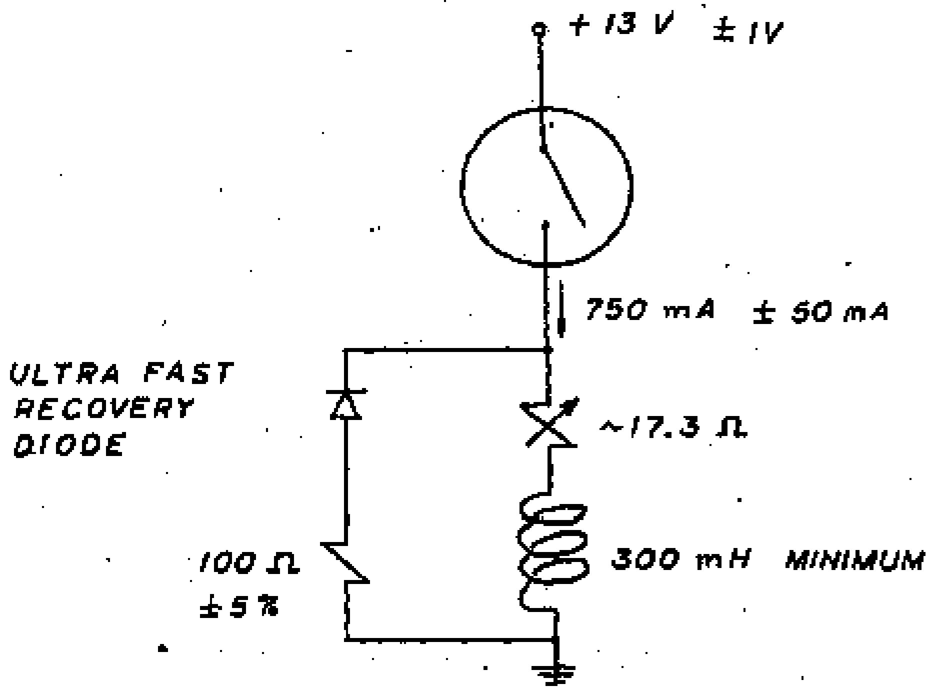
FIGURE 2.



Reference
SAE J512 OCT 80
Figure 5A

TEST FIXTURE PORT CONFIGURATION

FIGURE 3



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

Lubricant Specifications

ITEM	FORD PART NO.	PART NAME	FORD SPECIFICATION
Hinges, Checks and Pivots	[illegible]	Multi-Purpose Grease	[illegible]
Brake Master Cylinder	[illegible]	Ford Heavy Duty Brake Fluid	[illegible]
Front Suspension, Ball Joints and Steering Linkage	XG-1-C	Long Life Grease	[illegible]
Hood Latch and Auxiliary Catch	[illegible]	Multi-Purpose Grease Spray	[illegible]
Lock Cylinder	[illegible]	Ford Lock Lubricant	[illegible]
Door Weatherstrips	[illegible]	Silicone Lube	[illegible]
Rear Axle Conventional and Traction-Lok (1)	[illegible] or [illegible]	Premium Rear Axle Lubricant	[illegible]
Power Steering (Pump Reservoir)	[illegible]	Motorcraft Auto. Trans. Fluid — Type F	[illegible]
Automatic Overdrive Transmission (AOD)	[illegible]	Motorcraft MERCON® Auto. Trans. Fluid	MERCON®
Throttle Valve (TV) Linkage or Kickdown Linkage	XG-1-C	Long Life Grease	[illegible]
Engine Oil Filter 4.6L Engine	[illegible]	Motorcraft Oil Filter Long Life Type	[illegible]
Engine Oil — Gasoline Engines	[illegible] / [illegible]	Motorcraft Motor Oil: [illegible] Super Premium / [illegible] Premium	[illegible] and API [illegible]
Engine Coolant	[illegible]	Ford Cooling System Fluid	[illegible]

(1) For Traction-Lok Axle Add 4 oz. of [illegible] Friction Modifier for complete refill of rear axle.

Maintenance Schedule and Record Log

Maximum Oil Change Interval. . .
Schedule A: 3 months or 3,000 miles (4 800 km).
Schedule B: 6 months or 7,500 miles (12 000 km) whichever occurs first. See appropriate Schedule.

PO[illegible]IAL
FAILURE MODE A[illegible]FFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503788
Revision Level C
Revision Date 4-Nov-96

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
BASE [PS] (48515) Provides a system of slots which guide, locate, and physically support terminals.	Fails to properly locate terminals.	Terminals out of position.	5		Incorrect dimensions and/or tolerances specified between slots and terminals. Inadequate staking design concept.	1	Comparison with dimensions of similar 57PS product.	1	5							
	Fails to properly guide the terminals difficult insertion.	Device will not assemble properly; yield loss in mfg.	5		Incorrect dimensions and/or tolerances specified between slots and terminals. Insufficient lead-in.	1	Review with assembly equipment designers to determine correct clearances and lead in.	1	5							
	Fails to properly support the terminals.	Terminals move relative to each other or the base (such as under physical or thermal loadings).	5		Incorrect material specified. Excessively large dimensions specified on terminal slots.	1	Comparison with design of similar 57PS product.	1	5							
Provides features to enhance the effectiveness of terminal staking.	Terminal staking is insufficient.	Loose terminals. Shift/fluctuation in switch setpoints.	5		Incomplete understanding of design of staking features.	1	Comparison with design of similar 57PS product. Staking evaluations.	1	5							
Provides a dielectric medium for the electrical elements.	Current leakage between terminals or terminal-to-housing.	Improper switching action.	5		Low insulation resistance. Incorrect material specified.	1	Comparison with design of similar 57PS product. Material evaluation.	1	5							

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

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___ System
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X Component Pressure Switch

Design Responsibility Pressure Switch Group

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Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
BASE (PS) (46515) Provides physical isolation of the switch components.	Fails to physically isolate ingress of matter from external environment.	High current leakage. High millivolt drop. Erratic or inoperative switch action.	5		Incorrect material specified. Poor molded part design i.e. wall sections too thin, etc.	1	Comparison with design of similar 67PS product. Design review with molder. Mold flow analysis.	1	5							
Provides a reference surface which locates the electrical elements relative to the pressure sensor.	Fails to properly locate the switch elements relative to the pressure sensor.	Shift in setpoints. Erratic or inoperative switch.	5		Warpage of the reference surface. Intrusion of other design elements into the plane of the reference surface. Excessive clearance specified between mating features.	1	Specification of flatness on print. Raise this surface to prevent intrusion of other elements. Tolerances stackup analysis.	1	5							
Provides a flange to compress the internal environmental seal.	Improper compression of internal environmental seal.	Inadequate compression may lead to ingress of matter. Excessive compression may prevent switch from seating correctly to sensor assembly.	7		Incorrect seal gland design. Warpage.	1	Review of standard gland design practice. Comparison to similar products. Flatness specified on print.	1	7							

3713 7277

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1996

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
BASE [PS] [46515] Provides interference tabs to locate and temporarily hold the base in relation to the crimp ring prior to crimp.	Fails to properly locate/hold prior to crimp.	Too large may cause difficulty in assembly, base cracking, or prevent switch from seating to sensor. Too small provides no effect; possibly affecting subsequent assembly operations.	5		Design of interference tabs is insufficient.	1	Calculation and experimentation to determine limits of size. Tolerance stackup analysis.	1	5							
Provides a flange surface for the crimp ring.	Fails to provide adequate geometry for crimp ring.	Base loose or insufficient torque withstand. Base cracked.	7		Incorrect design of flange for crimp ring.	1	Comparison with design of similar 67PS product.	1	7							
Provides lock tabs, keys, and features which mate to electrical connector.	Mating electrical connector doesn't fit properly.	Connector difficult to install. Connector falls off.	6		Connector geometry improperly specified.	1	Review of dimensions relative to mating connector prints.	1	6							
Provides compression to environmental seal in connector.	Mating connector seal is not properly compressed.	Ingress of matter into switch cavity. Connector difficult to install and/or falls off.	7		Connector geometry and/or surface condition/flatness is improperly specified. Incorrect material specified.	1	Review of dimensions relative to mating connector prints. Material evaluation.	1	7							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number [illegible]
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Revision Date [illegible]

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 28-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
STATIONARY TERMINAL ([illegible] & 35725) Provides a brass blade for interconnection.	Poor interconnection.	Device appears open-circuit after mating connector installed.	7		Contamination of brass blade. Material specified too thin.	1	Review design and dimensions of mating connector to assure proper interference and wiping action.	1	7							
	Blade geometry improper.	Difficult to install mating connector.	5		Lead-in chamfers on terminal are insufficiently specified. Material specified too thick.	1	Review design and dimensions of mating connector. Comparison with design of similar 57PS product.	1	5							
Provides a silver inlay surface for electrical contact	Fails to provide adequate electrical contact.	Device appears open-circuited. Intermittent continuity. High millivolt drop.	7		Incorrect contact material specified. Contamination. Silver layer specified too thin.	1	Review of TI proprietary and general contact design info. Eliminate paths for ingress of contamination.	1	7							
	Excessive loss of contact height dimension (mechanical loads).	Shift in set points over life.	7		Silver layer specified too thick.	1	Review of TI proprietary and general contact design info. Life Testing.	1	7							
	Erosion of contacts due to electrical loads.	Shift in setpoints over life. Intermittent or no continuity.	7		Incorrect material specified for particular electrical loading.	1	Review of TI proprietary and general contact design info. Review and testing with actual electrical loads.	1	7							

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FAILURE MODE A FFECTS ANALYSIS
(DESIGN FMEA)

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___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
STATIONARY TERMINAL (30864 & 30765) Provides feature for device calibration.	Poor calibration	Mfg. yield loss Shift in setpoints over life.	5		Design is excessively stiff. Design has excessive spring back. Material hardness is incorrectly specified. Initial position requires excess deformation to calibrate. Design has inadequate strength to maintain calibration over life.	1	Mechanical (and/or FEA) analysis Force deflection springback testing Testing with actual production calibration equipment.	1	5							
Provides features to ensure adequate staking into base.	Terminal is inadequately staked into base.	Loose terminals. Shift/fluctuation in switch setpoints.	7		Incomplete understanding of design of staking features.	1	Comparison of design with similar 57PS product. Staking evaluations.	1	7							
Provides features which mate with slots in base for location of terminal.	Fails to properly locate terminal.	Terminals out of position.	5		Incorrect dimensions and/or tolerances specified between slots and terminals. Inadequate staking design concept.	3	Comparison of design with similar 57PS product.	1	8							
Provides electrical path from silver alloy contact to mating connector.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	6		Incorrect material specified. Inadequate cross-section area.	1	Calculations of resistance Testing	1	5							

3713 7280

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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Page 1

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By G. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
MOVABLE TERMINAL (26867) Provides a brass blade for interconnection.	Poor interconnection.	Device appears open-circuit when mating connector installed.	7		Material specified too thin.	1	Review design and dimensions of mating connector to ensure proper interference and wiping action.	1	7							
	Blade geometry improper.	Difficult to install mating connector.	5		Lead-in chamfers on terminal are insufficiently specified. Material specified too thick.	1	Review design and dimensions of mating connector. Comparison with design of similar 57PS product.	1	5							
Provides a mounting point for the spring via rivet.	Fails to allow proper spring/rivet installation.	Shift/fluctuation in switch setpoints (loose rivet). Inoperative device (rivet falls out completely). Mfg. yield loss.	7		Rivet hole size is specified incorrectly. Rivet hole position is specified incorrectly. Support surface for spring is incorrectly specified. Choice of fastener style incorrect.	1	Comparison with design of similar products. Check with recommendations of rivet manufacturer. Testing.	1	7							
Provides features to ensure adequate staking into base.	Terminal is inadequately staked into base.	Loose terminals. Shift/fluctuation in switch setpoints.	7		Incomplete understanding of design of staking features.	1	Comparison of design with similar 57PS product. Staking evaluations.	1	7							

3713 7281

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1996

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item, Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
MOVABLE TERMINAL (36867) Provides features which mate with slots in base for location of terminal.	Fails to properly locate terminal.	Terminals out of position.	3		Incorrect dimensions and/or tolerances specified between slots and terminals. Inadequate staking design concept.	3	Comparison of design with similar 57PS product.	1	9							
Provides electrical path from movable contact via spring to mating connector.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified. Inadequate cross-section area.	1	Calculations of resistance Testing	1	5							

3713 7292

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
SPRING (26881) Provides contact force.	Low contact force	High millivolt drop across contacts.	5		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing.	1	15							
	High contact force.	Shift in setpoints. Disc cracking over life.	7		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing.	1	21							
Provides electrical path from movable contact to movable terminal.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified. Inadequate cross-section area.	1	Calculations of resistance using R = (Rho)(L) / A Testing	1	5							
Provides feature to interface with transfer pin.	Fails to interface correctly with transfer pin.	Spring failure over life. Shift in setpoints over life. Sticking transfer pin causes intermittent operation.	7		Inadequate height of feature specified. Inadequate shape of feature specified. Improper position of feature specified.	1	Comparison of design with similar product. Dimension and tolerance stackup analysis. Actual measurement. Testing	1	7							
Provides feature for attachment to movable contact.	Fails to provide adequate mounting for movable contact.	Intermittent or erratic operation Open circuit.	6		Hole size/position incorrectly specified. Flatness inadequate.	1	Rivet mfg. recommendations. Comparison of design with similar product. Testing.	1	6							
Locates movable contact.	Fails to adequately locate movable contact relative to stationary contact.	High millivolt drop over life. Excessive contact erosion over life.	7		Spring geometry incorrectly specified.	1	Dimension and tolerance stackup analysis. Testing	1	7							

3719 7283

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1999

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
SPRING (56680) Provides feature for attachment to movable terminal.	Fails to properly attach to movable terminal.	Erratic or intermittent operation. Shift in setpoints. Open or short circuit.	9		Rivet hole size or position incorrectly specified. Flatness inadequate. Choice of fastener style incorrect.	1	Rivet mfg. recommendations. Comparison of design with similar product. Testing.	1	[illegible]							
Allows disc overtravel.	Fails to allow disc overtravel.	Shift in setpoints. Disc cracking. Device inoperative at assembly. Poor calibration.	5		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing.	1	15							
Provides force to open contacts.	Inadequate force to open contacts	Insufficient resistance to mechanical vibration. Short circuit.	6		Incorrect geometry specified. Incorrect material specified.	1	Beam deflection equations. Force/deflection testing.	1	[illegible]							
	Excessive force to open contacts.	Shift in setpoints. Disc cracking. Device inoperative at assembly. Poor calibration.	7		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing.	1	21							

3719 7284

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

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___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

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Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
GASKET (74383) Provides fluid seal between hexport and diaphragm.	Fails to provide adequate fluid seal.	Brake fluid leakage.	9		Insufficient compression specified. Very excessive compression specified, leading to displacement from gland. Incorrect ID and/or OD leading to displacement from gland. Incorrect cross-section shape specified. Incorrect material specified; fluid incompatibility. Incorrect design of sealing mechanism.	1	Review of general seal design principles. Manufacturer's recommendations. Burst, impulse, and thermal cycle tests. Comparison with design of similar products.	1	9							

3713 7285

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503065
Revision Level C
Revision Date 4-Nov-96

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
CUP (27715 OR 27286) Provides crimpable area which holds pressure sensor together.	Fails to provide a suitable geometry for crimp.	Leakage Low burst	6		Crimp wall thickness incorrectly specified. Crimp wall height incorrectly specified. Incorrect material specified.	1	Burst and impulse testing. Comparison of design with similar product.	1	6							
Locates heatport, diaphragm, and washer.	Fails to correctly locate heatport, diaphragm, or washer.	Difficult assembly.	5		I.D. specified incorrectly.	1	Tolerance stackup analysis.	1	5							
Provides support and location for disc.	Fails to support and locate the disc/converter correctly.	Shift in setpoints. Erratic operation. Stuck open at assembly. Reduced disc life.	7		Incorrect disc envelope specified. Bump true-position incorrectly specified. Poor surface condition of bump, no control specified.	1	Tolerance stackup analysis. Impulse testing.	1	7							
Provides guide for transfer pin.	Fails to guide transfer pin correctly.	Erratic operation. Device stuck short-circuit.	7		Pin guide geometry is incorrectly specified.	1	Tolerance stackup analysis.	1	7							
Provides portion of environmental seal gland.	Fails to allow a proper environmental seal.	Ingress of matter. Switch does not seal correctly to cup.	7		Surface condition required for good seal not understood or not correctly specified. Geometry incorrectly specified.	1	Environmental testing. Switch cavity pressurization testing. Review of standard gland design rules.	1	7							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 199[illegible]

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
CUP (27713 OR [illegible]) Provides surface to interface with base/switch assembly.	Fails to properly locate relative to switch.	Shift in setpoints. Erratic or inoperative switch.	5		Incorrect geometry of mating surface specified.	1	Tolerance stackup analysis. Cross-section actual devices for inspection of interface.	1	5							
(Post-sensor-crimp) provides geometry for final assembly with crimp ring.	Fails to allow proper final assembly with crimp ring.	Erratic operation. Ingress of matter. Cracked base.	7		Post-crimp geometry is not controlled per design intent. Cup diameter incorrectly specified.	1	Tolerance stackup analysis. Base torque testing.	1	7							

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POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503796
Revision Level D
Revision Date 4-Nov-98

Original (initial) Date 20-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
DIAPHRAGM (OR SEAL) [BFI] (74176) Forms flexible element of fluid containment cavity.	Fails to contain fluid.	Fluid leakage.	9		Gradual rupture over life due to improper design of supporting elements. Gradual rupture over life due to excessive pressure/displacement. Gradual rupture over life due to stress concentrations caused by asymmetric strain distributions. Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm material. Insufficient location/clamping of diaphragm.	1	Burst, impulse, and thermal cycle tests. Material mfg. recommendation. Comparison of design with similar products.	1	9							
Transfers pressure from fluid to pressure-sensing elements.	Change in area of pressure transfer over life.	Shift in setpoints over life.	5		Diaphragm too stiff. Incorrect material specified.	1	Life testing w/ characteristics at intermediate points.	1	5							
	Excessive change of pressure transfer area versus pressure.	Excessively high pressures needed to adequately form pressure transfer area; wide sigma on setpoints due to unpredictability at lower pressures.	9		Diaphragm too stiff. Incorrect material specified.	1	Force and pressure versus deflection testing to calculate effective areas.	1	9							

3713 7286

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503797
Revision Level C
Revision Date 4-Nov-98

Original (Initial) Date 20-Dec-93

Prepared By C. Wagner

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
WASHER (PS) (37936) Provides a portion of the support surface for diaphragm.	Fails to correctly support the diaphragm.	Reduced diaphragm life results in leakage.	6		Contours of diaphragm support surface are specified incorrectly. Condition of edges of support surface specified incorrectly. Clearance between washer I.D. and converter bump is specified too wide.	1	Burst, Impulse, and Thermal Cycle tests. Comparison of design with similar products.	1	6							
Provides support for compression of gasket.	Fails to allow proper gasket compression.	Leakage.	6		Washer flatness is incorrectly specified or unspecified. Washer thickness is specified too small. Washer material and/or heat-treat is in-correctly specified.	1	Burst, Impulse, and Thermal Cycle tests. Comparison of design with similar products.	1	6							
Locates and guides converter with respect to cup.	Converter is not properly located relative to cup.	Shift in setpoints. Erratic behavior.	5		Incorrectly specified button guide I.D. Incorrectly specified washer O.D.	1	Comparison of design with similar products. Tolerance stackup analysis.	1	5							
	Converter travel is restrained by washer.	Disc cannot release; device is stuck open-circuit.	7		Washer flatness is incorrectly specified or unspecified. Washer thickness is specified too small. Washer material and/or heat-treat is incorrectly specified. I.D. of button guide is too small.	1	Burst, Impulse, and Thermal Cycle tests. Comparison of design with similar products. Tolerance stackup analysis.	1	7							

3713 7289

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 003797
Revision Level C
Revision Date 4-Nov-96

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-91

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
WASHER [F8] (27696) Interfaces with cup feature and provides a portion of component stack for crimp.	Fails to interface correctly with cup.	Difficult assembly (washer O.D. too large). Poor washer/contactor location relative to cup (washer O.D. too small).	7		Washer O.D. specified incorrectly.	1	Comparison of design with similar products. Tolerance stackup analysis.	1	7							
	Fails to allow proper crimp.	Reduced burst capability leads to leakage. Reduced fatigue resistance leads to leakage.	8		Thickness incorrectly specified. O.D. incorrectly specified. Edge condition incorrectly or unspecified.	1	Tolerance stackup analysis. Burst, Impulse, and Thermal Cycle tests.	1	8							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503796
Revision Level E
Revision Date 13-May-96
Original (Initial) Date 20-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1996

Prepared By DJ Ha

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
CONVERTER (PS) (37408)																
Transfers pressure from fluid (via diaphragm) to a force on pressure-sensing disc.	Fails to correctly transfer fluid pressure to force on disc.	Shift in setpoints	5		Button O.D. incorrectly specified relative to washer I.D.	1	Tolerance stackup analysis.	1	5							
					Converter major O.D. incorrectly specified relative to cup I.D.		Force/deflection analysis to determine strength and resistance to plastic deformation.									
					Converter thickness incorrectly specified.		Burst, Impulse, and Thermal cycle tests.									
					Incorrect material specified.											
Provides alignment and support to disc.	Fails to properly align and support disc.	Loose tolerances allow misalignment which may cause shift in setpoints or erratic operation.	5		Button O.D. incorrectly specified relative to washer I.D.	1	Tolerance stackup analysis.	1	5							
		Disc-out-of-place relative to converter may cause erratic operation or inoperative device, stuck open-circuit.			Converter major O.D. incorrectly specified relative to cup I.D.		Comparison of design with similar product.									
					Disc support bump incorrectly specified. Disc retaining wall incorrectly specified.											

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FAILURE MODE [illegible] EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503798
Revision Level E
Revision Date 13-May-98
Original (Initial) Date 20-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By DJ Ha

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
CONVERTER (P3) (27408) Provides a portion of the support surface for diaphragm.	Fails to properly support diaphragm.	Reduced diaphragm life results in leakage.	5		Contours of surface in contact with diaphragm are specified incorrectly. Condition of edges in contact with diaphragm are specified incorrectly. Clearance between converter bump and washer I.D. are specified too wide.	1	Burst, Impulse, and Thermal cycle tests. Comparison of design with similar product.	1	5							
Provides disc support during over pressure (proofburst).	Fails to properly support disc during over pressure.	Disc deformation results in shift in setpoints. Reduced disc travel if disc motion is restricted prematurely. Reduced disc life.	6		Features which control disc motion during over pressure are incorrectly specified.	3	Pre-and post-proof characterization. Pressure-deflection measurements of disc motion.	1	18							
Vent in converter prevents pressure buildup from affecting setpoints.	Does not vent properly.	Shift in setpoints over temp. Reduced disc snap.	5		Vent hole incorrectly specified.	1	Comparison of design with similar product. Temperature characterizations.	1	5							

3713 7292

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 803780
Revision Level C
Revision Date 4-Nov-96

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
SPACER (72850) Reduce friction between disc and convector	Fails to effectively reduce friction.	Shift in setpoints over life. Reduced disc life.	5		Incorrect material specified. Incorrect dimensions specified.	1	Impulse and Thermal Cycle tests. Pre- and Post-life characterizations. Tolerance stackup analysis.	1	5							
Allow venting of chamber formed by disc and convector.	Fails to allow venting.	Shift in setpoints over temp. Reduced disc action.	5		Vent hole incorrectly specified.	1	Comparison of design with similar product. Temperature characterization.	1	5							

P[illegible]TIAL FAILURE MODE [illegible] EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503600
Revision Level C
Revision Date 4-Nov-95
Original (Initial) Date 29-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
DISC ([illegible]) Controls actuation and release set-points of switch relative to applied force.	Fails to actuate and/or release at the proper points at assembly.	Mfg. yield loss.	5		Disc material improperly specified. Dimensions and tolerances improperly specified.	1	Characterization experiments. Comparison of design with similar product.	1	5							
Key component in defining usable service life of device.	Disc actuation and/or release setpoints change excessively over life.	Shift in device setpoints over life.	5		Disc material improperly specified. Disc heat-treat improperly specified. Material thickness improperly specified. Excessive force applied by spring.	1	Impulse testing. Pre- and post-characterizations.	1	5							
	Service life shorter than customer requirements.	Drastic shift in setpoints over life. Device inoperative - open circuit.	7		Disc material improperly specified. Disc heat-treat-improperly specified. Material thickness improperly specified. Excessive force applied by spring.	1	Impulse testing. Pre- and post-characterizations.	1	7							

3713 7284

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 509801
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Revision Date 4-Nov-96
Original (Initial) Date 20-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
CRIMP RING (74787) Hold together base assembly and sensor assembly.	Fails to hold base to sensor correctly.	Erratic switch operation. Cracked base. Shift in setpoints. Low base torque withstand.	5		Incorrect geometry of crimpable area specified. Incorrect geometry of formed refill. Incorrect material specified.	3	Impulse, thermal cycle, base torque, and base/terminal impact tests.	1	15							
Provide a surface for part identification/date code.	ID characters illegible.	Improperly identified parts at assembly plant.	2		Geometry/flatness not properly specified. Wrong material specified.	1	Coding tests. Environmental tests.	1	2							
Impart environmental protection and aesthetics to device.	Inability to withstand environment.	Corrosion causes material consumption, loss of mechanical properties, switch eventually falls off sensor. Illegible coding.	7		Wrong material specified.	1	Environmental tests.	1	7							
Provide lubrication to crimp dies via wax coating.	Insufficient lubrication.	Metal flakes/particles on external device surfaces.	6		Incorrect or insufficient wax specified.	1	Crimping tests.	1	6							

3713 7295

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Page 1

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Document Number 505802
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Revision Date 4-Nov-95

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Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
TRANSFER PIN (74078) Transfers disc motion to movable electrical contact.	Fails to properly transfer disc motion.	Contacts stuck open. Contacts stuck closed. Erratic operation.	7		Diameter incorrectly specified. Chips/fragments cause pin to lodge.	1	Tolerance stackup between pin and pin guide in cap. Check with supplier for material properties regarding chips.	1	7							
Insulates electrical components from switch housing.	Fails to insulate.	Continuity between movable terminal and housing to ground.	5		Wrong material specified.	1	Check with supplier for material properties. Check with customer for electrical logic of movable terminal.	1	5							

3713 7296

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503803
Revision Level C
Revision Date 4-Nov-98
Original (initial) Date 22-Dec-93

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1995

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
ENVIRONMENTAL SEAL (74267) Prevents ingress of matter to switch cavity.	Contaminants enter switch cavity.	High current leakage High millivolt drop. Erratic or inoperative switch operation.	7		Gasket thickness is specified too small. Limits on porosity not specified. Incorrect material.	1	Review of standard practice for gland design. Review with gasket manufacturer. Comparison of design with similar product.	1	7							
Provides friction to aid in preventing base rotation.	Base rotates too easily.	Perceived as inadequate by assembly plant and/or service personnel.	5		Gasket thickness improperly specified.	1	Review of standard practice for gland design. Torque-to-rotate testing. Comparison of design with similar product.	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503604
Revision Level C
Revision Date 4-Nov-96

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
THREAD CAP ([illegible]) Protects Import threads from damage during shipping and transit.	Incorrect length.	Does not protect threads sufficiently.	8		Length incorrectly specified.	1	Dimensional stackup study.	1	8							
Prevents dust from entering the fluid cavity.	Loose Cap.	Allows dust to enter fluid cavity.	4		Incorrect diameter specified.	1	Dimensional analysis.	1	4							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number [illegible]
Revision Level C
Revision Date 30-Oct-98
Original (w/fist) Date 20-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
HEXPORT (38808) Provides a hydraulic sealing surface per SAE J512.	Fails to seal.	Leakage of brake fluid.	9	FF	Incorrect surface finish specification. Incorrect material specification. Incorrectly specified geometry. Excessive pressure.	1	Cross-check of print dimensions vs. SAE standard. Comprehensive evaluation of design at tolerance limits. Burst testing to customer-specified limits.	1	9							
Provides external thread for installation into mating port.	Fails to properly install in mating port.	Damages threads in mating port during installation. Does not allow installation.	7	FF	Threads specified improperly. Threads not gauged per ANSI spec's. Plating buildup.	3	Cross-check of applicable SAE and ANSI standards.	3	[illegible]							
	Apparently installs, but fails to properly seat and seal.	Brake fluid leakage.	9	FF	Threads specified improperly. Threads not gauge per ANSI spec's. Plating buildup.	1	Cross-check of applicable SAE and ANSI standards.	3	27							
Provides hex feature for 9/16" wrench.	Incorrect hex size.	Damage to hex flats during wrenching. 9/16" wrench does not fit.	5		Hex features improperly specified per established SAE/ANSI spec's.	1	Cross-check of applicable SAE and ANSI standards.	1	6							
Provides fluid passage to pressure-sensing elements.	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp.	7	FF	Inadequate size of fluid passage specified.	1	Review of Ford standard practices.	1	7							
		Subject to blockage by foreign matter.			Inadequate review of Ford standard practices.		Review of industry practices.									
	Fluid passage is too large.	Resulting thin wall section causes breakage: during installation during underhood service operations	7	FF	Fluid passage specified excessively large.	1	Torque testing.	1	7							

3719 7289

P TIAL
FAILURE MODE A... EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503805
Revision Level C
Revision Date 30-Oct-98
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___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1999

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
HEXPORT (30900) Provides gland for internal gasket.	Fails to seal internal gasket properly.	Leakage of brake fluid.	9		Gland dimensions improperly specified. Surface finishes improperly specified. Gland geometry improperly designed.	1	Cross-check with recommendations of gasket supplier. Comprehensive testing.	1	9							
Provides flange which interfaces with other components to form pressure-sensor structure.	Flange fails to mate properly with other components of pressure sensor.	Dia. too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor crimp. Flange too thin results in reduced burst capacity. Improper edge chamfer results in stress concentration which weakens crimp.	9		Improper or incomplete specification of dimensions and tolerances.	1	Experiments and analysis to determine proper thickness for required strength. Tolerance stack-up analysis. Print review.	1	9							
	Material too soft or weak.	Inadequate burst capacity. Damage/breakage during installation or subsequent service. Threads prone to damage, leads to assembly difficulties.	9		Improper material selection.	1	Comprehensive evaluation of physical properties.	1	9							
	Material creeps.	Loosening of crimp leads to leakage.	9		Improper material selection.	1	Review of material properties.	1	9							
	Material degrades in presence of working fluid(s).	Leakage	9		Improper material selection.	1	Cross-check with similar products.	1	9							
	Insufficient environmental protection.	Long-term attack causes weakening of key areas which leads to leakage or breakage.	9		Improper or insufficient plating specification.	1	Comprehensive environmental testing.	3	27							

3719 7300

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503605
Revision Level C
Revision Date 20-Oct-95
Original (initial) Date 20-Dec-93

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
HEXPORT (50000) Provides flange which interfaces with other components to form pressure-barrier structure.		Cosmetic problems.	9			1	Review of plating practices.	3	27							

3713 7301

[illegible] Number: [illegible]
[illegible]
Revision date: 1/?/97 JP
Prepared by: A. Arora/G. [illegible]

Part/Component: Movable Contact
Part No. / Revision: 20744 / D, 20479-1 / B
Process Flow: CR1
Device / Revision:

Design Responsibility: R. Arora / J. Pyle
Process/Quality/PQ. Responsibility: R. Meyer / J. Wall
Supplier:
Model Year/Vehicle(s):

Provide electrical switching interface with stationary terminal	Fails to provide adequate electrical contact	Device appears as an open circuit Intermittent continuity High millivolt drop	7	Contact material specified too thin Incorrect contact material specified Contamination Incorrect contact attachment method specified	1	Review of TI proprietary and general contact design info Minimize paths for ingress of contaminants	1	7
Provide electrical path from interface to contact arm	Fails to provide adequate conductivity	High resistance shows as high millivolt drop	7	Incorrect material specified	1	Review with contact manufacturer Experimental verification	1	7
Provide means of mechanical attachment to contact arm	Inadequate attachment to contact arm	Shift in setpoints over life Erratic operation Open circuit	7	Incorrect geometry specified Incorrect material specified	1	Manufacturer recommendation	1	7
Provide rigidity to maintain contact gap and therefore device calibration over life	Calibration shift	Shift in setpoints	6	Incorrect geometry specified Incorrect material specified	1	Manufacturer recommendation	1	6
Provide a feature to concentrate contact forces in a particular area	Inadequate force concentration	High millivolt drop	7	Incorrect geometry specified Incorrect material specified	1	Manufacturer recommendation	1	7
Provide features to allow feeding automation	Fails to allow feeding automation	Manufacturing yield loss	5	Incorrect geometry specified	7	Manufacturing validation	1	35

3713 7802

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 505770 Page 1
Revision Level B
Revision Date 5-Nov-95

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

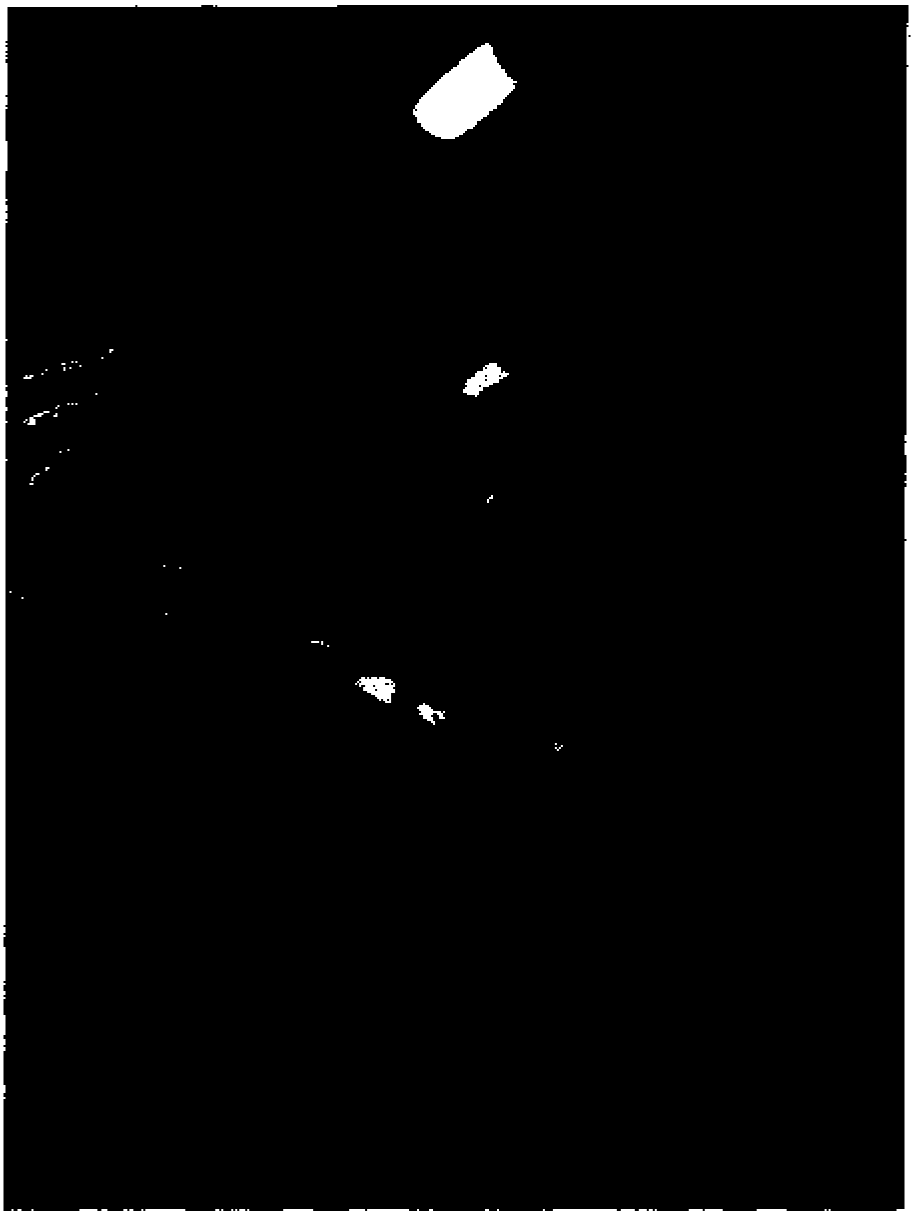
Key Date 1993

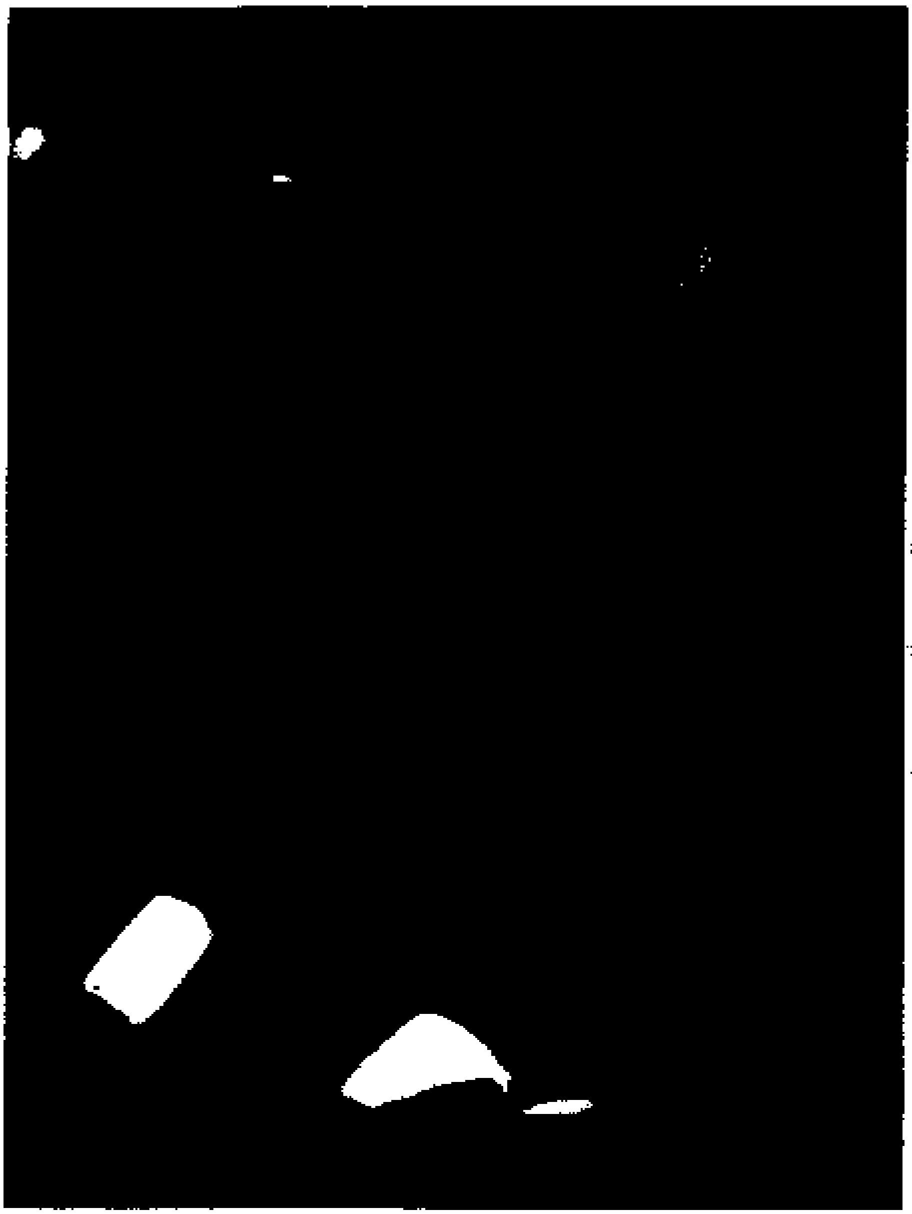
Prepared By D. Ha

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

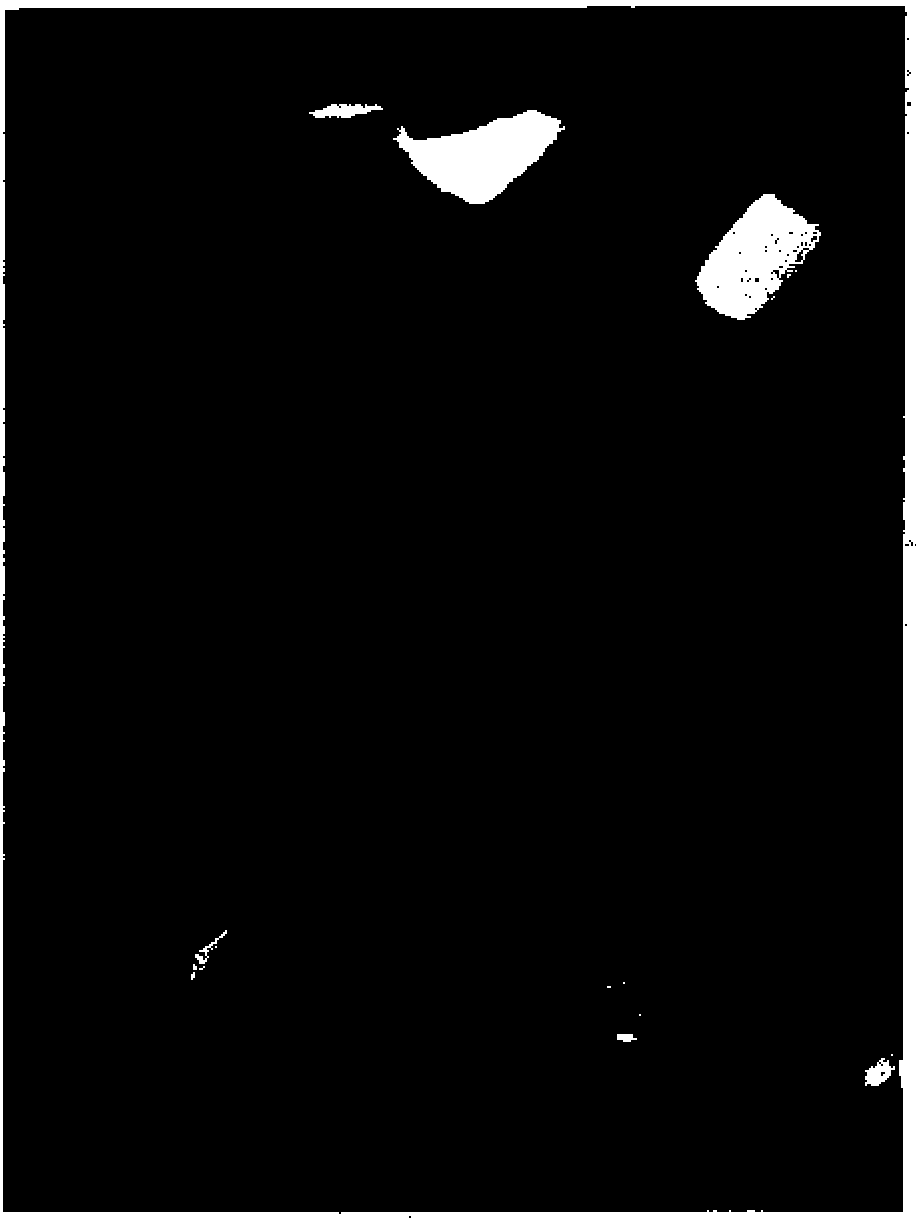
Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Design Controls	Detec	R.P.N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
RIVET (74516) Fastens spring to movable terminal.	Fails to adequately fasten spring to movable terminal.	Spring rotates about axis of rivet. Spring falls off movable terminal.	5		Improper rivet diameter for given hole sizes. Improper rivet length for given material thickness. Improper head size. Improper tubular feature. Improper material.	1	Rivet manufacturer recommendations. Comparison with similar products. Testing to determine torque to rotate spring.	1	5							
Provides a force between movable terminal and spring which ensures tolerable contact for current flow.	Inadequate force between spring and movable terminal.	High resistance or no continuity at interface of spring and movable terminal.	6		Improper rivet diameter for given hole sizes. Improper rivet length for given material thickness. Improper head size. Improper tubular feature. Improper material.	1	Rivet manufacturer recommendations. Comparison with similar products. Testing to determine torque to rotate spring.	1	6							

3713 7309

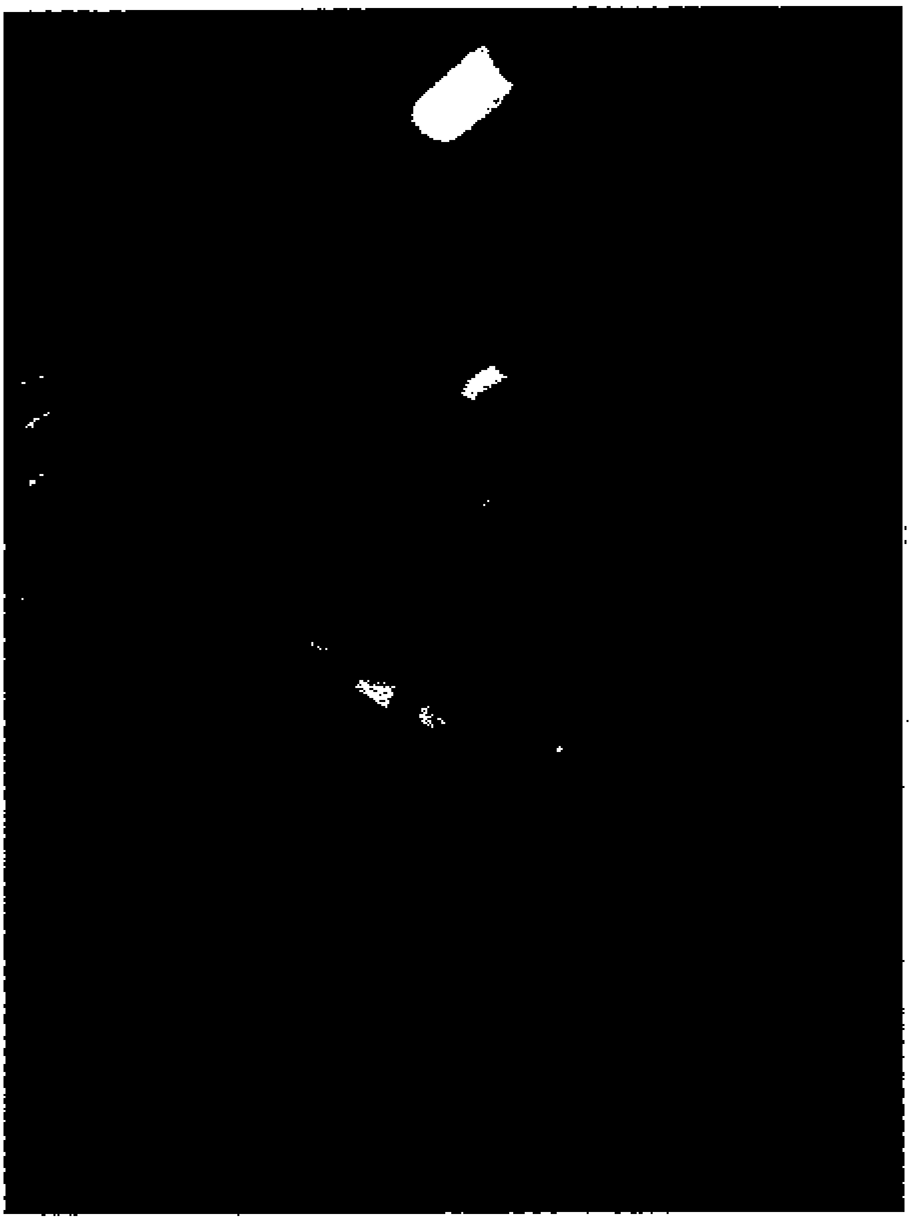




3713 7305



3713 7306



FE ANALYSIS SW;
REDDICK COMP

3713 7310

```
*****************************************************************************
*         Note printed by NLAPOINT on 23 Feb 1999 at 16:36:37              *
*****************************************************************************

From: I2060625--EXTERNAL                        Date and time    02/23/99 12:13:50
To: FPORTER --FORDMAIL 'Fred Porter ( For NLAPOINT--FORDMAIL 'Norm LaPointe ( F

From: Rahman, Aziz
Subject: FW: (U)Pressure Tests
```

You may have received this from Steve R. Interesting info on pressure profiles at various nodes. we will try to factor this into our vehicle test.

Regards
Aziz.

From: Steve Reimers SMTP:sreimers@ford.com
Sent: Friday, February 19, 1999 8:13 AM
To: Aziz Rahman, Texas
Subject: (U)Pressure Tests

fyi... I gave him a copy of your test plan and asked what pressure range and fr
equancy we should instrument for.

Steve Reimers   building 5 3C043
AVT Chassis E/E System Applications   mail drop 5011
39-03286 SREIMERS   sreimers@ford.com   fax 39-03286

*** Forwarding note from JJOYCE1 --DRBN007 02/18/99 19:40 ***
To: SREIMERS--DRBN007
cc: FPORTER --DRBN007

FROM: John Joyce   USAET(UTC -05:00)
Subject: (U)Pressure Tests

Steve,

I got your note and will be on vacation tomorrow through Wednesday. Here's the info.

The more I think about this, the more I think TC activation may be the mechanism.

I am not sure of the order of the things connected and that can influence the low frequency amplitude of the signals. But the short answer is to instrument for 0-250 Bar and sample at 1 kHz or more.

Since I'm not sure of where the pressure switch is hydraulically connected I'll give you pressures at nodes and states I do know. The worst case for the switch would be to be connected between the HCU and the prop valve, which
is where I think it is.

This is the low frequency component of the signal, I'll talk about the high-frequency component further down.

MC - HCU NODE
Maximum Pressure - ~175 Bar

3713 7311

Achieved by getting maximum vacuum (high revving engine and suddenly close throttle) then standing on the pedal as hard as you can. I don't remember this number very well it might be as low as ~130 or as high as 220. It also depends on your leg strength. This type of pressure is VERY RARE at this node. For this car, the driver will typically apply <20 bar and vary rarely exceed 50 bar.

HCU - PROP VALVE NODE
Standing Still - Same as MC pressure - see above.

ABS Maximum - ~110 Bar
This is achieved by loading to GVW and performing an ABS stop, you may find that you are pedal effort limited, not limited by ABS control. It's pretty rare to get this high of pressure in this mode.

TCS Maximum - ~180 Bar
This is a good candidate. On this vehicle because the HCU had to pump through the prop valve to do the brakes-only traction control, the pressures coming out of the HCU got very high. The pressure relief valve on the pump VERY OFTEN dictated the peak pressure which could be developed - not the control - put another way, because the pressure at the rear brake had to restrain the entire powertrain (no engine intervention) and push through a prop valve, it was often possible to drive through the TC - the engine could overpower the brakes, even though very high pressures were being generated at the HCU. The noise during TC activation in these applications was very dependant upon the pressure relief valve opening point. So the pressure relief valve value got changed a few times over the years as performance was sacrificed for NVH. Also the tolerance on the pressure relief valves was fairly large - a total of 40 bar, at that time I believe. The pressure relief valve pressure might be anywhere from 90 to 180 bar depending on part-to-part variation and the design generation that was agreed upon.

You can achieve this easiest by getting the rear wheels off the ground and putting the car in drive. Get into the throttle hard, but not so hard that you drive out of first gear or faster than ~15 mph. If you maintain this for a while, the thermal model to protect the rear linings will disable the Traction Control. You will then need to wait for them to cool, before the function will be reenabled. You can dramatically accelerate
the cooling time by cruising (without braking) at about 40 mph.

Typical drivers can regularly get high pressures in this mode.

PROP VALVE - REAR BRAKE NODE
ABS Maximum Pressure ~70 Bar
Load to GVW and perform an ABS stop at maximum pedal effort.

TCS Maximum Pressure ~100 Bar
This pressure level is strongly dependent upon the pressure relief valve level - see above.

Standing Still
Same as ABS Maximum Pressure

High Frequency Content
The high frequency content has two parts. If you are not in ABS or Traction Control there is practically no high frequency content - the pressure is modulated at <10 Hz. This is basically limited by Booster response times

and hydraulic dampening in the ABS orifices.

High Frequency Content Due To Control
During ABS/TC events the pressure is changed in quick steps. Typically it will increase by ~10 Bar in a few milliseconds, and this type of change occurs about every 100ms. The pressure will decrease by about 20 Bar every 300 ms. There can be quite a bit of variation in these numbers, but those are pretty typical. (Actually the numbers I assigned were for ABS, swap "increase" and "decrease" for TC activation.)

High Frequency Content Due to Shock Waves
This is a secondary effect from the control. Generally it is worst right at the outlet of the HCU. It is dampened and dissipated the further you get from the HCU. The shock wave is generated from the cyclical pulsing of the pump as well as the sudden changes in pressure when a solenoid valve is snapped open or shut.

The amplitude of this can be really big - I haven't looked at it in this generation unit for a few years, but I think it's about 50 Bar peak-peak right at the HCU. It will fall off as you move further away from the HCU.

The frequency is pretty high and I think some components are above the 1 kHz level, but you can get a very good idea of the disturbances by sampling at ~1kHz.

Regards,
John Joyce

DEALER 220 883 VIN 1LNLM82N0PY622977

		SUGGESTED RETAIL PRICE	AMOUNT
	1995 TOWN CAR SIGNATURE 4-DOOR	35494 00	30178 00
DG	CHINA BLUE CLEARCOAT MET		
DM	AQUAMARINE LTHR SEAT SURFACE		
99W	.4.6L EFI V8 ENGINE	NC	NC
44P	.ELECTRONIC AUTO O/D TRANS	NC	NC
T3P	.P215/70R15 WSW TIRES	NC	NC
153	FRONT LICENSE PLATE BRACKET	NC	NC
464	DUAL EXHAUST SYSTEM	83 00	69 00
D	LEATHER SEATING SURFACE T/C	570 00	479 00
919	TRUNK MOUNTED CD CHANGER	833 00	700 00
	TOTAL VEHICLE & OPTIONS	36980 00	31425 00
	DESTINATION & DELIVERY	590 00	590 00
	TOTAL FOR VEHICLE	37570 00	

18 U.S. GAL GAS FACTORY 18 20
PRICE ADJUSTMNT NOTICE APPLIES
BATCH-ID S796000001 D TO AA
SCHEDULE-B LEVEL 00000
PRICE LEVEL 301010M82 VIN: 1LNLM82N0PY622977
SHIPPING WEIGHT 3891 LBS.

THIS INVOICE MAY NOT REFLECT THE FINAL COST OF THE VEHICLE IN VIEW OF THE POSSIBILITY OF FUTURE REBATES, ALLOWANCES, DISCOUNTS AND INCENTIVE AWARDS FROM FORD MOTOR COMPANY TO THE DEALER.
* THIS PORTION OF THE VEHICLE PRICE WILL BE PROVIDED TO THE APPROPRIATE FDAF [illegible] TO SUPPORT REGIONAL/DEALER ADVERTISING.

REGIONAL MARKETING ADVERTISING *	INVOICE TOTAL	LESS HOLDBACK FOR DEALER ACCOUNT	LESS [illegible] FINANCING COST FOR DEALER ACCOUNT	[illegible] LESS HOLDBACK & FIN. COST	A PLAN
361.00	32,392.20	1,109.00	360.00	30,923.20	30,923.20
1109.00	44.00	1248.00	.00	1065.00	29815.00

SOLD TO
[redacted]
Memphis TN [redacted]

FURTHER TERMS ON REVERSE SIDE

TA		STATE
2		TN

PLT RLSE DTE
09/14/92
RS20

SHIP TO (IF OTHER THAN ABOVE) 22663

DATE					
09	01	92	22-2077	DH	08

SHIP THROUGH

VEHICLE UNIT IDENTIFICATION NO. 1LNLM82N0PY[redacted]
FINAL ASSEMBLY POINT WIXOM
FINANCE COMPANY AND/OR BANK FORD MOTOR CREDIT 000001

THIS INVOICE TO BE USED FOR THE BILLING OF VEHICLES ONLY

DEALER COPY

3713 7314

DEALER 220 663 VIN 1LNLM82H0PY622977

BATCH-ID S796000001 0 TO AA

PRICE LEVEL 301010M82 VIN: 1LNLM82H0PY[redacted]

REQUEST[redacted] CASE: LAPOINTE, N

THIS INVOICE MAY NOT REFLECT THE FINAL COST OF THE VEHICLE IN VIEW OF THE POSSIBILITY OF FUTURE REBATES, ALLOWANCES, DISCOUNTS AND INCENTIVE AWARDS FROM FORD MOTOR COMPANY TO THE DEALER.
* THIS PORTION OF THE VEHICLE PRICE WILL BE PROVIDED TO THE APPROPRIATE FORD [illegible] TO SUPPORT REGIONAL/DEALER ADVERTISING.

[illegible] ADVERTISING *	INVOICE TOTAL	[illegible] FOR DEALER ACCOUNT	[illegible] COST FOR DEALER ACCOUNT	[illegible]	A PLAN

SOLD TO
Schilling L-M/Mendenhall Inc 220663
2660 South Mendenhall
Memphis TN 38115

FURTHER TERMS ON REVERSE SIDE

[illegible]	[illegible]	STATE
2		TN

PLT RLSE DTE
09/14/92
RS2D

SHIP TO (IF OTHER THAN ABOVE) 22663

DATE			[illegible]		
09	01	92	22-2077	DM	08

SHIP THROUGH

1LNLM82H0P[redacted] WIXOM FORD MOTOR CREDIT 000001

THIS INVOICE TO BE USED FOR THE BILLING OF VEHICLES ONLY

DEALER COPY

3713 7315

3713 7315

LINCOLN

STANDARD EQUIPMENT INCLUDED AT NO EXTRA CHARGE

- AUTOMATIC CLIMATE CONTROL
- ELECTRONIC ENGINE CONTROLS
- SEQUENTIAL MULTI-PORT ELECTRONIC FUEL INJECTION
- SPEED SENSITIVE STEERING
- POWER FOUR WHEEL DISC ANTI-LOCK BRAKE SYSTEM
- BODY-ON-FRAME CONSTRUCTION
- REAR AIR SPRINGS
- WSW MICHELIN RADIAL TIRES
- GEOMETRIC SPOKE AL. WHEELS
- DUAL POWER HEATED MIRRORS
- REAR WINDOW DEFROSTER
- INTERVAL WINDSHIELD WIPERS
- ELECTRONIC INSTRUMENTATION WITH MESSAGE CENTER
- ELECTRONIC DIGITAL CLOCK
- ILLUMINATED VISOR MIRRORS
- HEADLAMP CONVENIENCE GROUP
- TINTED GLASS
- DRIVER AND PASSENGER SIDE AIR BAG SRS
- 5 MPH BUMPERS
- REAR OUTBOARD 3-POINT RESTRAINT SYSTEM
- POWER WINDOWS, DOOR LOCKS, DECKLID RELEASE/PULLDOWN
- REMOTE FUEL FILLER RELEASE
- HIDDEN BODYSIDE DRIP RAILS
- ELECTRONIC AM/FM STEREO RADIO WITH CASSETTE TAPE PLAYER AND PREMIUM SOUND
- AUTOMATIC POWER ANTENNA
- TILT STEERING COLUMN
- FRONT AND REAR FLOOR MATS
- 6-WAY POWER SEATS
- DUAL MANUAL RECLINERS
- FINGERTIP SPEED CONTROL
- REMOTE KEYLESS/ILLUM ENTRY
- LEATHER WRAP STEERING WHL.

PRICE INFORMATION

	Manufacturer's Suggested Retail Price
STANDARD VEHICLE PRICE	$35494.00
OPTIONAL EQUIPMENT	
FRONT LICENSE PLATE BRACKET	NO CHARGE
DUAL EXHAUST SYSTEM	83.00
LEATHER SEATING SURFACE T/C	570.00
TRUNK MOUNTED CD CHANGER	835.00
TOTAL VEHICLE & OPTIONS	36980.00
DESTINATION & DELIVERY	590.00

[illegible]

SOLD TO
[illegible]
[illegible] TN 38115

SHIP TO (IF OTHER THAN SOLD TO)

SHIP THROUGH ITEM#: 22-2077

VEHICLE IDENTIFICATION NO.		FINAL ASSEMBLY POINT	MEANS OF TRANSP.		
1LNLM82W[redacted]	22D 643	WIXOM	RAIL	RS20	5796 D TD AA 281 000001

```
********************************************************************************
Report Created by: nlapoint          Report Date: Tue Dec 15 13:45:34 EST 1998
********************************************************************************

      5. BROADCAST MESSAGES
      6. E D S R - ELECTRONIC DEALER SERVICE REPORT *
      7. SELECT LANGUAGE *
     99. DISCONNECT FROM OASIS
 *  NOTE:  OPTION NOT AVAILABLE IN ALL MARKETS
 ENTER SELECTION NUMBER &lt;RTN&gt;
2

                                                      12/15/1998  13:47:54
 ENTER VIN <RTN>  FOR VEHICLE WARRANTY HISTORY
   M. MENU      1-7. MENU SELECTION NUMBER    99. BYE
1lnlm82w0py622977

                                                      12/15/1998  13:48:21
 1993 TOWN CAR                         4 DR SEDAN SIGNATURE
 4.6L SOHC (ROMEO)    318JR10A 4 SPD OD AODE             AXLE CODE:  JY
 *OPEN CAMPAIGNS
  NO CAMPAIGN MESSAGE(S) FOUND
 *WARRANTY START DATE   02/08/1993 BUILD DATE   09/10/1992 START ODOM
LESS THAN TWO DEALER APPROVED AWA REPAIR VISITS PAID TO DATE
NO ESP INFORMATION AVAILABLE

                                                      12/15/1998  13:48:21
NO REPAIR HISTORY ON VEHICLE

                                                      12/15/1998  13:48:22
 ENTER VIN <RTN>  FOR VEHICLE WARRANTY HISTORY
   OR <RTN> FOR     1LNLM82W0PY[redacted]
   M. MENU      1-7. MENU SELECTION NUMBER    99. BYE
99

                                                      12/15/98   13:48:35
THANK YOU FOR USING THE OASIS/EDSR MENU SYSTEM


DISCONNECTED FROM FORD COMPUTER  #1336
THANK YOU FOR TYPING BYE, THIS HELPS TO REDUCE LOGIN TIME FOR OASIS/EDSR.

PLEASE TURN OFF YOUR TERMINAL...

please log in:
```

3713 7317

TEXAS INSTRUMENTS March 21, 1997

FACSIMILE TRANSMITTAL

TO:	**Name:**	**Norman LaPointe**
	Location:	**Design Analysial Department**
	Phone Number:	
	FAX Number:	**(313) 337-9256**
FROM:	**Bryan Degue**	
	TEXAS INSTRUMENTS	**MS 12-29**
	Phone Number:	**(508) 236-3234**
	FAX Number:	**(508) 236-3586**

Total number of pages (including header page): ~~5~~ 4

Norm,

Here is the information that we have sent Fred over the past few days.

Let me know if you need anything else.

Regards,
Bry

TEXAS INSTRUMENTS INCORPORATED * 34 FOREST STREET * ATTLEBORO, MA 02703

3713 7318

Dagus, Bryan

From:	Douglas, Charles
Sent:	Wednesday, January 06, 1999 9:00 AM
To:	Dagus, Bryan
Subject:	FW: Florida information

Charlie

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

From:	Douglas, Charles
Sent:	Monday, January 04, 1999 6:23 PM
To:	'Porter, Fred (Ford)'
Subject:	FW: Florida information

Fred,

I was not able to get answers to all of your questions and will pass along what we know right now:

- While the exact melt temperature of the Noryl GTX 830 was not available, we do know that this material is molded in the 540 F - 580 F range.
- Kapton does not melt nor burn. Technically it "chars". While we have not been able to determine the exact char temperature of the Kapton, we do know that it is well above 800 F.
- Our team is working on the information on the gasket --> we need to get this from our supplier.

I have a meeting with Bryan Dagus and Al Hopkins first thing in the morning and will raise these questions again with them (Al is only returning from vacation on Tuesday). My concern is that we may be reliant on our suppliers for some of the information that you are requesting. What I will try to understand from Al and Bryan is if we have the capability to run tests to determine these temperatures ourselves (if this is the best way to generate the information).

Regards,

Charlie

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

From:	K. Porter[SMTP:kporter@voyager.net]
Sent:	Monday, January 04, 1999 12:19 AM
To:	c-douglas2@ti.com
Cc:	Fred Porter
Subject:	Florida Information

3713 7319

Dague, Bryan

From:	Douglas, Charles
Sent:	Wednesday, January 06, 1999 8:59 AM
To:	Dague, Bryan
Subject:	FW: 99-003: PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

Charlie

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

From:	Douglas, Charles
Sent:	Wednesday, January 06, 1999 8:27 AM
To:	'Porter, Fred (Ford)'; Sharpe, Robert
Subject:	FW: 99-003: PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

Fred,

Attached is the protocol for disassembly and analysis we plan to follow tomorrow. Please feel free to offer your thoughts relative to any additions or modifications your team may desire.

Rob,

Please make sure Norm gets a copy of this at your earliest convenience.

Regards,

Charlie

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

From:	Hopkins, Al,
Sent:	Tuesday, January 05, 1999 7:37 PM
To:	Dague, Bryan; Prais, Stephen; Douglas, Charles
Cc:	Baumann, Russ; Baker, Gary; McGuirk, Andy; Beringhause, Steven; Andreas, Andy; Sluzalek, Allen; Russo, Joe
Subject:	99-003: PROPOSED PROTOCOL FOR DISASSEMBLY AND ANALYSIS OF SWITCH FROM 77PS FROM LINCOLN TOWN CAR

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

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

3713 7320

- Review Ford's Analysis data that they are bringing in.
- Examine threads and determine if it is OK to just chase the threads to get a good seal or should we remove material for analysis.
- Pressure Leak Test the device (15 minute static-hold, air-pressurized test).
- Decide if we should remove any material or try any other analysis before we start disassembling the device.
- Do a practice decap using the below procedure on a deliberately fractured part (to mimic the condition that the returned device will be in) before performing it on the real sample. Bryan, you and I could do this now.
- Procedure to remove aluminum crimp ring
- Use aluminum foil (or plastic if Ford prefers) to mask the analysis surface.
- Also create a paper/tape shield to further reduce chance of contamination during cutting of crimp ring.
- Place a piece of tape over the area to be cut.
- Cut crimp ring using jewelers saw or Dremel cutoff wheel in one of the two areas indicated on optical photo.
- Cut corners of ring at 180 degree orientation
- Unfold crimp ring
- Optically examine revealed surfaces. Take optical photographs (Digital camera with macro lens plus instant microphotography) and document observations where appropriate. Examine the following areas
  - Inside surface of crimp ring.
  - Seal area and underside of base
  - Top of cap
- Start SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis on the inside of the ring and on various surfaces of the plastic base.
- Reprotect the top surface and remove the cap. Bryan had originally suggested just using an end mill to remove the cap. I wouldn't, however, go all the way through with the end mill. I would leave some material behind as a shield. I would suggest then bending the cap off.
- Optically document all revealed surfaces starting with cap.
- Meanwhile, start SEM-EDX analysis on top side of cap. Particularly focus in on the edges of the ceramic pin guide and on the indented ring that lines up with interior wall of the switch cavity. Particularly look for evidence of corrosion or arcing.
- Decide if we should try to flake off any of the overlaying debris to try to examine the underlying metal surface.
- Proceed to perform SEM-EDX analysis on other component surfaces revealed by removal of cap.
- Non-destructively probe inside of the grommet to determine its resilience which will give us an indication of the temperature that it saw. Another indication might be the depth of the indentations left by the grommet seal rings in the wire.
- Decide if it makes sense to further examine the mating connector or grommet seal.

Regards,

Al

END-OF-FAX

3713 7321

VIEW THE NOTE
N01

From: PKLAAS --FORDNA1 Date and time 01/05/99 16:19:07
To: NLAPOINT--FORDMAIL LaPointe, Norman (

From: Klaas, Pete (P.F.)
Subject: RE: (U) Part Analysis

Done, thanks. IR shows brake fluid, according to Gayle, SEM work underway.

P. F. Klaas
Ford Motor Co.
Room 220, Central Laboratory
313-322-1613, fax 313-322-1614
Internet: mailto:pklaas@ford.com

-----Original Message-----
From: Norman Lapointe [mailto:nlapoint@gw.ford.com]
Sent: Tuesday, January 05, 1999 3:28 PM
To: pklaas@mail.ford.com
Subject: (U) Part Analysis

PF1 Alternate PFs PF2 File NOTE PF3 Keep PF4 Erase PF5 Forward Note
PF6 Reply PF7 Resend PF8 Print PF9 Help PF10 Next PF11 Previous PF12 Return

- Review Ford's analysis data that they are bringing in.
- Examine threads and determine if it is OK to just chase the threads to get a good seal or should we remove material for analysis. ?
- Pressure Leak Test the device (15 minute static-hold, air-pressurized test).
- Decide if we should remove any material or try any other analysis before we start disassembling the device.
- Do a practice decap using the below procedure on a deliberately fractured part (to mimic the condition that the returned device will be in) before performing it on the real sample. Bryan, you and I could do this now.
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- Use aluminum foil (or plastic if Ford prefers) to mask the analysis surface.
- Also create a paper/tape shield to further reduce chance of contamination during cutting of crimp ring.
- Place a piece of tape over the area to be cut.
- Cut crimp ring using jewelers saw or Dremel cutoff wheel in one of the two areas indicated on optical photo.
- Cut corners of ring at 180 degree orientation
- Unfold crimp ring
- Optically examine revealed surfaces. Take optical photographs (Digital camera with macro lens plus instant microphotography) and document observations where appropriate. Examine the following areas
  - Inside surface of crimp ring.
  - Seal area and underside of base
  - Top of cap
- Start SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis on the inside of the ring and on various surfaces of the plastic base. - need hyflate?
- Reprotect the top surface and remove the cap. Bryan had originally suggested just using an end mill to remove the cap. I wouldn't, however, go all the way through with the end mill. I would leave some material behind as a shield. I would suggest then bending the cap off.
- Optically document all revealed surfaces starting with cap.
- Meanwhile, start SEM-EDX analysis on top side of cap. Particularly focus in on the edges of the ceramic pin guide and on the indented ring that lines up with interior wall of the switch cavity. Particularly look for evidence of corrosion or arcing.
- Decide if we should try to flake off any of the overlaying debris to try to examine the underlying metal surface.
- Proceed to perform SEM-EDX analysis on other component surfaces revealed by removal of cap.
- Non-destructively probe inside of the grommet to determine its resilience which will give us an indication of the temperature that it saw. Another indication might be the depth of the indentations left by the grommet seal rings in the wire.
- Decide if it makes sense to further examine the mating connector or grommet seal.

Regards,

Al

End-of-Fax

DATE	TIME	TO/FROM	MODE	MIN/SEC	PGS	CMD#	STATUS
13 01/06	10:37	FORD CONTROL LAB	G3--S	00'52"	001	044	OK

FORD ENG DEARBORN MI

** TX CONFIRMATION REPORT ** AS OF JAN 06 '99 10:37 PAGE.01

3713 7323

Corrosion of Brass contact surfaces.

Nature of corrosion products

Brake Fluid — I.R. / Chloroform solvent /

Water

Unknown

Leakage determination

Internal Leakage

Physical Testing - Blow air at low pressure throught the fluid side for a seal check

If no passage- no internal brake fluid issue

If passage- did fire damage the seal

Water bath only e.g. not good.

Chemical analysis- determine if brake fluid exists on wrong side of diapham. IR as above.

External Leakage

Determine if wires are path:

Internal- along copper straings- need to cut insulation for examination.

External path along insulation surface to contacts.

Connector cavity- Determine white power composition.

Fracture Analysis of internal contact components.

Stationary contact - Two fractures & two cracks.

file/ pressaw.wp.nrl.122298

- green residue → tiny sample → push → SEM.
- brass oxides → scrape small → " → "
- fire ext. → " " → " → "

1/4/99

n

Corrosion of Brass contact surfaces.
Nature of corrosion products
Brake Fluid- I. R.
Water - Green Oxides, and corrosion oxide - SEM
Unknown- White powder - SEM

Fracture Analysis of internal brass contact components.
Stationary contact - Two fractures & two cracks. Nature of fractures?

Leakage determination
Internal Leakage
Physical Testing - Blow air at low pressure ~ 125psi throught the fluid side for a seal, check:
If no passege- no internal brake fluid issue.
If passege- did fire damage the seal? Cut to determine.

Chemical analysis I.R. - determine if brake fluid exists on wrong side of diaphem.-

Connector Side
External Leakage- Look for contamination path along or in wires.
Determine if wires are path:
Internal- along copper strainds- need to cut insulation for examination.
External path along insulation surface to contacts.

Connector cavity- Determine white power composition. SEM

file/ pressw.wp.nrl.122298

STAINLESS AND HEAT-RESISTING STEELS

[illegible]

Galvanic and Concentration-Cell Corrosion

When two unlike metals are connected in good contact and exposed to a solution capable of carrying an electric current, the more noble metal will corride less rapidly, whereas the less noble metal will corrode more rapidly than normal as a result of the development of an electric current. The simple dry cell, when shorted, is an excellent example of current generation produced by two dissimilar metals in contact with an electrolyte. Because corrosion of this type is associated with the generation of an electrical current,

Table IX
Galvanic Series of Metal Alloys

Magnesium	Corroded end. (Anodic, or least noble)
Magnesium Alloys	
Zinc	
Aluminum 2 S	
Cadmium	
Aluminum 24 ST	
Steel or Iron	
Cast Iron	
13 Per Cent Chromium-iron (active)	
Ni-Resist	
18 Per Cent Chromium-8 Per Cent Nickel Steel (active)	
18 Per Cent Chromium-8 Per Cent Nickel-3 Per Cent Molybdenum Steel (active)	
Hastelloy C	
Lead-tin Solders	
Lead	
Tin	
Nickel (active)	
Inconel (active)	
Hastelloy A	
Hastelloy B	
Brasses	
Copper	
Bronzes	
Copper-nickel Alloys	
Monel	
Silver Solder	
Nickel (passive)	
Inconel (passive)	
Chromium-iron (passive)	
18 Per Cent Chromium-8 Per Cent Nickel Steel (passive)	
18 Per Cent Chromium-8 Per Cent Nickel-3 Per Cent Molybdenum Steel (passive)	
Silver	
Graphite	Protected end. (Cathodic, or most noble)
Gold	
Platinum	

NHTSA Investigation

ASO contact William Abramczyk x 23284

93 ~~93~~ Town Car MY 1993

VIN 1 LnLm 82 wφ py 62 29 77

P/N #'s F2VC - 9F [redacted] Date code 2056

Name Brake Activated pressure sw.

12-15-98 Quick look

- Sw. charred internally @ path where b-fluid, if weeping, could cause a high resistance path between LG/R wire & ground.
- metal/steel tab corroded
- wrong side of switch appeared wet.
- White debris under the weatherproof seal.
- Neither wire appeared overheated.
- pyrolized on inside @ one edge, of elec. connector
- exterior melted, of elec. connector.

12-16 • Xray - Orange wire side melted @ contact.

Theory Assessment: Brake fluid leak passed ~~diagram~~ in switch caused a high resistance (weak short) between either wire to ground.

Root cause F2VC - 9F924 - AB

Need to verify this theory!

Alternate theory - contamination came from wire side

Need to check for water/salt/unknowns.

All shaded areas must be filled in to process your request

Request for Central Laboratory Service

15000 Century Dr., Dearborn MI 48120-1267 Phone [313] 32-21676 FAX [313] 32-21614

Administrative Use Only	
Laboratory Number: 9804105	Date: 12-17-98

Your Name [Send report to]	Telephone	PROFS ID	FAX
G. STEVENS	36686	GSTEVEN1	36686
Secondary Contact	Telephone	PROFS ID	FAX
N. LAPOINTE	42686	NLAPOINT	

Send Report To / Bill To

Room No./Mail Drop/PO Box	Department/Activity	Building	Location Code	Dept. #	Work Task # [For 5100 Loc. Only]
MD5006	MATERIALS AVT	BLDG 5	5100	T-113	XQG04

Sample

Total # of Samples	Sample Handling	TOX/CAS#	Source	Supplier Code
1	X Return after test ___ Dispose after test ___ Dispose after 30 days			

Part/Material Name	Sample Identification (Continue below if needed)	Part Number (if any)	Material Specification (if any)	CPSC Code	Supplier
				--.--.--	TEXAS
SPEED CONTROL	BURNED	F2VY-9F924-A	NA	--.--.--	INSTRUMENTS
CUT-OFF SWITCH	CONNECTOR &			--.--.--	
	PRESSURE ACTUATOR			--.--.--	
	(REDDICK)			--.--.--	

Investigation

Nature of Investigation/Specific Tests Required [Check all that apply]
- ___ Production/Plant problem
- X Failure Analysis
- X Legal
- ___ Specification Compliance
- ___ Perform Tests as in Lab No.________
- ___ Photograph (Describe below)
- ___ Use Specification ________ as a guide
- ___ Other (Describe below)

Requester Info. Box [For requester use]: HIGH PRIORITY - POSSIBLE LEGAL

Stop testing upon failure? ___ No ___ Yes

Does this support CAE testing? ___ No ___ Yes [If "Yes", what is the expected outcome?]

Do you need to know your CL contact and timing? ___ Yes

Additional Sample Information/Testing Requirements

DETERMINE CAUSE OF BURNED CONNECTOR
- RADIOGRAPH
- PHOTOGRAPH
- PRESSURE TEST DIAPHRAGM

EVALUATE/UNDERSTAND CIRCUITRY OF NEW SWITCHES

ATTN: S. LAROCHE

NOTE: ALL COMMUNICATIONS/REPORT, ETC. TO BE DUAL (I.E. NLAPOINT &

Report

Date you would like report: 1-19-99

Date you must have report: 1-14-99

Format [Check all that apply]
- X FAX preliminary results
- ___ FAX typed report
- ___ FAX hand written
- ___ Mail hand written
- ___ Mail typed report
- ___ Electronically transfer report
- ___ Phone preliminary results

For information about services or assistance in completing this form please refer to the Central Laboratory WEB page. [www.pro.ford.com/central/home.htm]
Laboratory number and date cannot be assigned without receipt of samples.
Samples will be disposed of after 30 days unless otherwise indicated above.

CL-Form #CLF07_01

Request for Central Laboratory Service

Receipt

Lab Request Number: 009804105
Date of Request: 12/17/1998 10:50:33 AM
Print Date: 12/17/1998 10:50:42 AM

I. ...est Description: SPEED CONTROL CUT-OFF SWITCH

Requester Information:

Primary Contact: STEVENS, GREG - 10008	Phone: (313) 323-8886	PROFS ID: GSTEVEN1	Fax: (313) 390-7224
Secondary Contact: LA POINTE, NORM - 10075	Phone: (313) 594-2888	PROFS ID: NLAPOINT	Fax: (313) 337-8256

Send Report to: MD 5008/2G065, AVT MATERIALS, BLDG. #5

Bill to:
Acctg.Location: 6100
Dept: T113
Work Task: XOG04

Sample Information:

Total Number of Containers: 1 — Sample Handling: Return after test
Source: Not specified — Supplier Code: Not specified

Part/Material Name	Qty	Sample Identification	Part Number	Material Spec	CPSC Code	Supplier
SPEED CONTROL CUT-OFF SWITCH	1	BURNED CONNECTO R *	F2VY-9F924-A	NA	18.08.00	TEXAS INST RUMEN TS

Investigation Information:

Nature of Investigation: Requestor Info. Box: Mail typed report
Fax preliminary results
HIGH PRIORITY - POSSIBLE LEGAL

Additional Sample Information/Testing Requirements:

SAMPLE ID: BURNED CONNECTOR & PRESSURE ACTUATOR (REDDICK)

DETERMINE CAUSE
...JRNED CONNECTOR - RADIOGRAPH, PHOTOGRAPH, PRESSURE TEST
DI... HRAGM.

EVALUATE/UNDERSTAND CIRCUITRY OF NEW SWITCHES.

ATTN: S. LA
ROUCHE - SAMPLE IN LAB

NOTE: ALL COMMUNICATIONS/REPORT, ETC. TO BE DUAL
(I.E. N. LA POINT).

Reporting Directions:

Date customer would like report: 01/13/1999
Date customer must have report: 01/14/1999

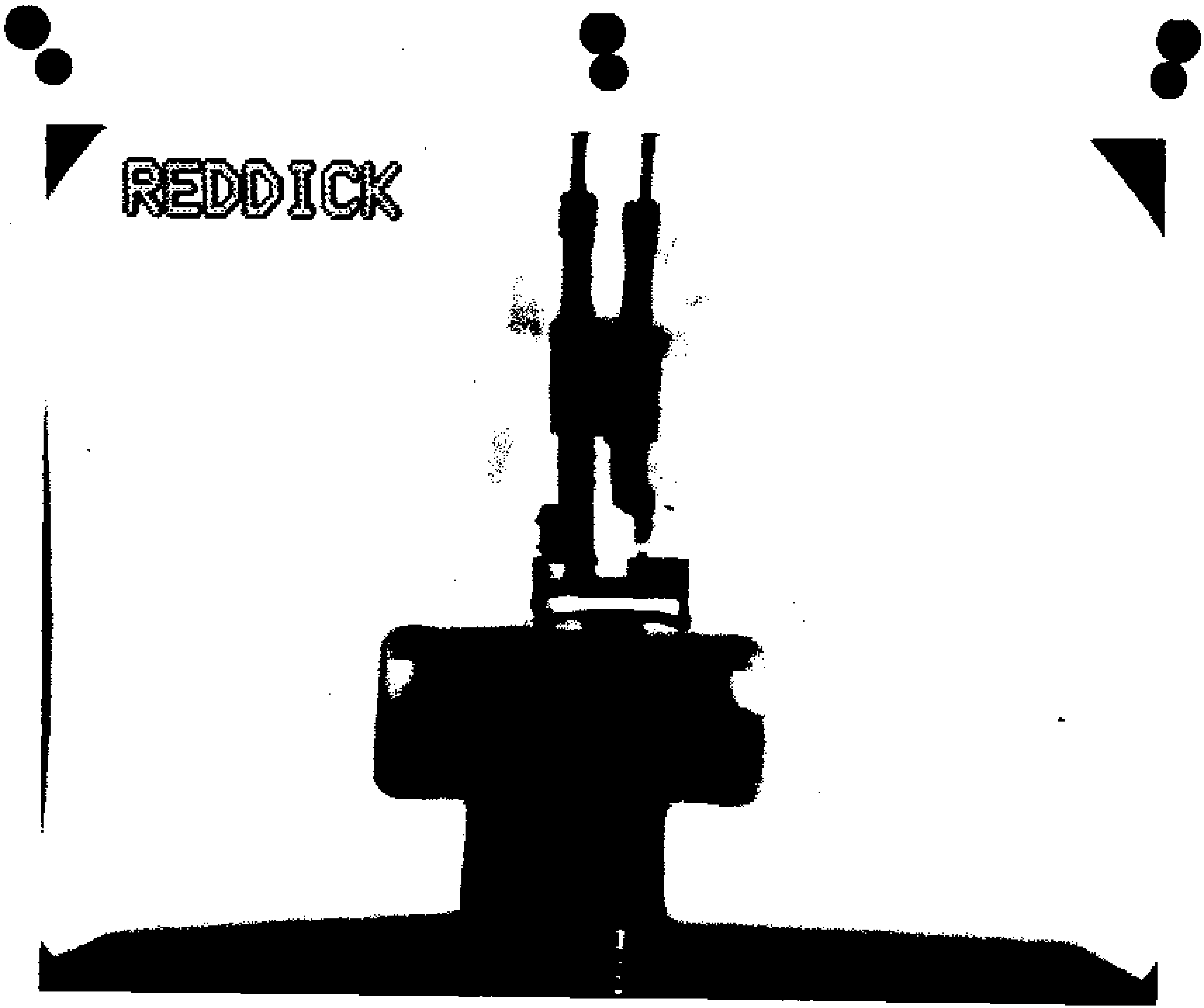
Report Format(s):

Log-in Information:

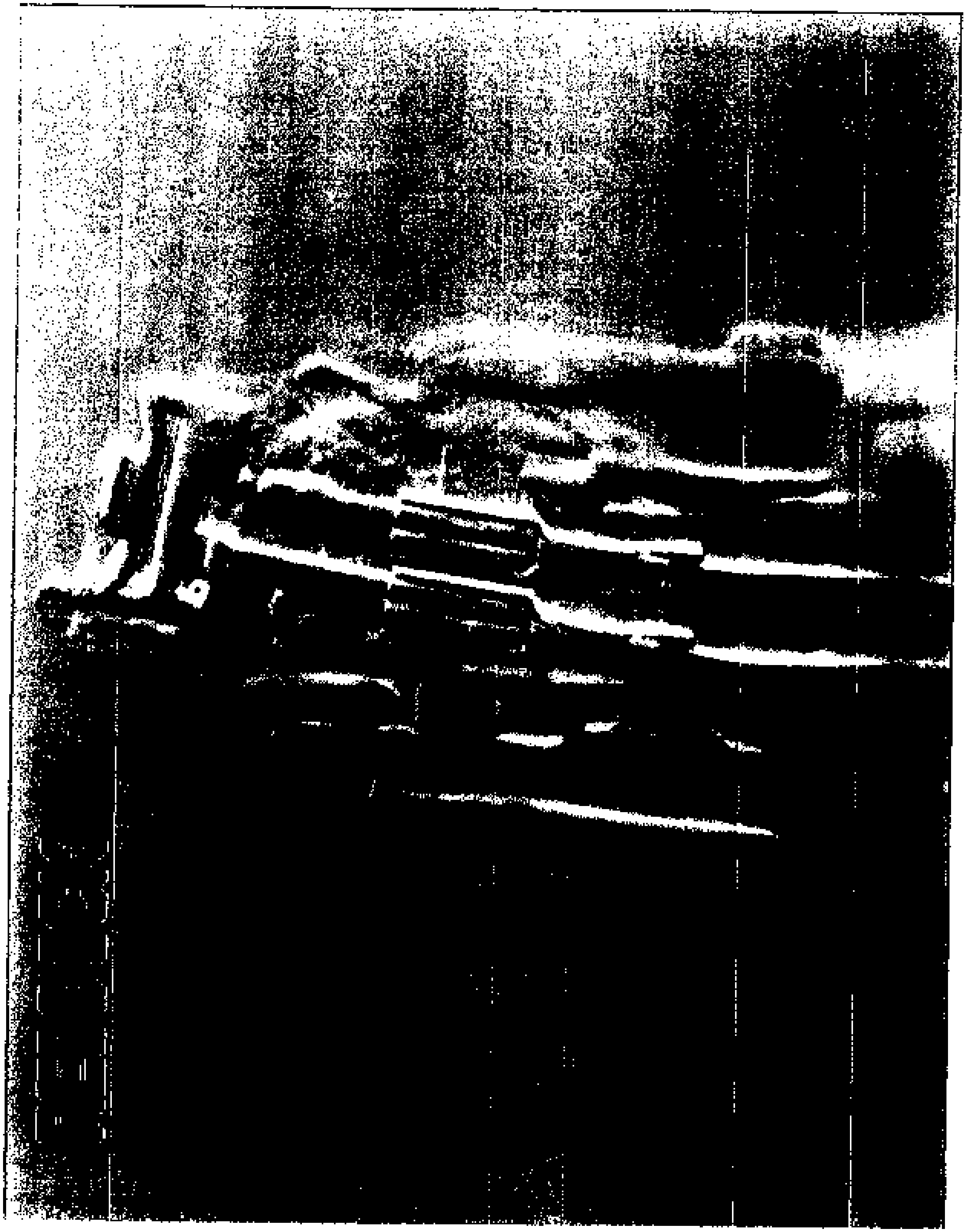
Initial Routing: Metallurgy
Accepted for Central Laboratory by: Morton, Jacqueline R. — Phone: 59-47064

Program Name: KALISLab Engr Module
Program Version: Version: 2.0.6

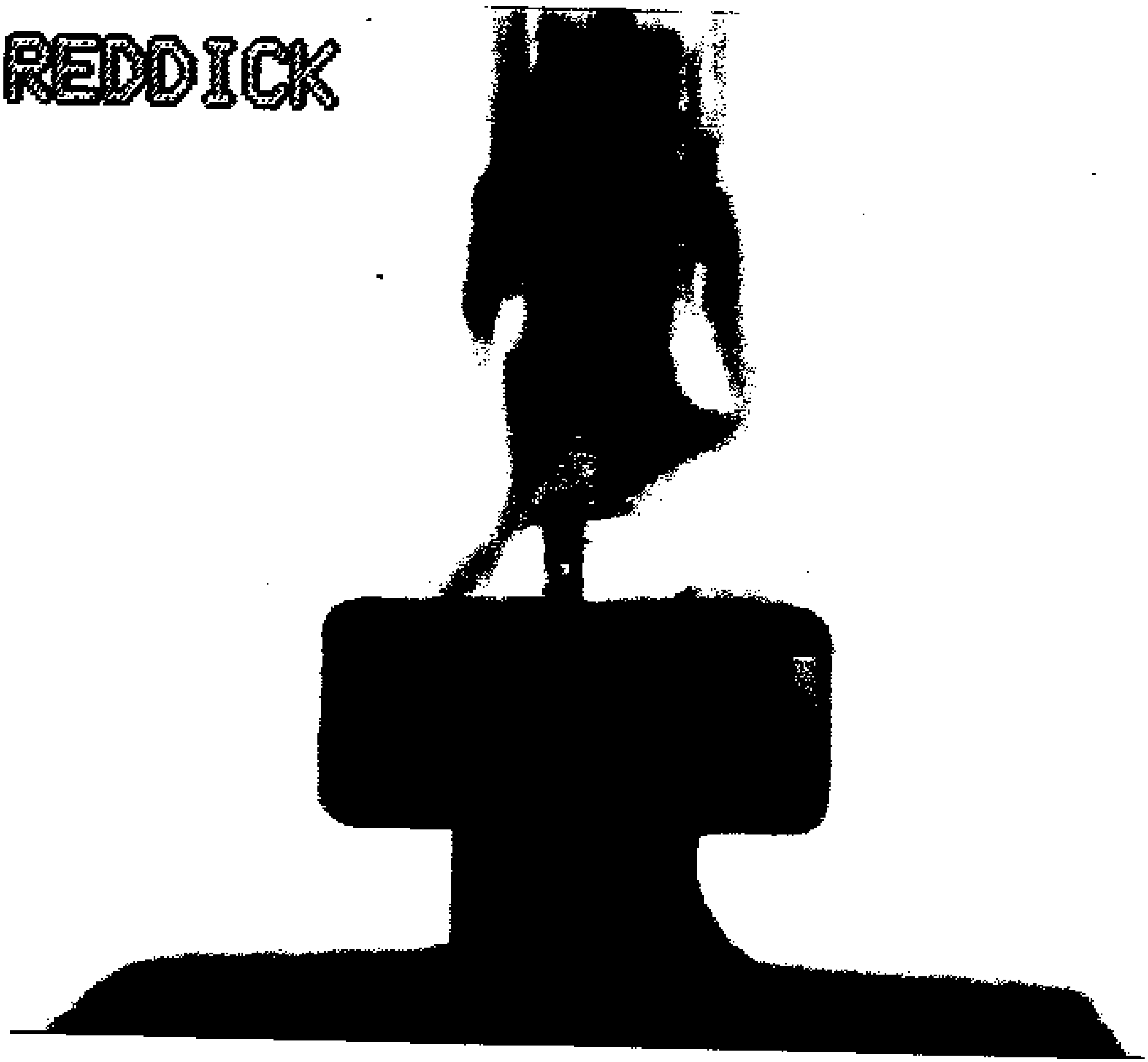
View your test status at: 'HTTP://bd4web.pd7.ford.com/kalis'



3713 7330



REDDICK



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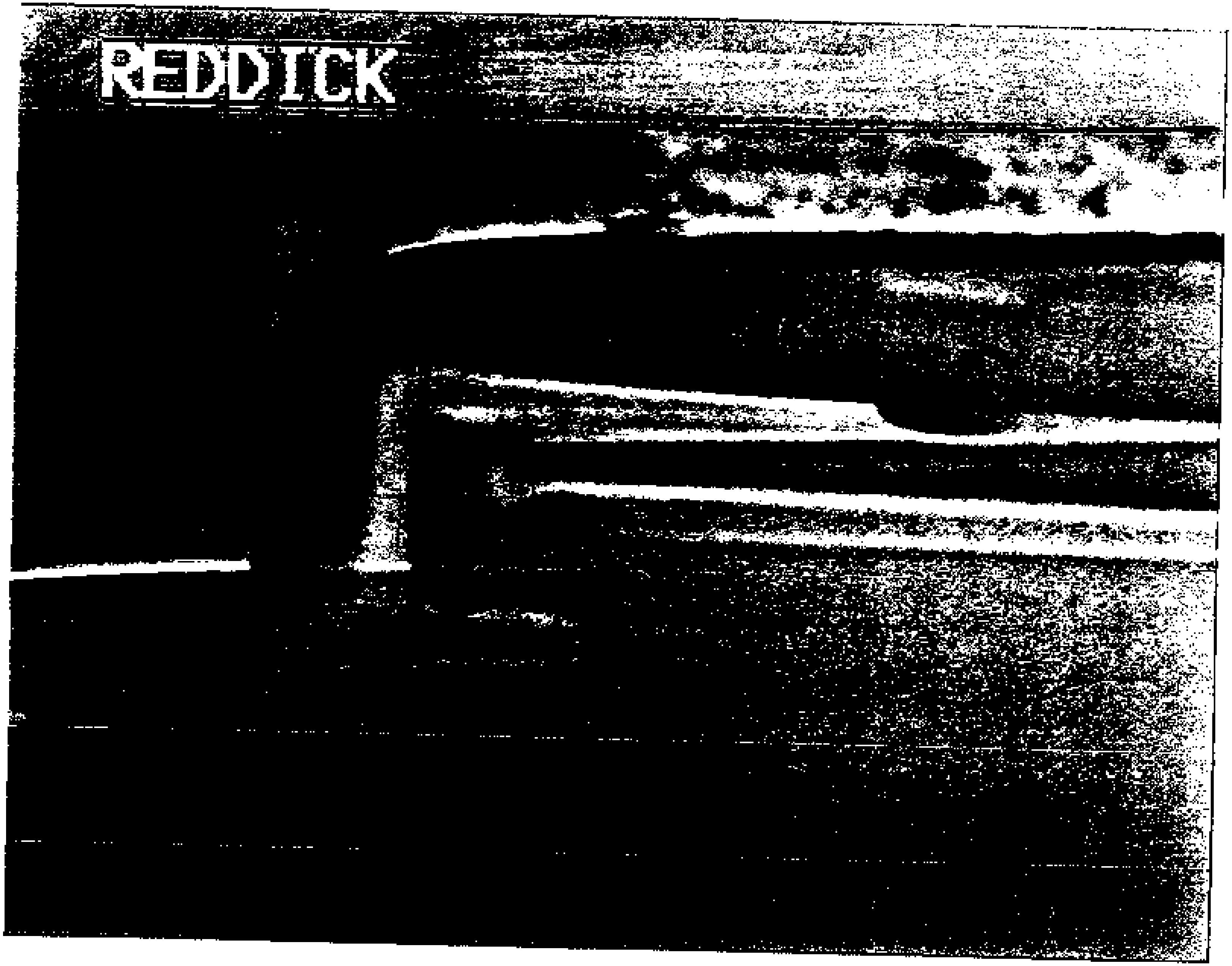
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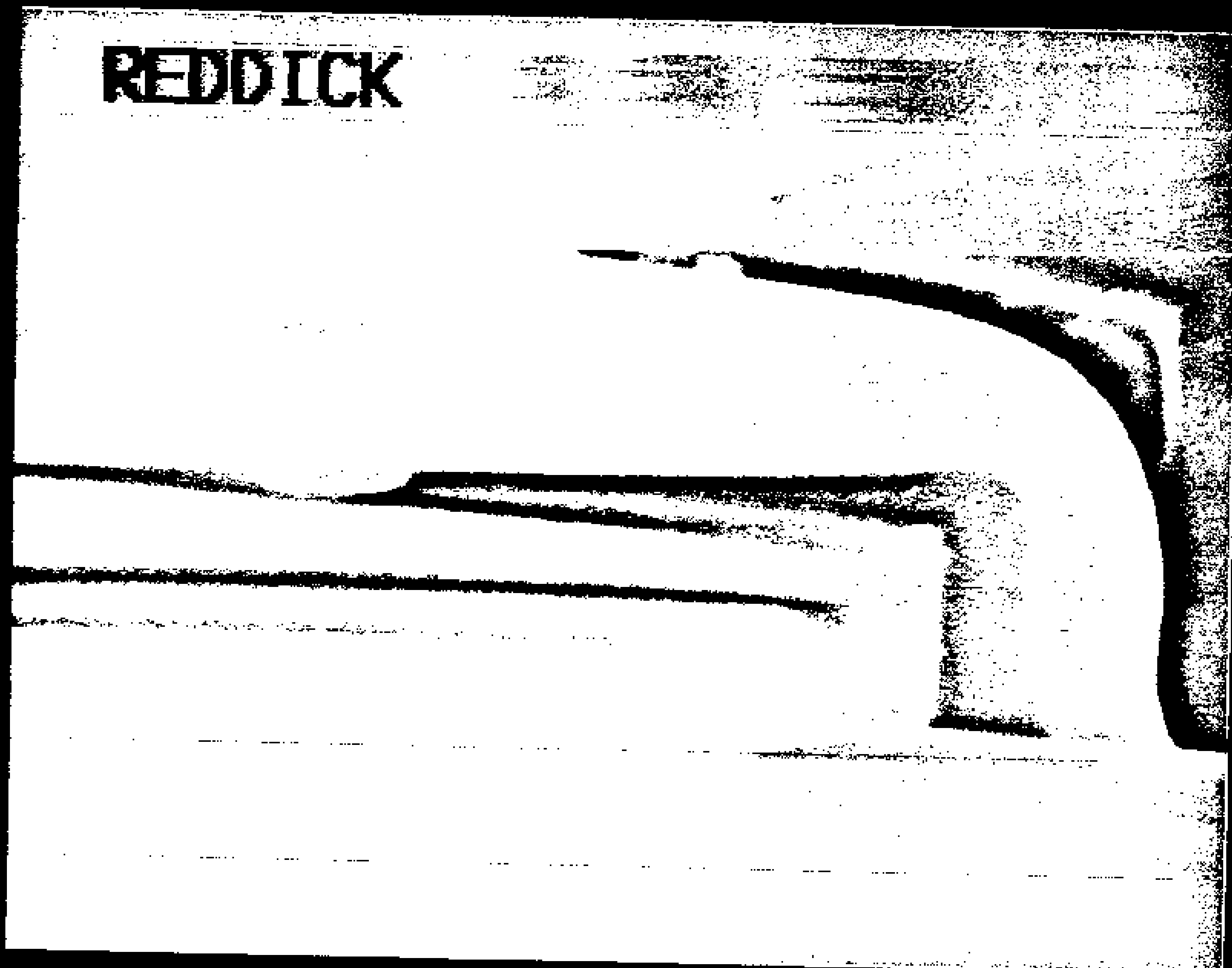

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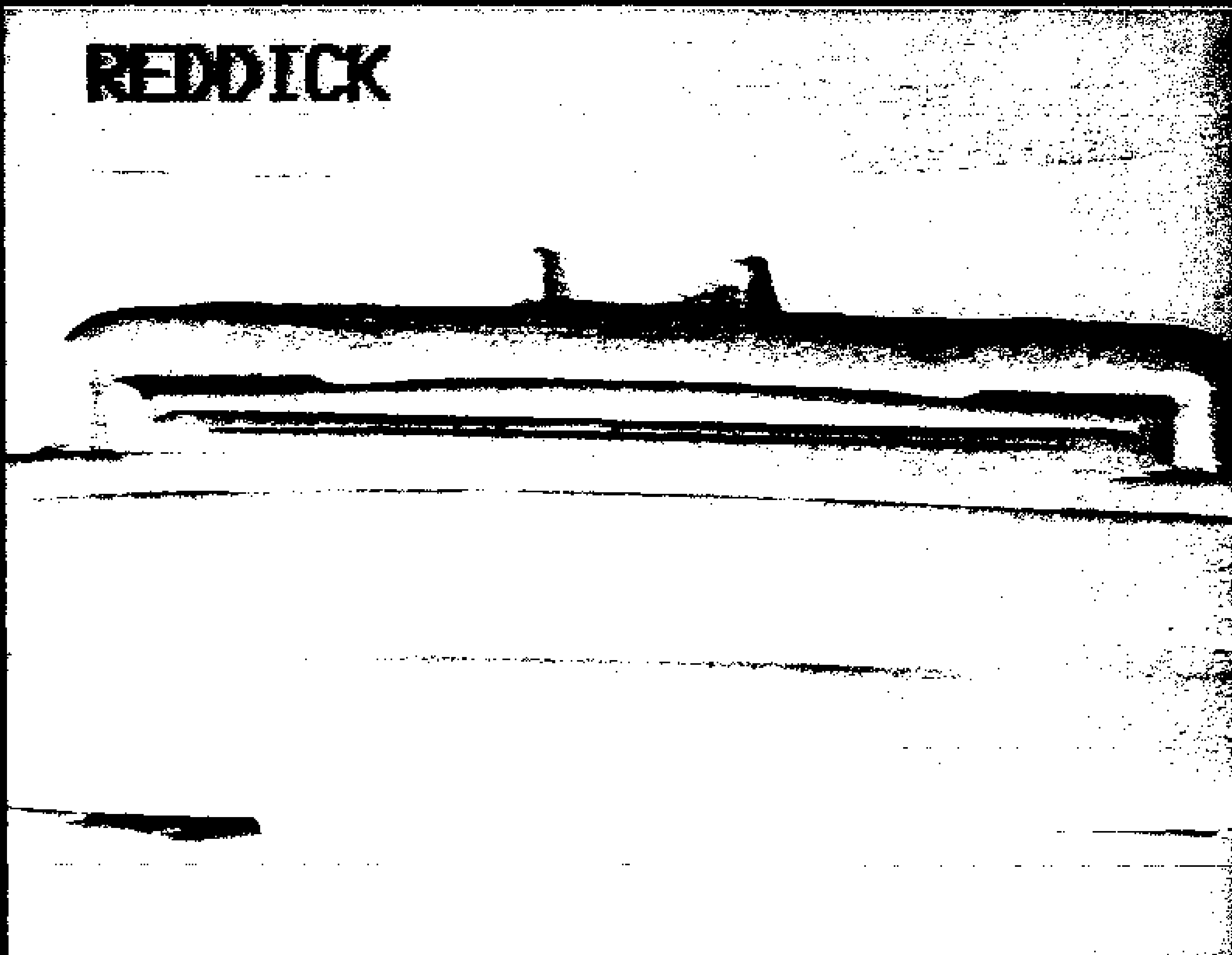
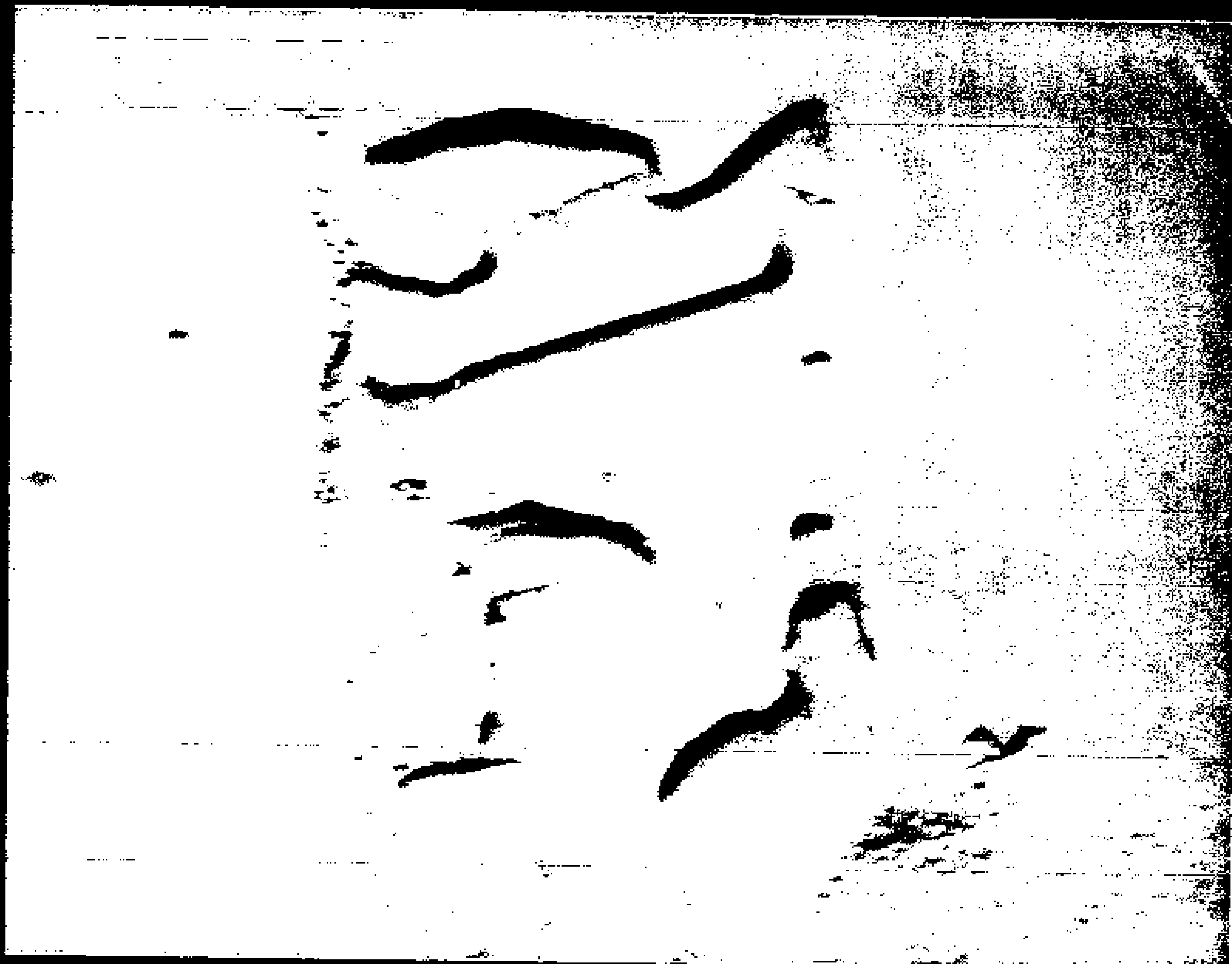

REDDICK



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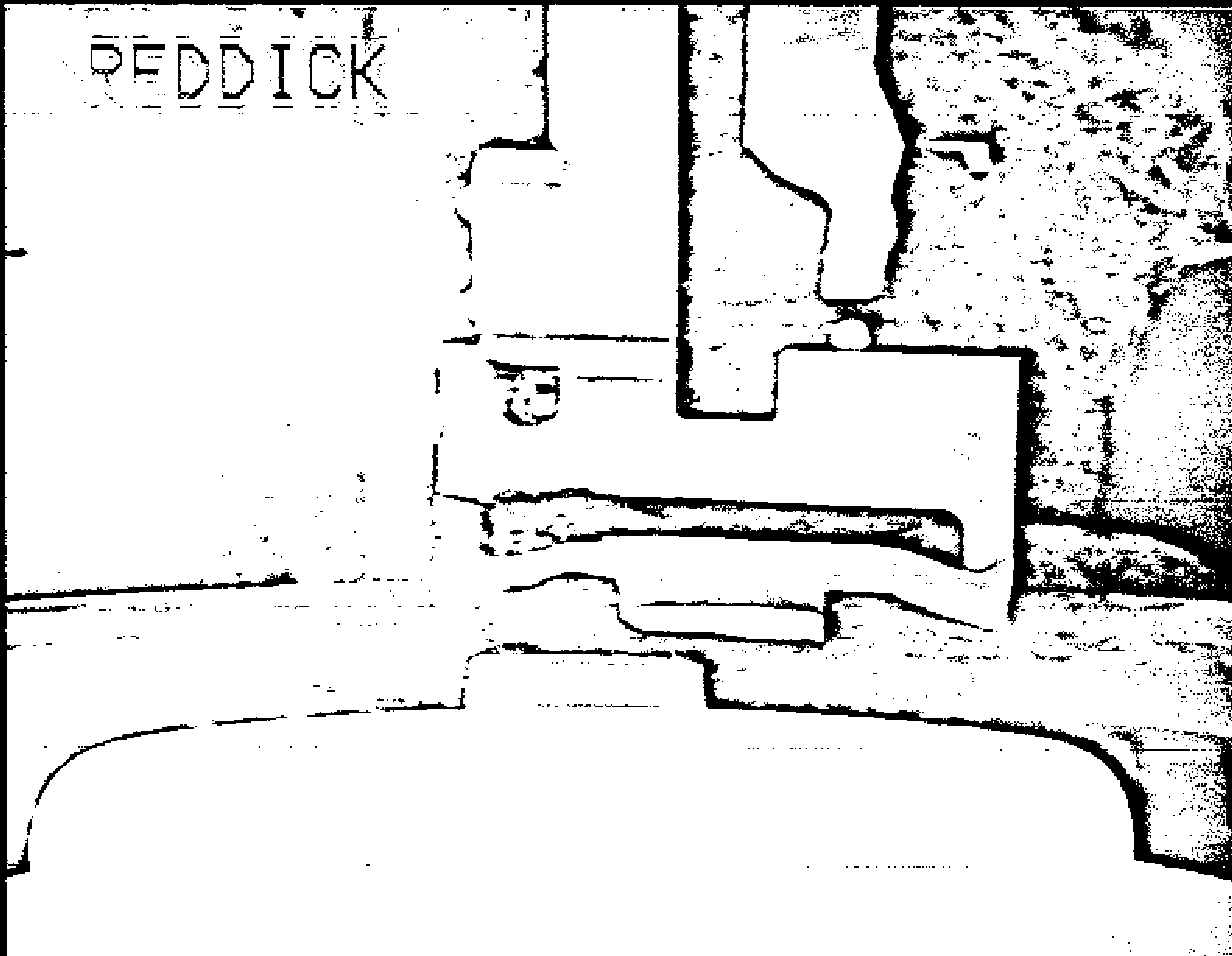

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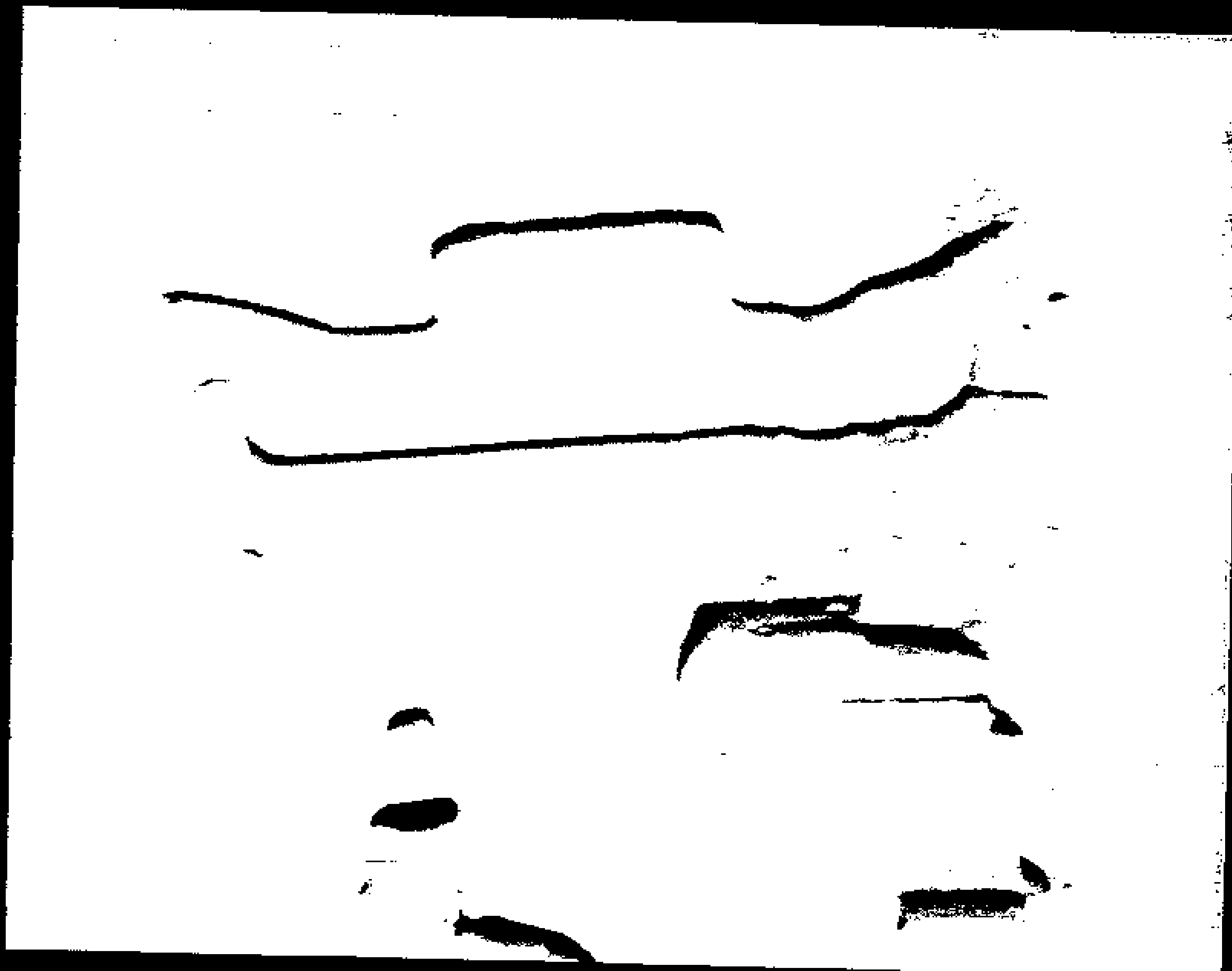

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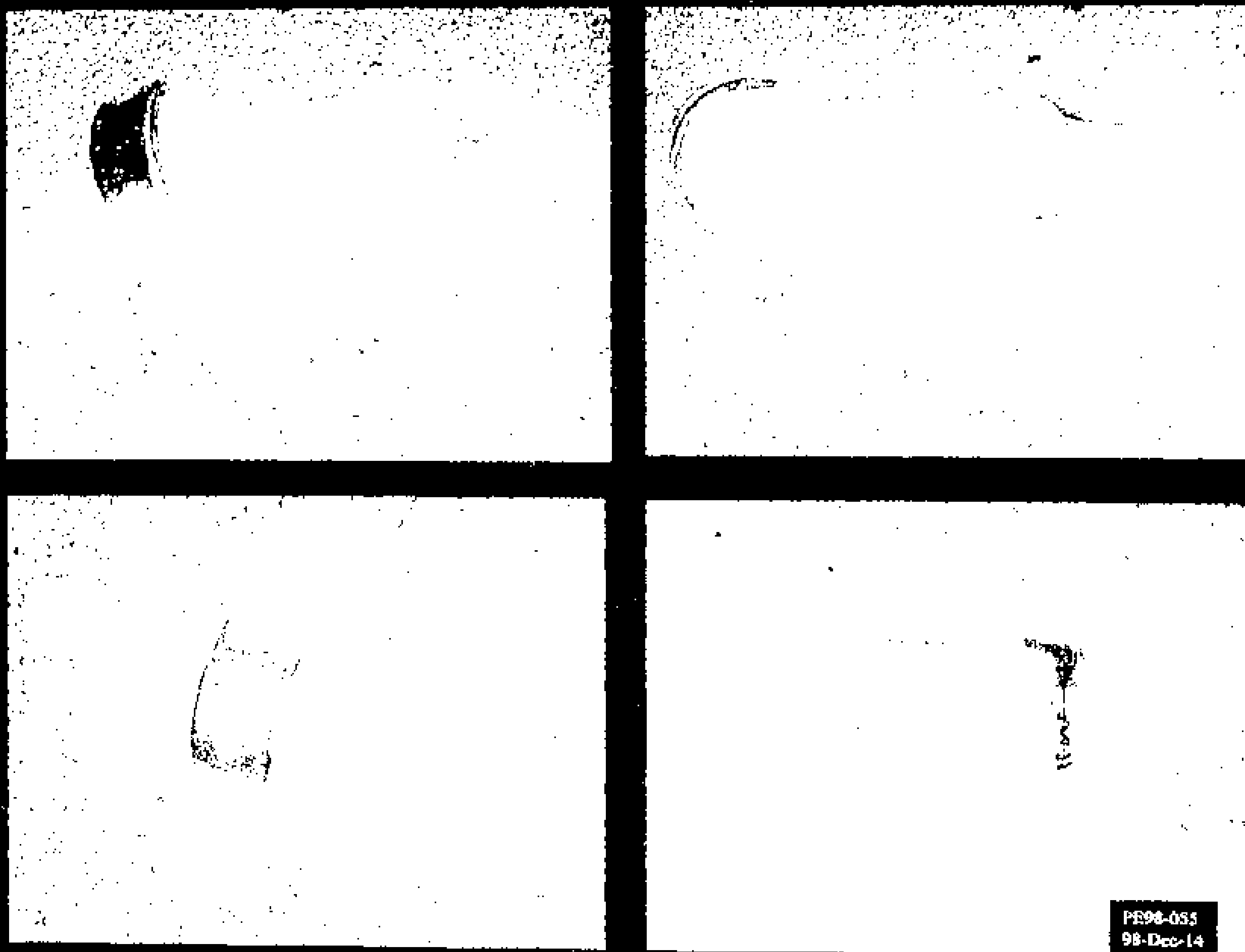
PE98-055
98-Dec-14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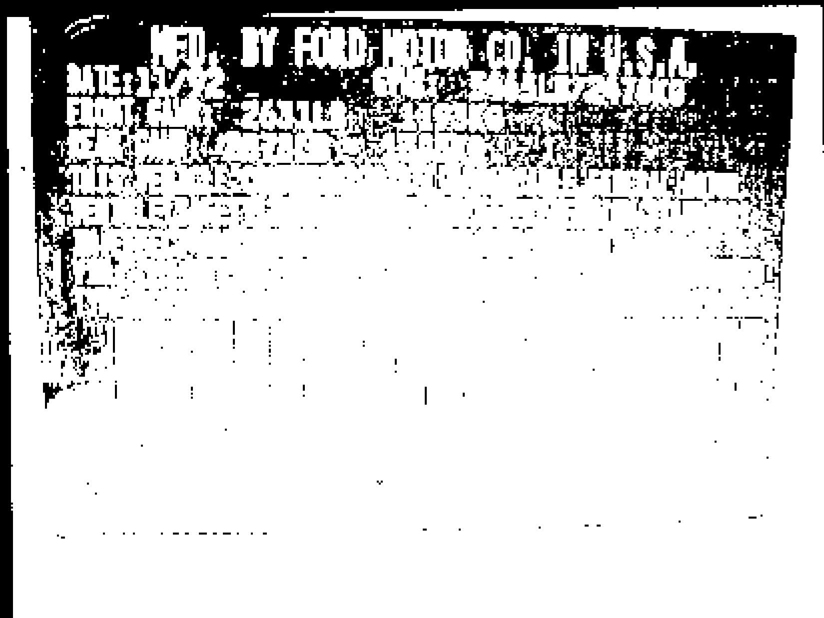
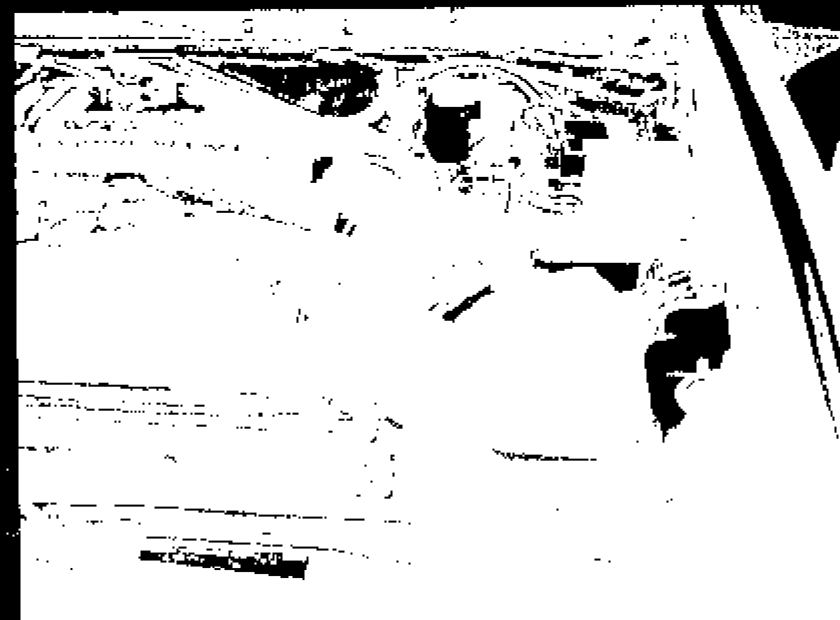
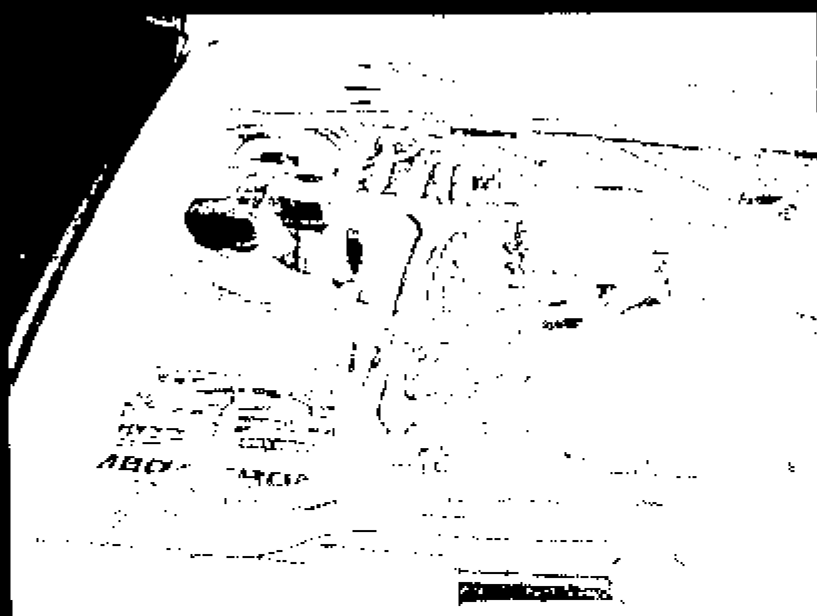
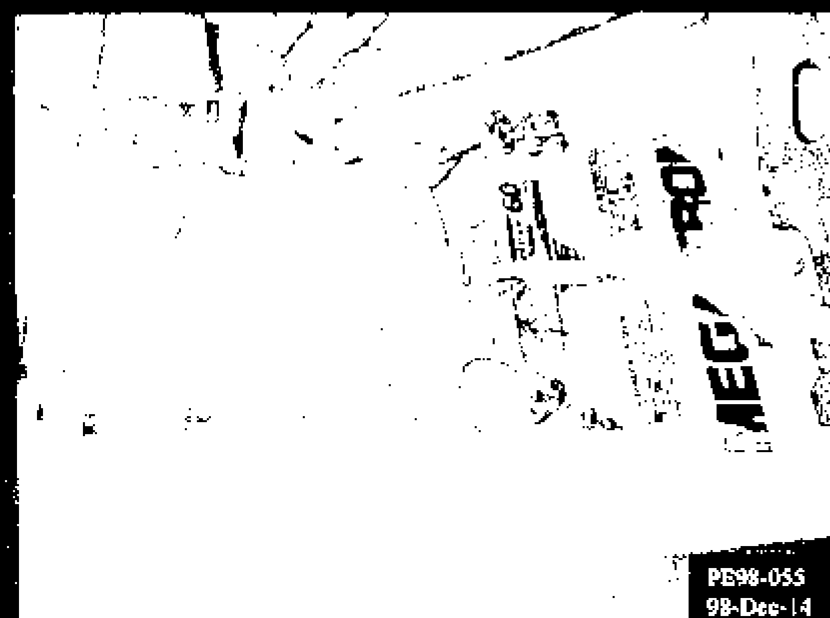
98-Dec-14





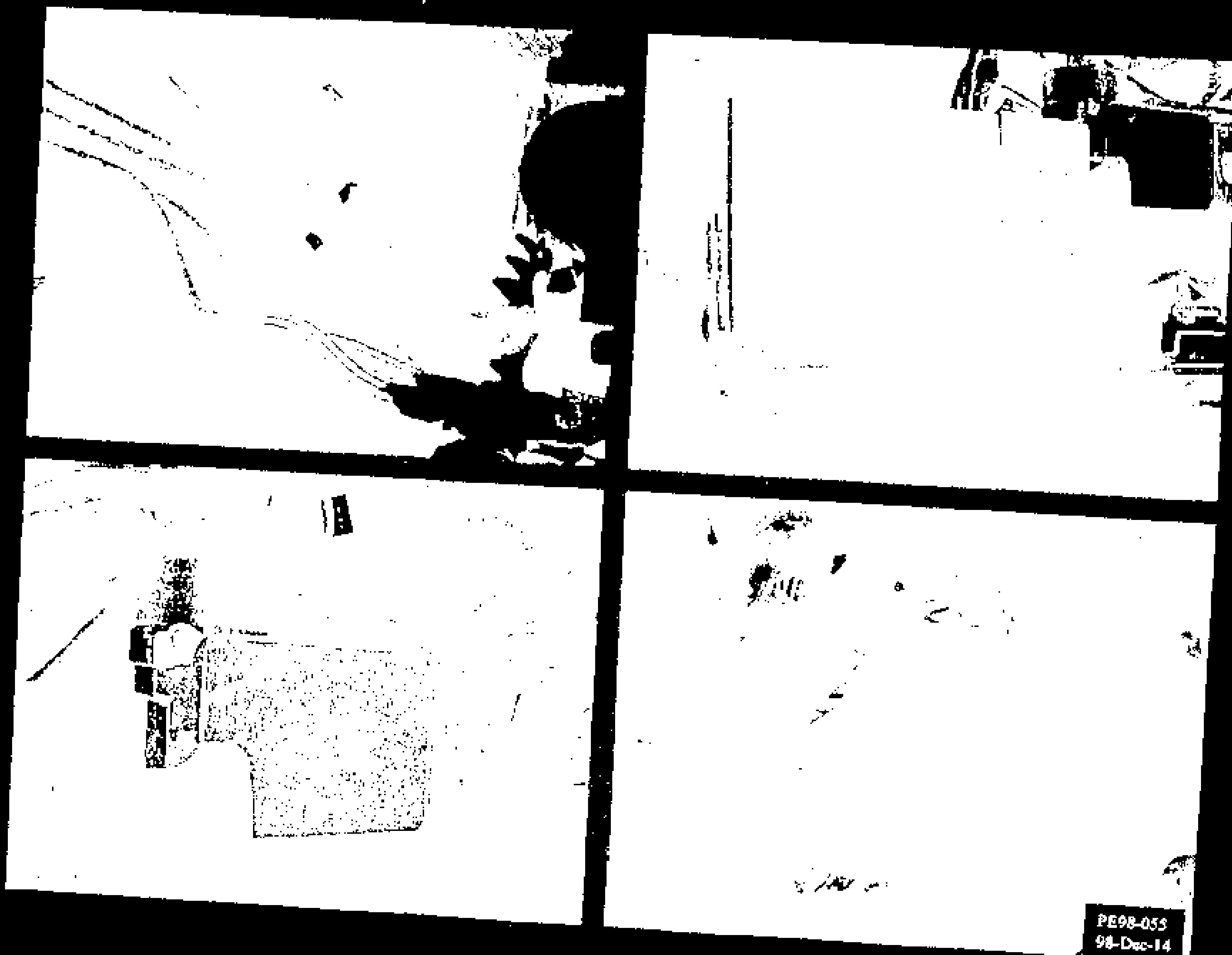




PE98-055
98-Dec-14

3713 7341

3713 7342



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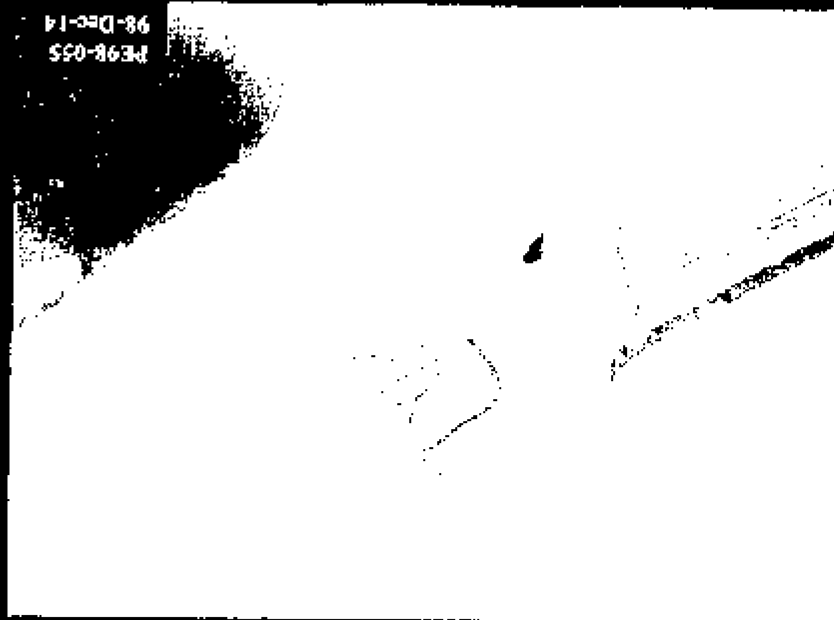

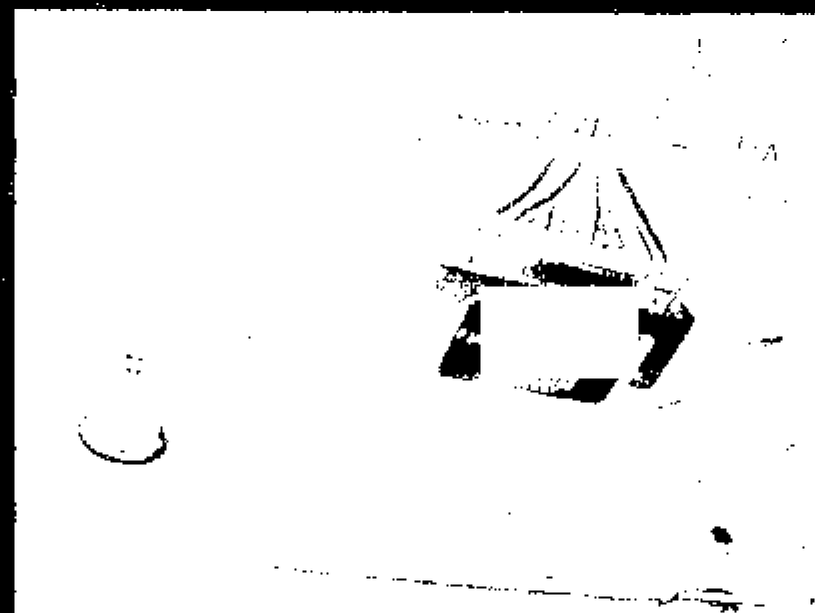

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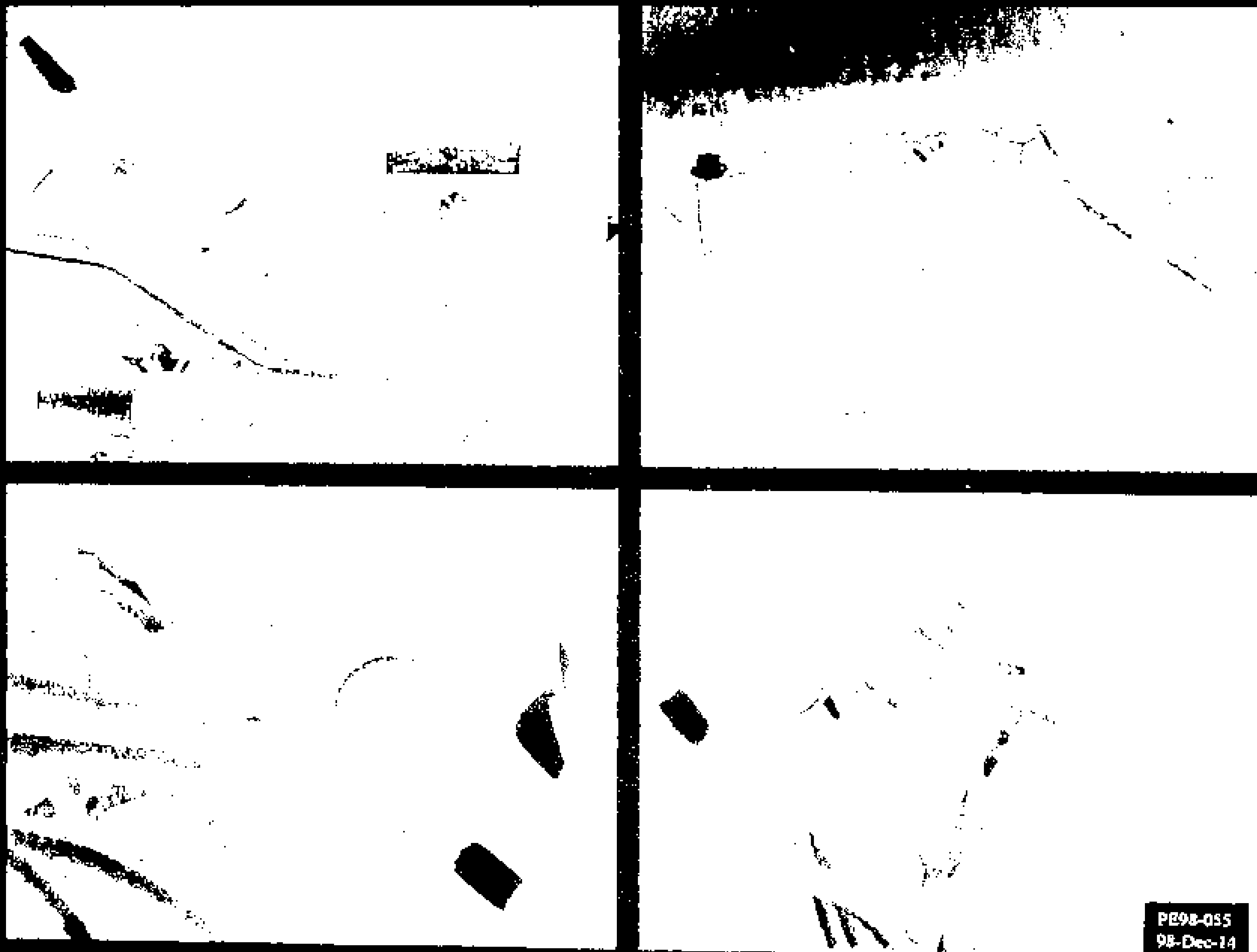
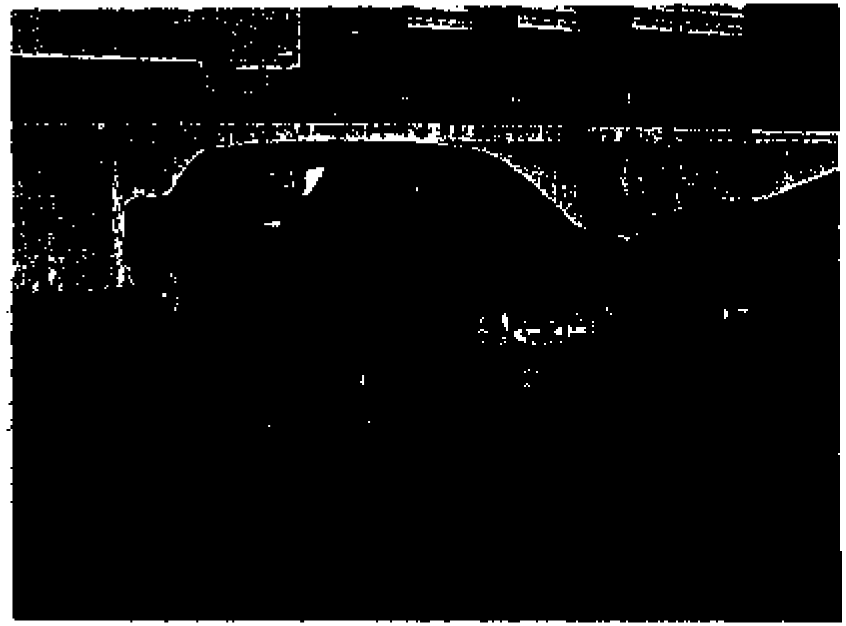


8713 7345

PE98-055
98-Dec-14

3713 7347

FIELD RETURN SAMPLES

Brake Pressure Switch   Plan Updated 2/16/99
Evaluation Plan for Field Returns

Sw #		Date of update	
Mileage		Sw Date Code	
Sw P/N			

Category	Step #	Action	Notes/Data	Comments
Field Info	1	Log Field Info into Switch Log.xls		
	2	Photograph Switch.		
	3	Record any unusual external visual observations		
	4	Check for Connector engagement		If not correct conduct X-Ray to determine fit-up between base lip and red seal
Switch + Connector Assembly	5	Wire 1 to Wire 2 Resistance		
	6	Wire 1 to Hexport Resistance		
	7	Wire 2 to Hexport Resistance		
	8	Separate Harness from Switch		
Connector Only	9	Verify Connector Seal		Visual check of Red Seal, Dirt lines, Indentation mark. Indentation mark must be 360 degrees.
	10	Wire 1 to Wire 2 resistance		
	11	Current Leakage Wire 1 to Wire 2		
	12	Check for full engagement of connector		Visual check of dirt lines on mated switch base
	13	Check wire insulation		
	14	Check wire gray seals		
	15	Cut wire insulation to check for corrosion		Cut insulation longitudinally to check for wicking along wires. If signs of corrosion, identify color, save samples for chem Lab.
Switch External Unpressurized	16	Assemble Switch to Calibration Stand		
	17	Terminal 1 to Terminal 2 Resistance		
	18	Terminal 1 to Hexport Resistance		
	19	Terminal 2 to Hexport resistance		
	20	Base to Hexport Resistance		
	21	Current Leakage Terminal 1 to Hexport		
	22	Current Leakage Terminal 2 to Hexport		
	23	Voltage drop at 750 mA		
Switch External Pressurized	24	Switch Opening Pressure		Do not perform on parts from underhood fires, as may disturb diaphragm/other condition
	25	Switch Closing Pressure		Do not perform on parts from underhood fires, as may disturb diaphragm/other condition
	26	Proof Test for Leakage		Do not perform on parts from underhood fires, as may disturb diaphragm/other condition
	27	Repeat Steps 17 through 23 at 100 psig		
Switch Internal		Procedure to remove aluminum crimp ring		
		Use aluminum foil (or plastic if Ford prefers) to mask the analysis surface.		
		Also create a paper/tape shield to further reduce chance of contamination during cutting of crimp ring.		
		Place a piece of tape over the area to be cut.		
		Cut crimp ring using jewelers saw or Dremel cutoff wheel		
		Cut corners of ring at 180 degree orientation		
		Unfold crimp ring		

3713 7348

	Optically examine revealed surfaces. Take optical photographs (Digital camera with macro lens plus instant microphotography) and document observations where appropriate. Examine the following areas Inside surface of crimp ring. Seal area and underside of base Top of cup
Analytical Techniques SEM/EDX/IR	Assess Need for Analytical Techniques Start SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis on the inside of the ring and on various surfaces of the plastic base. Repressurize the top surface and remove the cup Optically document all revealed surfaces starting with cup. Meanwhile, start SEM-EDX analysis on top side of cup. . Particularly look for evidence of corrosion or arcing Particularly focus in on the edges of the ceramic pin guide and on the indented ring that lines up with interior wall of the switch cavity Particularly look for evidence of corrosion or arcing Decide if we should try to flake off any of the overlaying debris to try to examine the underlying metal surface. Proceed to perform SEM-EDX analysis on other component surfaces revealed by removal of cup.
[redacted]	
Data Entry	Log All data from this sheet into Switch Log Photographs, Elemental maps etc must be retained and referenced by Switch #

3713 7349

Sample	VIN	Prefix/ Date Code	Condition	Findings: Hexport, Washer, Converter, and Spacer	Findings: Seals	Findings: Cup	Findings: Base/Switch Cavity/Terminals
Reddick (Memphis, 1993 Town Car)	1LNLM82W0PY[redacted]	[illegible]	Partially burned.	Black residue containing glycol based material (probably brake fluid) and a metal oxide. Indicates presence of brake fluid on fluid and switch sides of seals.	Environmental seal and gasket intact and appear to have had good sealing. All three Kapton seals are buckled and exhibit brittle cracks which most likely formed leak path. Damage appears to have initiated in seal closest to washer. Damaged Kapton deformed and embrittled by unknown mechanism.	Green Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product. Glycol based material (probably brake fluid) also detected in this area.	Base separated below crimp ring. Transfer pin and movable contact missing. Stationary contact exhibits loss of material due to corrosion, evidence of dezincification, stress corrosion cracking. Base of movable contact melted back into bulkhead between switch and terminal cavities. Appears to have occurred in later stages of event. Surfaces of terminals covered with black and green deposits which appear to be sulfur compounds of the terminal materials.
A (1993 Town Car, Houston)	1LNLM82W1PY[redacted]	????[illegible]	Burned	Elements from contact material detected at fitting and at hexport. Indicate possible flow of fluid back through seals. Traces of silicone detected.	Gasket and environmental seal missing. Charred fragments Kapton seals remain.	Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product.	Base, stationary contact, movable contact, and terminals missing.
B (1992 Town Car, Houston)	1LNLM82W5N[redacted]	F2VC2114	Burned	Elements from contact material detected at fitting and at hexport. Indicate possible flow of fluid back through seals.	Not permitted to disassemble switch.	Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product.	Transfer pin and movable contact missing. Stationary contact exhibits crack in similar location as that in Reddick sample.
C (1992 Town Car, Houston)	1LNLM81W8N[redacted]	F2VC[illegible]	Burned	Elements from contact material detected at fitting and at hexport. Indicate possible flow of fluid back through seals. Black deposit in cavity contains traces of hydrocarbons and silicone.	Gasket appears charred. Environmental seal missing. Damage to Kapton seals currently being evaluated.	Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product.	Base, stationary contact, movable contact, and terminals missing.
D (1997 Crown Victoria)	2FALP71W1V[redacted]	F2VC????	Apparent leakage.	Black residue containing glycol based material (probably brake fluid) and a metal oxide. Indicates presence of brake fluid on fluid and switch sides of seals.	Environmental seal and gasket intact and appear to have had good sealing. Kapton seals exhibit damage similar to that found in Reddick sample. All three exhibit brittle cracks which most likely formed a leak path.	Dark green deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product. Deposits appear to have formed a bridge between movable contact and cup. Liquid in interior and on face of cup is glycol based (probably brake fluid).	Switch cavity and terminal cavity contain glycol based material (probably brake fluid). Contacts appear intact. Dark green deposits on movable and stationary contacts contain elements from brass contact material. Terminals appear clean (no apparent deposits or corrosion).
E (#11 from survey)		F2VC2137	No leaks or other apparent problems.	Black residue containing glycol based material (probably brake fluid) and a metal oxide. Indicates presence of brake fluid on fluid and switch sides of seals.	Environmental seal and gasket intact and appear to have had good sealing. Kapton seals exhibit deformation and buckling similar to that found in Reddick sample. Cracking on surfaces suggest incipient damage is occurring.	Face of cup appears clean and dry.	Switch cavity and terminal cavity appear clean and dry. No apparent deposits or corrosion.
F	1LNLM82W1N[redacted]	F2VC2[illegible]	Apparent leakage	Black residue containing glycol based material (probably brake fluid) and a metal oxide. Indicates presence of brake fluid on fluid and switch sides of seals.	Environmental seal and gasket intact and appear to have had good sealing. Kapton seals exhibit damage similar to that found in Reddick sample. All three exhibit brittle cracks which most likely formed a leak path.	Dark green deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product. Liquid in interior and on face of cup is glycol based (probably brake fluid).	Switch cavity and terminal cavity contain glycol based material (probably brake fluid). Stationary contact is intact, but does show stress corrosion cracking in progress in bridge area (same location as in Reddick switch). Movable contact appears to have separated as a result of loss of material (~80% of thickness) due to corrosion. No evidence of heating or arc damage. Dark green deposits on movable and stationary contacts contain elements from brass contact material, as well as sulfur. Terminals exhibit green deposits (currently being analyzed). Deposits extend in from both sides of bulkhead between switch and terminal cavities, but do not meet.

Brake Pressure Switch Test Log
Updated 2/10/99

Category	Test	Location	Test Parameters	Results Update
Lab Simulation of Potential Ignition in Switch	1	TI	Various Levels of Brake Fluid, Water, Detergent 24Vdc to one terminal, hexport grounded	100+ hours into test, max current 6mA No significant change with time
	2	TI	Various Levels of Brake Fluid, Water, Detergent 1 Amp through switch terminals	100+ hours into test No significant temperature rise with time
	3	AVT	Brake Fluid in Switch, 24 VDC to one terminal Hexport Grounded	> 200 hours into test, max current 7mA No significant change with time
	4	AVT	Brake Fluid in Switch, 24 VDC to one terminal Hexport Grounded, Ambient at 140 C	16 hours into test max current 5mA No significant temperature rise with time
	5	AVT	Brake Fluid in Switch, 15 Amps Through switch terminals	Temperature rise of 25 C above room temp Delta T reached steady state at 25 C
	6	TI	Solid heater clamped into Switch Test to Failure	Expected update 2/19
Life Cycle Reliability of Pressure Switch	7	TI	0-1400 psig pressure pulses at 150 C ambient per ES	Fails at 600k cycles, no leaks. Will continue to failure
Diaphragm Wear Field vs Lab Correlation	8	TI	0-1400 psig pressure pulses at 150 ambient	Parts withdrawn every 200k cycles, being analyzed for wear
	9	Central Labs	Various Field returns, from dealer lots, Junkyards	Parts in Central Labs, being processed
Design Of Experiments Evaluating Factors Affecting Diaphragm Wear	10	TI	Various Levels of Brake Fluid, Water, Under ES conditions, to failure	Test being structured. Expected Phase One to begin 2/19
On-Vehicle Characterization of Pressure & Temperature Profile in Town Car	11	AVT	Monitor Pressure and Temperature at Switch Location for ABS and non-ABS braking events.	Logistics being worked out.

3713 7361

```
********************************************************************************
*        Note printed by NLAPOINT on 17 Feb 1999 at 16:26:26                 *
********************************************************************************
```

From: I2060625--EXTERNAL   Date and time   02/17/99 08:53:37
To: FPORTER --FORDMAIL 'Fred Porter (For NLAPOINT--FORDMAIL 'Norm LaPointe (F
SLAROUCH--FORDMA1 'Steve LaRouche (SREIMERS--FORDMAIL 'Steve Reimers (F

From: Rahman, Aziz
Subject: Switch Dissection Proposal

Please review the attached dissection guidelines. Please add/edit, and I will incorporate them in the process flow.

Thanks
Aziz.

Decide if we should remove any material or try any other analysis before we start disassembling the device.

* Procedure to remove aluminum crimp ring
* Use aluminum foil (or plastic if Ford prefers) to mask the analysis surface.
* Also create a paper/tape shield to further reduce chance of contamination during cutting of crimp ring.
* Place a piece of tape over the area to be cut.
* Cut crimp ring using jewelers saw or Dremel cutoff wheel in one of the two areas indicated on optical photo.
* Cut corners of ring at 180 degree orientation
* Unfold crimp ring
* Optically examine revealed surfaces. Take optical photographs (Digital camera with macro lens plus instant microphotography) and document observations where appropriate. Examine the following areas
    * Inside surface of crimp ring.
    * Seal area and underside of base
    * Top of cap
* Start SEM-EDX (Scanning Electron Microscope with Energy Dispersive Analysis of X-rays) analysis on the inside of the ring and on various surfaces of the plastic base.
* Reprotect the top surface and remove the cap.
* Optically document all revealed surfaces starting with cap.
* Meanwhile, start SEM-EDX analysis on top side of cap. Particularly focus in on the edges of the ceramic pin guide and on the indented ring that lines up with interior wall of the switch cavity. Particularly look for evidence of corrosion or arcing.
* Decide if we should try to flake off any of the overlaying debris to try to examine the underlying metal surface.
* Proceed to perform SEM-EDX analysis on other component surfaces revealed by removal of cap.

FOED LAB RESULTS

```
*************************************************************************
*           Note printed by NLAPOINT on 2 Mar 1999 at 15:22:45          *
*************************************************************************
```

From: SLAROUCH--FORDNA1 Date and time 03/02/99 11:56:23
To: FPORTER --FORDMAIL Porter, Fred (F.J. NLAPOINT--FORDMAIL LaPointe, Norman (
SREIMERS--FORDMAIL Reimers, Steve (S. I2060625--EXTERNAL 'A. Rahman'
SMCCART3--FORDMAIL McCarthy, Shaun (S SLAROUCH--FORDNA1 LaRouche, Steve (S

From: LaRouche, Steve (S.)
Subject:

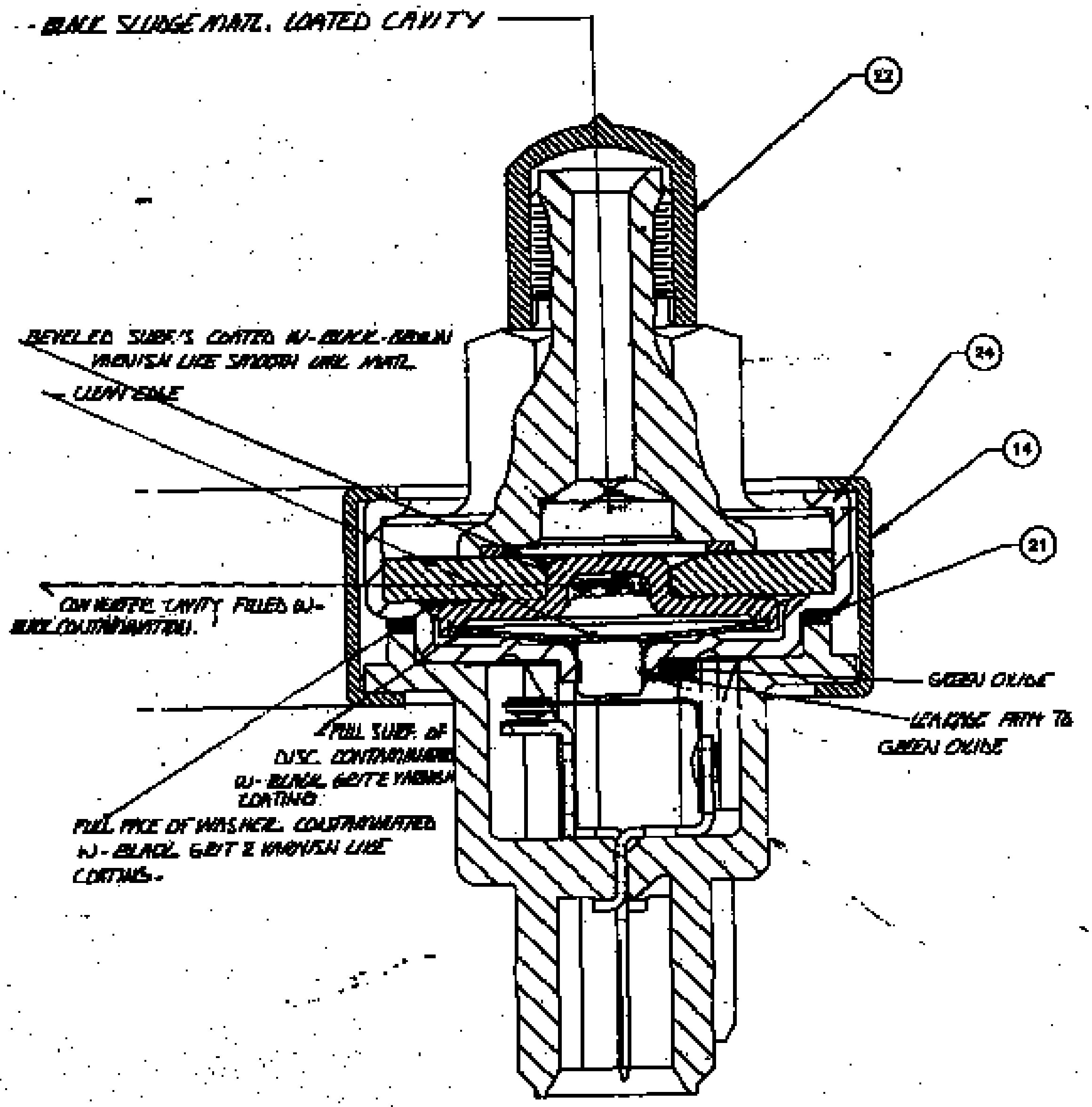
We have found three switches so far (including the one to be analyzed by the Sci Lab), that will not open electrically when disc is heard to snap under application of air pressure. I sectioned one of these switches and found what appears to be water (it evaporated rather quickly at room temp) and corrosion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

Steve LaRouche (SLAROUCH)
Metallurgy Section, Central Laboratory, Room N416
(313) 845-4876 (313) 322-1614 FAX

3713 7354

Log Updated 2/15/1999

Sw #	Sw Date Code	Vehicle	VIN	Event	Mileage	Leaks?	Kapton #1	Kapton #2	Kapton #3	Term-Hsgpc Resistance	Present Location of Sw.	Present Status	Comments
Memphis		Town Car		Sw. Fire			Tear	Tear	Tear		Central Lab		
A		Town Car		Underhood Fire							Central Lab	Analysis in Progress	
B		Town Car		Underhood Fire							N/A	Sw. not available	
C		Town Car		Underhood Fire							Central Lab	Analysis in Progress	
D		Crown Vic Police Car		Cruise Insp			Tear?	Tear?	Tear?		Central Lab	Analysis in Progress	
E		Town Car		Reference							Central Lab	Analysis in Progress	
F		Town Car		Cruise Insp			Tear?	Tear?	Tear?		Central Lab	Analysis in Progress	
1	2305	Town Car	[illegible]	Reference	79404						AVT		
3	2015	Town Car	[illegible]	Reference	71097						AVT		
4	2040	Town Car	[illegible]	Reference	80087						AVT		
5		Town Car		Reference	96548						Central Lab	Analysis in Progress	
6		Town Car		Reference	47928						Central Lab	Analysis in Progress	
7	2089	Town Car	[illegible]	Reference	[illegible]						AVT		
8	[illegible]	Town Car	[illegible]	Reference	68514						AVT		
9	2200	Town Car	[illegible]	Reference	??						AVT		
10	2281	Town Car	[illegible]	Reference	58224						AVT		
11	2025	Town Car	[illegible]	Reference	91508						AVT		
From TX trip of 3/10 to 3/12													
1	3035	Town Car	[illegible]	Reference							AVT		With Connector and servo
2	3066	Crown Vic Police Car	[illegible]	Reference	148839						AVT		With Connector and servo
3	[illegible]	Grand Marquis	[illegible]	Reference	??						AVT		With Connector and servo
4	3035	Crown Vic	[illegible]	Reference	40542						AVT		With Connector
5	[illegible]	Town Car	[illegible]	Reference	73118						AVT		With Connector
6	??	Town Car	[illegible]	Underhood Fire	??						AVT		
7	3084	Town Car	[illegible]	Reference	??						AVT		With Connector
8	3045	Town Car	[illegible]	Underhood Fire	105510						AVT		With Servo, Prop Valve
9	3089	Town Car	[illegible]	Reference	??						AVT		With Connector, Prop Valve, Servo
10	2272	Crown Vic	[illegible]	Reference	72514						AVT		With Connector, Prop Valve, Servo
11	2115	Town Car	[illegible]	Reference	??						AVT		With Connector
12	[illegible]	Town Car	[illegible]	Reference	??						AVT		With Connector
13	[illegible]	Town Car	[illegible]	Reference	105048						AVT		With Connector and Servo



UNLE DIM

FRACT

MATE

NOTES AFTER T.I. DISASSEMBLY

3713 7356

Sample	VIN	Pyrofil Date Code	Condition	Findings: Hexport, Washer, Converter, and Spacer	Findings: Seals	Findings: Cup	Findings: Base/Switch Cavity/Terminals
Reddick (Memphis) 93 Town Car		F2VD/2008	Partially burned.	Black residue containing glycol based material (probably brake fluid) and a metal oxide. Indicates presence of brake fluid on fluid and switch sides of seals.	Environmental seal and gasket intact and appear to have had good sealing. All three Kapton seals are buckled and exhibit brittle cracks which most likely formed leak path. Damage appears to have initiated in seal closest to switch. Damaged Kapton darkened and embrittled by unknown mechanism.	Green Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product. Glycol based material (probably brake fluid) also detected in this area.	Base separated below crimp ring. Transfer pin and movable contact missing. Stationary contact exhibits loss of material due to corrosion, evidence of dezincification, stress corrosion cracking. Base of movable contact melted back into bulkhead between switch and terminal cavities. Appears to have occurred in later stages of event. Surfaces at terminals covered with black and green deposits which appear to be sulfur compounds of the terminal materials.
A (1995 Town Car, Houston)	1LNLM82W1[redacted]	???/2001	Burned	Elements from contact material detected at fitting end of hexport. Indicate possible flow of fluid back through seals.	Gasket and environmental seal missing. Charred fragments Kapton seals remain.	Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product.	Base, stationary contact, movable contact, and terminals missing.
B (1992 Town Car, Houston)	1LNLM83W4[redacted]	F2VC/2114	Burned	Elements from contact material detected at fitting end of hexport. Indicate possible flow of fluid back through seals.	Not permitted to disassemble switch.	Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product.	Transfer pin and movable contact missing. Stationary contact exhibits crack in similar location as that in Reddick sample.
C (1992 Town Car, Houston)	1LNLM81W2[redacted]	F2VC/2003	Burned	Elements from contact material detected at fitting end of hexport. Indicate possible flow of fluid back through seals. Black deposit in cavity currently being analyzed (possibly charred gasket).	Gasket appears charred. Environmental seal missing. Damage to Kapton seals currently being evaluated.	Deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product.	Base, stationary contact, movable contact, and terminals missing.
D (1997 Crown Victoria)	2FALP74W1[redacted] 1 - 6.9 m 2 - 1.1 m ~~3 - low resistance~~ 3. [illegible]	F2AC/????	Apparent leakage.	Black residues currently being analyzed. same as Reddick	Environmental seal and gasket intact and appear to have had good sealing. Kapton seals exhibit damage similar to that found in Reddick sample. All three exhibit brittle cracks which most likely formed a leak path.	Dark green deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product. Liquid on surface currently being analyzed.	Switch cavity and terminal cavity contain what appears to be brake fluid (currently being confirmed). Contacts appear intact. Dark green deposits on movable and stationary contacts contain elements from brass contact material. Terminals appear clean (no apparent deposits or corrosion).
E (1911 from survey)	1 6.3 m 2 6.73 M 3 low [redacted]	F2AC/2137	No leaks or other apparent problems.	Dark residues currently being analyzed. ~~[illegible]~~ ~~[illegible]~~ same as Reddick	Environmental seal and gasket intact and appear to have had good sealing. Kapton seals exhibit deformation and buckling similar to that found in Reddick sample. Cracking on surfaces suggest incipient damage is occurring.	Face of cup appears clean and dry.	Switch cavity and terminal cavity appear clean and dry. No apparent deposits or corrosion.
F	1LNLM82W[redacted] 1 - 4 m 3 - [illegible] - 2 m	F2VC/2126	Apparent leakage	Black residues currently being analyzed. same as Reddick	Environmental seal and gasket intact and appear to have had good sealing. Kapton seals exhibit damage similar to that found in Reddick sample. All three exhibit brittle cracks which most likely formed a leak path.	Dark green deposits on face of cup contain elements from brass contacts indicating transfer of contact material to cup probably as oxide, sulfide, or corrosion product. Liquid on surface currently being analyzed.	Switch cavity and terminal cavity contain what appears to be brake fluid (currently being confirmed). Stationary contact appears intact. Movable contact appears to have separated as a result of corrosion. Dark green deposits on movable and stationary contacts contain elements from brass contact material, as well as sulfur. Terminals exhibit green deposits (currently being analyzed).

why was this one chosen

CHK: OPTIONS? ABS & TRACTION

1 - Resis between cup, terminals
2 - Resis between cavity & threaded fitting
3 - Resis between cavity & case

3719 7357

Brake Pressure Switch Table:

Definitions:

Resistance Measurement #1 = Resistance reading between connector terminals (NC switch)

Resistance Measurement #2 = Resistance reading between sensor case and threaded fitting.

Resistance Measurement #3 = Resistance reading between both connector pins and sensor case.

	Sensor	Id Code	Date	Zip Code	Res. #1	Res. #2	Res. #3	
	#1	PY754575	5-93	42621	0.2 Ohm	167.0 Ohms	Inf. Resistance	
	#2	NY740208	6-92	53237	0.3 Ohm	0.3 Ohms	Inf. Resistance	
	#3	PY688795	1-93	NA	0.3 Ohm	4.48 M Ohms	Inf. Resistance	
	#4	PX629934	11-92	68302	0.2 Ohm	1.5 Ohms	Inf. Resistance	
	#5	PY650225	10-92	72114	0.2 Ohm	1.7 Ohms	Inf. Resistance	
	#6	PX638867	12-92	55333	0.3 Ohm	17 K Ohms	Inf. Resistance	
	#7	PX665270	4-93	66689	0.3 Ohm	2.9 Ohms	Inf. Resistance	
	#8	PX643515	12-92	43531	0.2 Ohm	0.4 Ohms	Inf. Resistance	
	#9	PX623672	10-92	94145	0.2 Ohm	24 M Ohms	Inf. Resistance	
	#10	PY695374	1-93	NA	0.2 Ohm	11.30 M Ohms	Inf. Resistance	
"E"	#11	NX758774	7-92	97199	0.2 Ohm	6.79 M Ohms	Inf. Resistance	
	#12	BY639984	9-93	97199	0.2 Ohm	0.2 Ohms	Inf. Resistance	
"D"	'Leaking sensor'	VIN 2FALP71W1V[redacted]			0.4 Ohm	1.1 Ohms	4.80 M Ohms	
				CENT. LAB.		1-34	140K GROWING TO 6M [illegible]	
	New sensor #1				0.2 Ohm	0.4 Ohm	Inf. Resistance	
	New sensor #2				0.2 Ohm	1.1 Ohm	Inf. Resistance	UNSTABLE

"F" PHASE 2120 1LNLM82W1N[redacted] [illegible]

300K - 2M

116117

3713 7368

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*************************************************************************
*          Note printed by NLAPOINT on 17 Feb 1999 at 16:15:06          *
*************************************************************************

From: FPORTER --DRBN007                        Date and time    01/22/99 09:51:02
To: NLAPOINT--DRBN005

FROM: F. J. Porter                          USAET(UTC -05:00)
Subject: RE: (U) Brake Fluid Questions

Regards,
Fred Porter           OV - fporter        fporter@ford.com
Chassis E/E Systems Applications          (313)845-3722
Bldg 5 - Mail Drop 5030 - Cubicle 3E004   fax: 390-4145
*** Forwarding note from GGULLEN --FORDNA1  01/22/99 08:12 ***
To: CTHOMAS5--FORDSNTP Thomas, Clark (C.D MHAGA    --FORDNA1  Haga, Mary (M.C.)
    GGULLEN --FORDNA1  Gullen, Gayle (G.D
cc: FPORTER --FORDMAIL Porter, Fred (F.J. GSTEVEN1--FORDMAIL Stevens, Gregory (
    KGRIBBLE--FORDMAIL                    RKOWALC3--FORDNA1  Kowalczyk, Richard

From: Gullen, Gayle (G.D.)
Subject: RE: (U) Brake Fluid Questions
```

I just talked to Mike Kitt at Dow and he informed me that Gregg Stevens is faxing him a list of questions to answer. The one that Mike can't answer is regarding whether or not brake fluid reacts with copper/brass. The answer to that is yes, under some circumstances. We have seen several instances over the years in various assembly plants where brake fluids have formed an organometallic copper complex. This only occurs after there has been some type of welding repair to the delivery system. Dow does not add anything copper based to their system and they have never been able to assist us in determining the exact nature of the copper complex formed. Eventually this material flushes from the plant system, however, in an enclosed system like a switch I suspect we could have flocculating particulates.

```
-----Original Message-----
From: Clark Thomas  mailto:cthomas5@accms1.dearborn.ford.com
Sent: Thursday, January 21, 1999 5:27 PM
To: mhaga@mail.ford.com; ggullen@mail.ford.com
Cc: fporter@gw.ford.com; gsteven1@gw.ford.com; kgribble@gw.ford.com
Subject: (U) Brake Fluid Questions
```

Gayle/Mary: Can you comment on this? It is in reference to the issue of fires
possibly caused by the Texas Instrument Cruise Control Switch being looked at by NHTSA and our Legal Staff. Thanks.

```
Regards, Clark Thomas
AVT Materials (Plastics/Elastomers)
313-59-41313 (Bld5); 313-32-23108 (POEE)
*** Forwarding note from FPORTER --DRBN007  01/21/99 10:13 ***
To: CTHOMAS5--DRBN005                    GSTEVEN1--DRBN005

FROM: F. J. Porter                          USAET(UTC -05:00)
Subject: (U) Brake Fluid Questions
```

Two questions:

Is brake fluid conductive? How much?

3713 7359

Will brake fluid react with copper or brass? Will an electric field or current cause a reaction?

Regards,

Fred Porter OV - fporter fporter@ford.com
Chassis E/E Systems Applications (313)845-3722
Bldg 5 - Mail Drop 5030 - Cubicle 3E004 fax: 390-4145

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*****************************************************************************
*          Note printed by NLAPOINT on 17 Feb 1999 at 09:08:40              *
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From: SREIMERS--DRBN007                        Date and time    02/16/99 18:12:29
To: JNENE    --DRBN005                         NLAPOINT--DRBN005
    RNEVI    --DRBN005                         SLAROUCH--FORDMA1
    I2060625--EXTERNAL Aziz Rahman, Texas

FROM: Steve Reimers                            USAET(UTC -05:00)
Subject: (U)
Can you help me get smart regarding the "LOOSE METAL PART" mentioned above?

Steve Reimers                           building 5  3C043
AVT Chassis E/E System Applications     mail drop  5011
39-03286 SREIMERS   sreimers@ford.com   fax 39-03286       ;>
*** Forwarding note from SCOLE1  --DRBN005  02/16/99 18:04 ***
To: SREIMERS--DRBN007
cc: DGOEL    --DRBN005

From: Sam L. Cole                              USAET(UTC -05:00)
Subject: (U)
THE PREVIOUS CONCERN OF THE "LOOSE METAL PART" WAS MENTIONED IN THE LAST
MEETING WITH JACK. HE WILL WANT A FOLLOW UP ON THIS AT THIS FRIDAY'S
MEETING. PLEASE GET UP TO SPEED ON THE HISTORY OF THIS CONCERN. IF IT
TURNS OUT THAT THIS MAY BE A CAUSE, THEN WE WILL NEED TO KNOW WHEN THE
ISSUE WAS IN THE FIELD, WHEN IT WAS FIXED AND HOW MANY ARE OUT THERE TO
BE CONCERNED ABOUT. THANKS.

Thank You,
Sam
Ext. 21959
BLDG. 2, 22J31 - MD# 1220 - SCOLE1@FORD.COM
*** Forwarding note from SREIMERS--DRBN007  02/16/99 16:52 ***
To: SCOLE1  --DRBN005                         DGOEL    --DRBN005

FROM: Steve Reimers                            USAET(UTC -05:00)
Subject: (U)
I have the part to show and a take-apart version too.  I am not familiar with t
he previous problem but a loose metal part in the switch cavity is definitely a
 potential cause of this concern.

Steve Reimers                           building 5  3C043
AVT Chassis E/E System Applications     mail drop  5011
39-03286 SREIMERS   sreimers@ford.com   fax 39-03286       ;>
*** Forwarding note from DB7AWAYR--DRBN007  02/16/99 13:41 ***
Subject:  AWAY Facility/VM messages
This note was generated by the AWAY Facility/VM 5799-FLP (c) IBM Corp.
                     DO NOT REPLY TO THIS NOTE

AWA110I This mail item is being routed to you from SCOLE1 at DRBN005
on behalf of FPORTER at DRBN007.

To: FPORTER --DRBN007
cc: TMASTERS--DRBN005                         TDONOVAN--DRBN005
    DGOEL    --DRBN005

From: Sam L. Cole                              USAET(UTC -05:00)
Subject: (U)
I UNDERSTAND THAT THERE WILL BE A FOLLOW UP MEETING WITH JACK PASKUS
```

3713 7361

THIS FRIDAY ON THE TOWN CAR INVESTIGATION. I MET WITH JACK TODAY FOR A 1 ON 1, AND HE REQUESTED SOME SPECIFIC INFO. AT FRIDAYS MEETING, PLEASE BRING A SAMPLE SWITCH TO SHOW JACK.

ALSO, HE IS INTERESTED IN KNOWING OUR PROGRESS AND INVESTIGATING IF THE PREVIOUS PROBLEM WITH THE INTERNAL COMPONENTS BREAKING LOOSE IS A POTENTIAL CAUSE OF THIS CONCERN. PLEASE BE PREPARED TO DISCUSS THIS ON FRIDAY. THANKS.

Thank You,
Sam
Ext. 21959
BLDG. 2, 22J31 - MD# 1220_- SCOLE1@FORD.COM

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***************************************************************************
*          Note printed by NLAPOINT on 17 Feb 1999 at 16:26:48           *
***************************************************************************
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From: SREIMERS--DRBN007 Date and time 02/17/99 09:41:08
To: NLAPOINT--DRBN005 I2060625--EXTERNAL Aziz Rahman, Texas

FROM: Steve Reimers USAET(UTC -05:00)
Subject: RE: (U)

Steve Reimers building 5 3C043
AVT Chassis E/E System Applications mail drop 5011
39-03286 SREIMERS sreimers@ford.com fax 39-03286 ;>
*** Forwarding note from SLAROUCH--FORDMA1 02/17/99 08:18 ***
To: SREIMERS--FORDMAIL Reimers, Steve (S.

From: LaRouche, Steve (S.)
Subject: RE: (U)

Steve: The switch in question is switch F. The copper-berylium arm of the movable contact separated from the brass base. Now that we have had a chance to look at it in closer detail, it appears that the arm separated due to a loss of material thickness from corrosion. We have also found evidence of stress corrosion cracking in the stationary contact. We did not see any evidence of heat or arc damage in this switch. It looked like the arm separated, fell away, and stuck to the wall of the switch cavity.

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

-----Original Message-----
From: Steve Reimers mailto:sreimers@gw.ford.com
Sent: Tuesday, February 16, 1999 6:13 PM
To: jname@gw.ford.com; nlapoint@gw.ford.com; rnavi@gw.ford.com; slarouch@mail.ford.com; Aziz Rahman, Texas
Subject: (U)

Can you help me get smart regarding the "LOOSE METAL PART" mentioned above?

Steve Reimers building 5 3C043
AVT Chassis E/E System Applications mail drop 5011
39-03286 SREIMERS sreimers@ford.com fax 39-03286 ;>
*** Forwarding note from SCOLE1 --DRBN005 02/16/99 18:04 ***
To: SREIMERS--DRBN007
cc: DGOEL --DRBN005

From: Sam L. Cole USAET(UTC -05:00)
Subject: (U)
THE PREVIOUS CONCERN OF THE "LOOSE METAL PART" WAS MENTIONED IN THE LAST MEETING WITH JACK. HE WILL WANT A FOLLOW UP ON THIS AT THIS FRIDAY'S MEETING. PLEASE GET UP TO SPEED ON THE HISTORY OF THIS CONCERN. IF IT TURNS OUT THAT THIS MAY BE A CAUSE, THEN WE WILL NEED TO KNOW WHEN THE ISSUE WAS IN THE FIELD, WHEN IT WAS FIXED AND HOW MANY ARE OUT THERE TO BE CONCERNED ABOUT. THANKS.

Thank You,
Sam

Ext. 21959
BLDG. 2, 22J31 - MD# 1220_- SCOLE1@FORD.COM
*** Forwarding note from SREIMERS--DRBN007 02/16/99 16:52 ***
To: SCOLE1 --DRBN005 DGOEL --DRBN005

FROM: Steve Reimers USAET(UTC -05:00)
Subject: (U)
I have the part to show and a take-apart version too. I am not familiar with t
he previous problem but a loose metal part in the switch cavity is definitely a
potential cause of this concern.

Steve Reimers building 5 3C043
AVT Chassis E/E System Applications mail drop 5011
39-03286 SREIMERS sreimers@ford.com fax 39-03286 ;>
*** Forwarding note from DB7AWAYR--DRBN007 02/16/99 13:41 ***
Subject: AWAY Facility/VM messages
This note was generated by the AWAY Facility/VM 5799-FLP (c)IBM Corp.
DO NOT REPLY TO THIS NOTE

AWA110I This mail item is being routed to you from SCOLE1 at DRBN005 on behalf of FPORTER at DRBN007.

To: FPORTER --DRBN007
cc: TMASTERS--DRBN005 TDONOVAN--DRBN005
DGOEL --DRBN005

From: Sam L. Cole USAET(UTC -05:00)
Subject: (U)
I UNDERSTAND THAT THERE WILL BE A FOLLOW UP MEETING WITH JACK PASKUS THIS FRIDAY ON THE TOWN CAR INVESTIGATION. I MET WITH JACK TODAY FOR A 1 ON 1, AND HE REQUESTED SOME SPECIFIC INFO. AT FRIDAYS MEETING, PLEASE BRING A SAMPLE SWITCH TO SHOW JACK.

ALSO, HE IS INTERESTED IN KNOWING OUR PROGRESS AND INVESTIGATING IF THE PREVIOUS PROBLEM WITH THE INTERNAL COMPONENTS BREAKING LOOSE IS A POTENTIAL CAUSE OF THIS CONCERN. PLEASE BE PREPARED TO DISCUSS THIS ON FRIDAY. THANKS.

Thank You,
Sam
Ext. 21959
BLDG. 2, 22J31 - MD# 1220_- SCOLE1@FORD.COM

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*****************************************************************************
*          Note printed by NLAPOINT on 4 Feb 1999 at 13:17:44              *
*****************************************************************************
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From: SLAROUCH--FORDMA1 Date and time 02/02/99 09:51:57
To: FPORTER --FORDMAIL Porter, Fred (F.J. NLAPOINT--FORDMAIL LaPointe, Norman (

From: LaRouche, Steve (S.)
Subject: Status of S/C Switches

Fred/Norm: The SEM portion of the work is pretty much complete. Pat has acquired all the spectra and is interpreting them. Copper and zinc were detected on the cup surfaces of the A, C, D, and F samples, which indicates transfer of oxide or corrosion product from the contacts to the cup. This suggests corrosion of the contacts as a common thread among the leaking and burned switches. The infrared work is in progress. We've given them alot of samples, so it is going to take them awhile to finish their analyses. Apparently, they can't take their sample until just before they analyze it and that has prevented me from routing these samples for further analyses. I asked them to give the seals priority so I can have Vlad in polymers look at them. I hope to have the seals later today.

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

3713 7365

Ford
Central Laboratory
15000 Century Drive
Dearborn, MI 48120-1267

January 15, 1999

Preliminary Findings:

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

The stationary contact exhibits intergranular cracks which indicate stress corrosion cracking (SCC). SCC is caused by combination of a specific corrosive environment and a sustained tensile stress (can be localized). Ammonia, ammonia compounds, sulfur compounds, and moisture are known to cause SCC in brass. The contact material has been reported to be 360 brass, which is highly susceptible to SCC.
260

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

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

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

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

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

Steve LaRouche

Mini-FAX Transmittal 1/20/99 1
To: Dept. PLT
Fax No. 78256
Fax No. 21644

3713 7366

Conclusions:

Kapton seals are becoming brittle and cracked, forming leak path for brake fluid to enter switch.

Presence of elements of brass contact material on face of steel cup indicates transfer of contact material to cup. This suggests that a cell may be being formed between the contacts which are positive, and the cup which is ground. The brake fluid may be acting as the electrolyte.

The stationary contact in the Redddick switch exhibits corrosion and dezincification. Dezincification indicates presence of water in switch cavity. The contact also shows evidence of stress corrosion cracking (intergranular cracks), which is most often caused by exposure to ammonia, ammonia compounds, sulfur, or moisture.

$i = 0.75\,A$ normal

TI test 135°C 24 sw.

0 → 1400 psi @ 500,000 $N_f = 1.6 \times 10^6$

@ 2Hz ok leaks

N_f 900,094 @ fails

1.13×10⁶ → 1.13×10^6
1.3
1.32
1.34
1.35
1.4
1.41

leaks

3713 7368

Central Laboratory
15000 Century Drive
Dearborn, MI 48120-1267
FAX (313) 322-1614

Report 9804106

January 19, 1999

To: G. Stevens/N. LaPointe/S. LaRouche (313) 32-38686 07224 FAX

From: Gayle D. Gullen (313) 32-27322

Subject: Speed Control Cut-Off Switch
Part Number: F2VY-9F924-A
Source: Customer Vehicle

Received: One opened switch which had undergone a thermal event and one unused switch housing were received on January 4, 1999, from S. LaRouche. The switch was returned on January 11, 1999, after disassembly and preliminary examination by Texas Instruments.

Object: Determine if any fluid is present on the switch base in metallic-exposed area and compare the switch housing material to the unused material. Determine the nature of the black residue in the hexport and converter and determine the type of fluid in the diaphragm squares.

Conclusion/ Discussion: There was spectral evidence of a glycol ether [spectrally similar to Dow HD 50-4 brake fluid] and a metal soap on the metallic-exposed area of the switch cup. The customer base and unused base are spectrally similar and are composed of a polyester material. ~~This is not the 'Noryl' material which was specified. [Noryl is a styrenated PPO (polyphenylene oxide).]~~

The exact nature and source of the noted metal soap could not be conclusively determined. Metal soaps can be utilized as polymeric compounding and/or mold release agents. Metal soaps are also utilized in greases [this glycol ether material does not match known carrier grease fluids] and may also be formed in the presence of acids and metal salts [both perhaps a reaction of the polymeric housing and metallic interference during the event].

The black residue in the hexport, converter, and washer are similar and are composed of a glycol based material [probably brake fluid] and a metal salt [probably an oxalate salt]. The black residue on the spacer is composed of a metal salt [probably oxalate salt], and a glycol based fluid [probably brake fluid]. The fluid removed from the #2 diaphragm was glycol based [probably brake fluid] and contained a metal salt [probably oxalate salt]. The hexport deposit appears to contain ~10% water, however, this value may be artificially elevated due to reactions with the salts and other compounds in the deposit.

Decomposition of the polyester base causes acid formation, with one of these acids likely being oxalic acid. Reaction with the metals in the system forms oxalate salts. Based on this, it is highly unlikely that the oxalate salts were introduced into the system in this fashion but were likely formed during the thermal decomposition of the housing.

Data and Analysis:

<u>Molecular Characterization</u>
(FTIR, Qualitative, Microscopic)

Arrow B in Figure 2 points to area where analysis was performed). Spectra of the fluid noted on the metallic surface [chloroform micro casts - several areas] are characteristic of a glycol ether [spectrally similar to Dow HD 50-4 brake fluid] with evidence of an ester and metal soap.

Spectra of the new, brown base are characteristic of a polyester on the base of terephthalic acid.

Spectra of the blackened, customer base are similar to the new base and are characteristic of a polyester on the base of terephthalic acid.

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