EA02-025

TEXAS INSTRUMENTS, INC.'S

9/10/03

REQUEST NO. 7

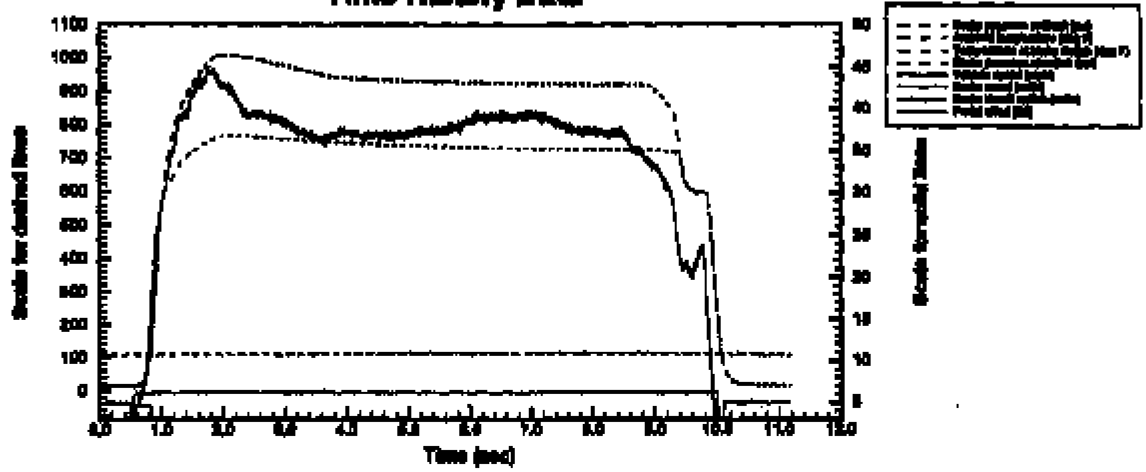
BOX 9

PART A – R

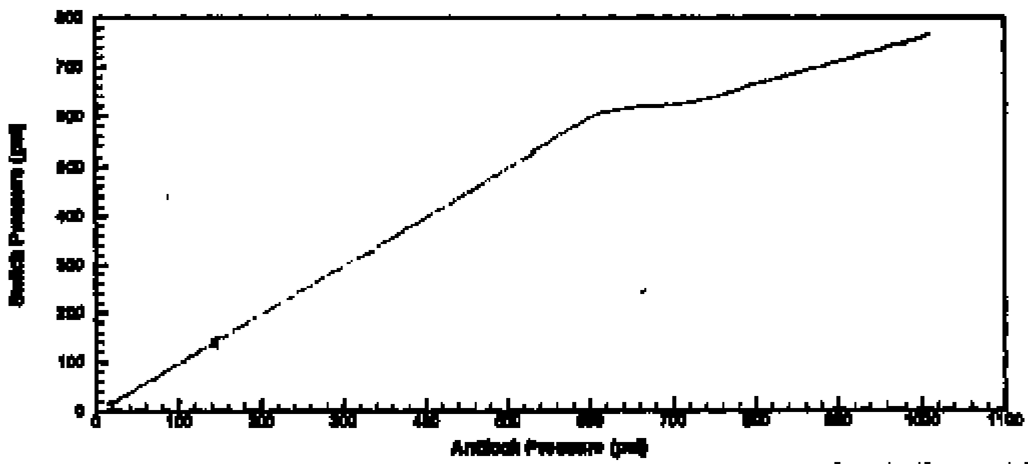
PART R

static brake effort	Ford Test Data: Lincoln Towncar	File Name: BLincoln.001

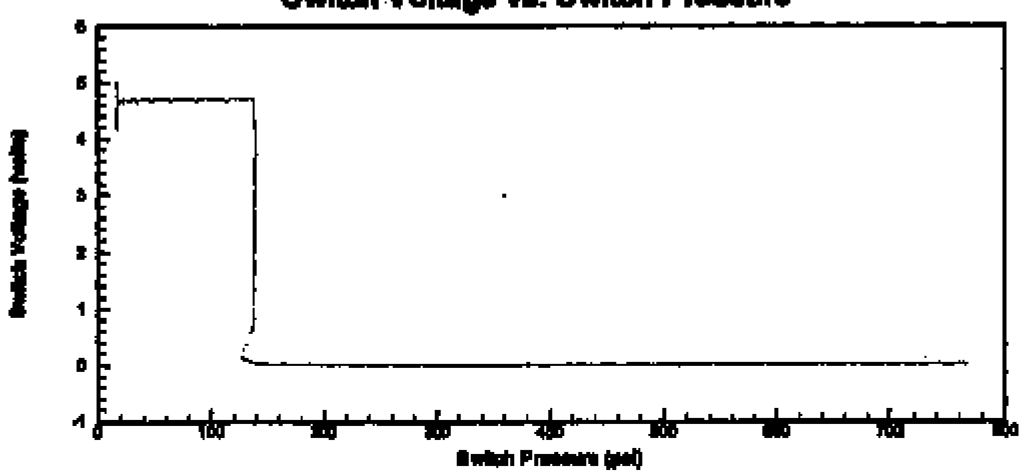
Time History Data



Switch Pressure vs. Antilock Pressure

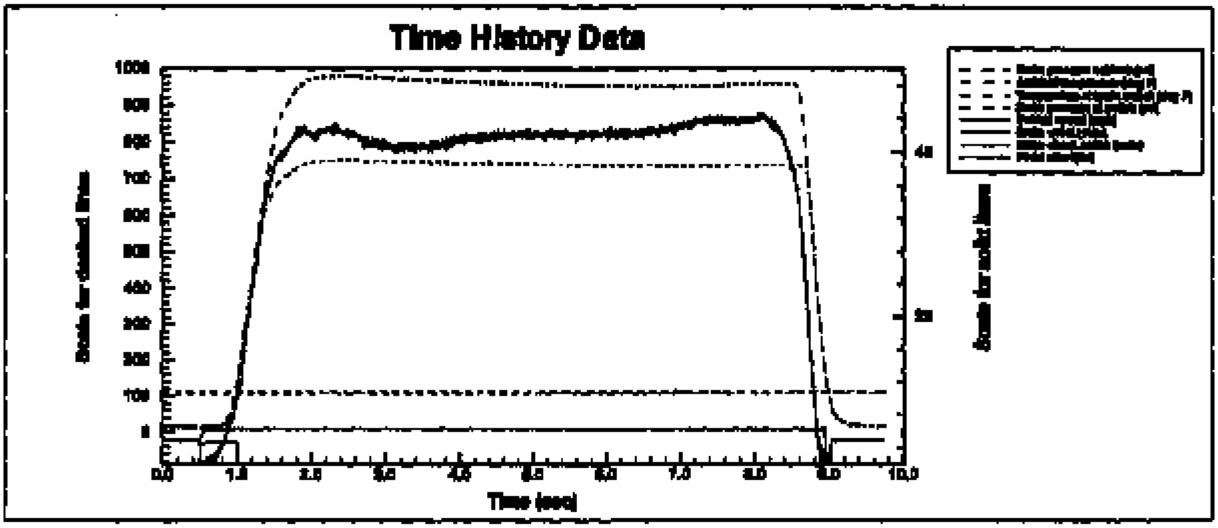


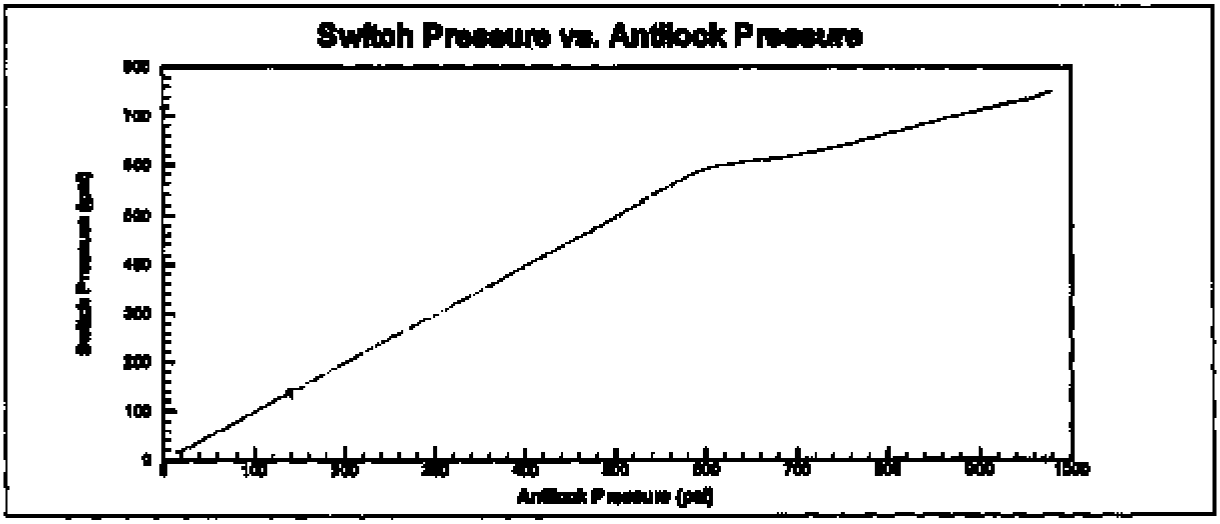
Switch Voltage vs. Switch Pressure

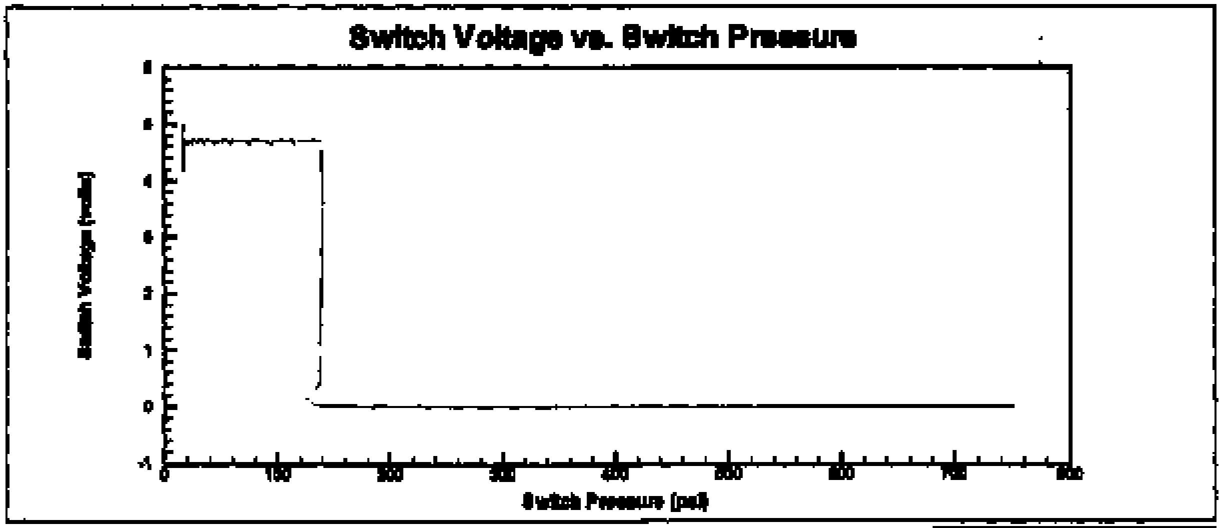


Design Research Engineering

static brake effort	Ford Test Data: Lincoln Towncar	File Name: lincoln.002

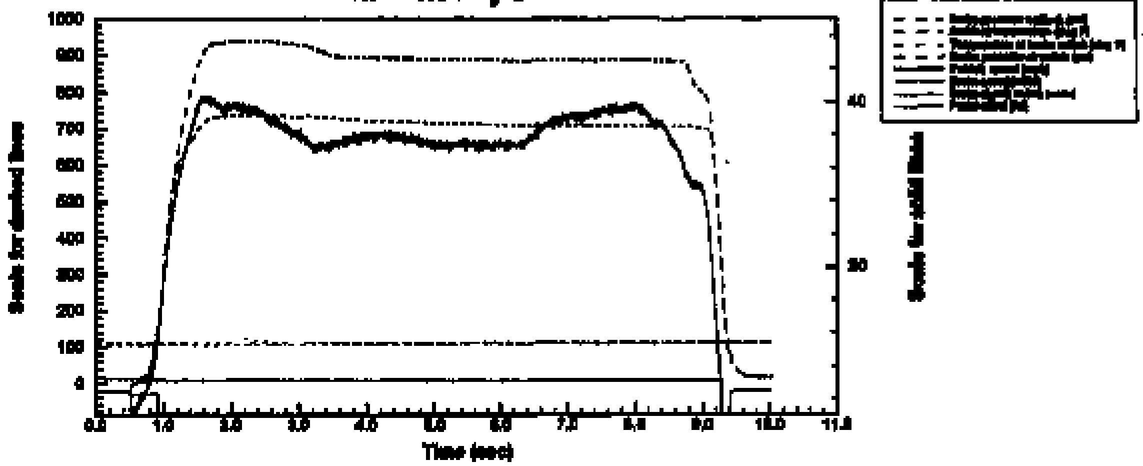




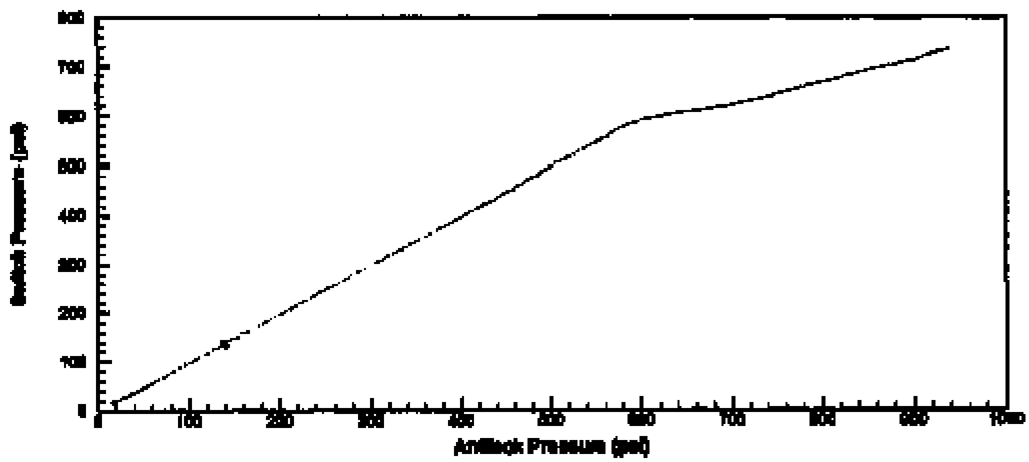


Design Research Engineering

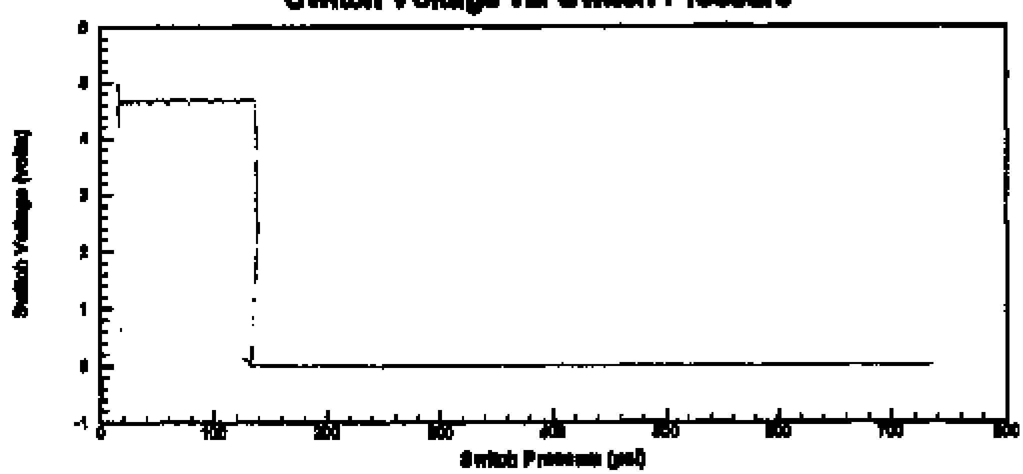
Time History Data



Switch Pressure vs. Antilock Pressure



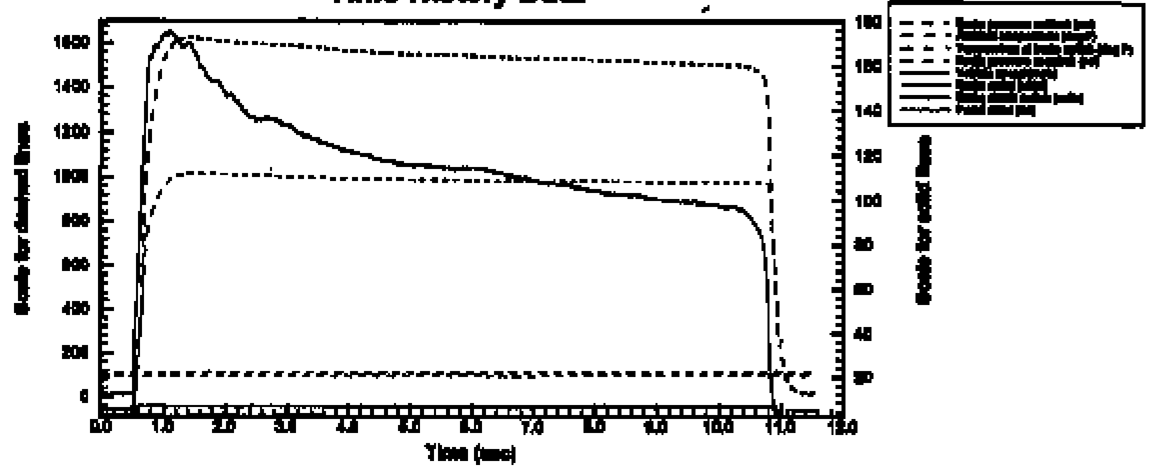
Switch Voltage vs. Switch Pressure



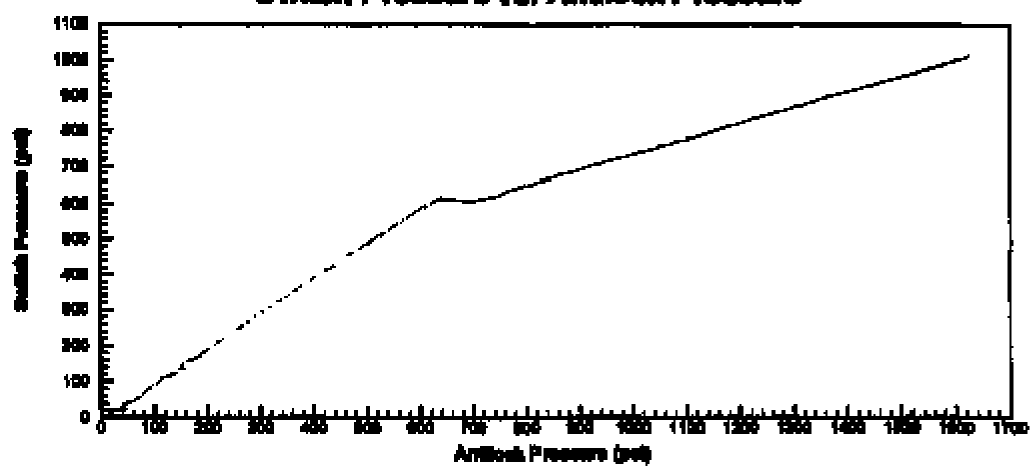
Design Research Engineering

static brake effort | Ford Test Data: Lincoln Towncar | File Name: 1Lincoln.068

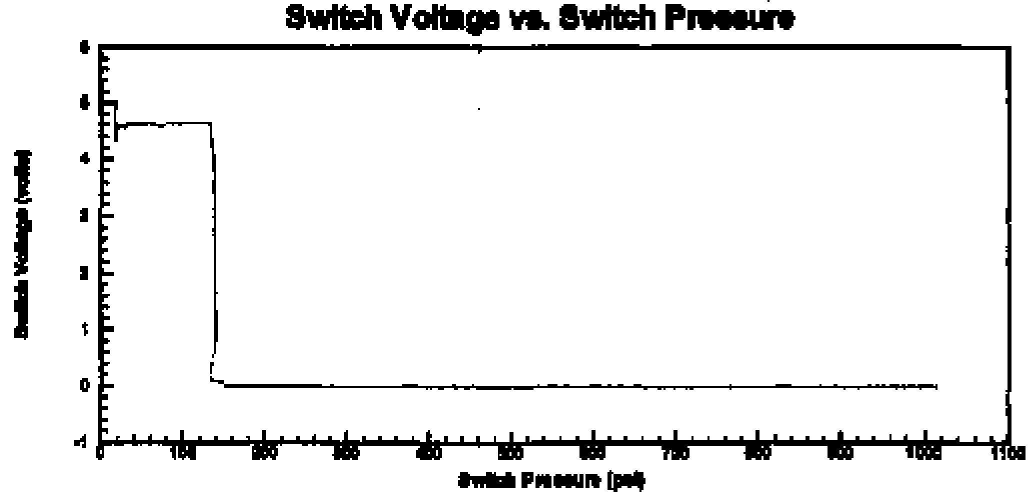
Time History Data



Switch Pressure vs. Antilock Pressure

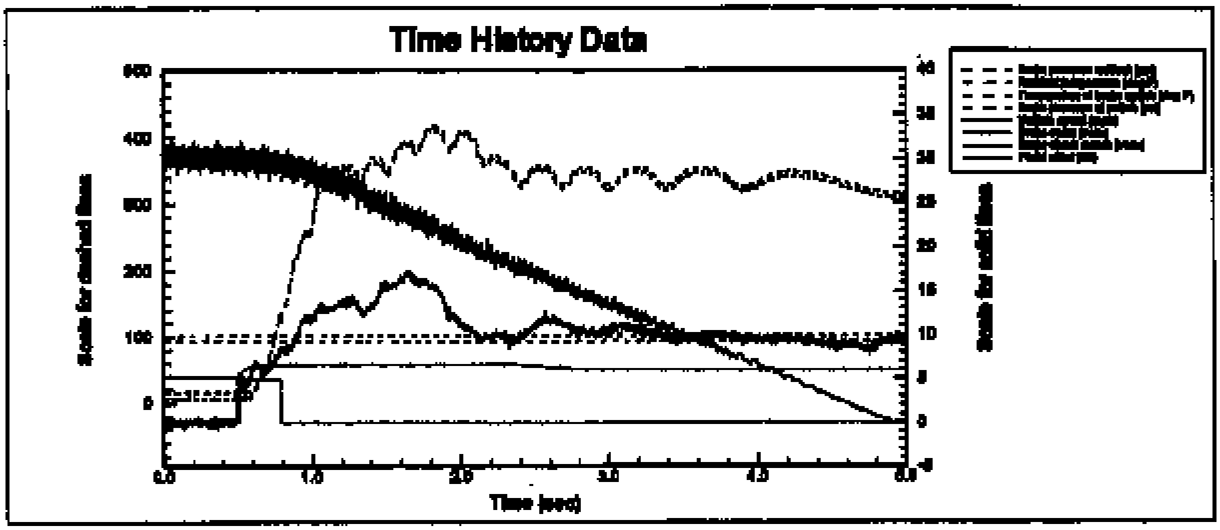


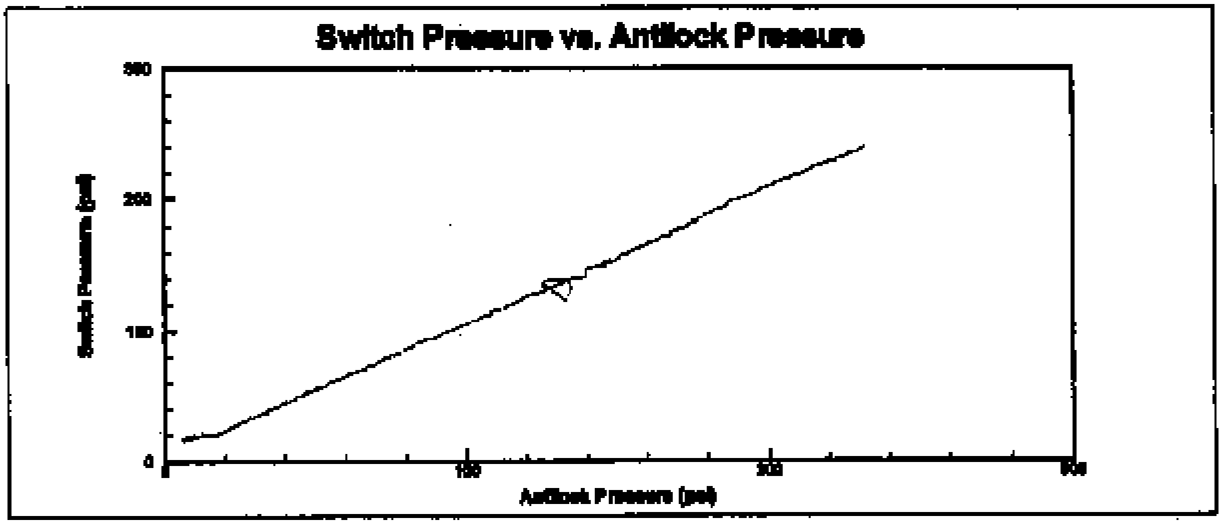
Switch Voltage vs. Switch Pressure

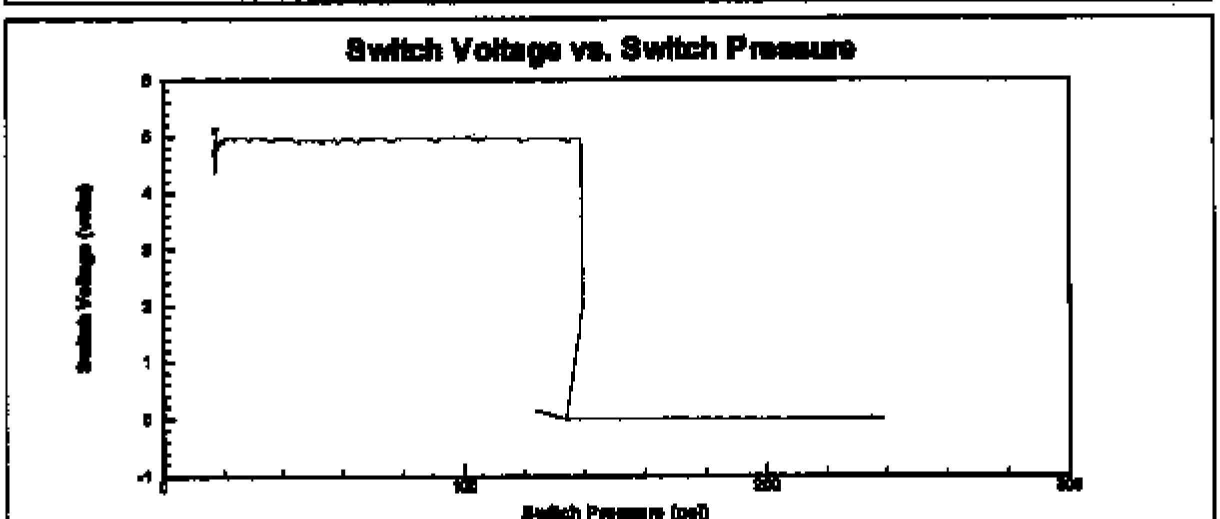


Design Research Engineering

30 mph normal	Ford Test Data: Lincoln Towncar	File Name: tLincoH.001





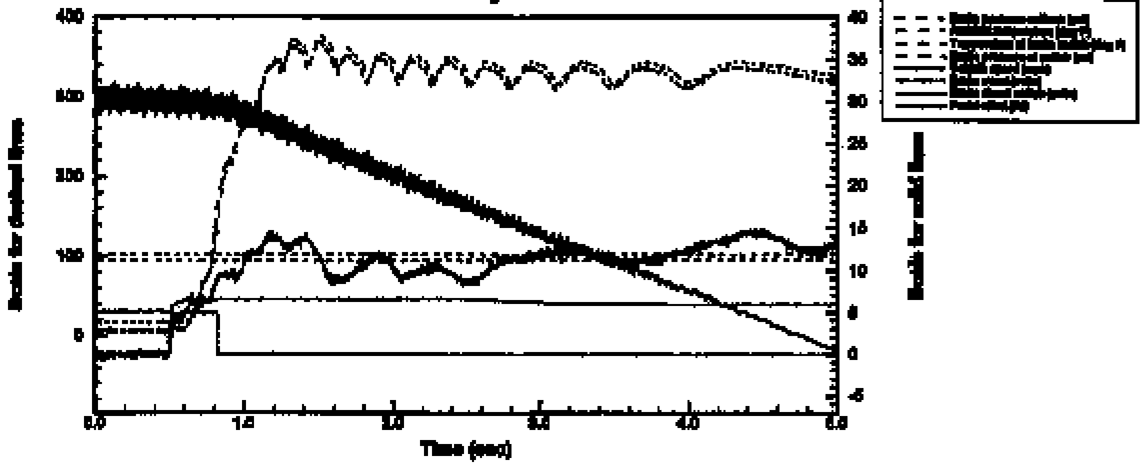


Design Research Engineering

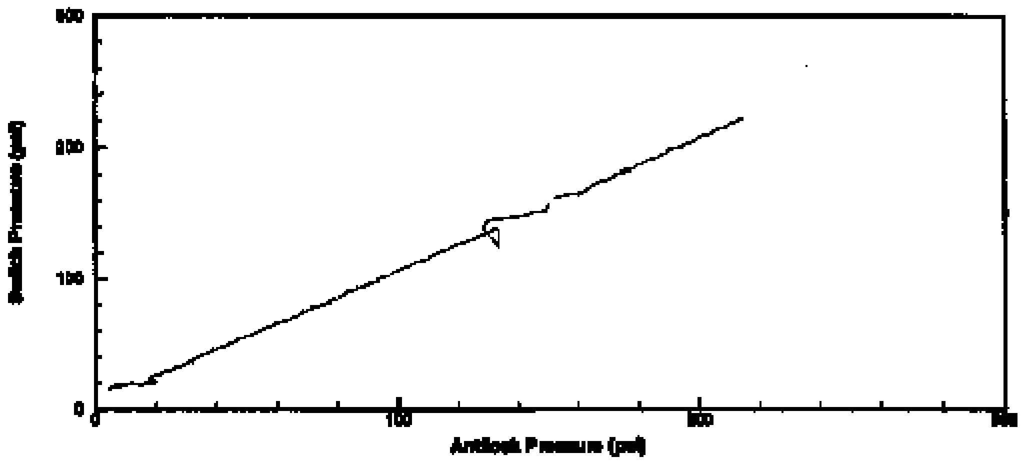
TI-NHTSA 014909

30 mph normal	Ford Test Data: Lincoln Towncar	File Name: ILincol1.002

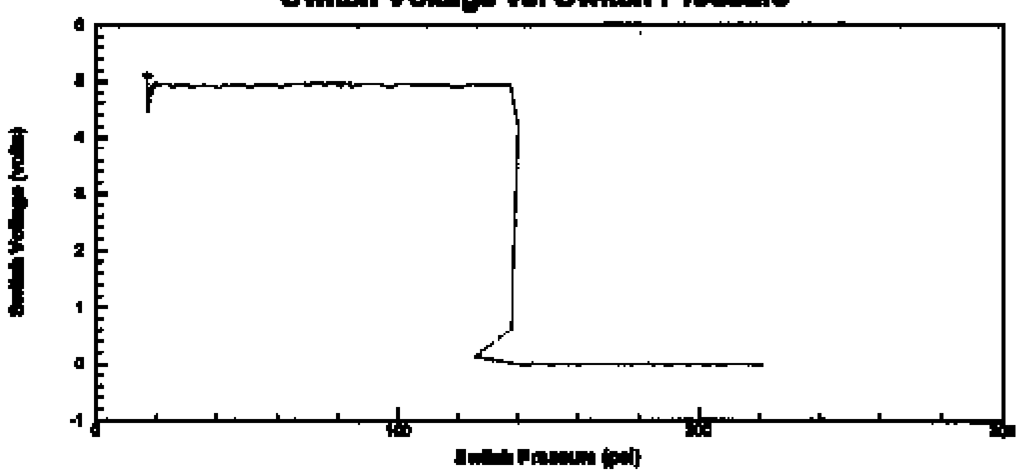
Time History Data



Switch Pressure vs. Antilock Pressure



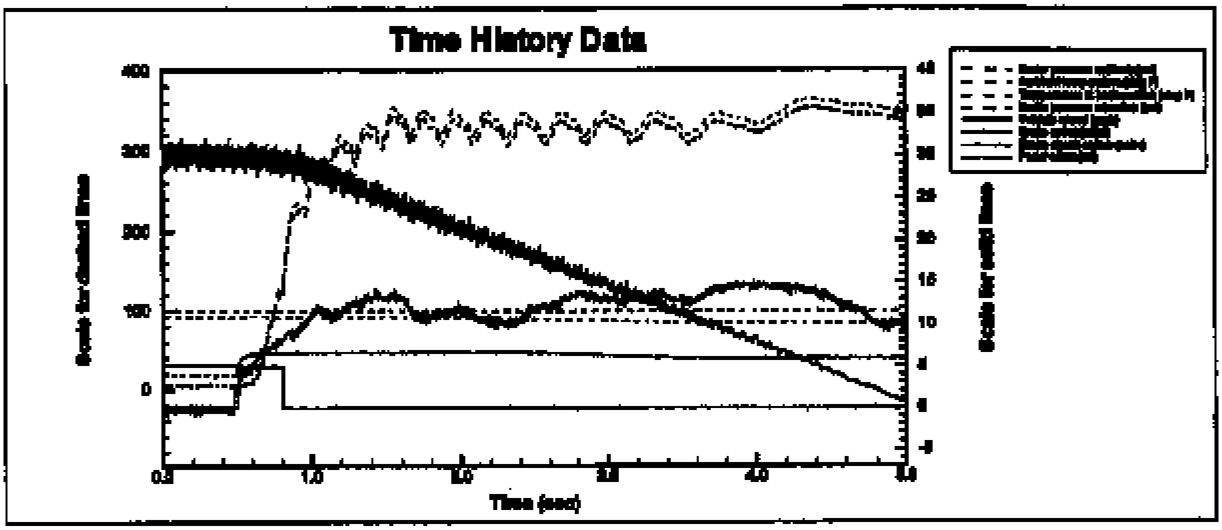
Switch Voltage vs. Switch Pressure

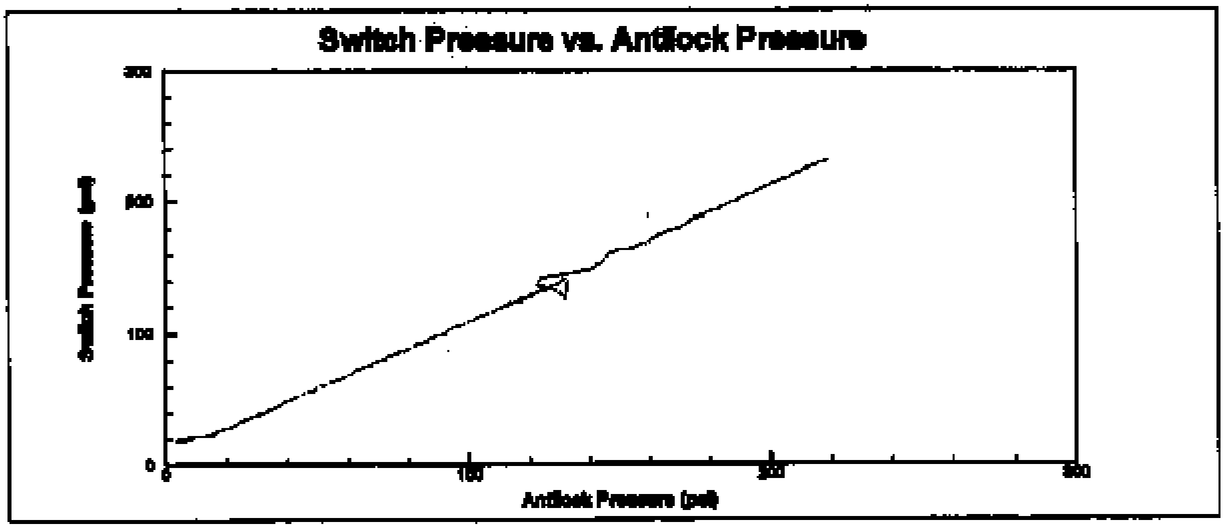


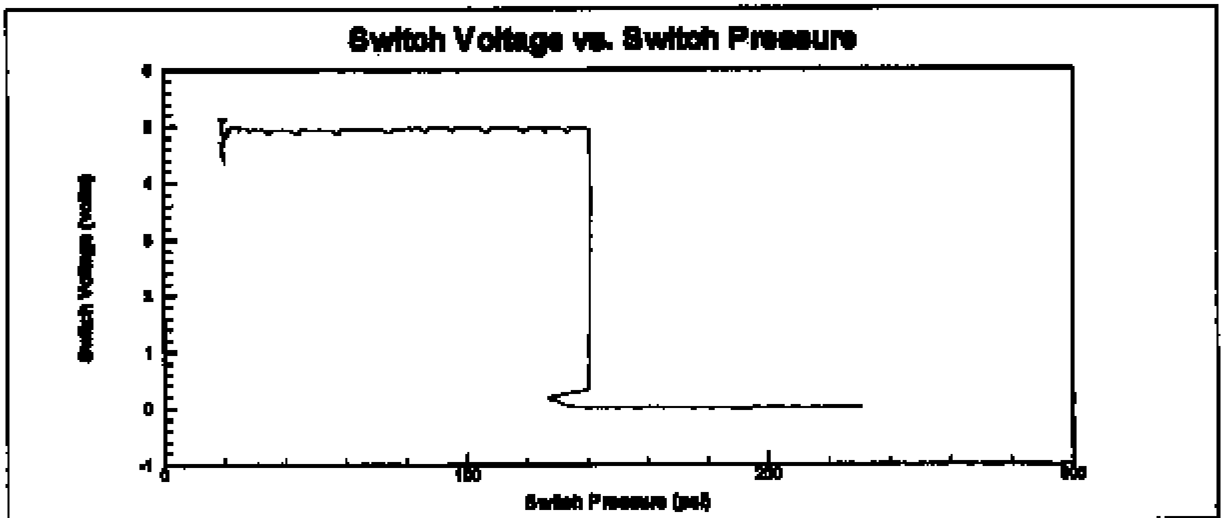
Design Research Engineering

TI-NHTSA 014910

30 mph normal	Ford Test Data: Lincoln Towncar	File Name: lLincol1.003



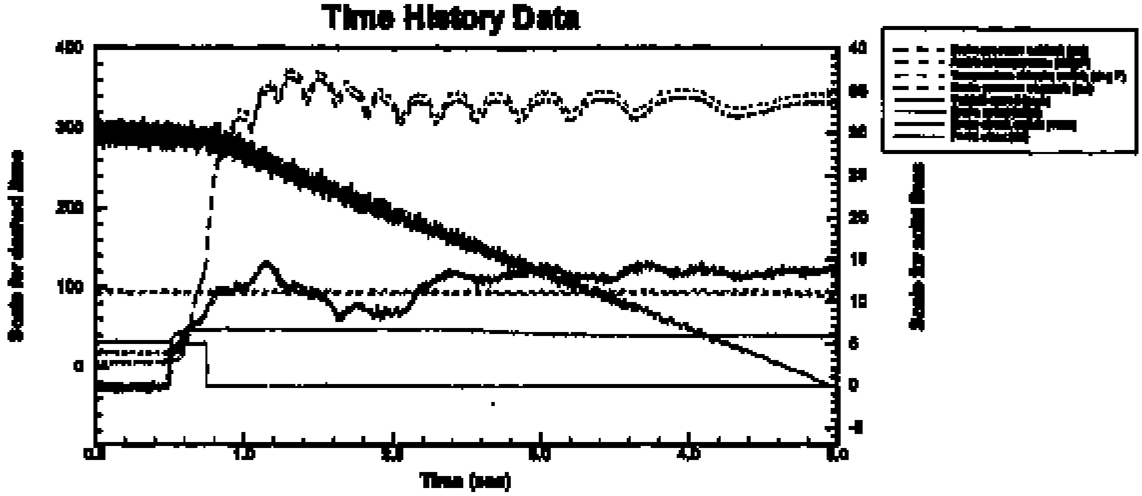




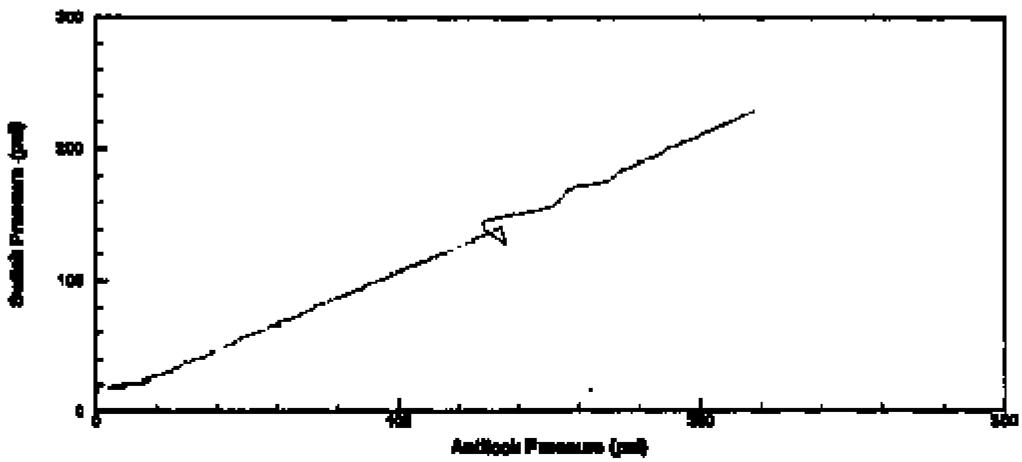
Design Research Engineering

30 mph normal	Ford Test Data: Lincoln Towncar	File Name: ILincol1.s04

Time History Data



Switch Pressure vs. Antilock Pressure

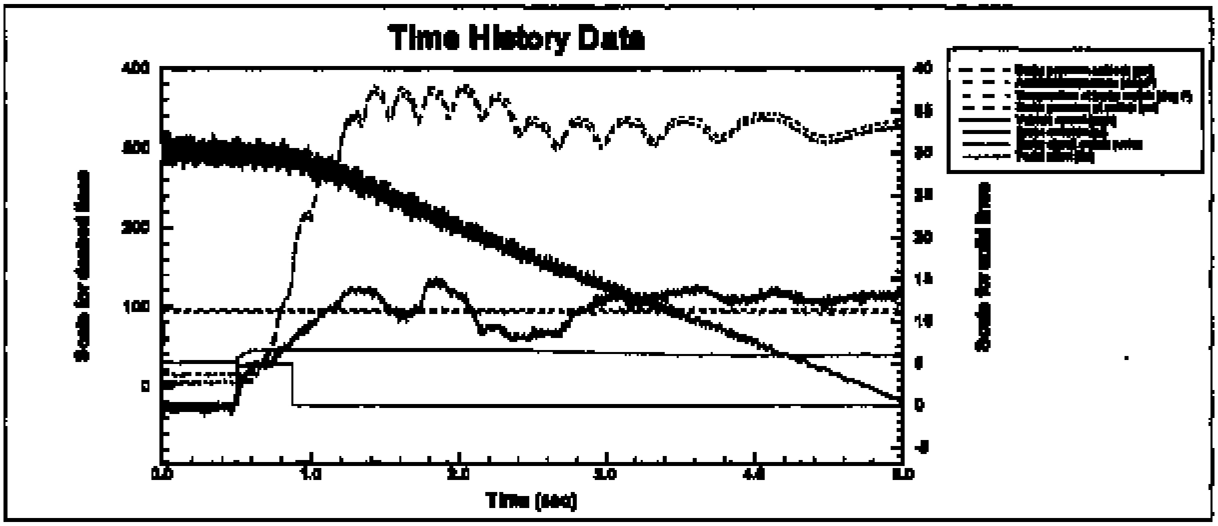


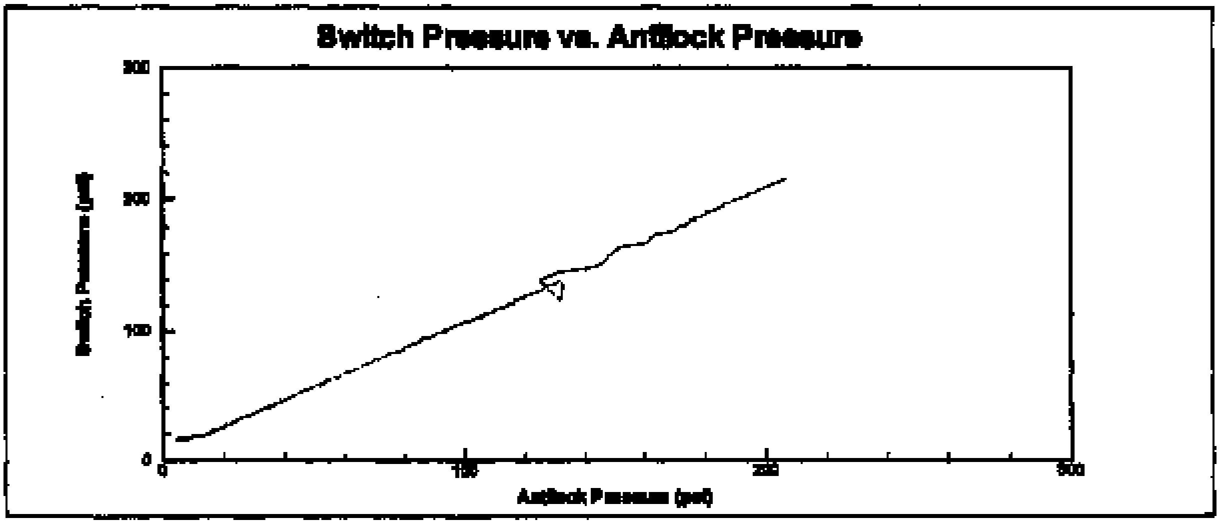
Switch Voltage vs. Switch Pressure

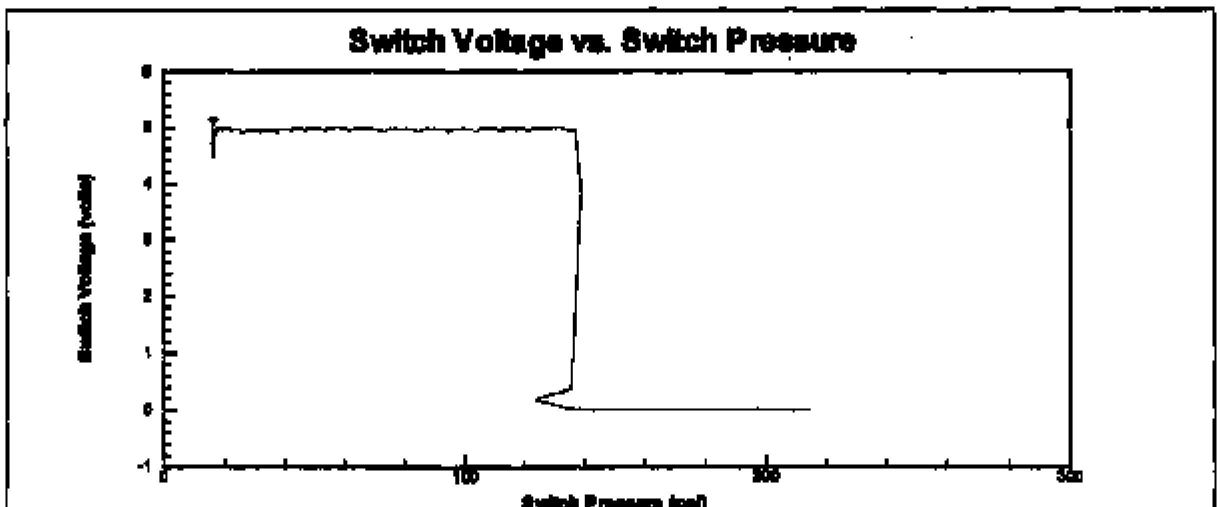
Design Research Engineering

TI-NHTSA 014912

35 mph normal	Ford Test Data: Lincoln Towncar	File Name: ILincol1.005





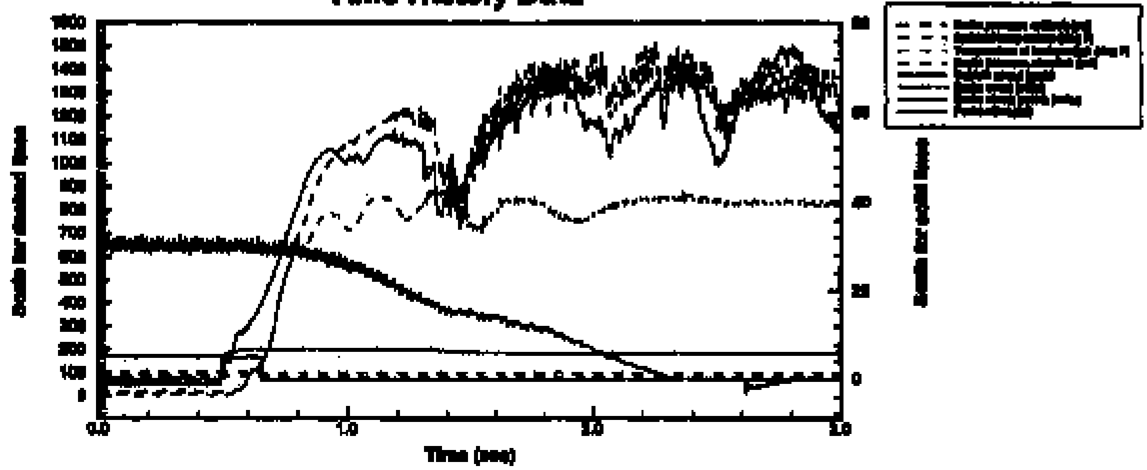


Design Research Engineering

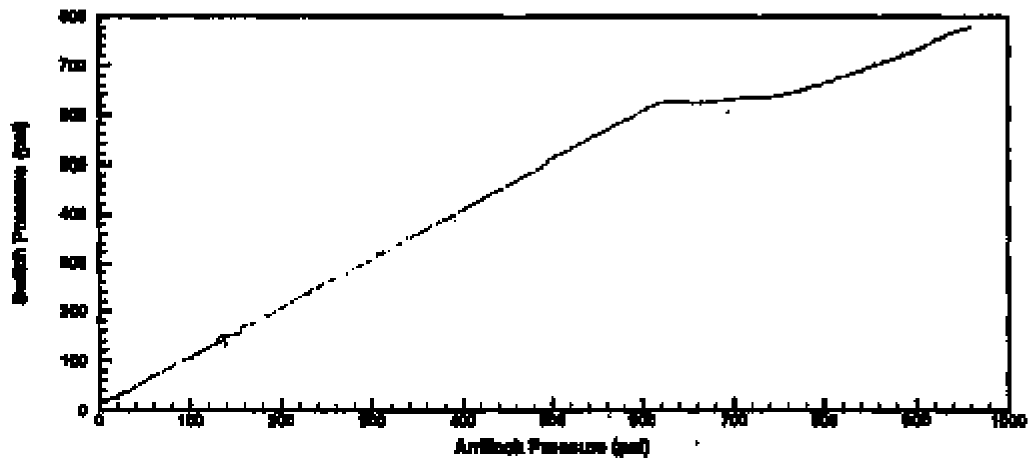
TI-NHTSA 014913

30 mph ABS	Ford Test Data: Lincoln Towncar	File Name: [illegible]

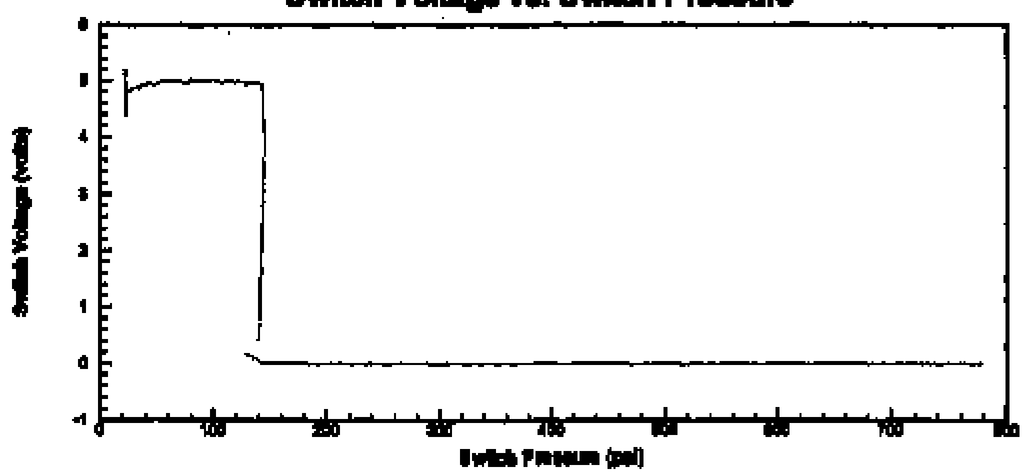
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

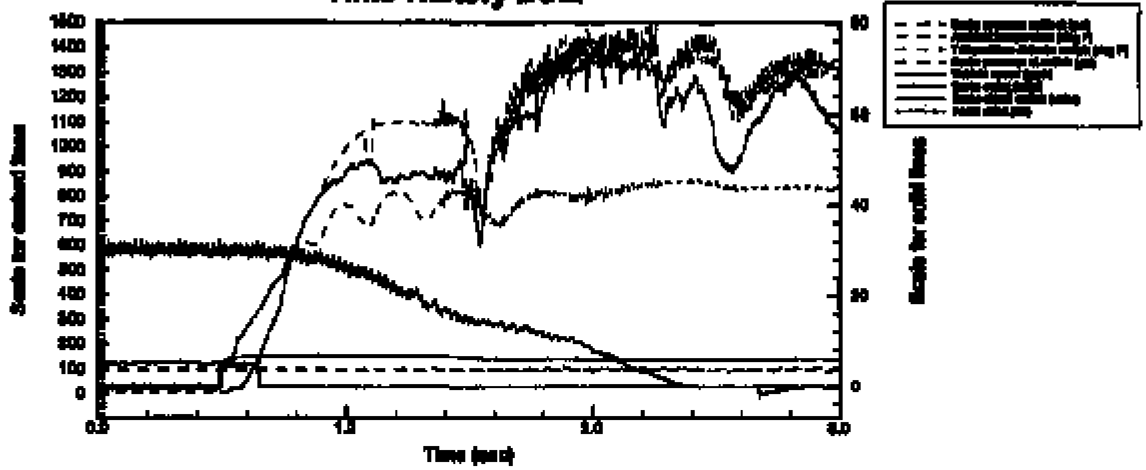


Design Research Engineering

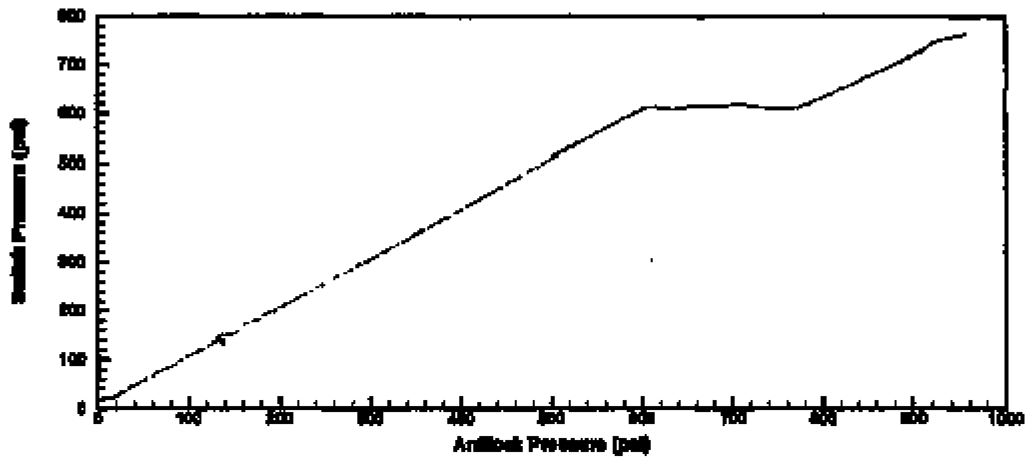
TI-NHTSA 014914

30 mph ABS | Ford Test Data: Lincoln Towncar | File Name: ILincolt.037

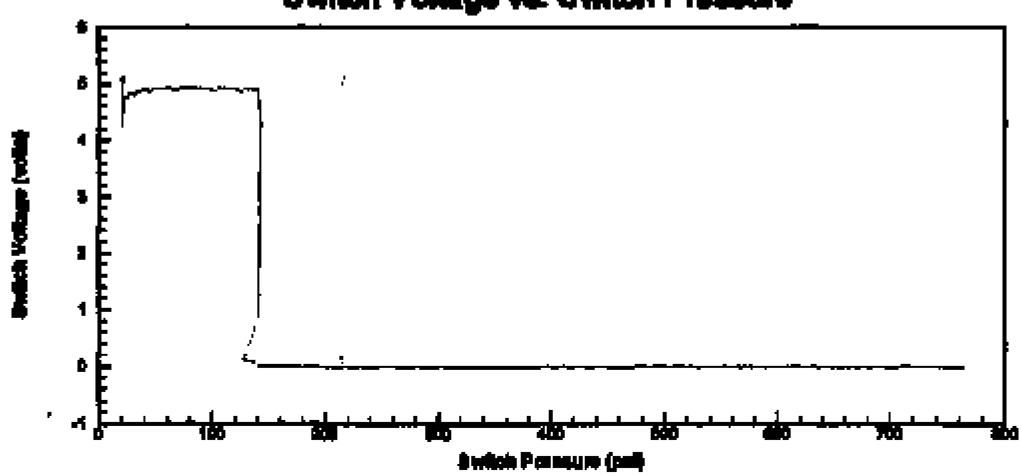
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

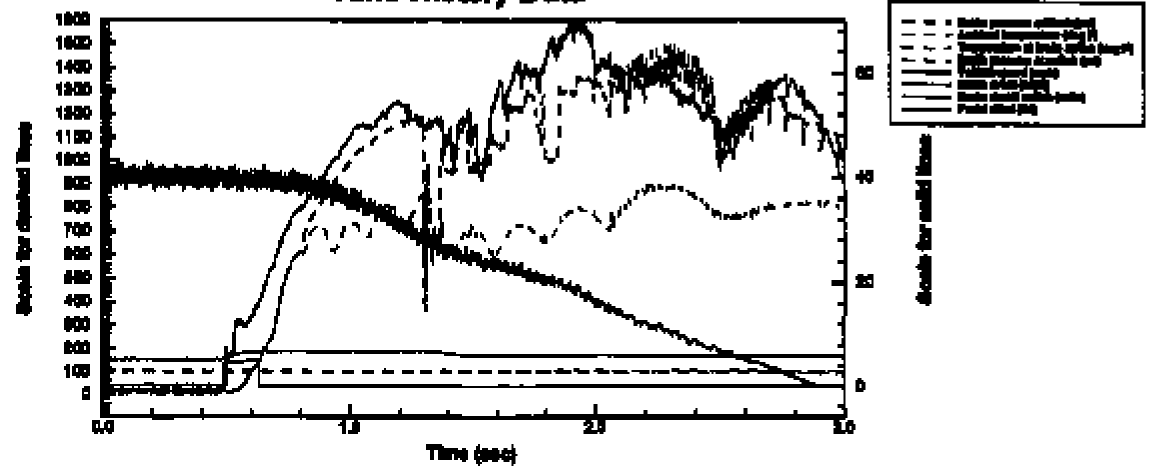


Design Research Engineering

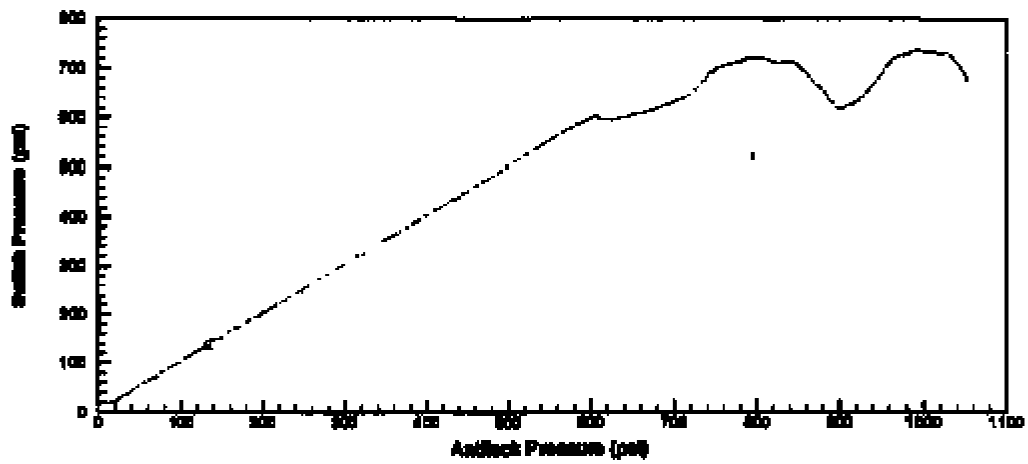
TI-NHTSA 014915

40 mph ABS	Ford Test Data: Lincoln Towncar	File Name: lLincoln.005

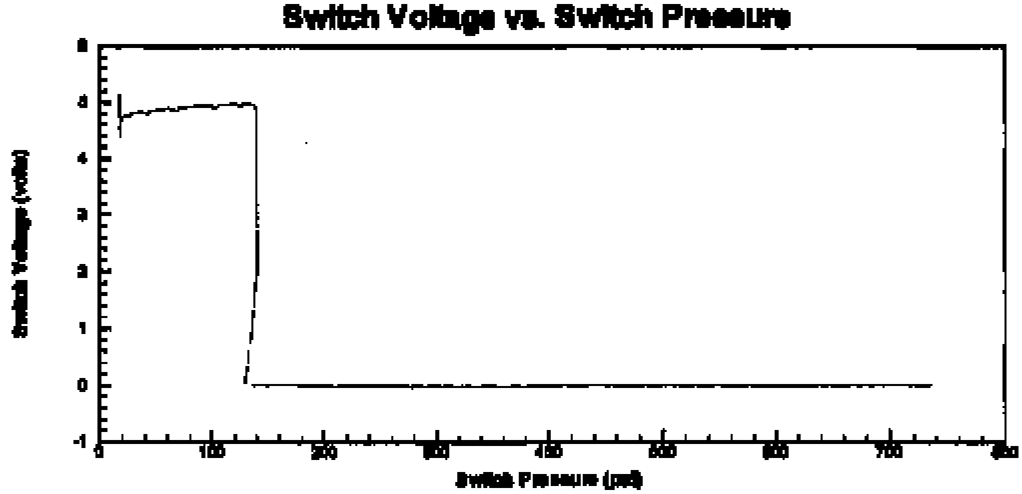
Time History Data



Switch Pressure vs. Antilock Pressure



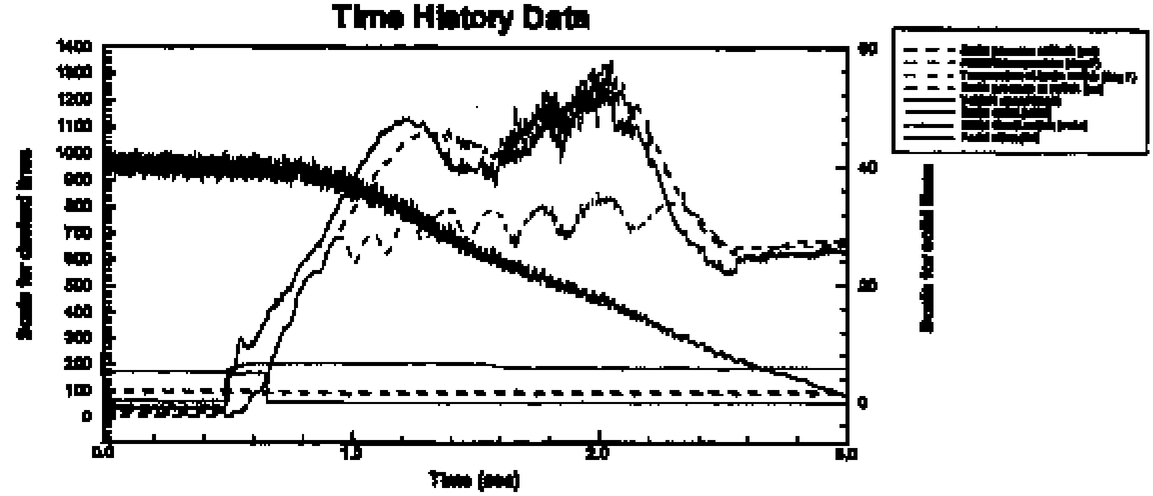
Switch Voltage vs. Switch Pressure



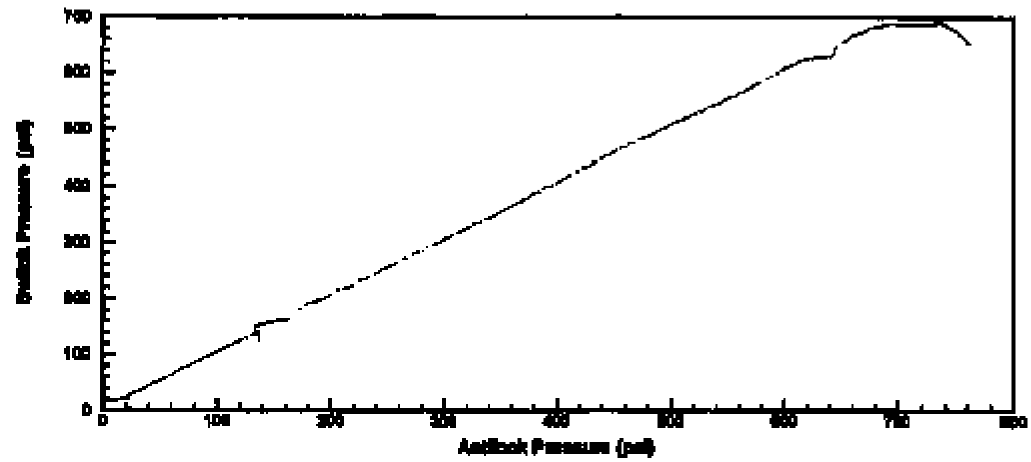
Design Research Engineering

40 mph ABS | Ford Test Data: Lincoln Towncar | File Name: lLincoln.069

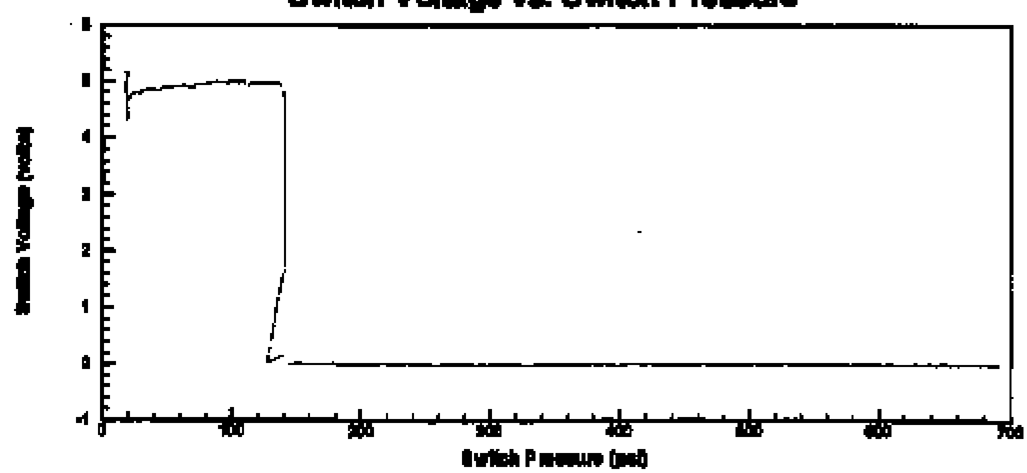
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

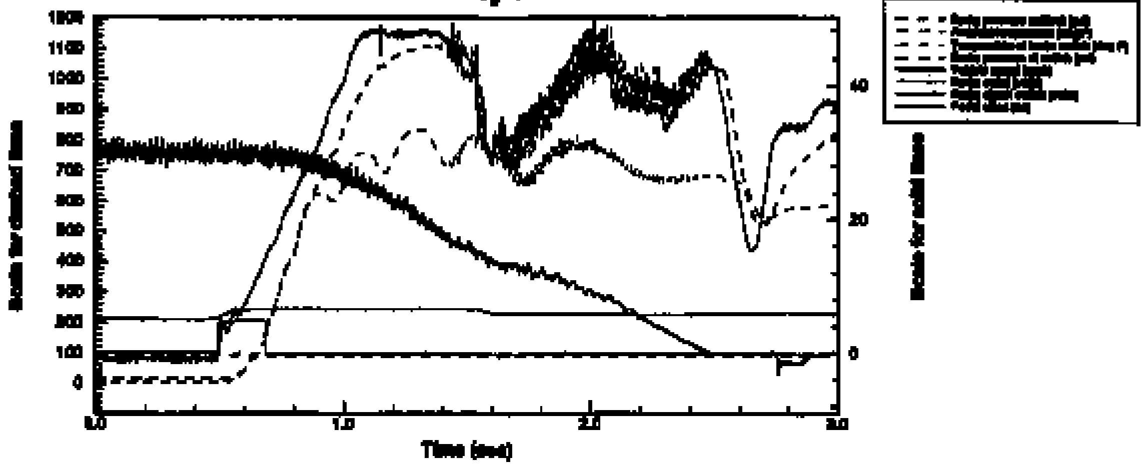


Design Research Engineering

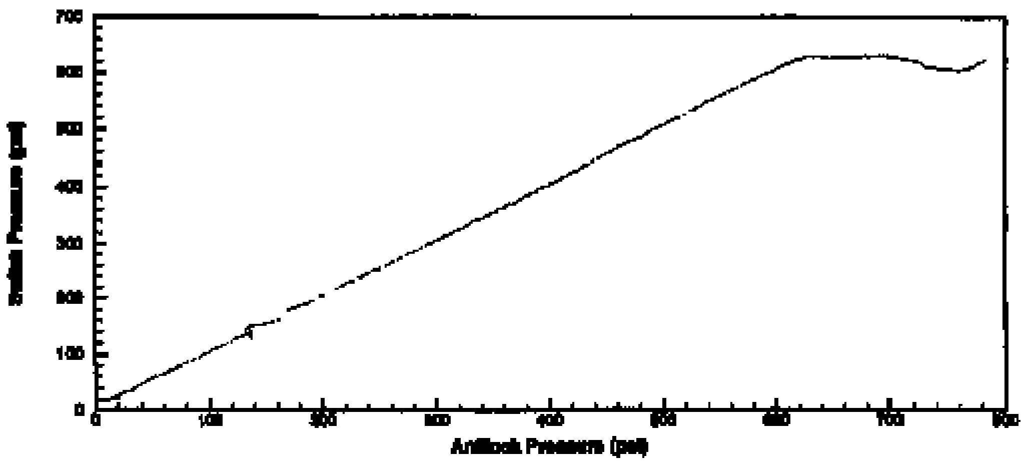
TI-NHTSA 014917

30 mph ABS	Ford Test Data: Lincoln Towncar	File Name: lLincolt.010

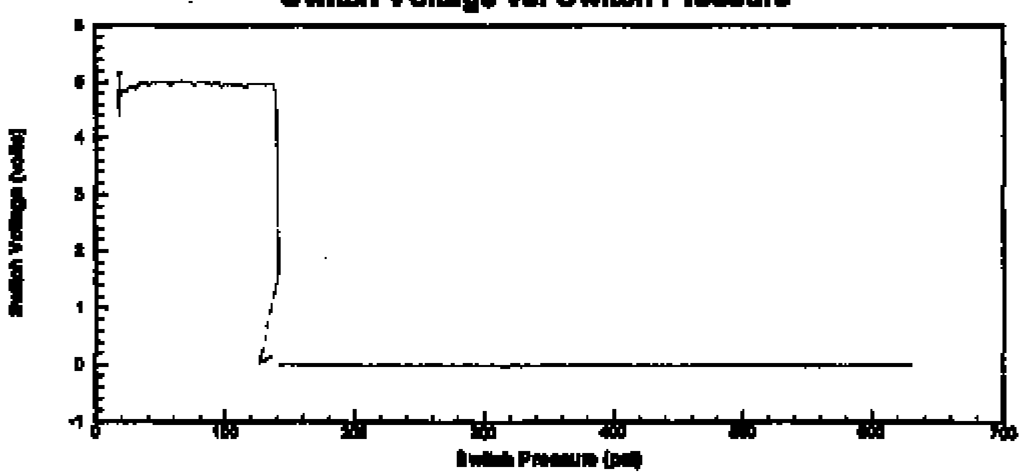
Time History Data



Switch Pressure vs. Antilock Pressure



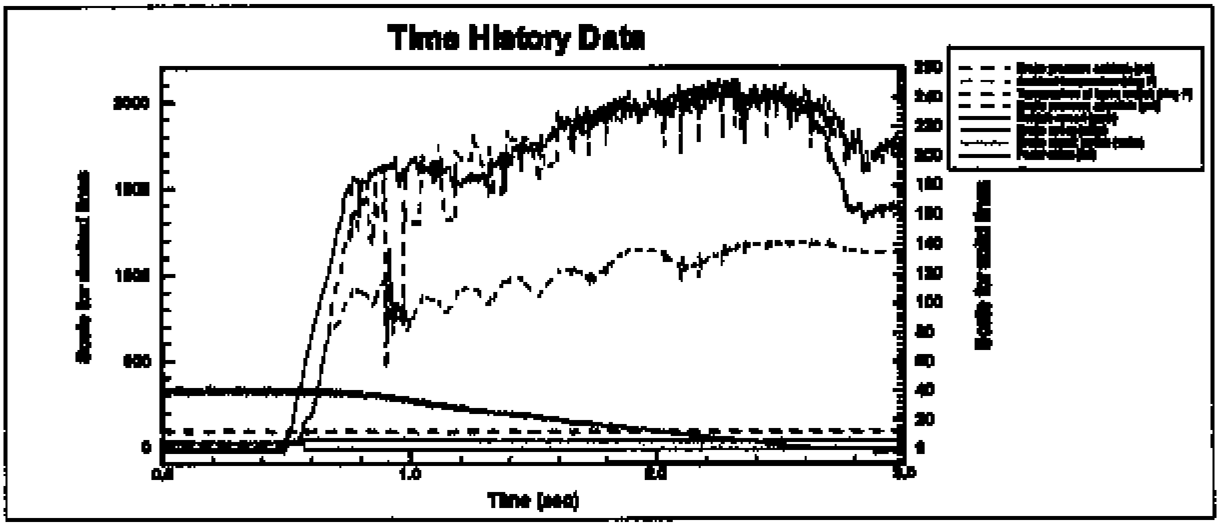
Switch Voltage vs. Switch Pressure

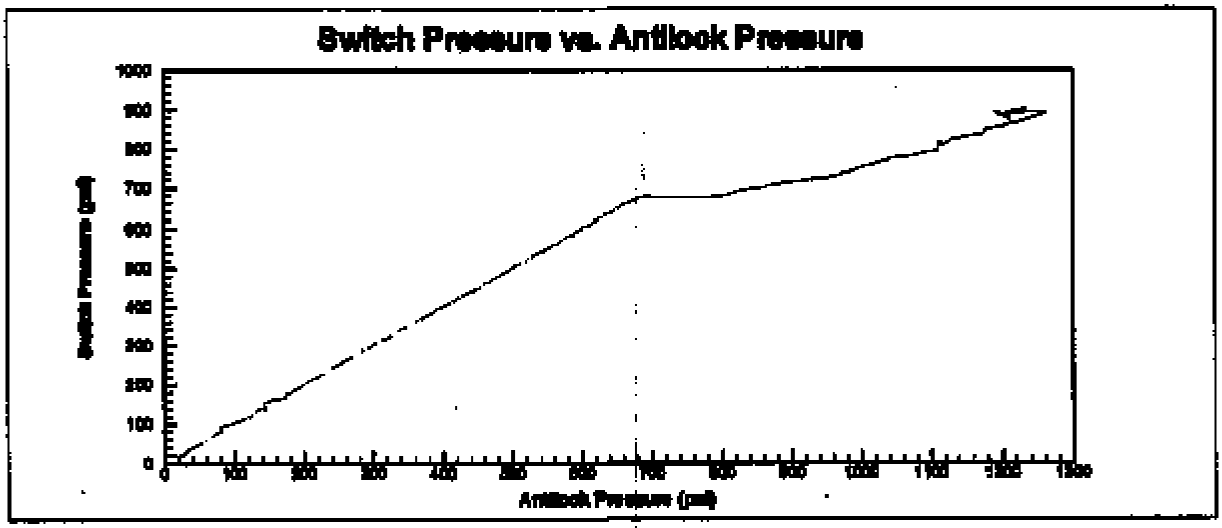


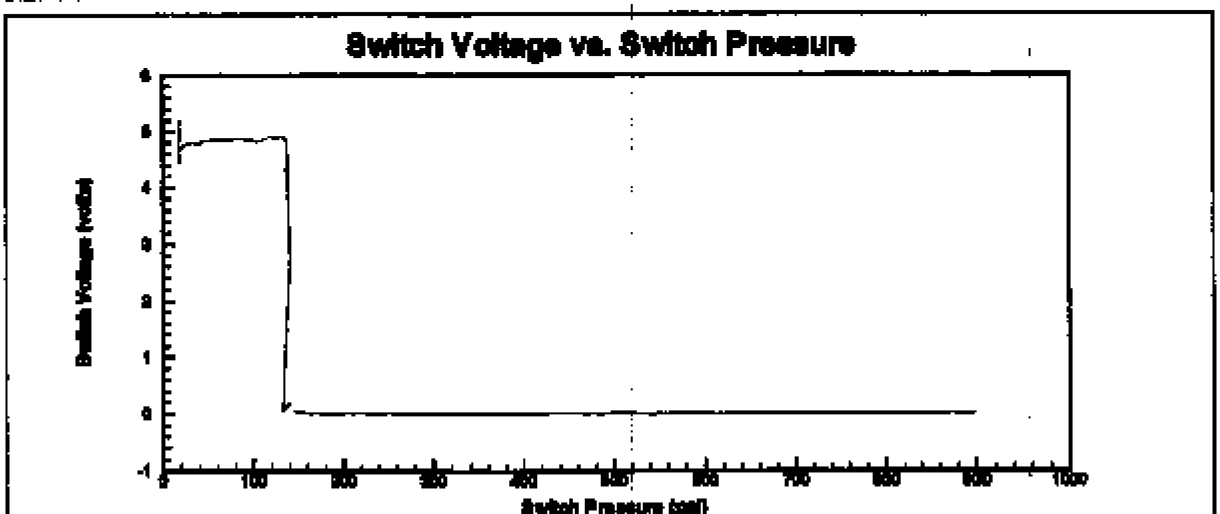
Design Research Engineering

TI-NHTSA 014916

40 mph ABS PANIC	Ford Test Data: Lincoln Towncar	File Name: ILincol1.011



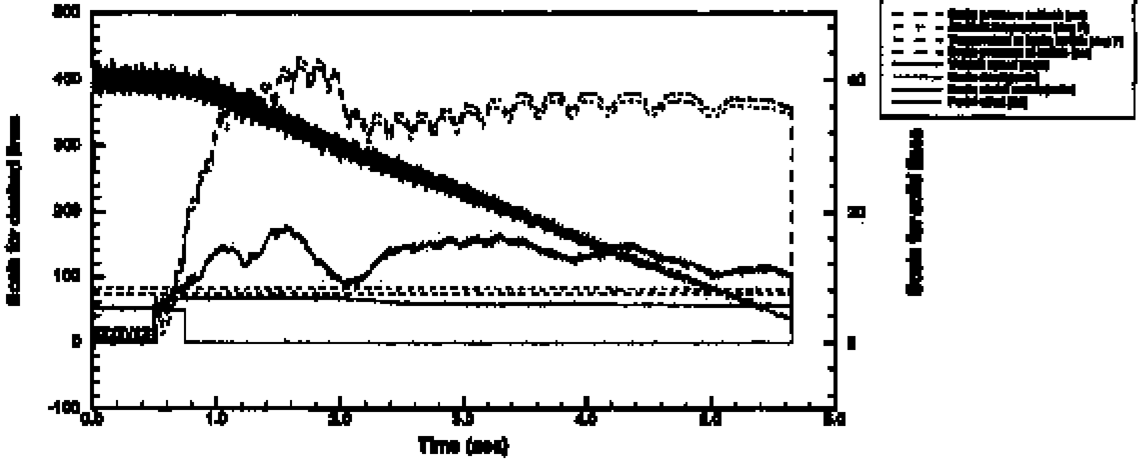




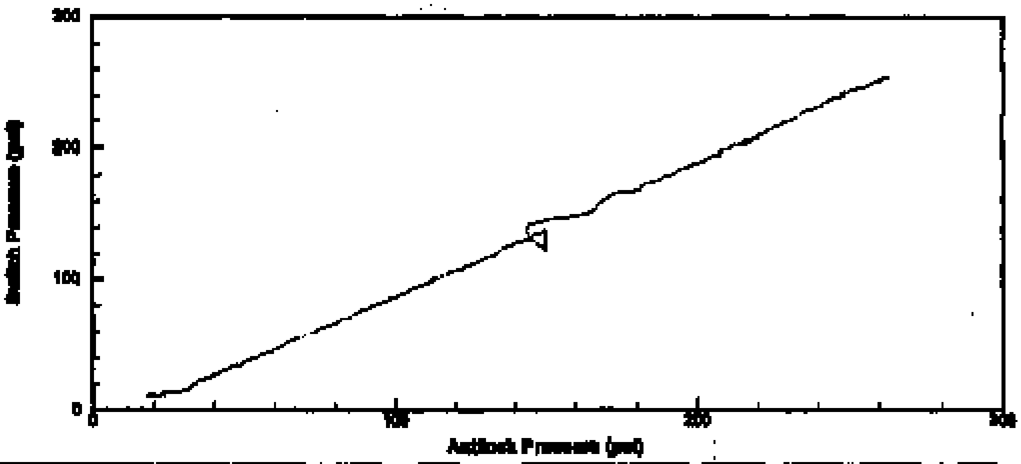
Design Research Engineering

40 mph normal NO ABS | Ford Test Data: Lincoln Towncar | File Name: 1lJeco02.001

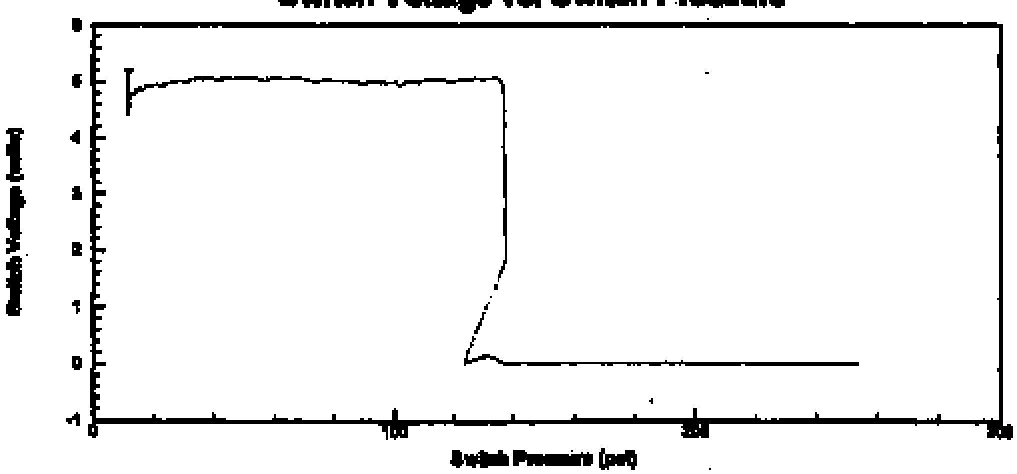
Time History Data



Switch Pressure vs. Antilock Pressure



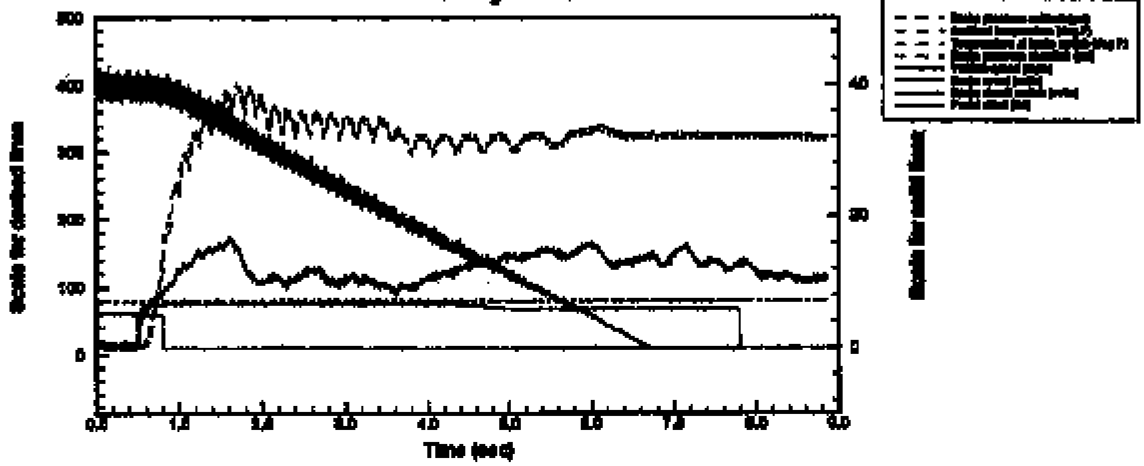
Switch Voltage vs. Switch Pressure



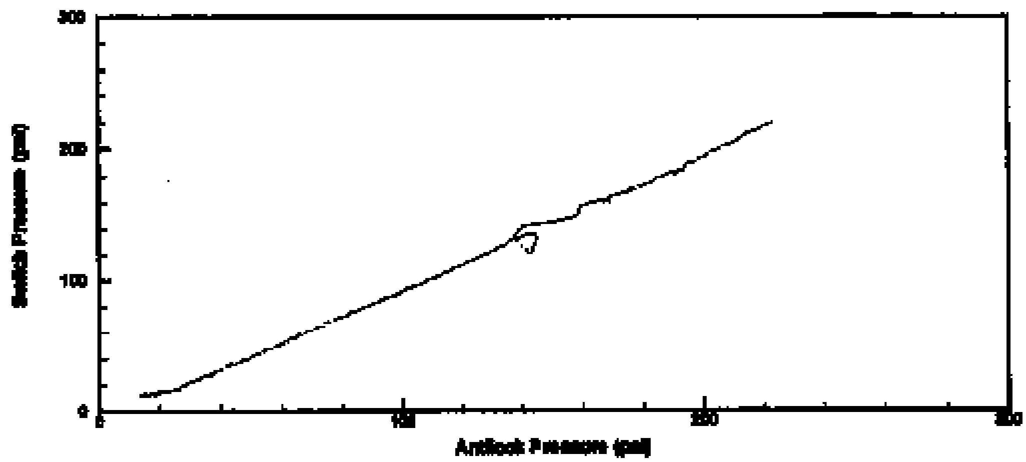
Design Research Engineering

40 mph normal NO ABS | Ford Test Data: Lincoln Towncar | File Name: [illegible].002

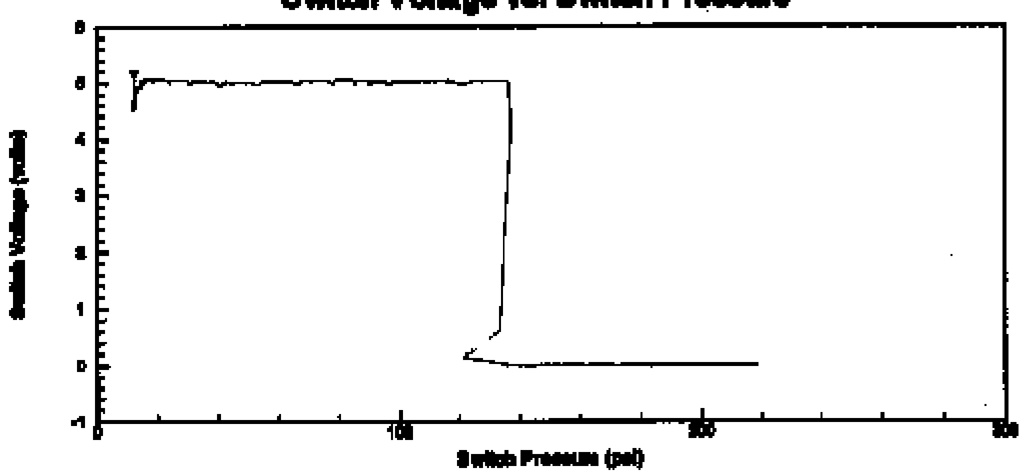
Time History Data



Switch Pressure vs. Antilock Pressure



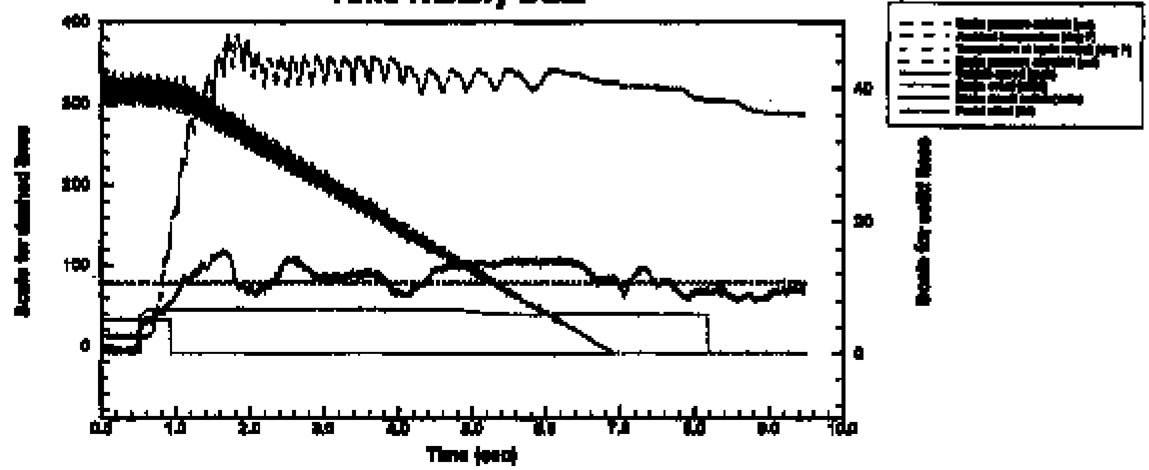
Switch Voltage vs. Switch Pressure



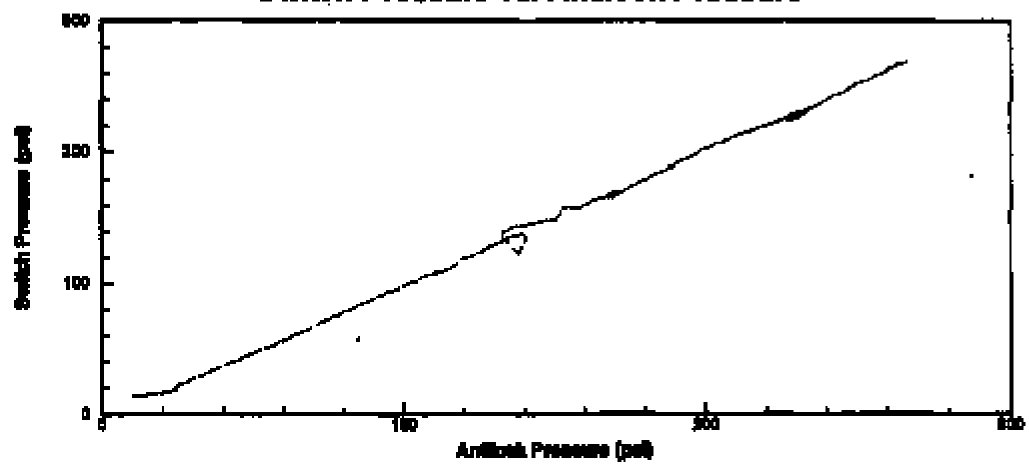
Design Research Engineering

40 mph normal NO ABS	Ford Test Data: Lincoln Towncar	File Name: lLincol2.003

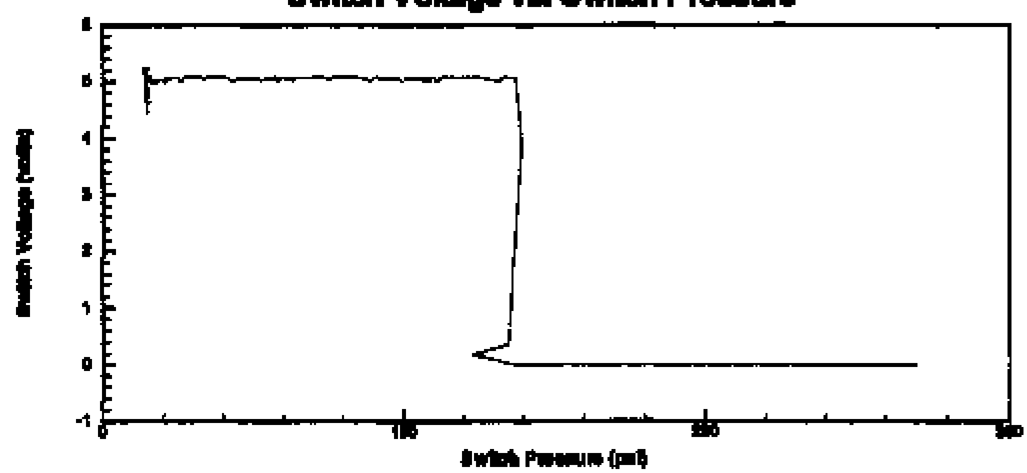
Time History Data



Switch Pressure vs. Antilock Pressure



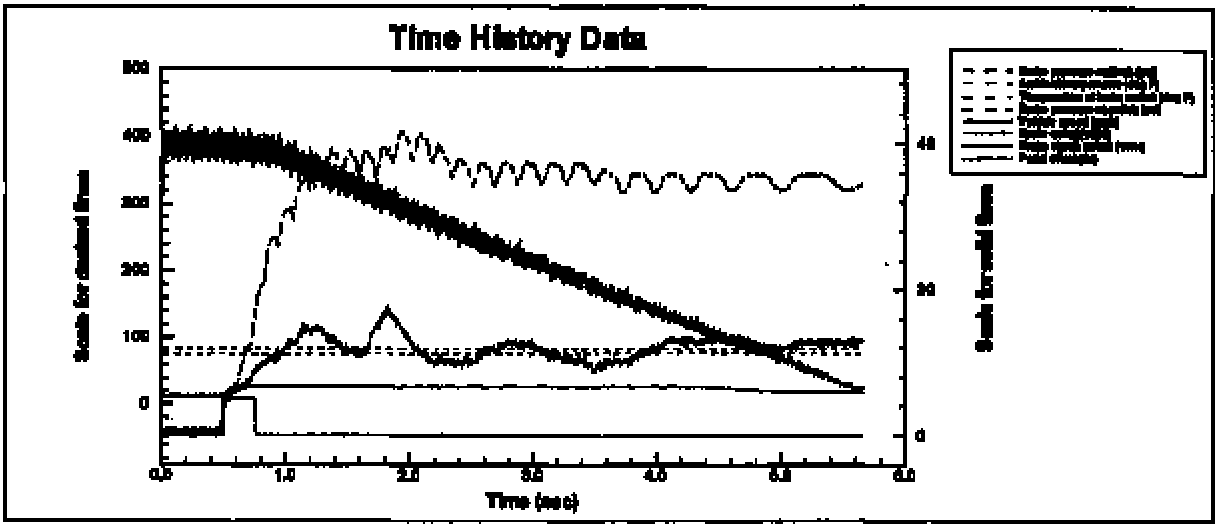
Switch Voltage vs. Switch Pressure

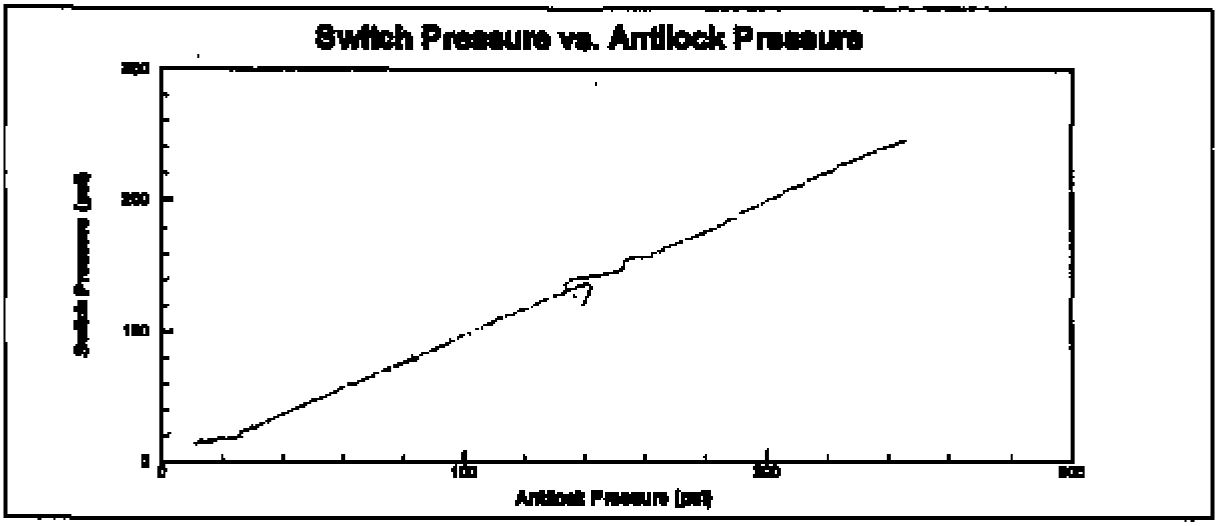


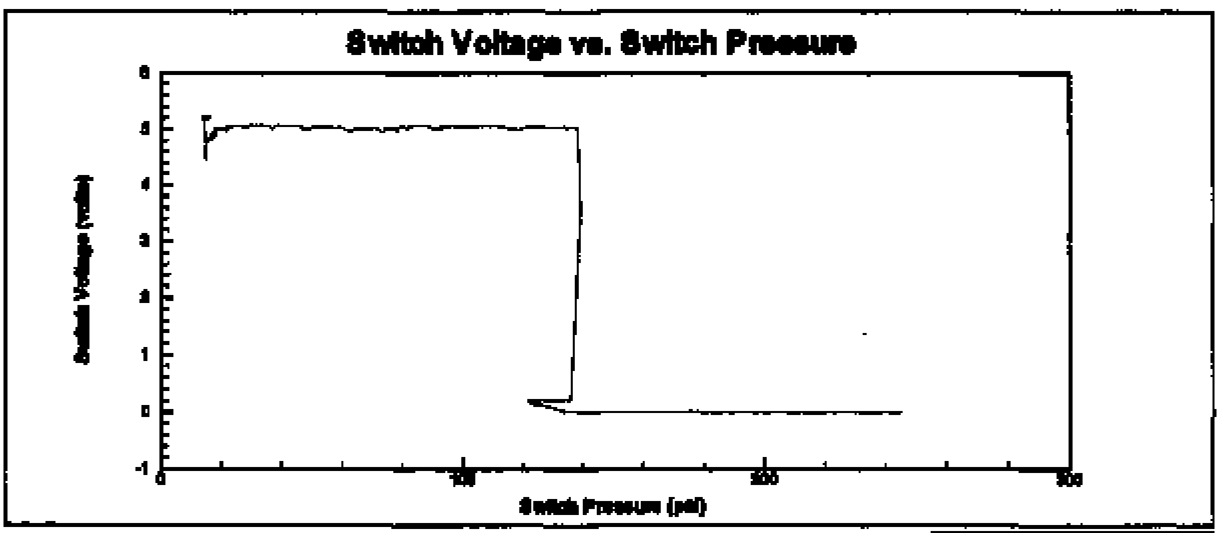
Design Research Engineering

TI-NHTSA 014922

40 mph normal NO ABS	Ford Test Data: Lincoln Towncar	File Name: ILincol2.004



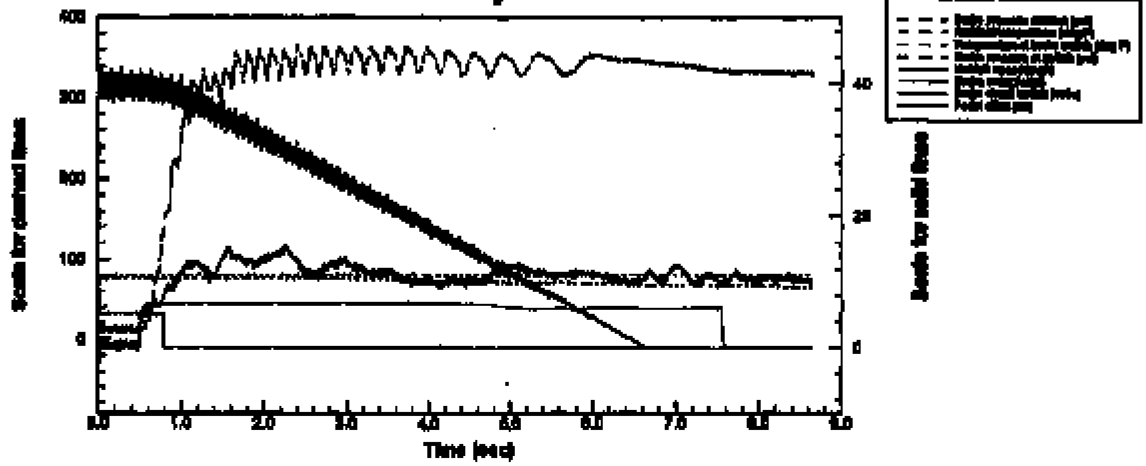




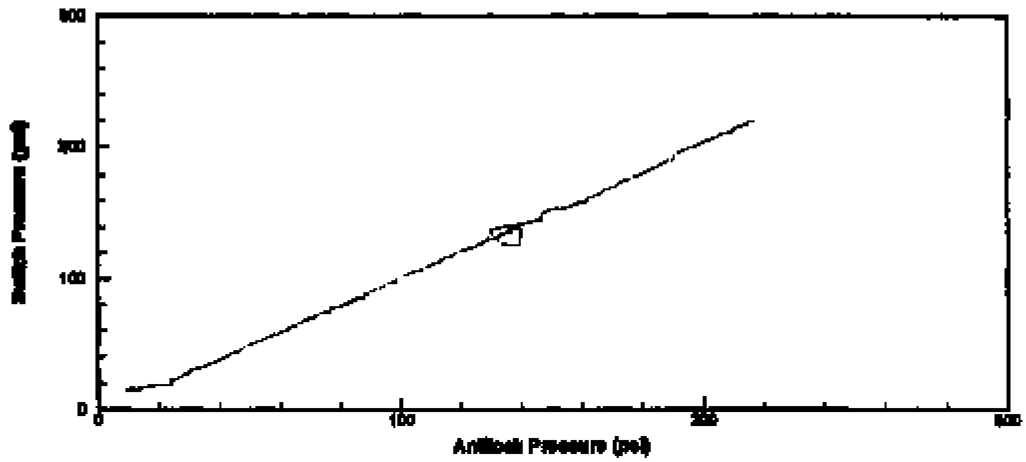
Design Research Engineering

40 mph normal NO ABS | Ford Test Data: Lincoln Towncar | File Name: ILinco2.005

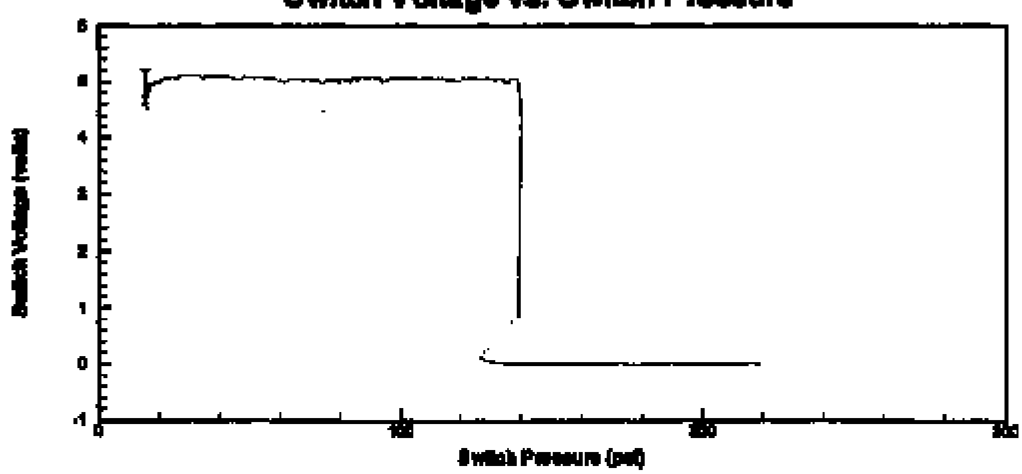
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

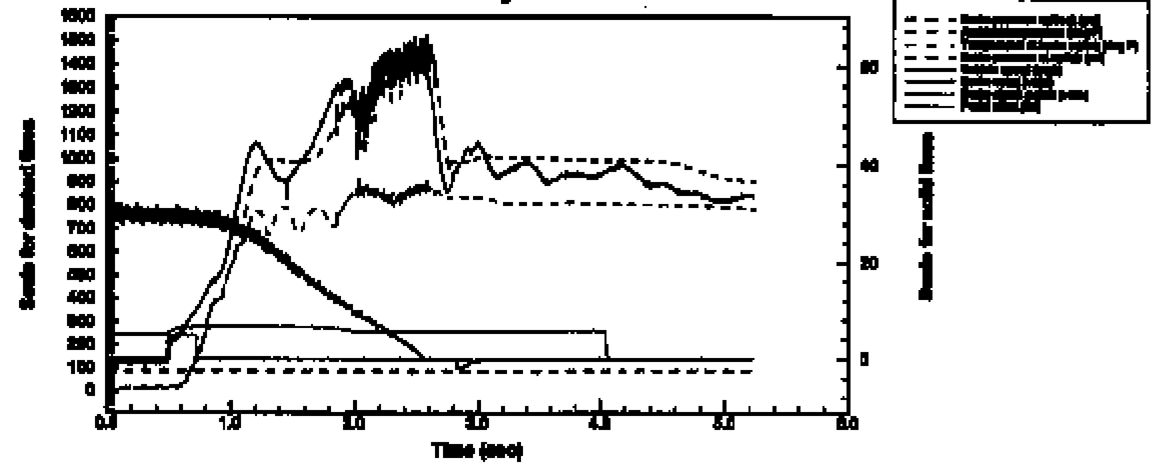


Design Research Engineering

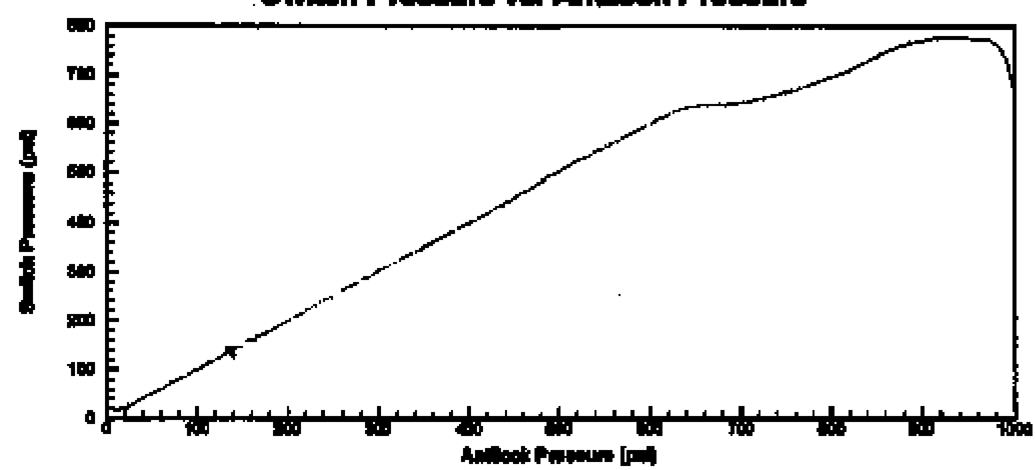
TI-NHTSA 014924

30 mph nonsel ABS	Ford Test Data: Lincoln Towncar	File Name: lLincol2.006

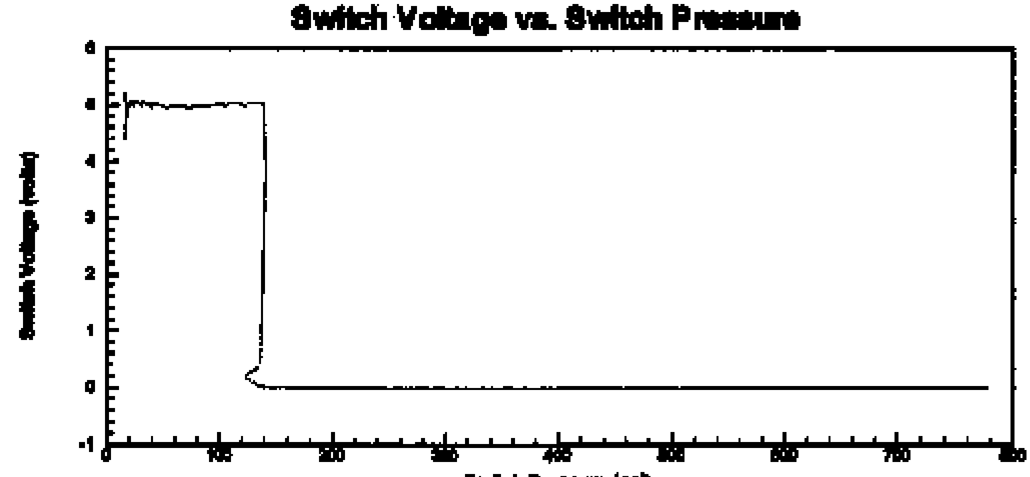
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

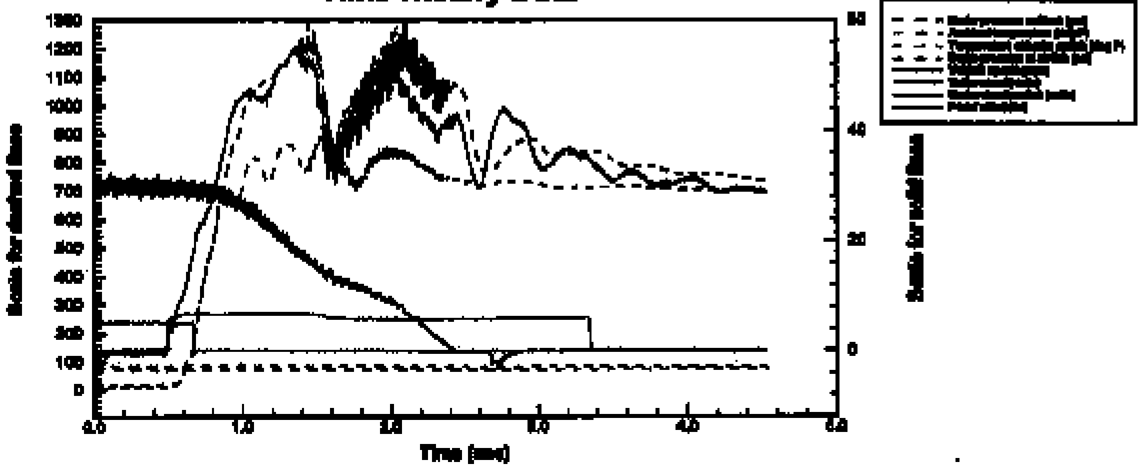


Design Research Engineering

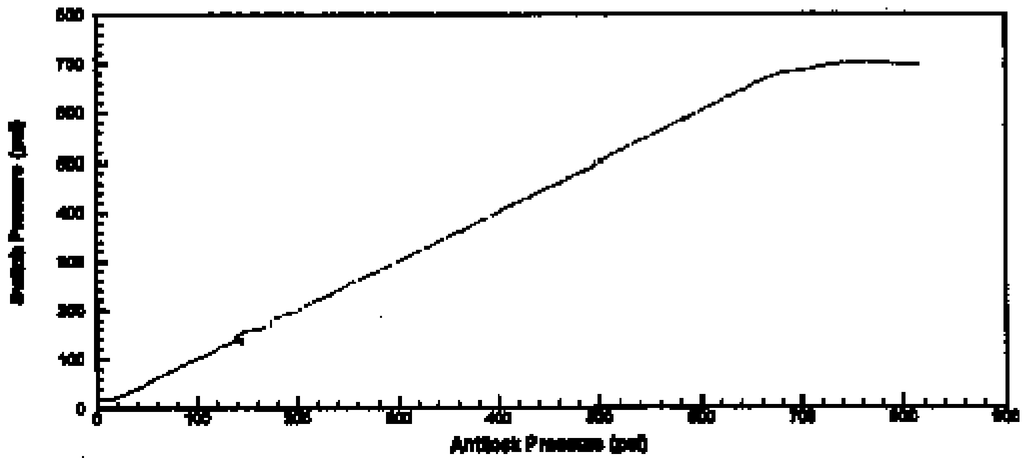
TI-NHTSA 014925

30 mph normal ABS | Ford Test Data: Lincoln Towncar | File Name: ILJasol2.007

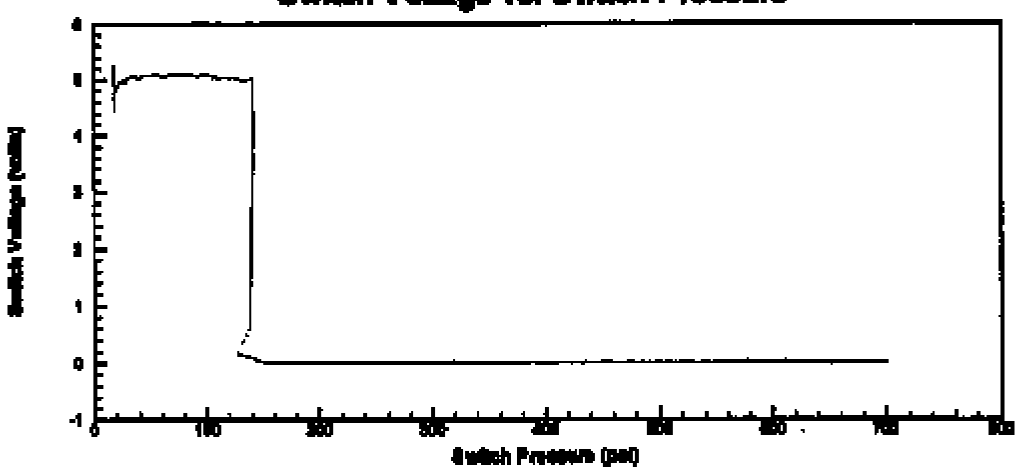
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

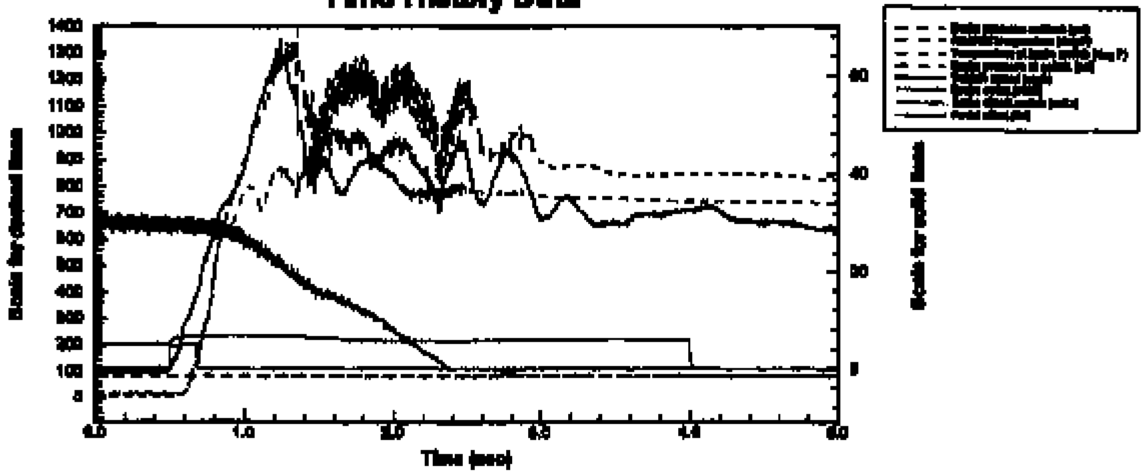


Design Research Engineering

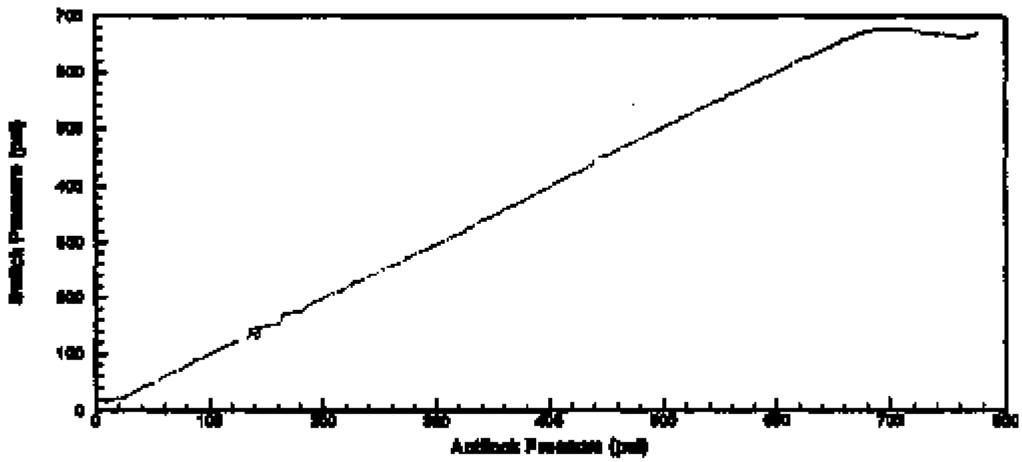
TI-NHTSA 014928

36 mph normal ABS | Ford Test Data: Lincoln Towncar | File Name: lLincol2.066

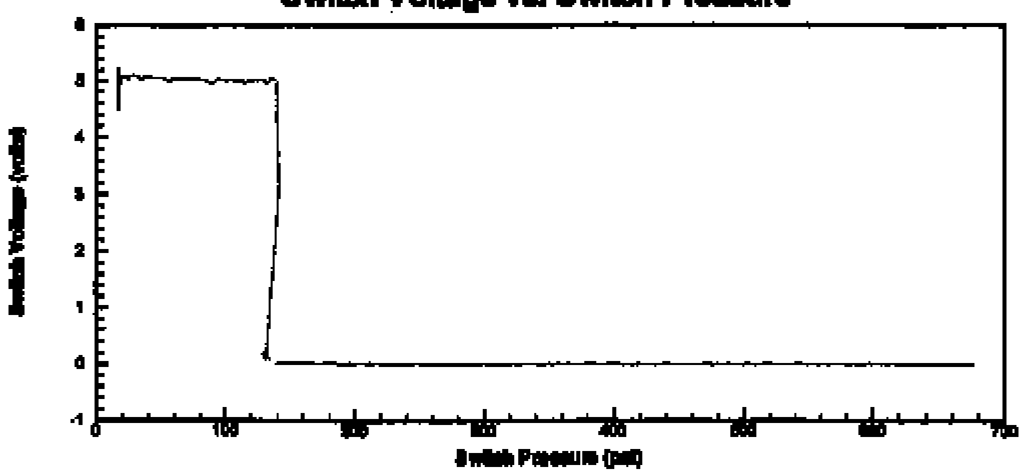
Time History Data



Switch Pressure vs. Antilock Pressure



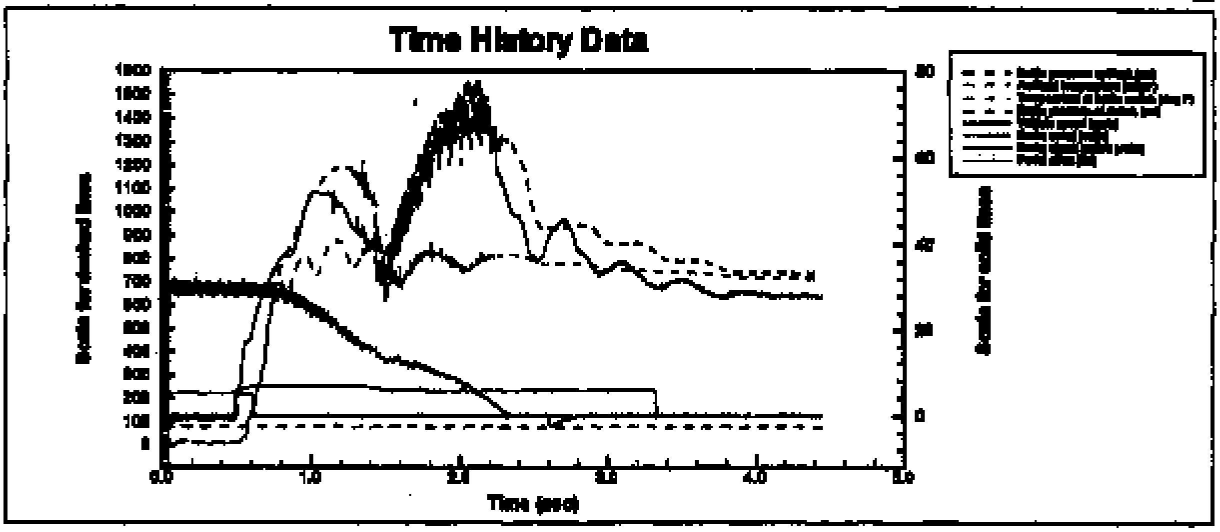
Switch Voltage vs. Switch Pressure

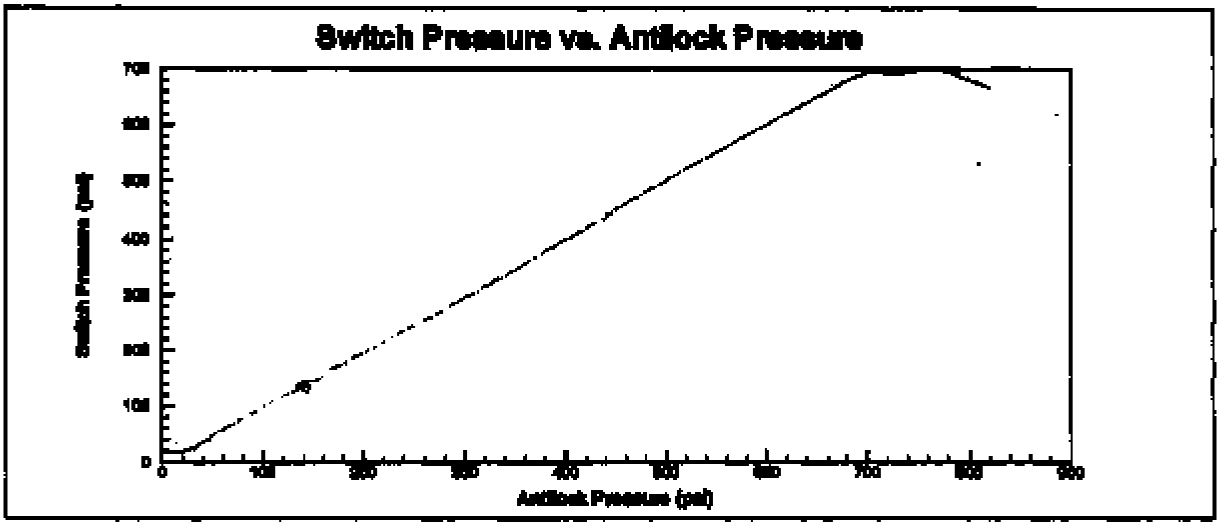


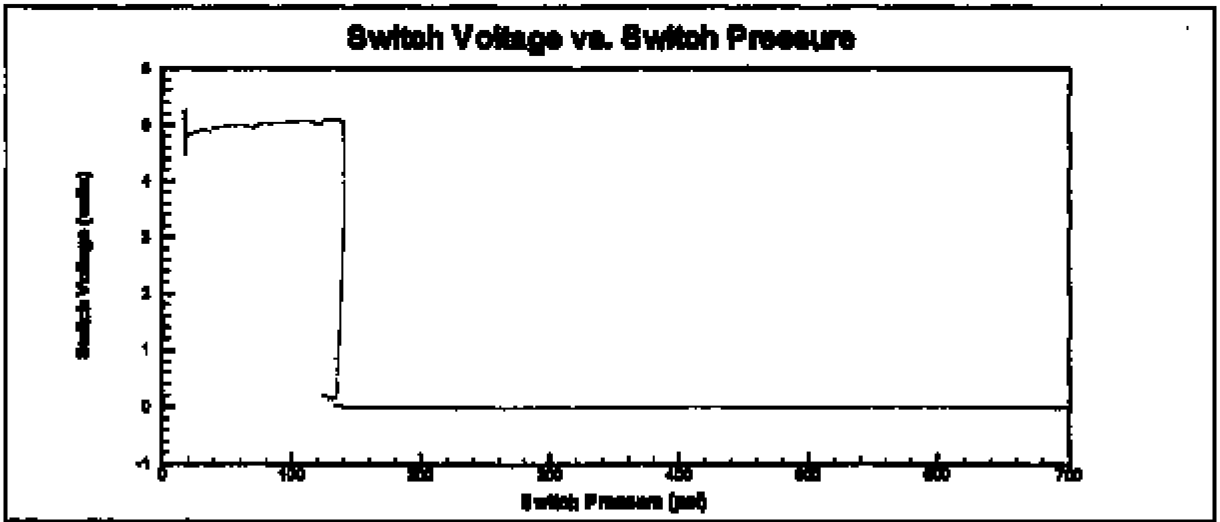
Design Research Engineering

TI-NHTSA 014927

30 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: ILincol2.009



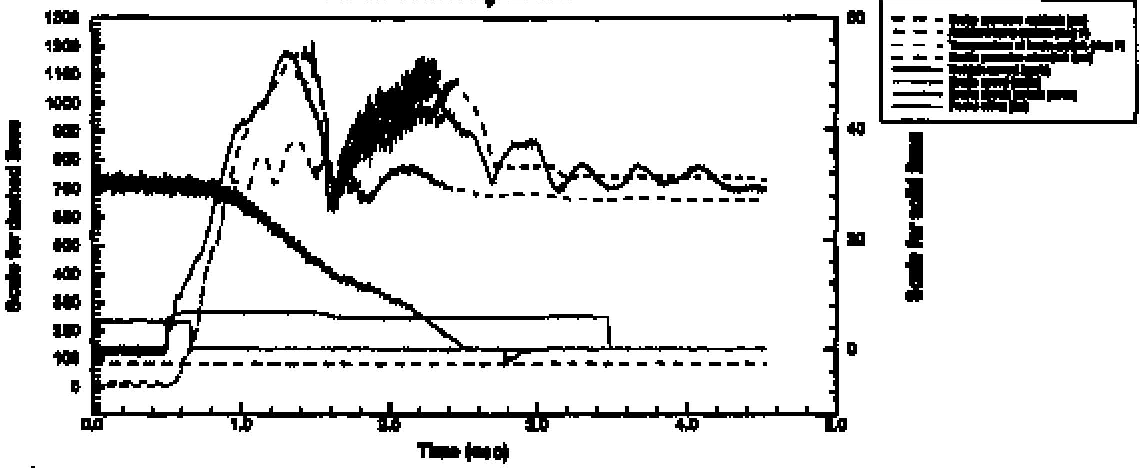




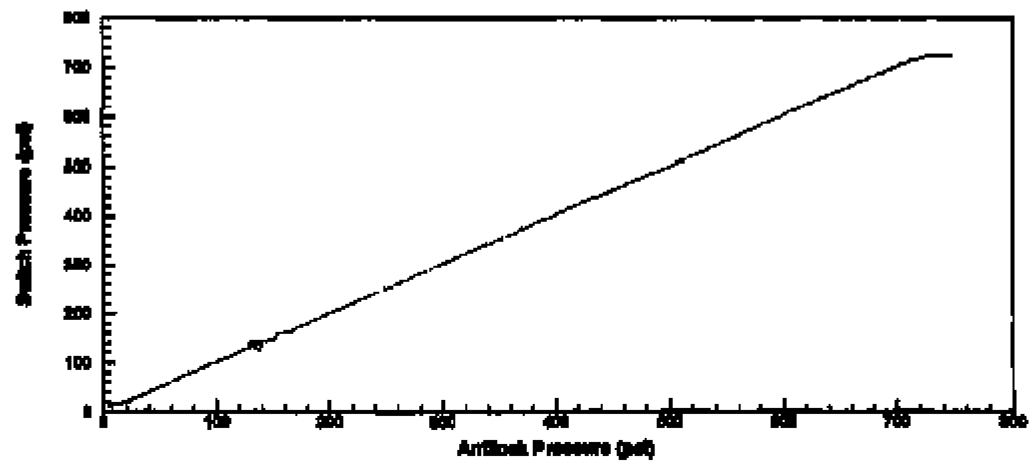
Design Research Engineering

30 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: ILincoln.010

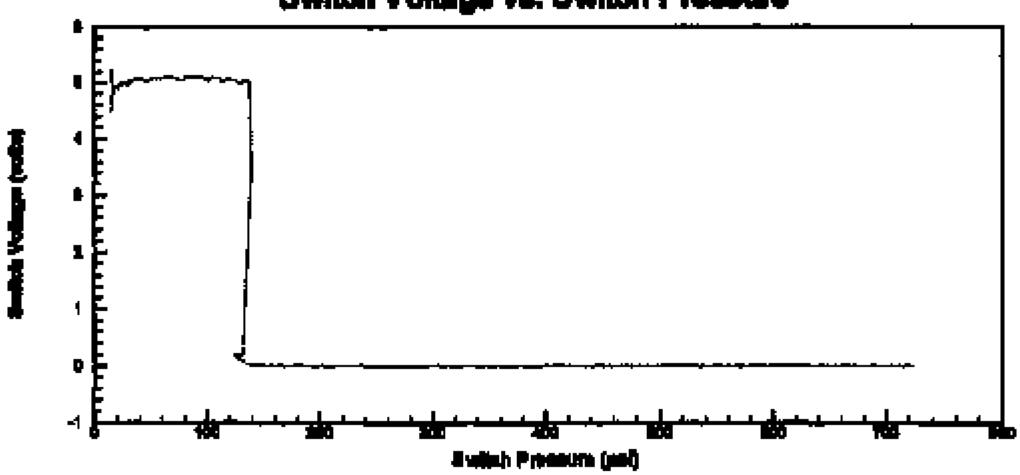
Time History Data



Switch Pressure vs. Antilock Pressure

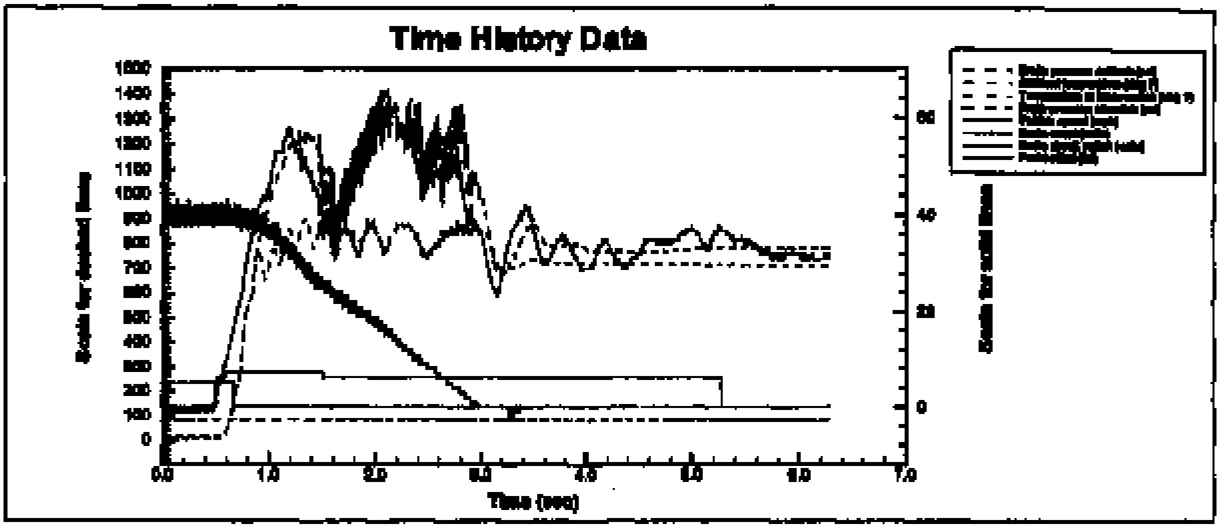


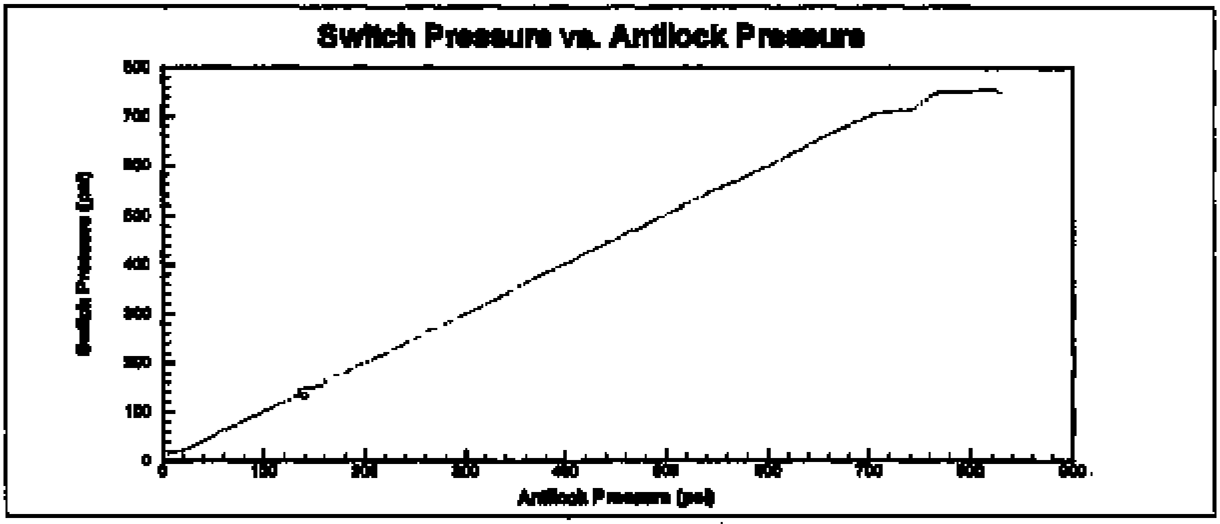
Switch Voltage vs. Switch Pressure

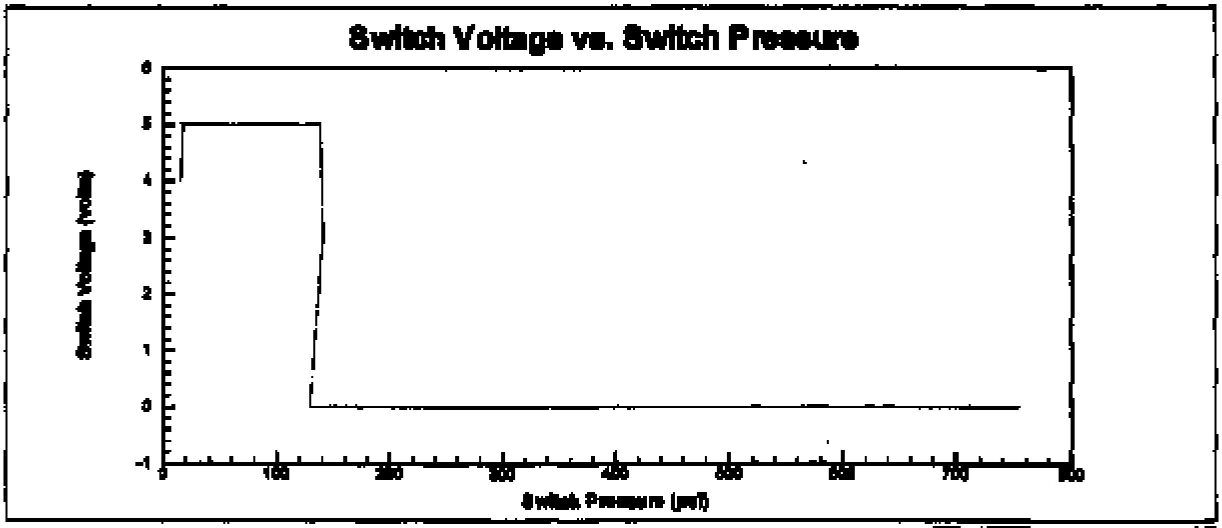


Design Research Engineering

40 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: R.lncoll.011





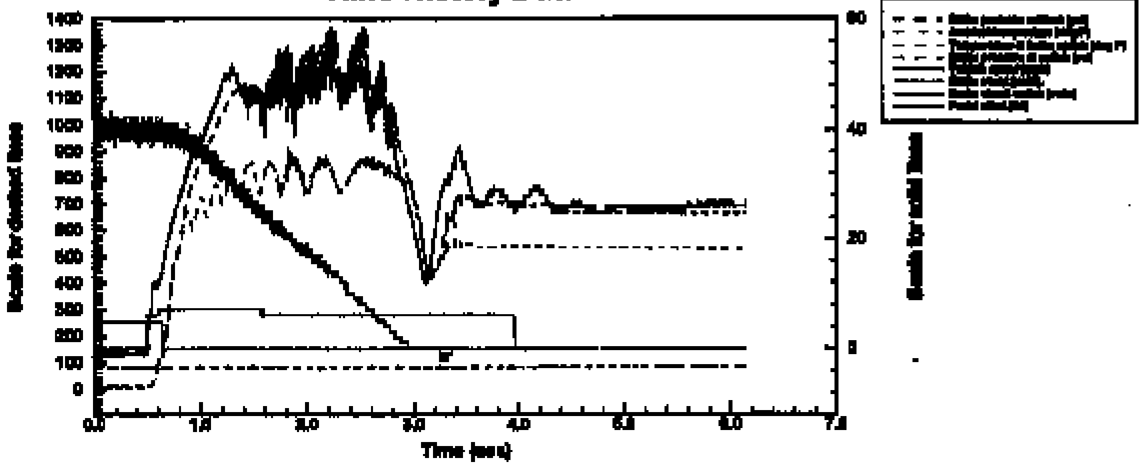


Design Research Engineering

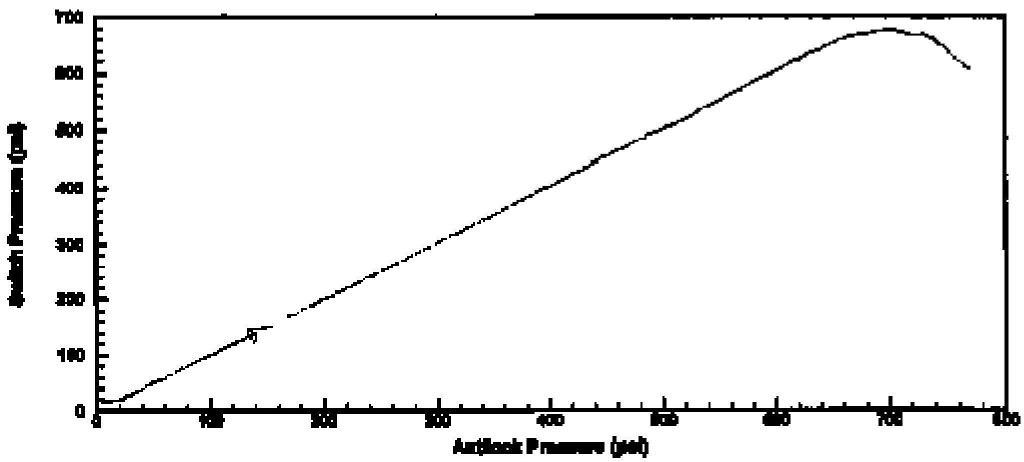
TI-NHTSA 014930

40 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: ILinco02.012

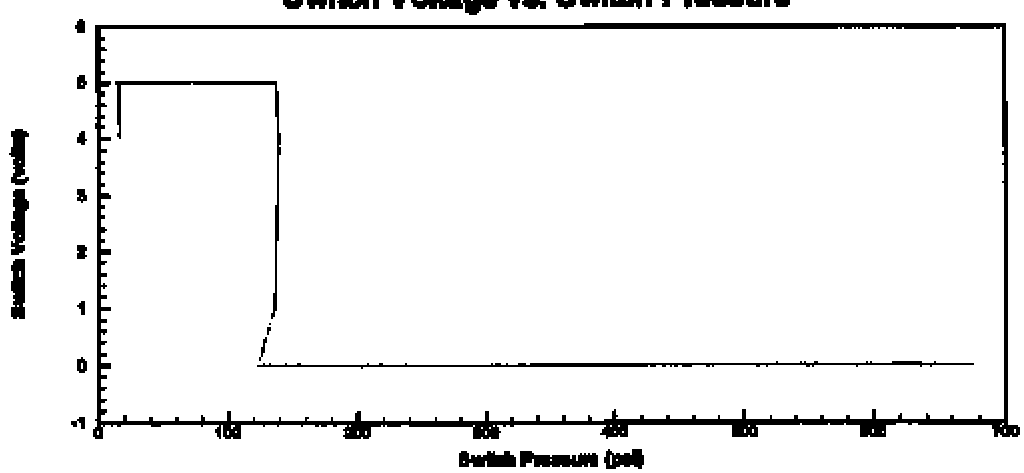
Time History Data



Switch Pressure vs. Antilock Pressure



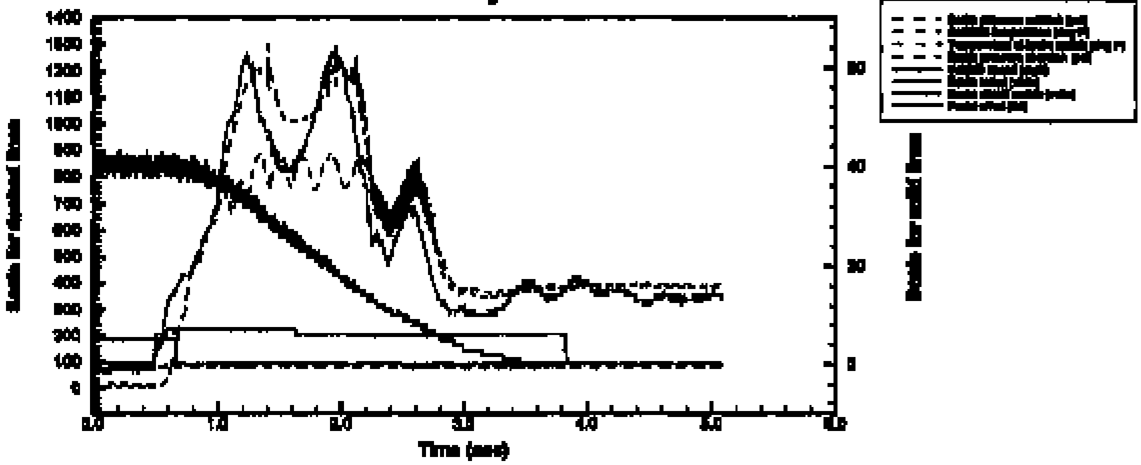
Switch Voltage vs. Switch Pressure



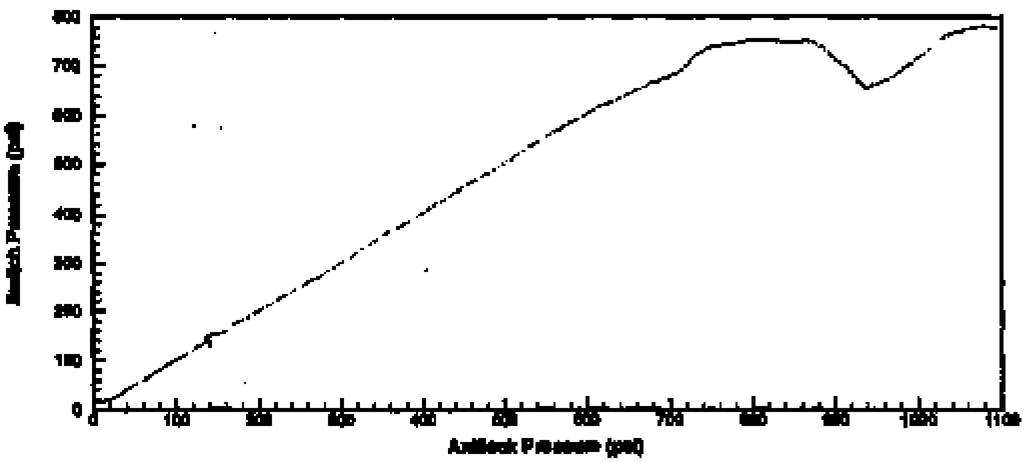
Design: Research Engineering

40 mph normal ABS | Ford Test Data: Lincoln Towncar | File Name: lLinco2.013

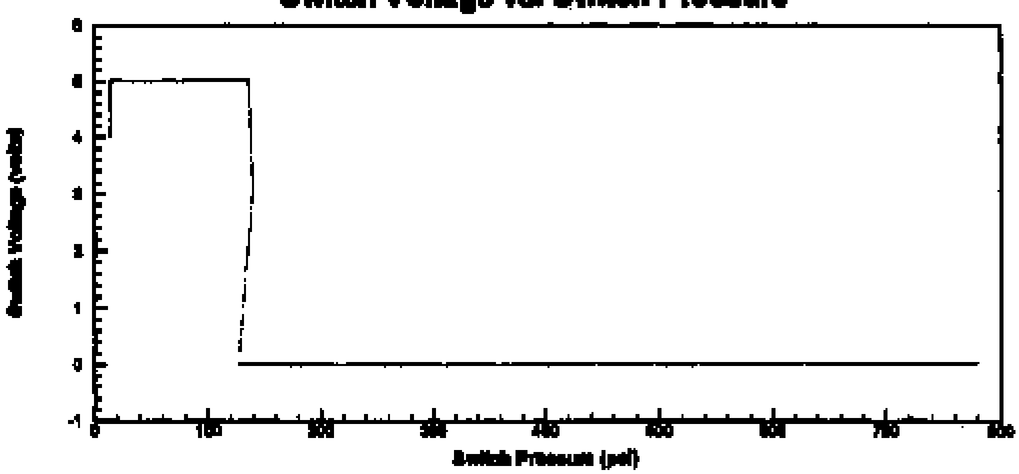
Time History Data



Switch Pressure vs. Antilock Pressure



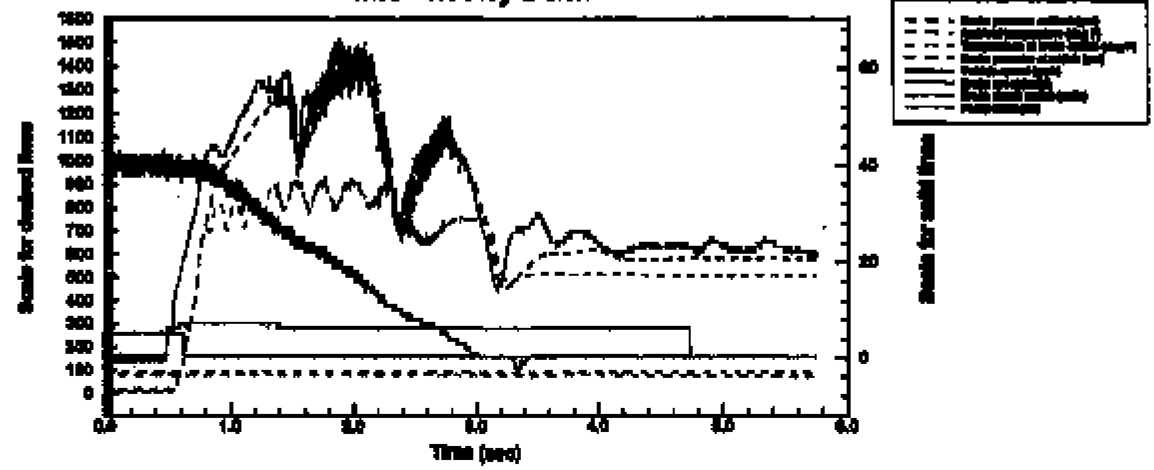
Switch Voltage vs. Switch Pressure



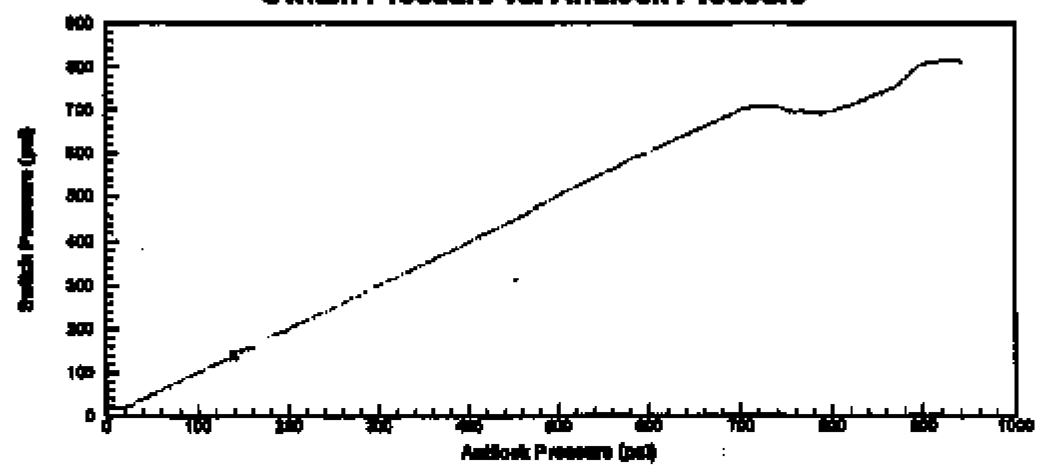
Design Research Engineering

40 mph normal ABS | Ford Test Data: Lincoln Towncar | File Name: ll-incol2.014

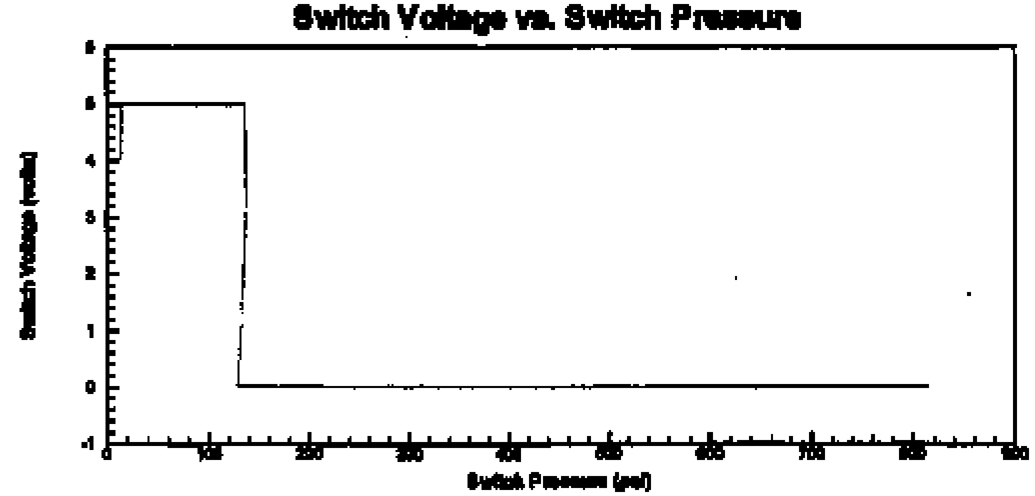
Time History Data



Switch Pressure vs. Antilock Pressure

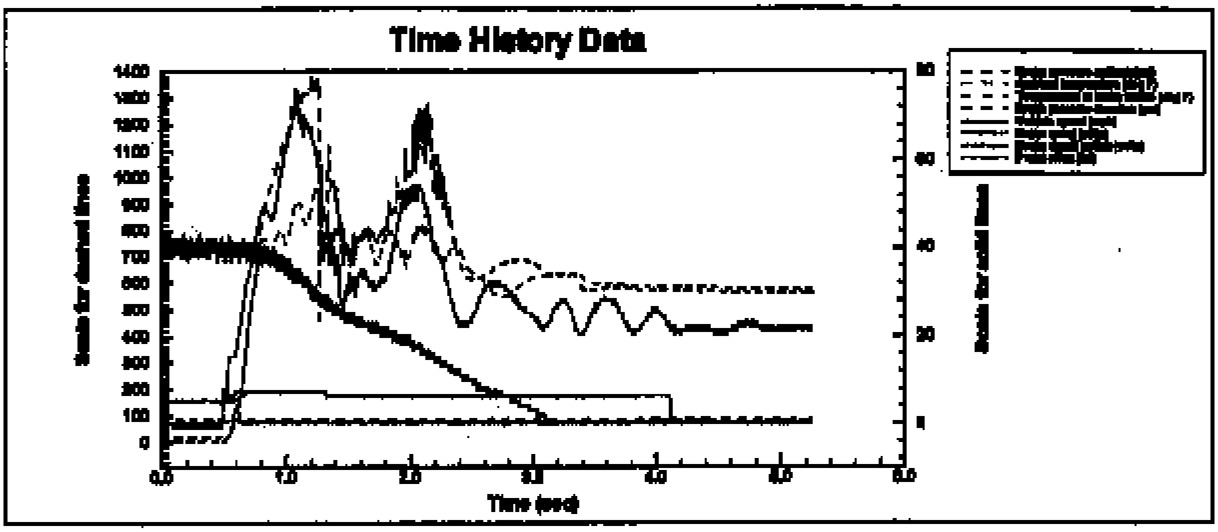


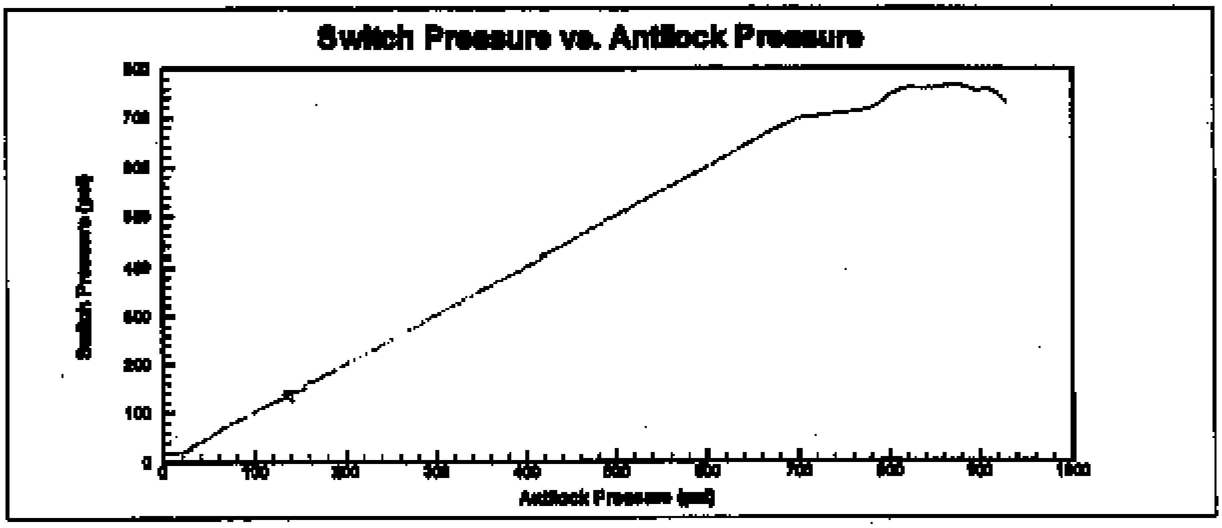
Switch Voltage vs. Switch Pressure

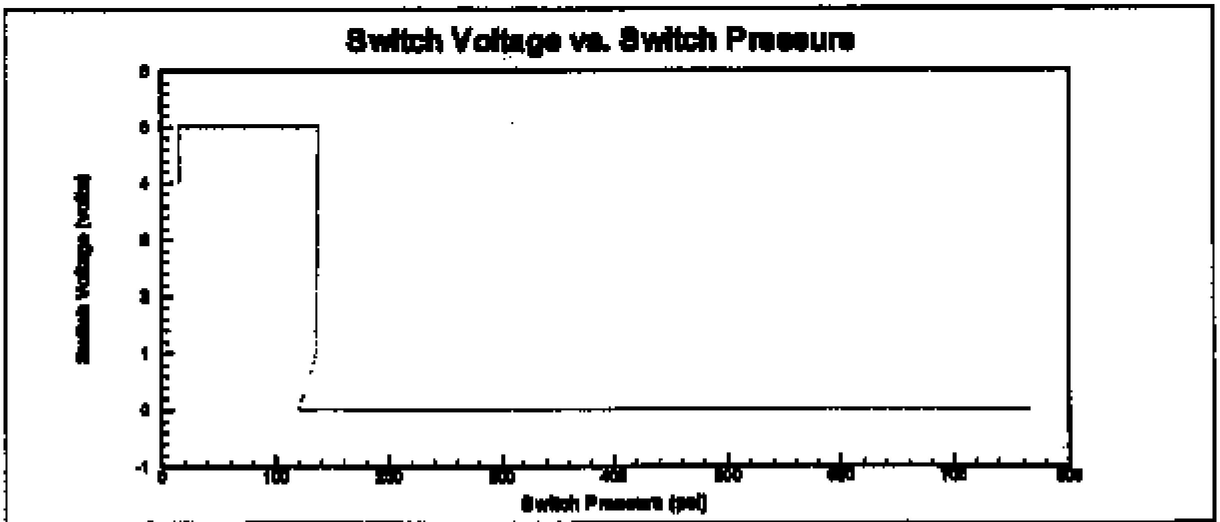


Design Research Engineering

40 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: lLinco##.018



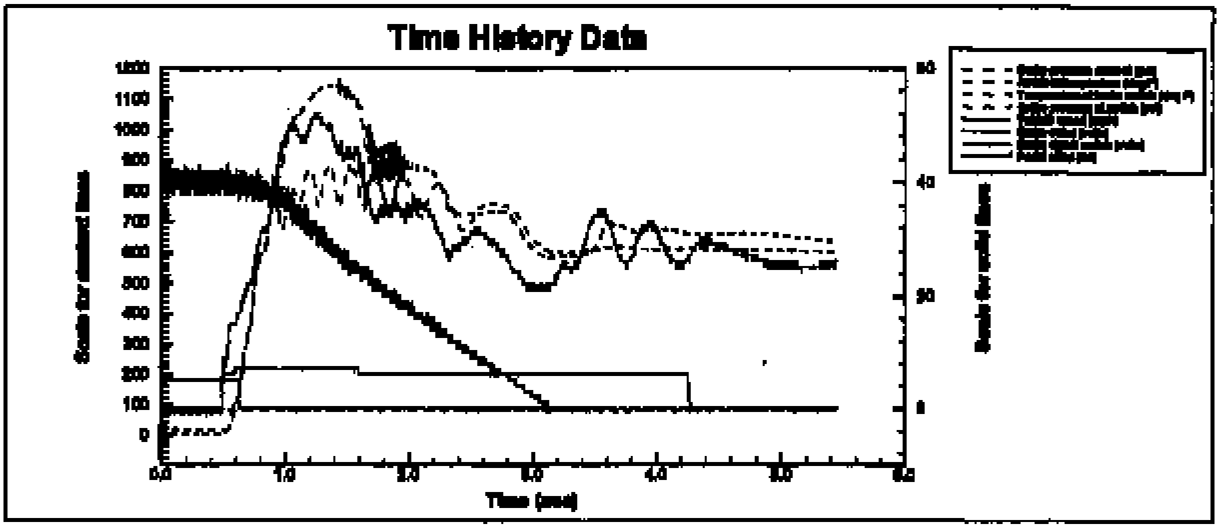


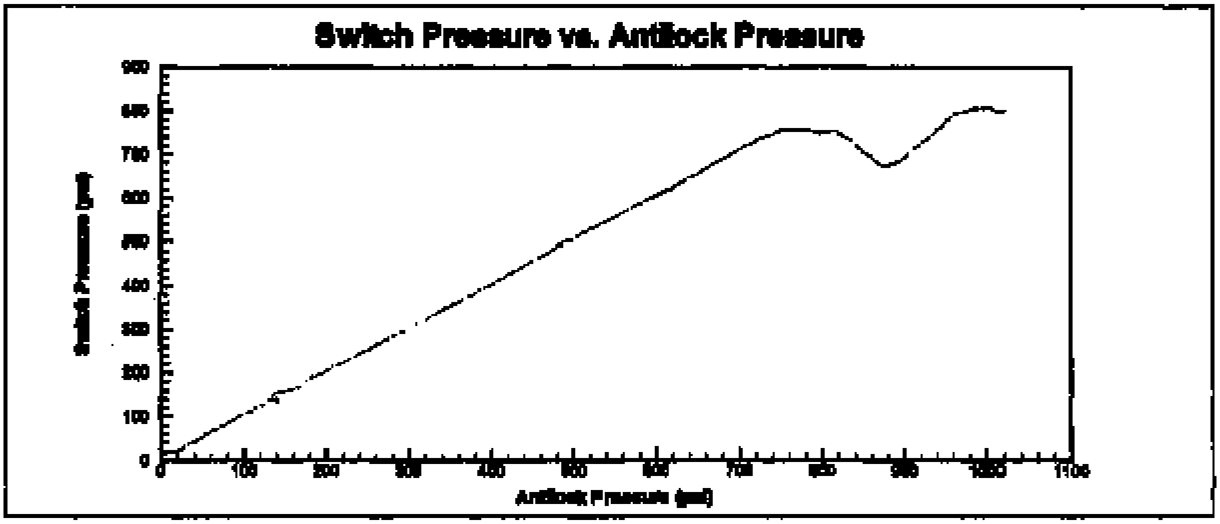


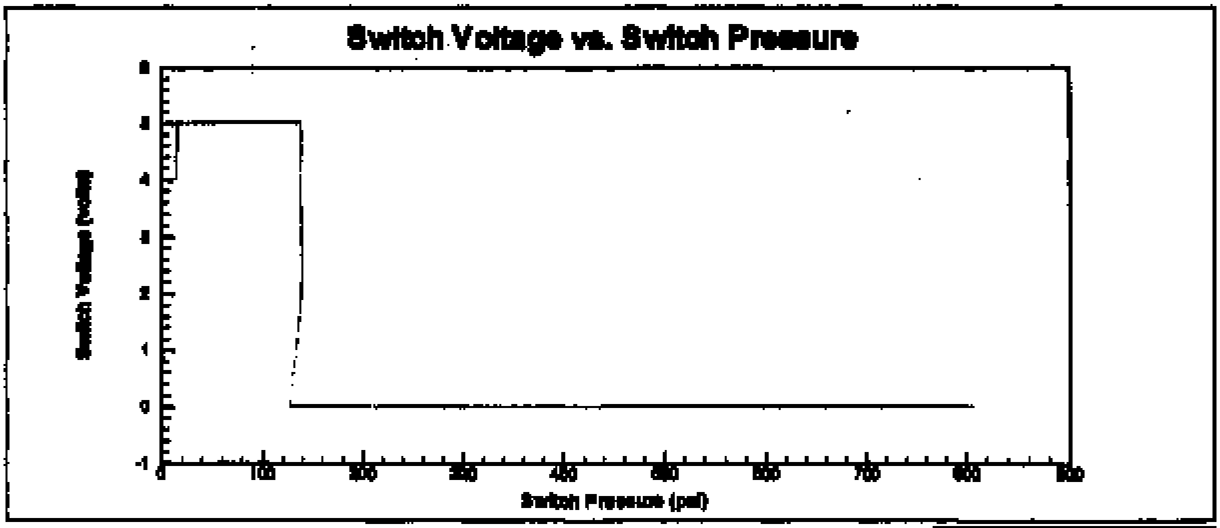
Design Research Engineering

TI-NHTSA 014934

40 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: lLincol2.016



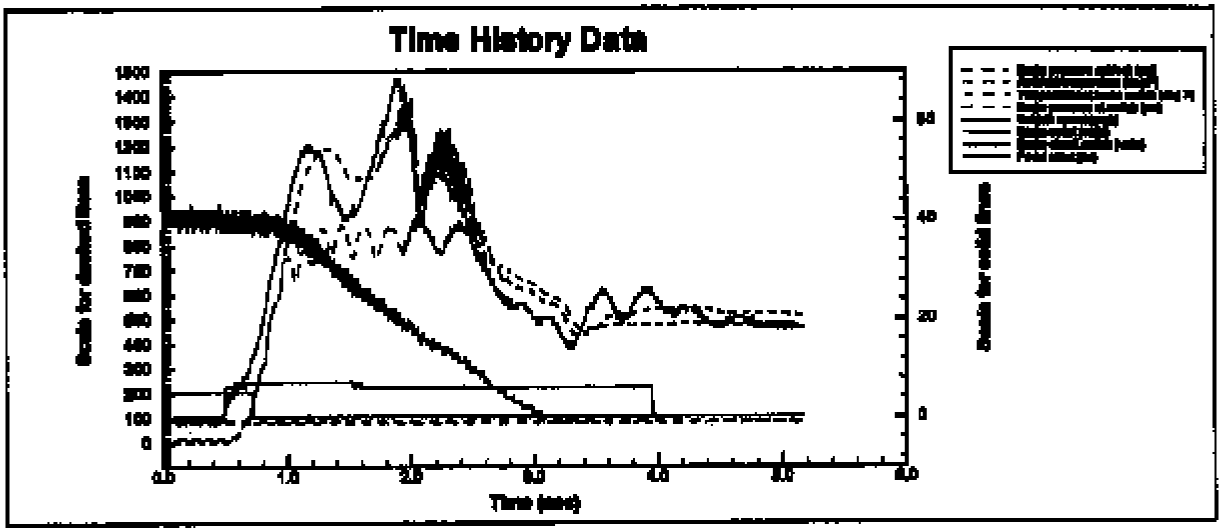


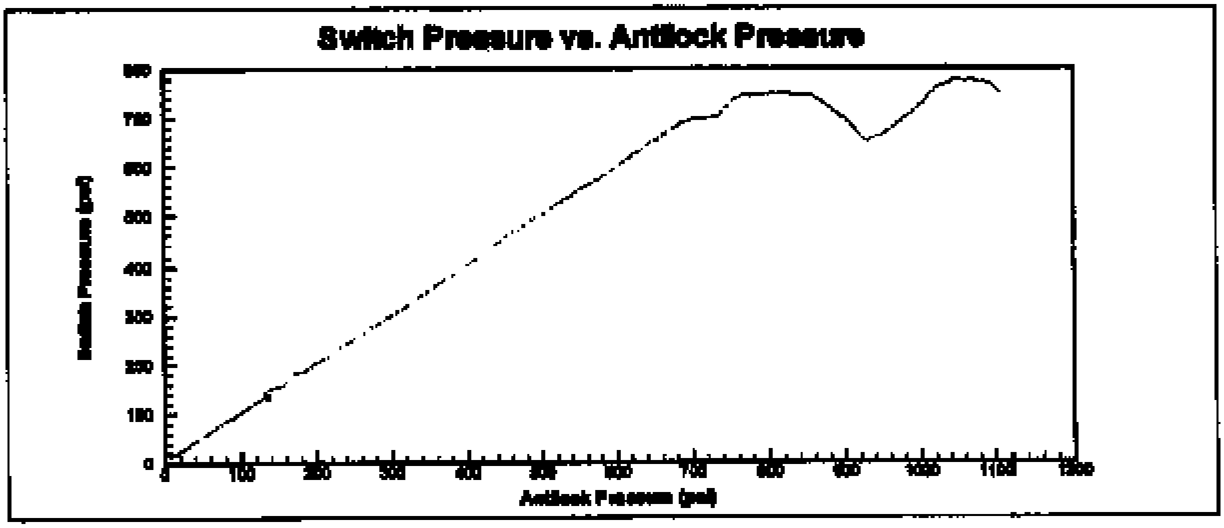


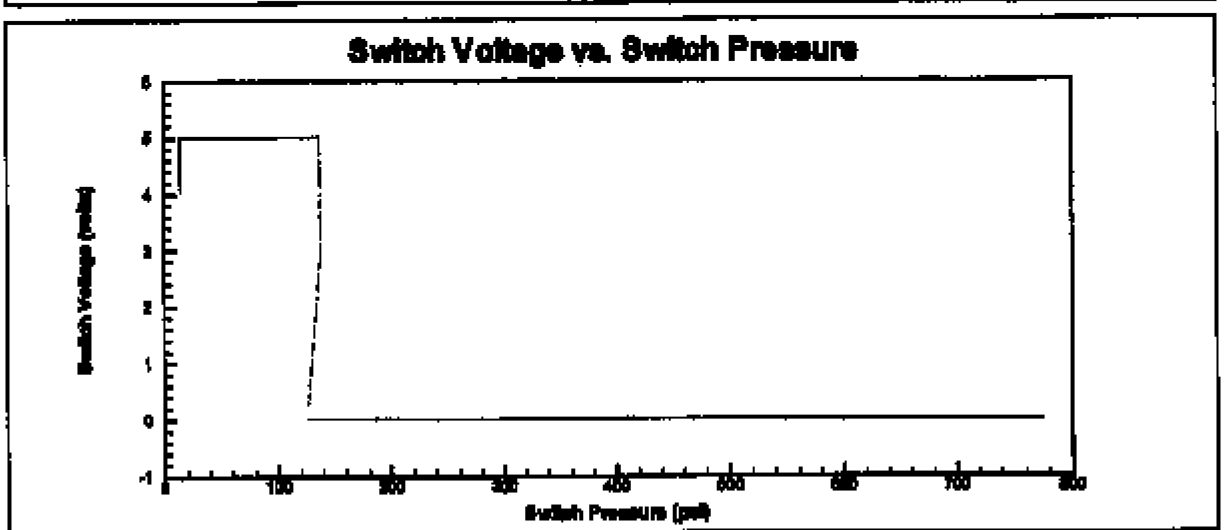
Design Research Engineering

TI-NHTSA 014936

40 mph normal ABS	Ford Test Data: Lincoln Towncar	File Name: fl.incol2.017



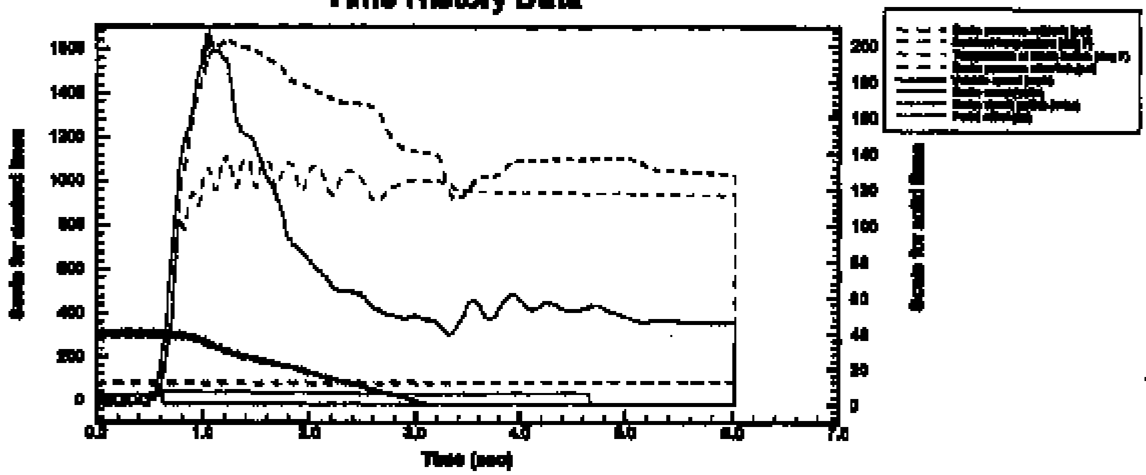




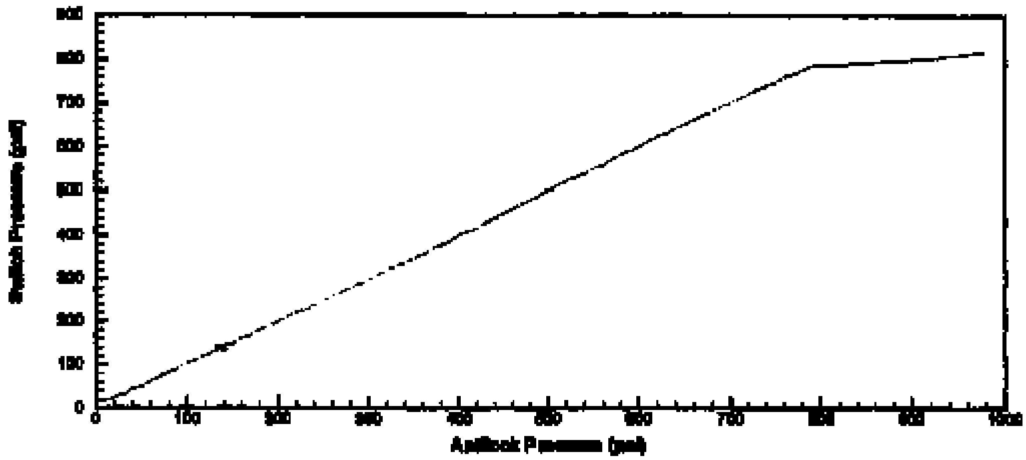
Design Research Engineering

40 mph panic/agressive NO ABS | Ford Test Data: Lincoln Towncar | File Name: lLinco12.018

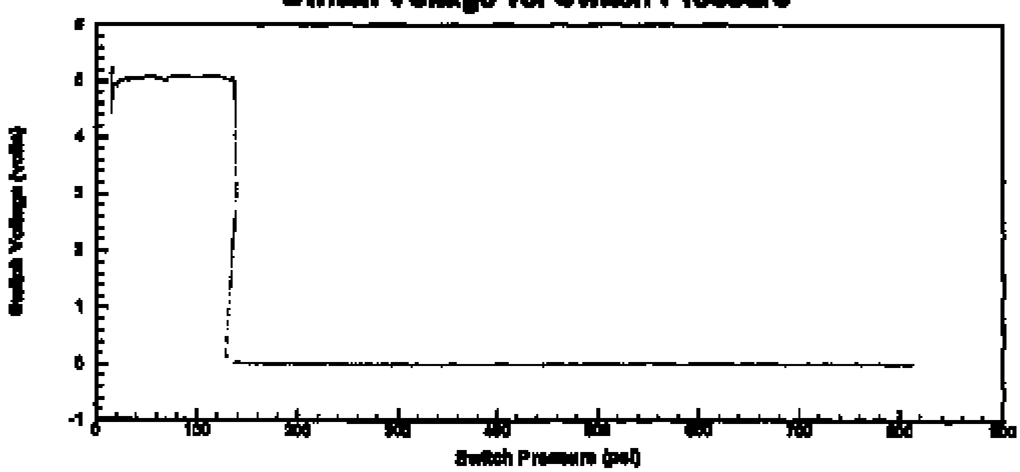
Time History Data



Switch Pressure vs. Antilock Pressure



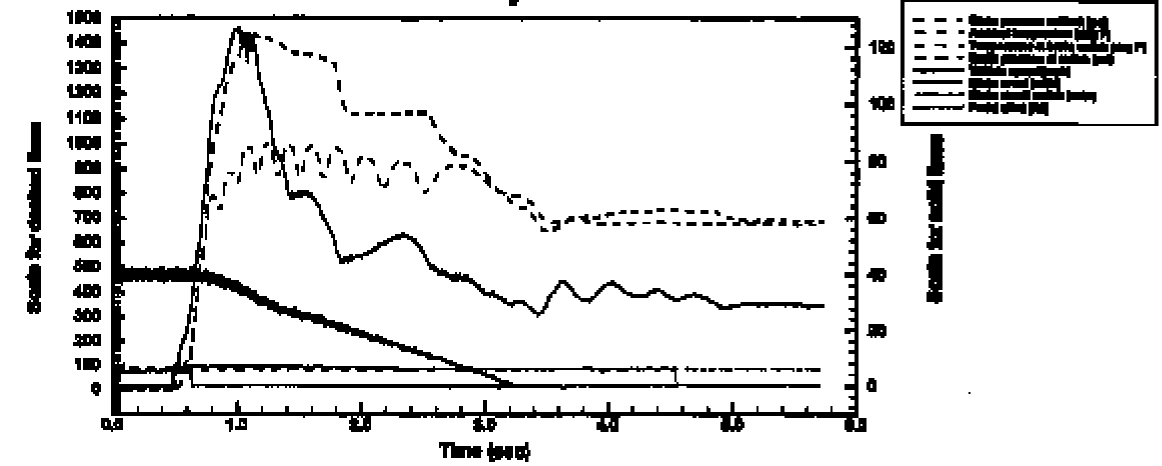
Switch Voltage vs. Switch Pressure



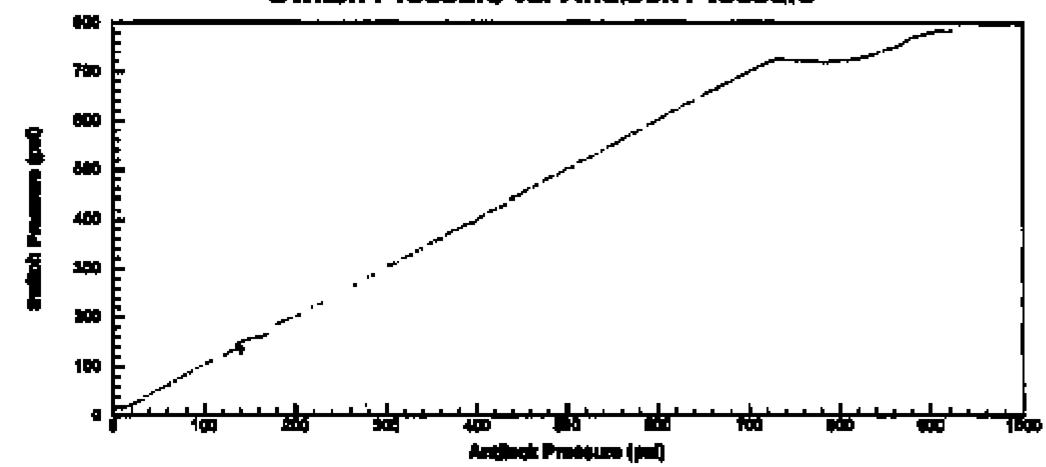
Design Research Engineering

40 mph panic/agressive NO ABS | Ford Test Data: Lincoln Towncar | File Name: lLincol2.019

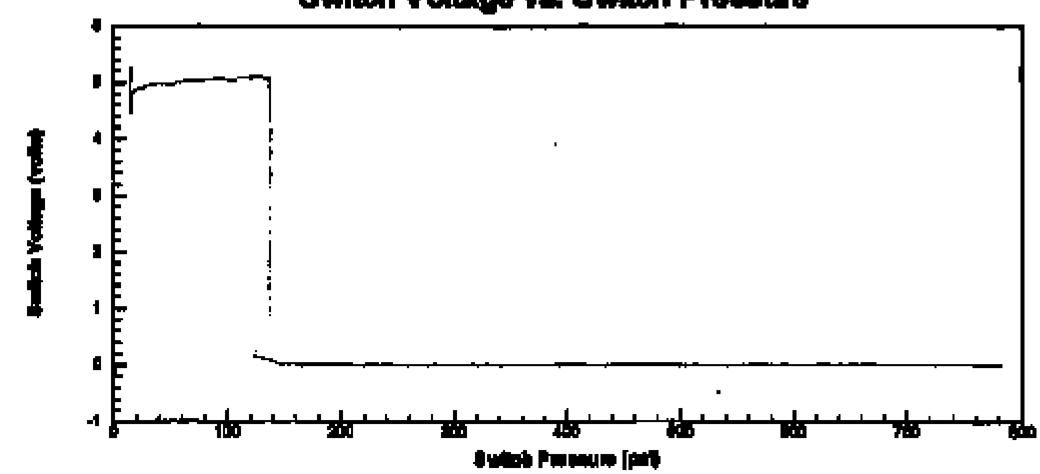
Time History Data



Switch Pressure vs. Antilock Pressure



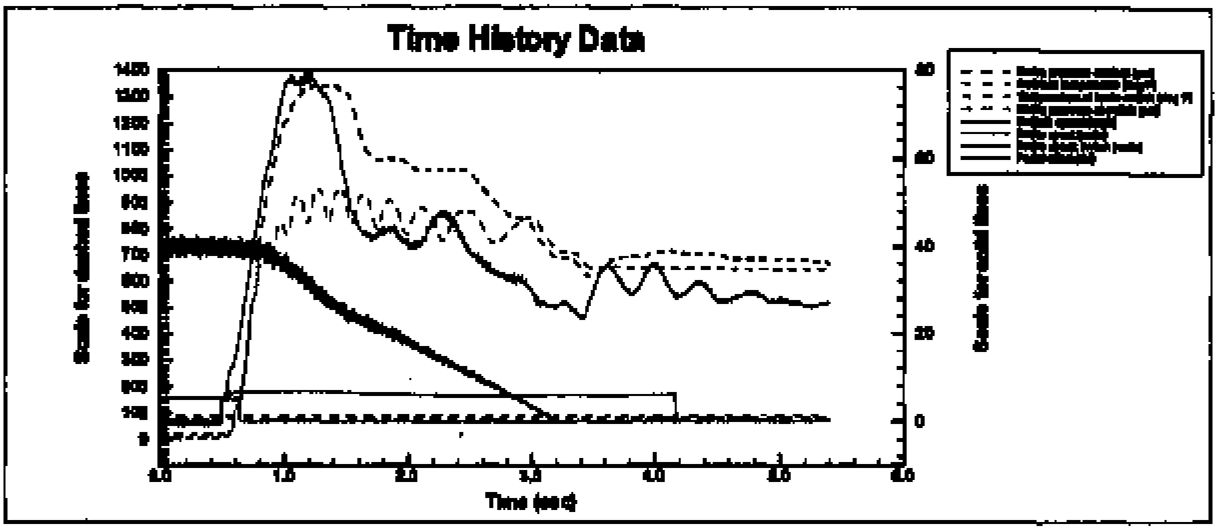
Switch Voltage vs. Switch Pressure

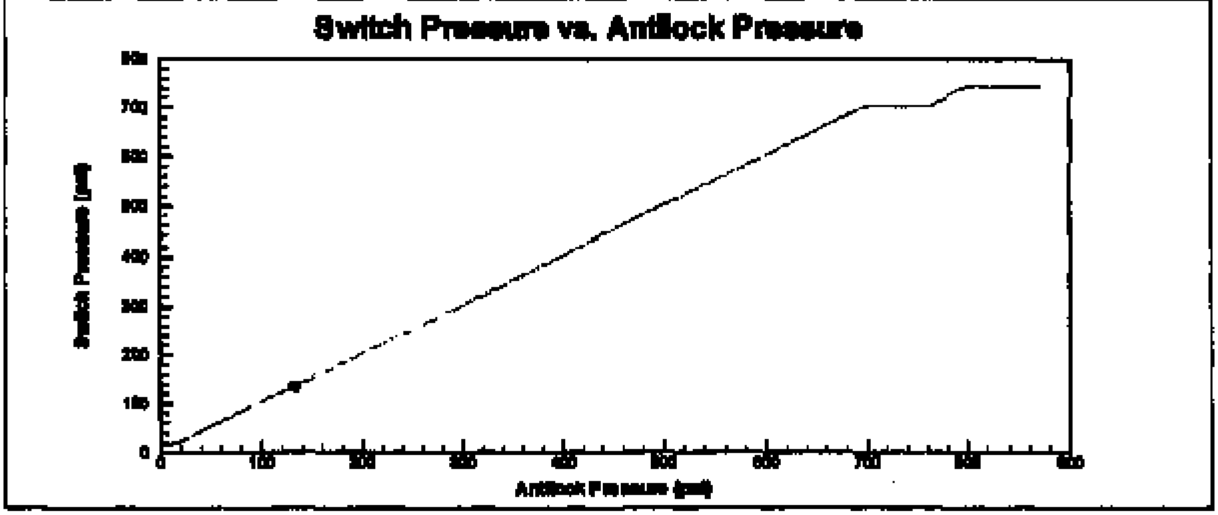


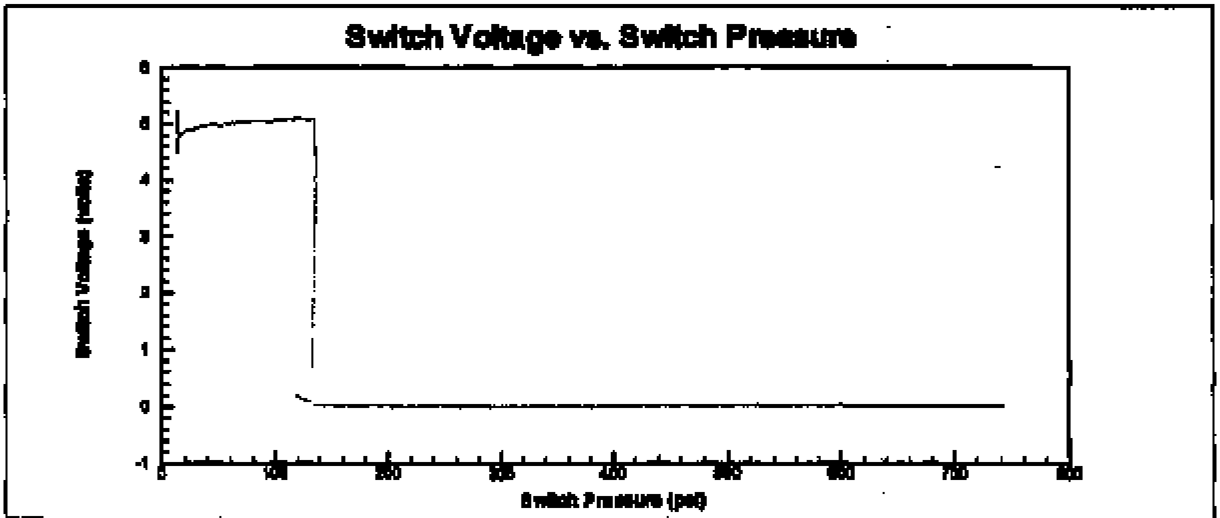
Design Research Engineering

TI-NHTSA 014938

40 mph panic/aggressive NO ABS | Ford Test Data: Lincoln Towncar | File Name: lLinco2.020



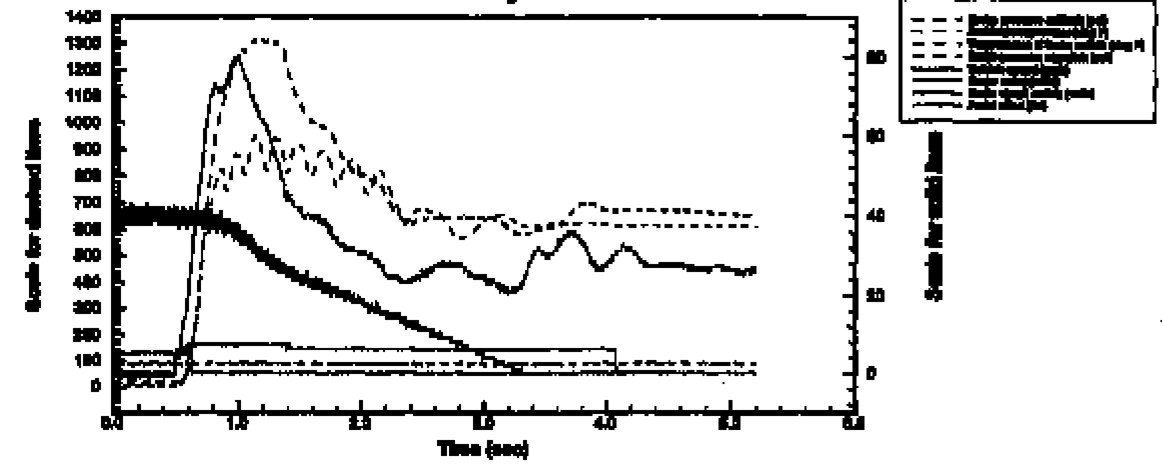




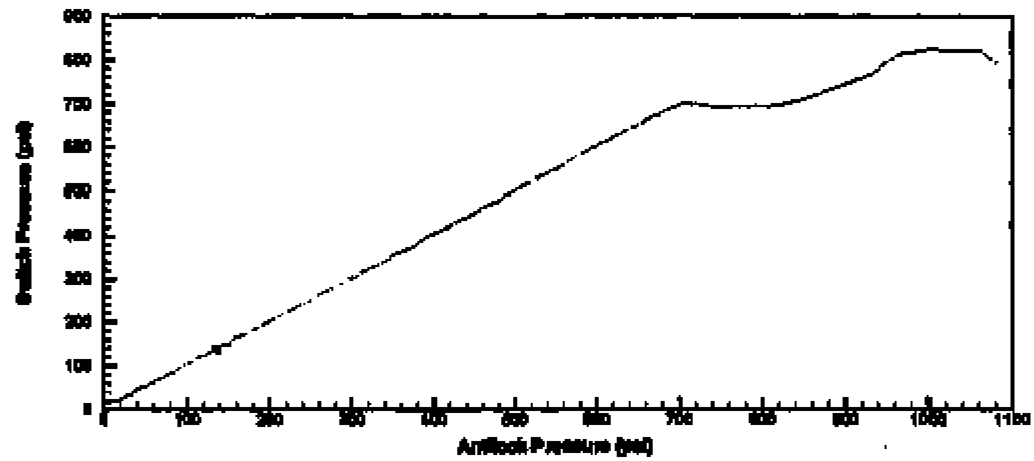
Design Research Engineering

40 mph panic/agressive NO ABS | Ford Test Data: Lincoln Towncar | File Name: lLincol2.021

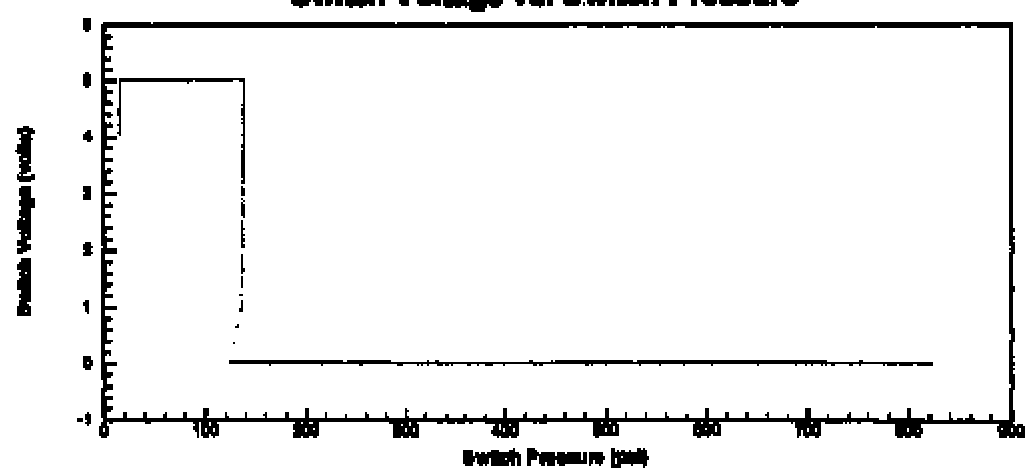
Time History Data



Switch Pressure vs. Antilock Pressure

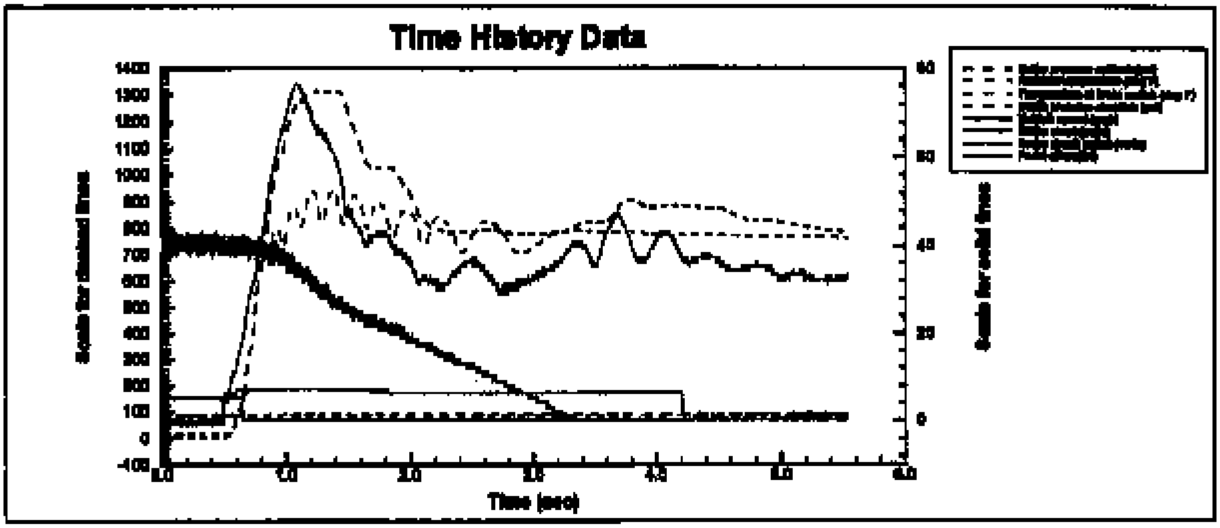


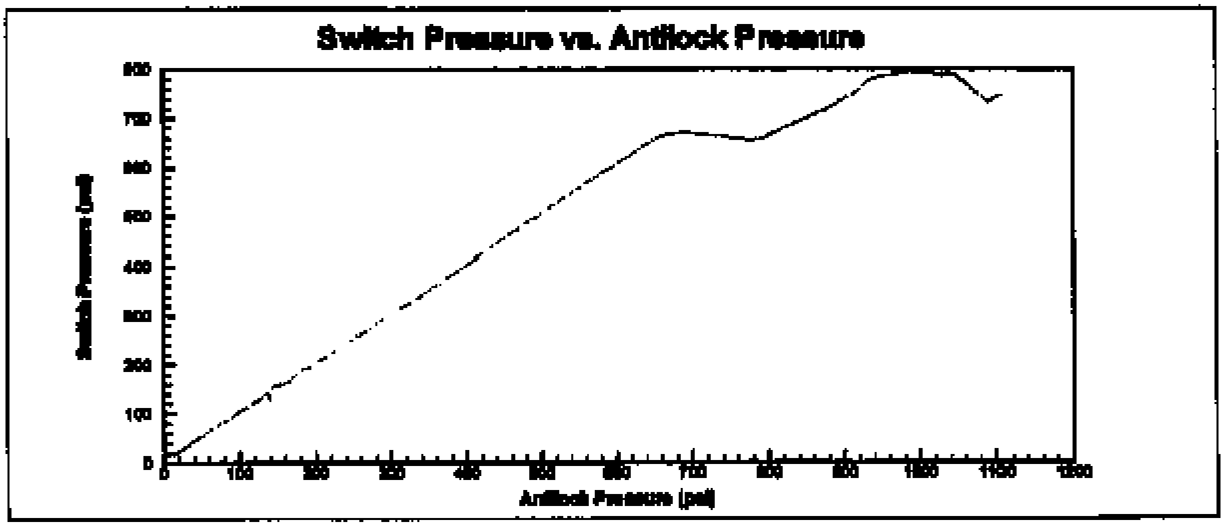
Switch Voltage vs. Switch Pressure

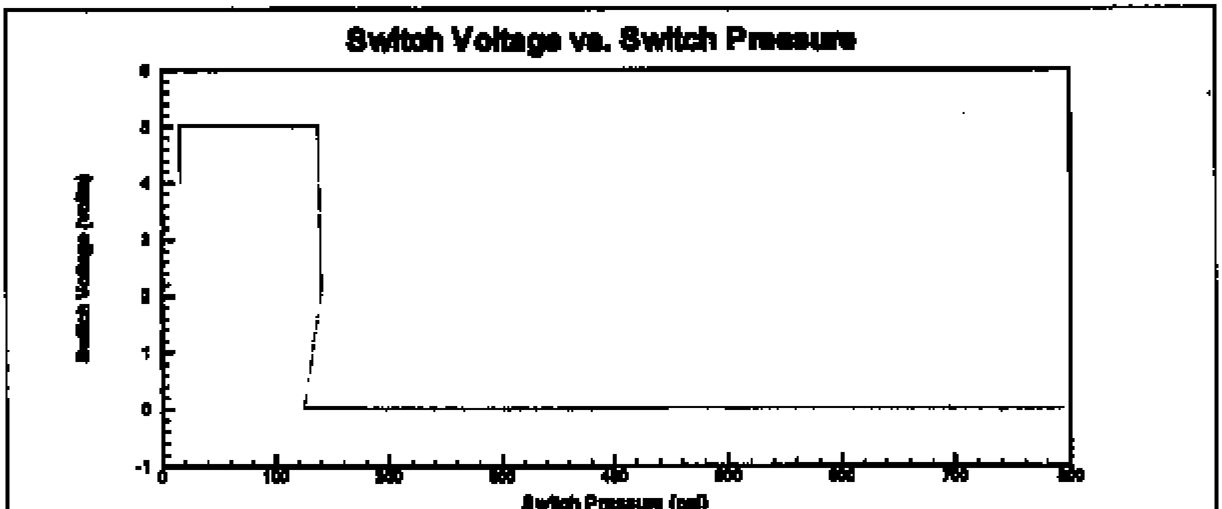


Design Research Engineering

40 mph panic/agressive NO ABS	Ford Test Data: Lincoln Towncar	File Name: ILinco2.032





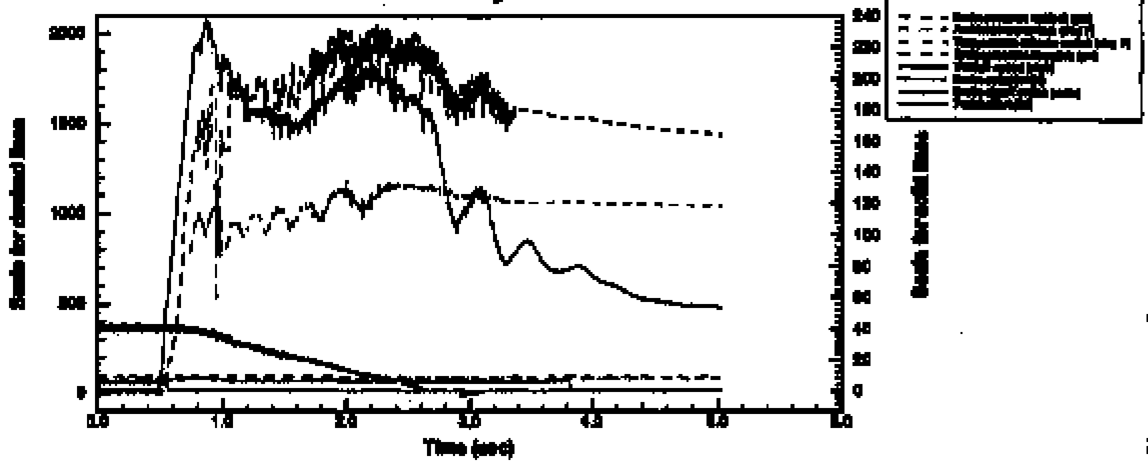


Design Research Engineering

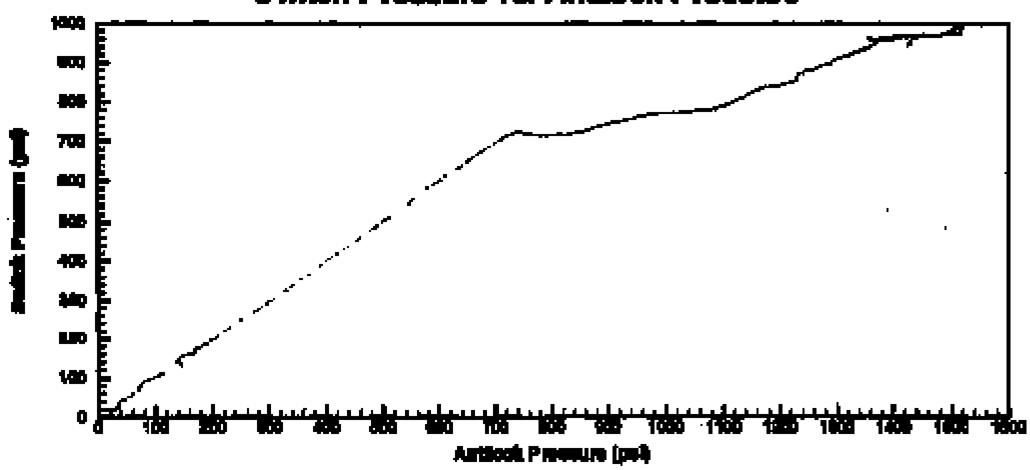
TI-NHTSA 014941

40 mph panic/aggressive ABS | Ford Test Data: Lincoln Towncar | File Name: LLincol2.023

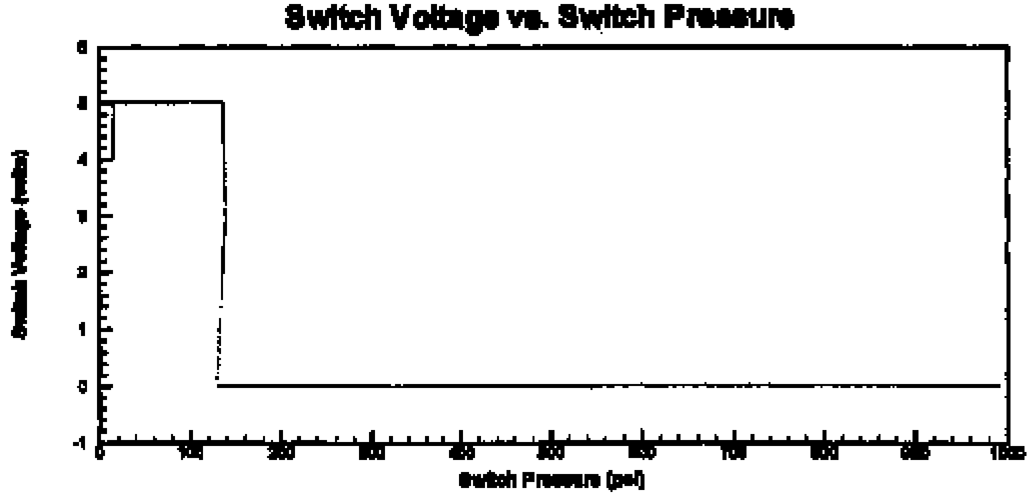
Time History Data



Switch Pressure vs. Antilock Pressure



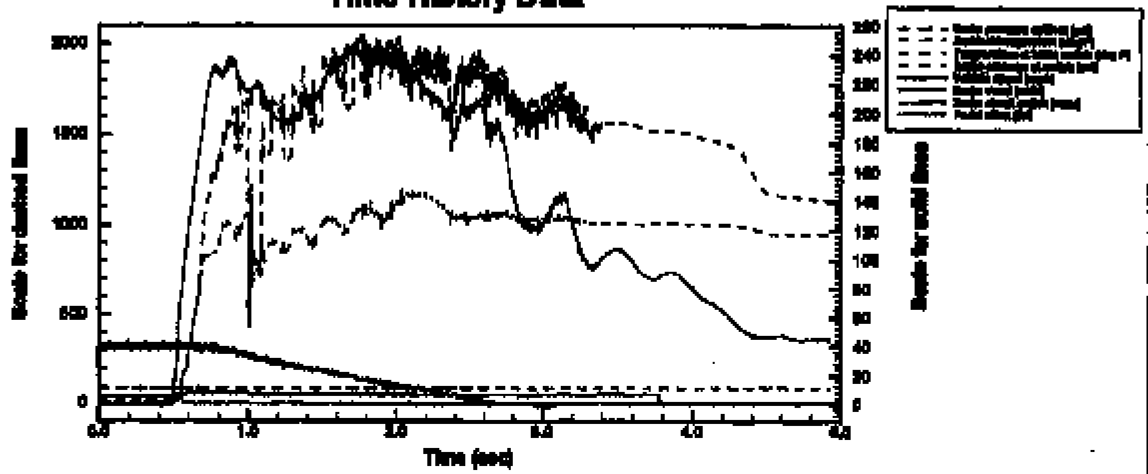
Switch Voltage vs. Switch Pressure



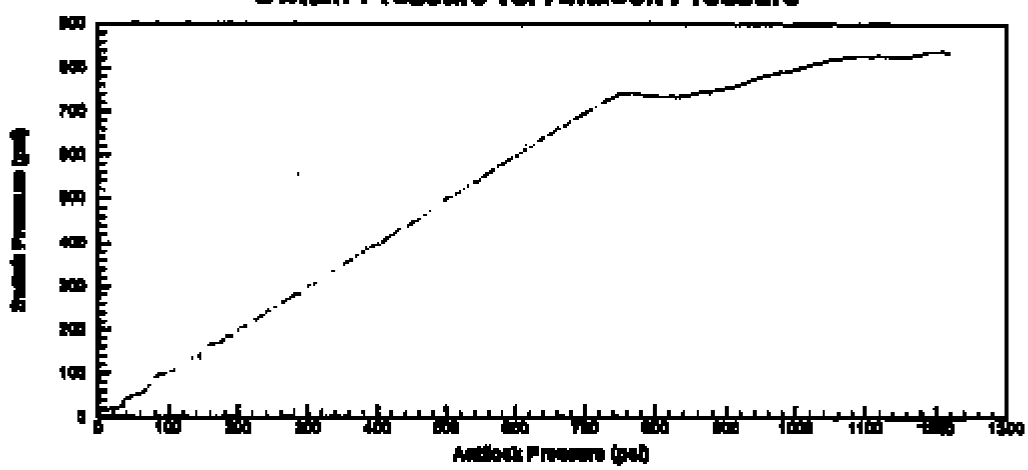
Design Research Engineering

40 mph panic/aggressive ABS | Ford Test Data: Lincoln Towncar | File Name: ILinco0.024

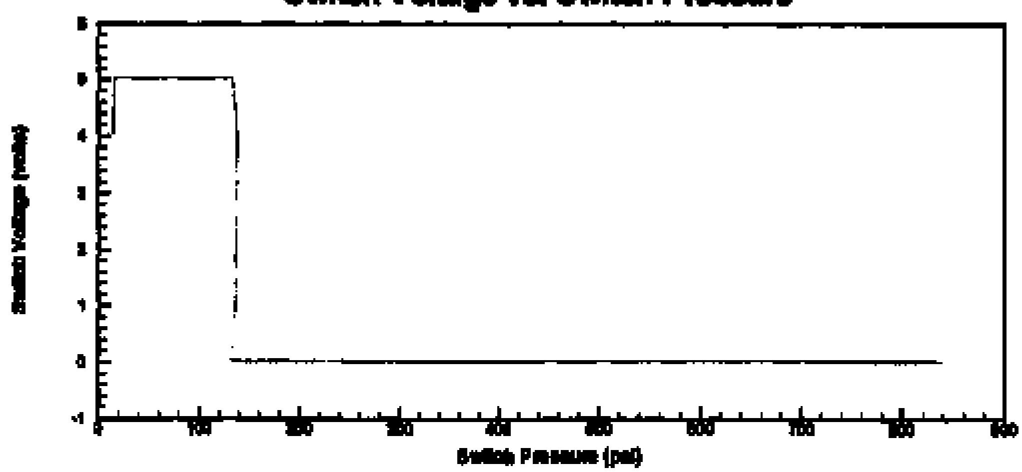
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

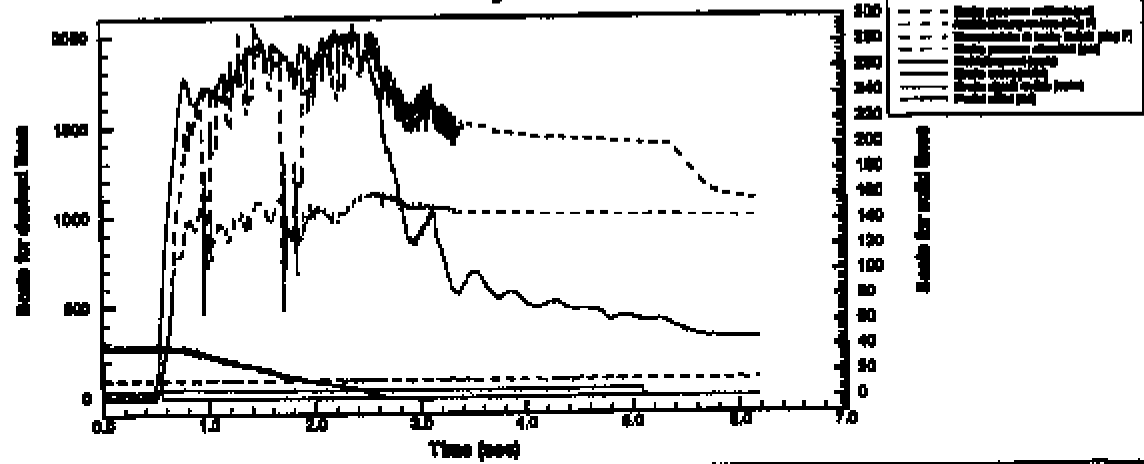


Design Research Engineering

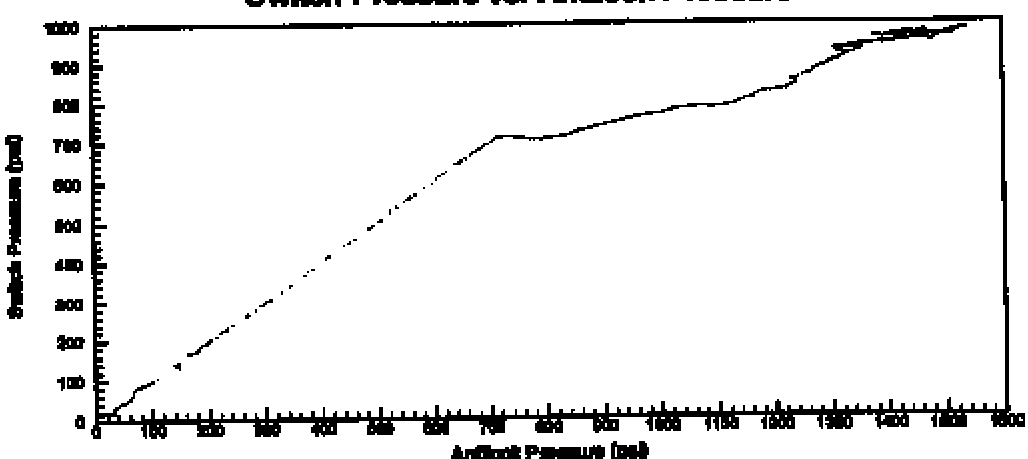
TI-NHTSA 014943

40 mph panic/agressive ABS | Ford Test Data: Lincoln Towncar | File Name: fLinco12.025

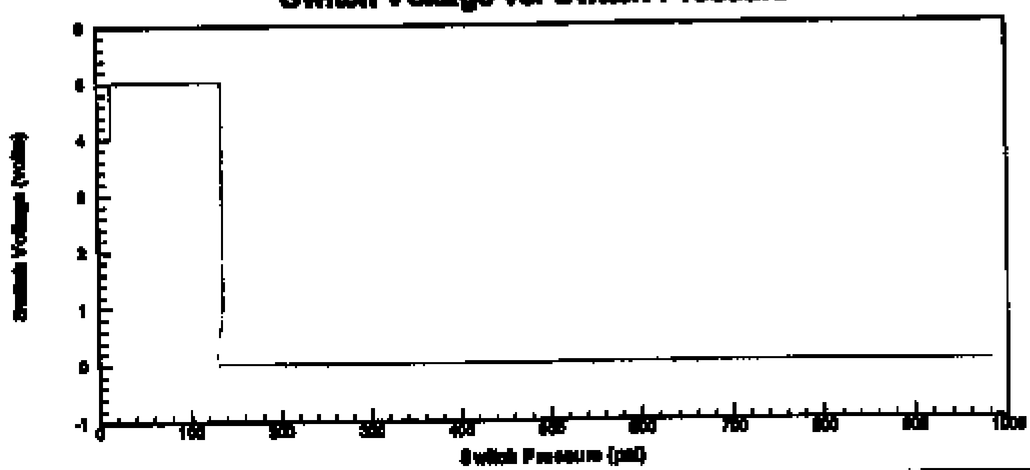
Time History Data



Switch Pressure vs. Antilock Pressure



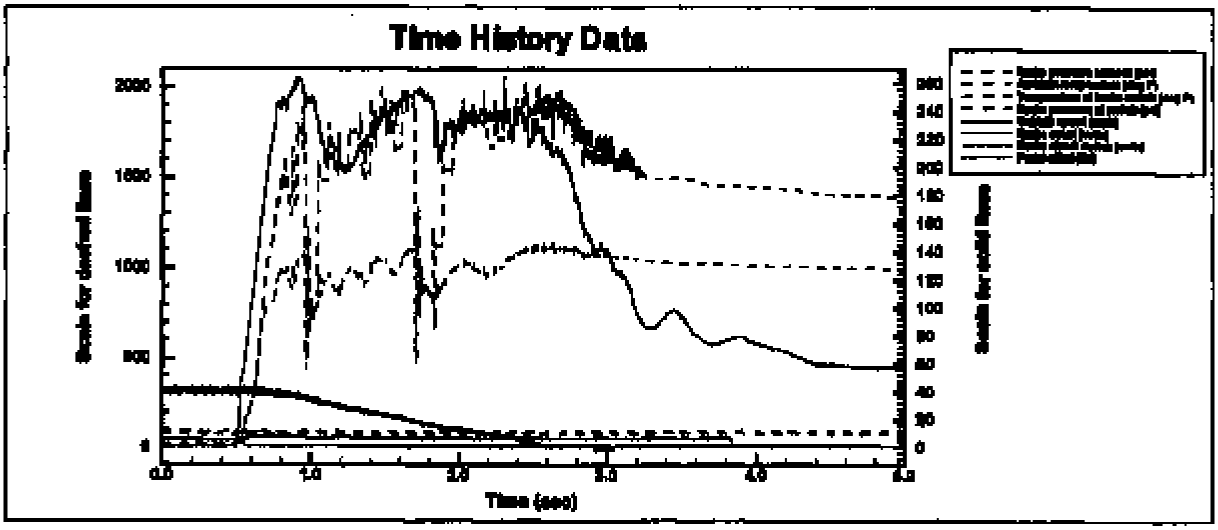
Switch Voltage vs. Switch Pressure

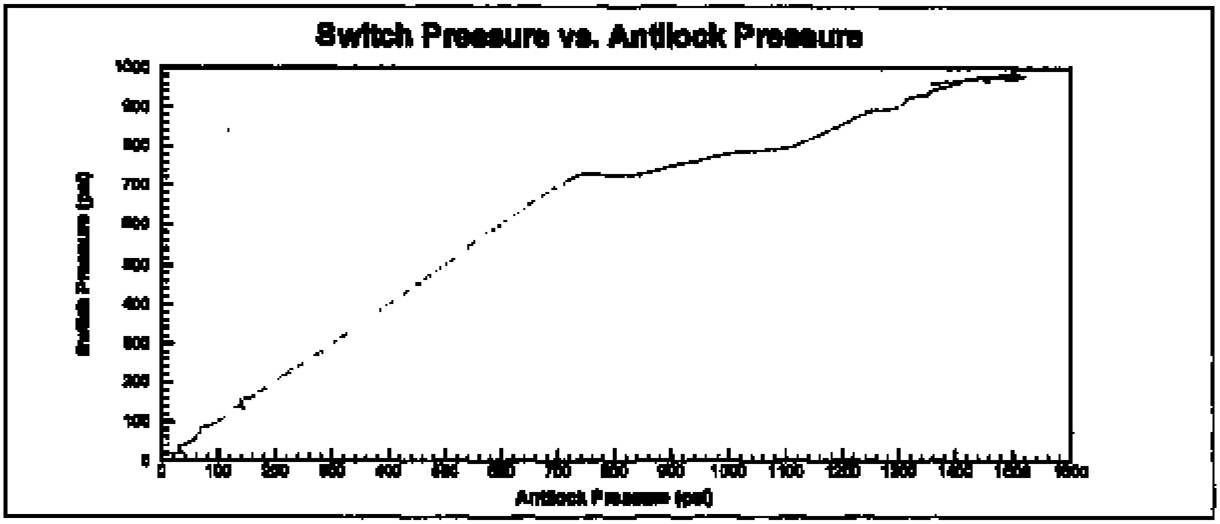


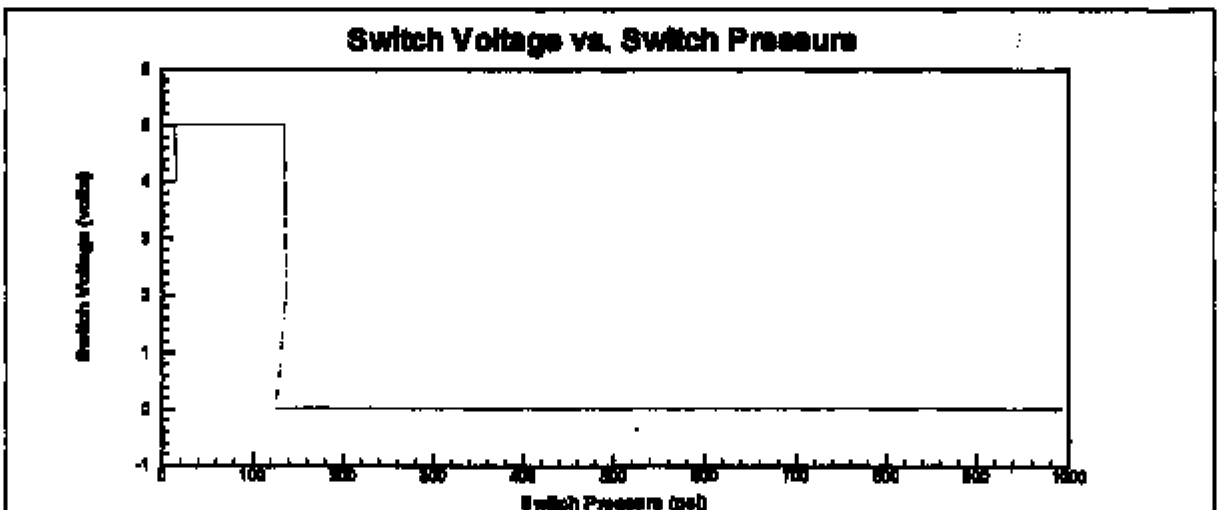
Design Research Engineering

TI-NHTSA 014944

40 mph panic/agressive ABS	Ford Test Data: Lincoln Towncar	File Name: 1Lincol2.036





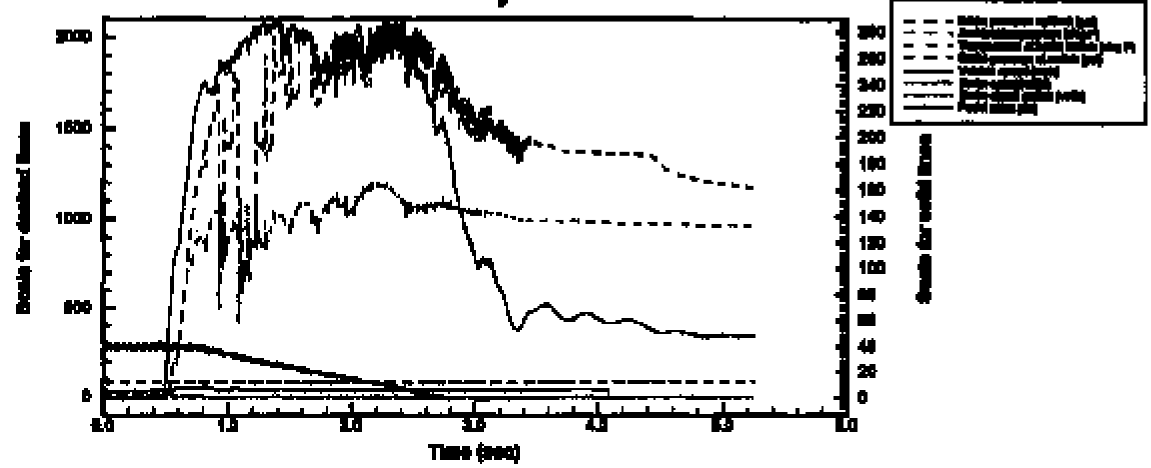


Design Research Engineering

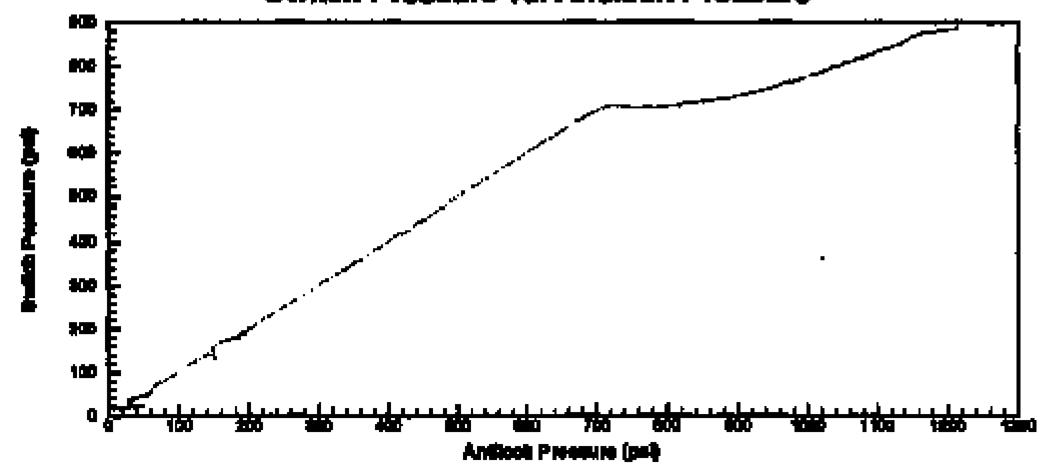
TI-NHTSA 014945

40 mph panic/agressive ABS	Ford Test Data: Lincoln Towncar	File Name: ILincol3.027

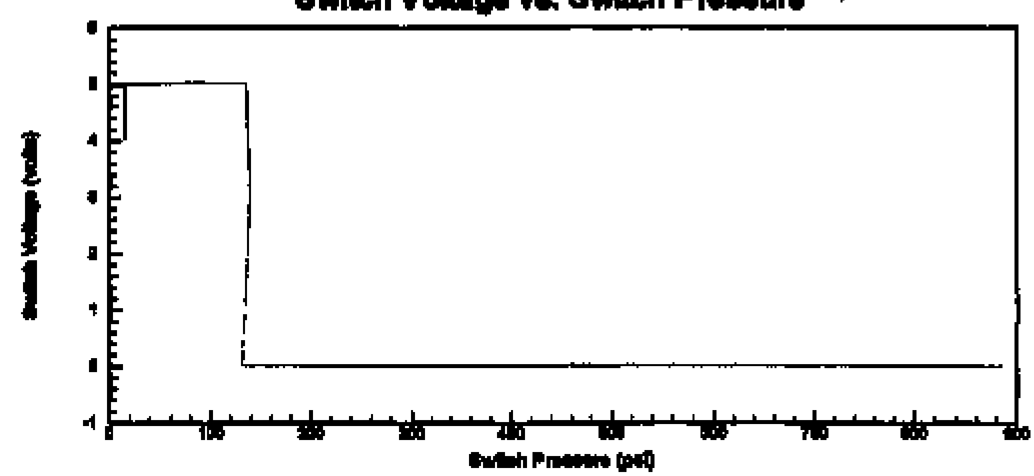
Time History Data



Switch Pressure vs. Antilock Pressure



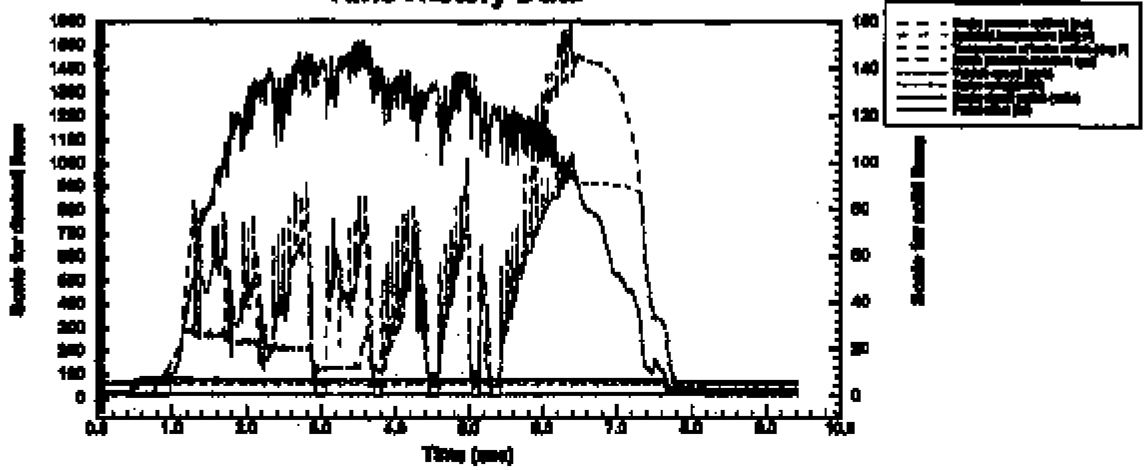
Switch Voltage vs. Switch Pressure



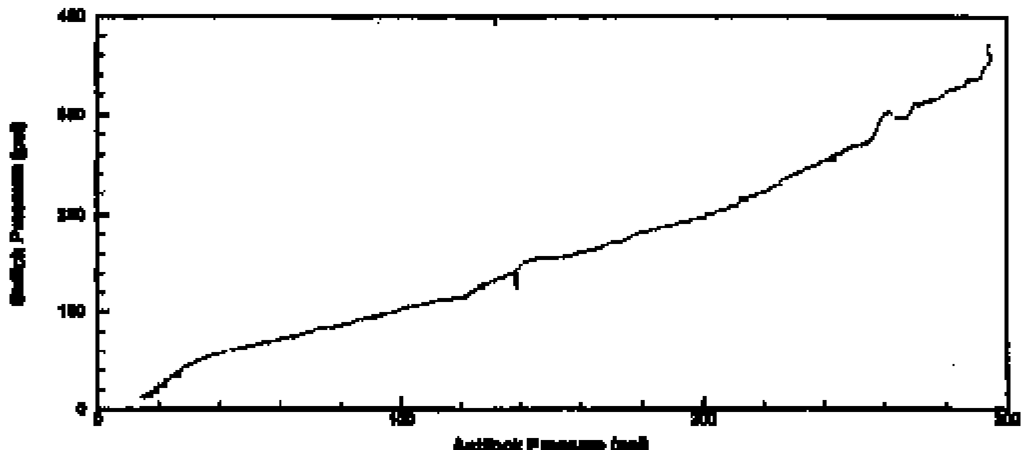
Design Research Engineering

30 mph panic/aggressive ABS LOW Mu | Ford Test Data: Lincoln Towncar | File Name: ILinco3.061

Time History Data



Switch Pressure vs. Antilock Pressure

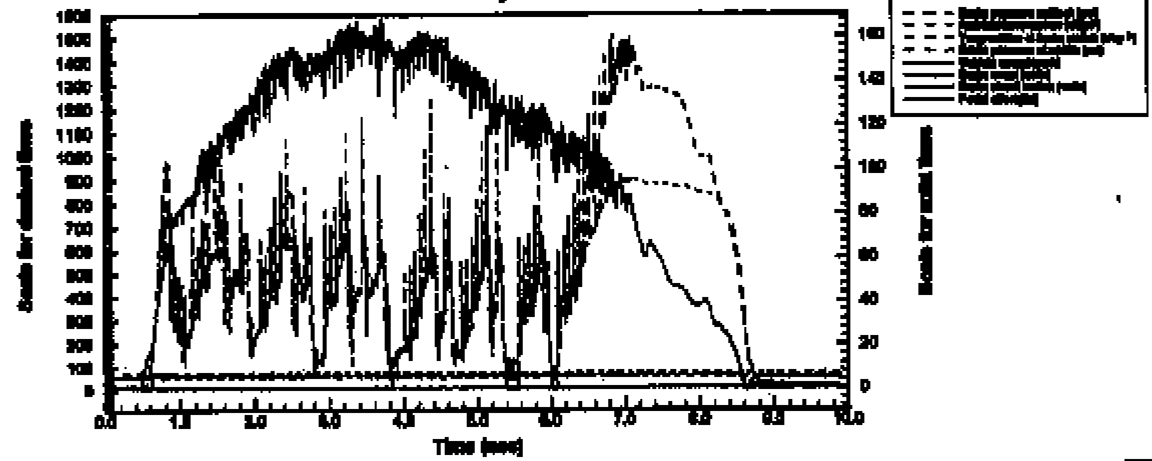


Switch Voltage vs. Switch Pressure

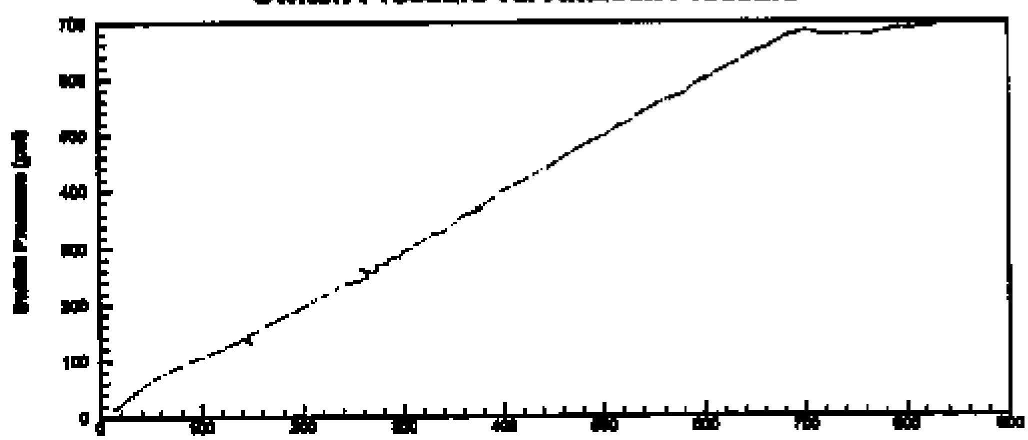
Dailey Research Engineering

40 mph panic/aggressive ABS LOW Mu   Ford Test Data: Lincoln Towncar   File Name: ILinco3.002

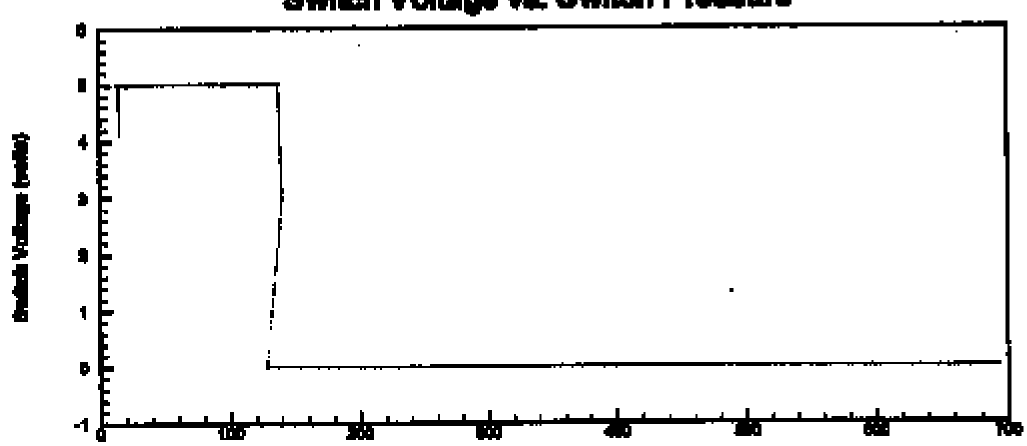
Time History Data



Switch Pressure vs. Antilock Pressure



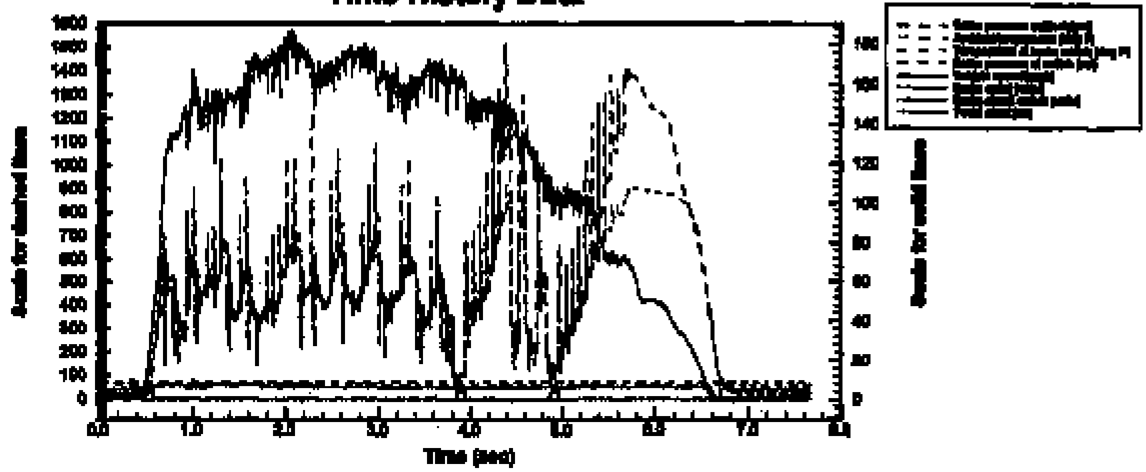
Switch Voltage vs. Switch Pressure



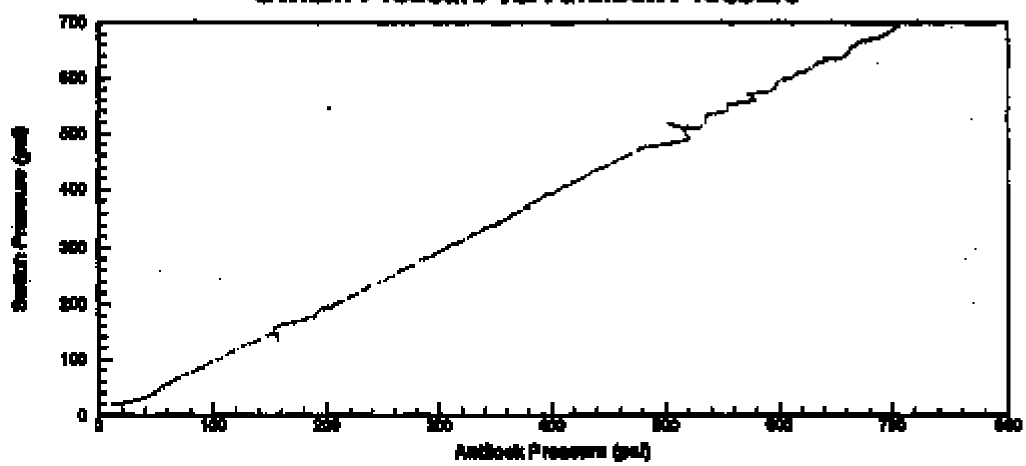
Design Research Engineering

30 mph panic/aggressive ABS LOW Mu   Ford Test Data: Lincoln Towncar   File Name: LLincoln.003

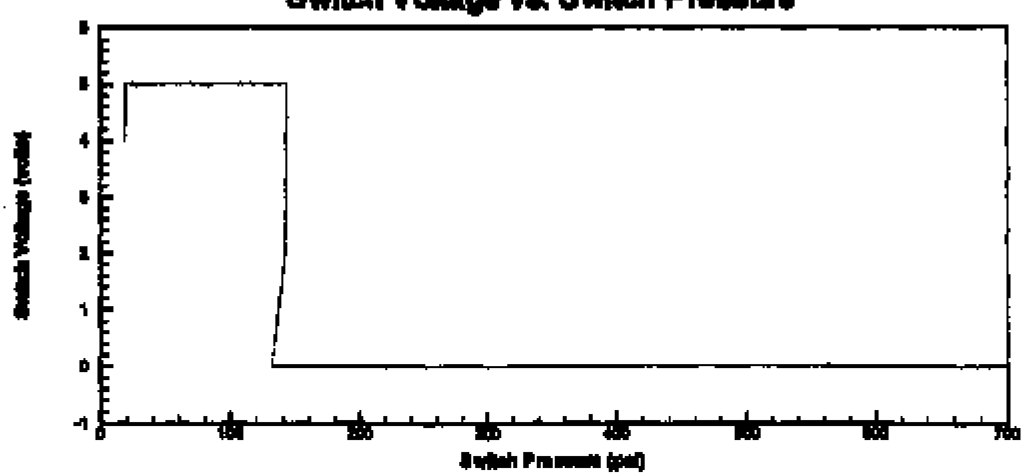
Time History Data



Switch Pressure vs. Antilock Pressure



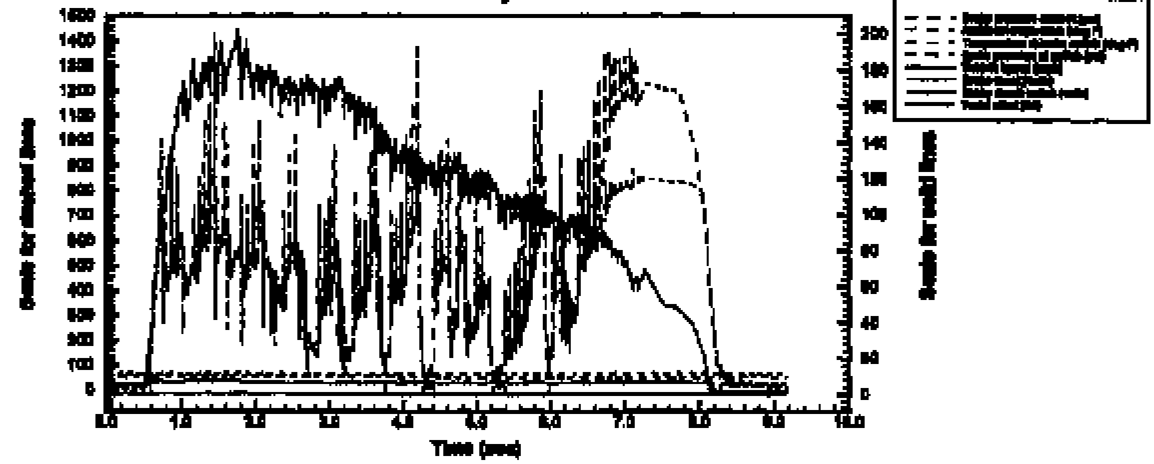
Switch Voltage vs. Switch Pressure



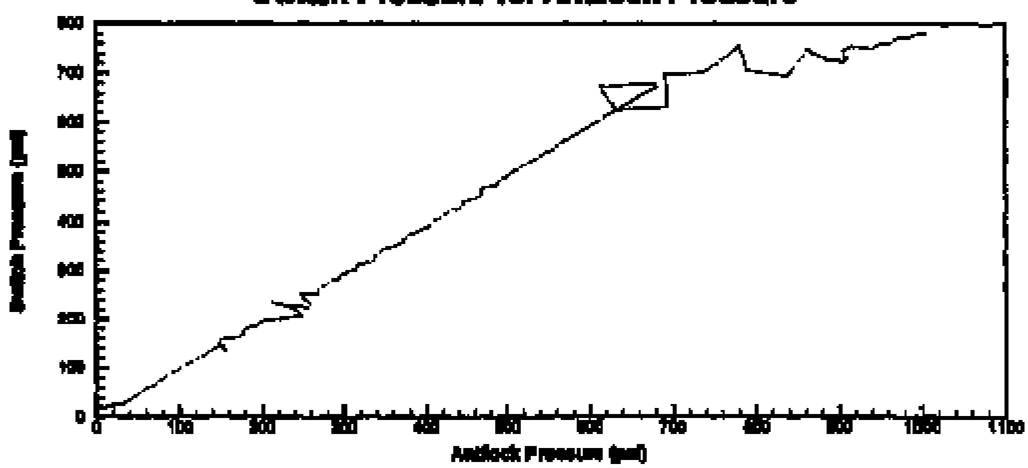
Design Research Engineering

40 mph peridofagressive ABS LOW Mu   Ford Test Data: Lincoln Towncar   File Name: ILincol3.004

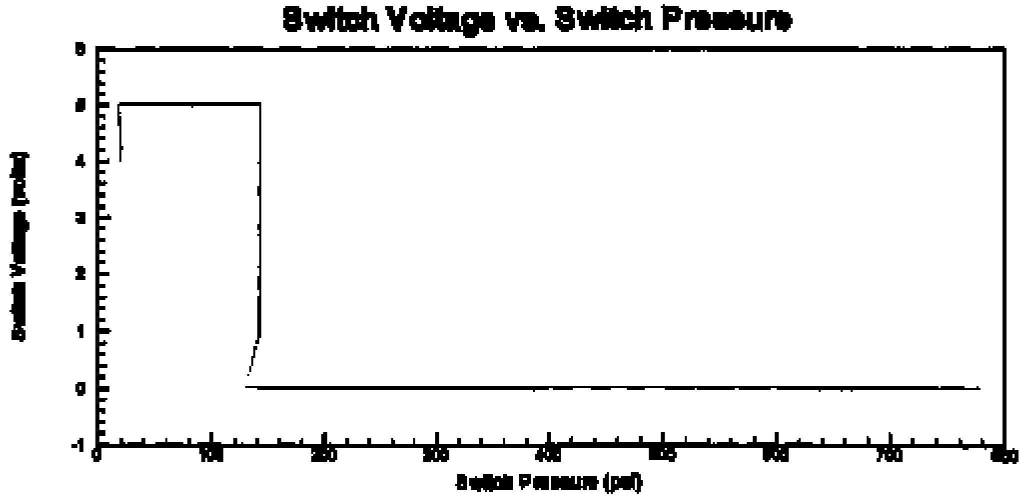
Time History Data



Switch Pressure vs. Antilock Pressure



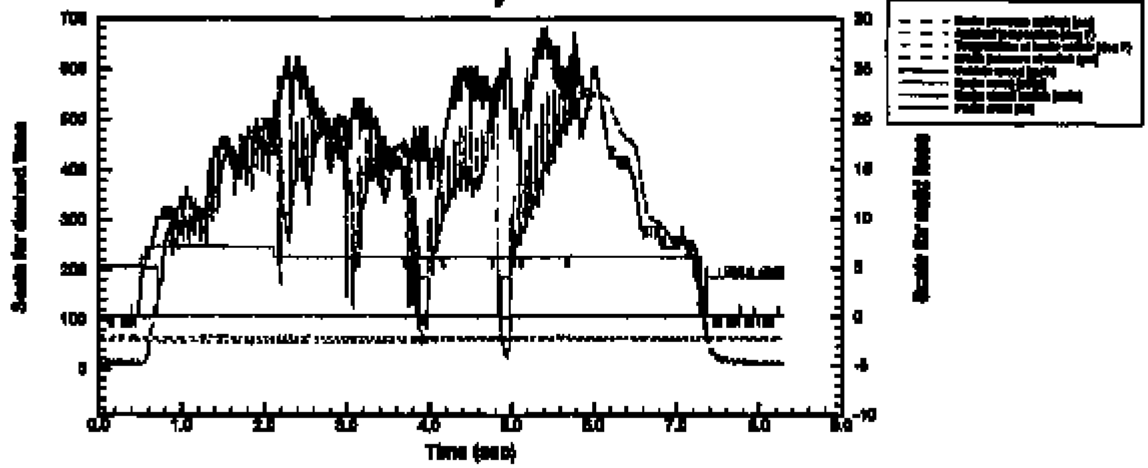
Switch Voltage vs. Switch Pressure



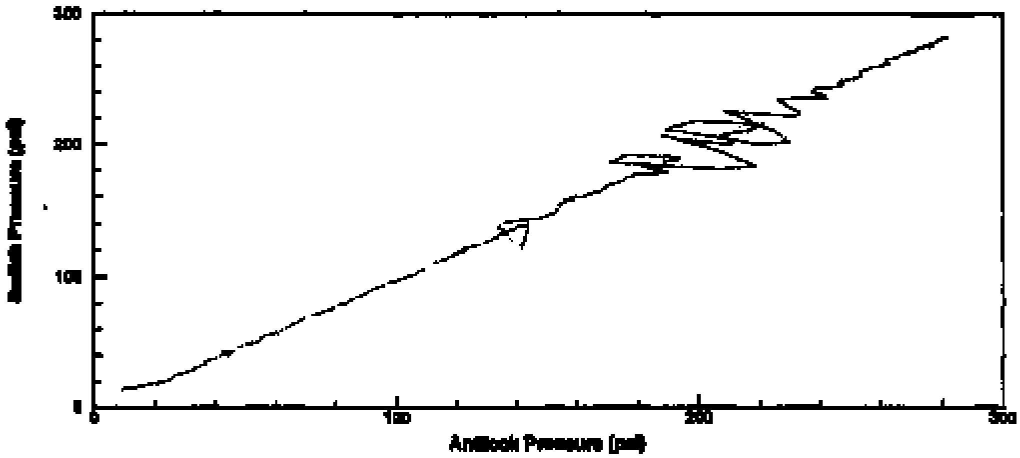
Design Research Engineering

30 mph 10 ft/s² LOW Mu	Ford Test Data: Lincoln Towncar	File Name: lLinco13.003

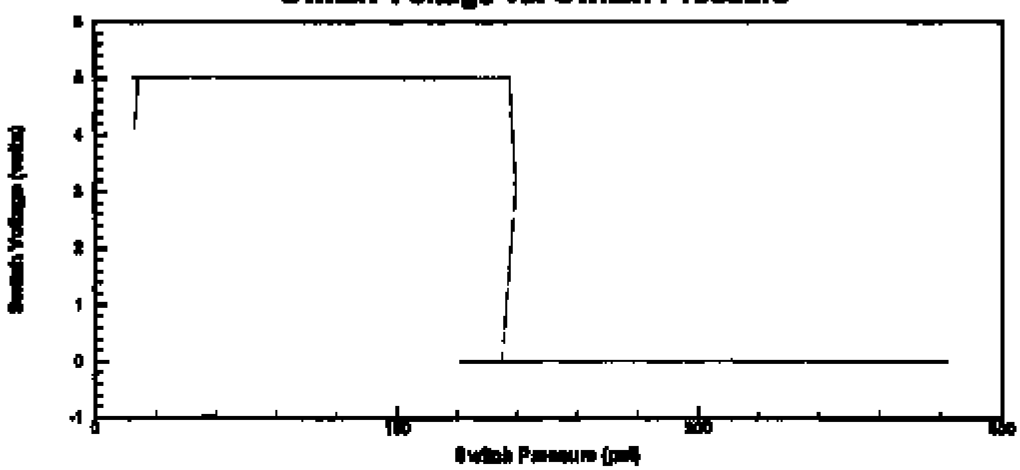
Time History Data



Switch Pressure vs. Antilock Pressure



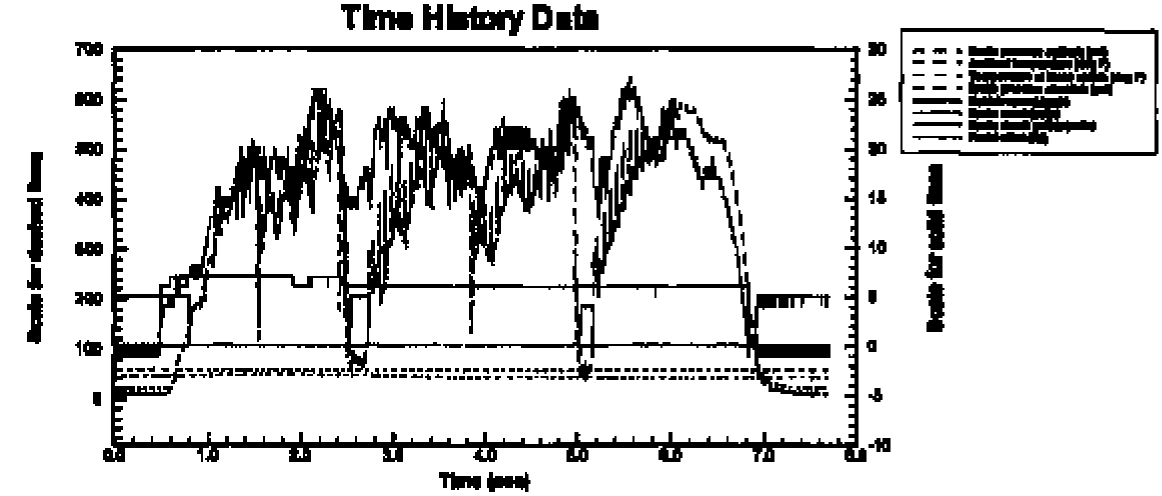
Switch Voltage vs. Switch Pressure



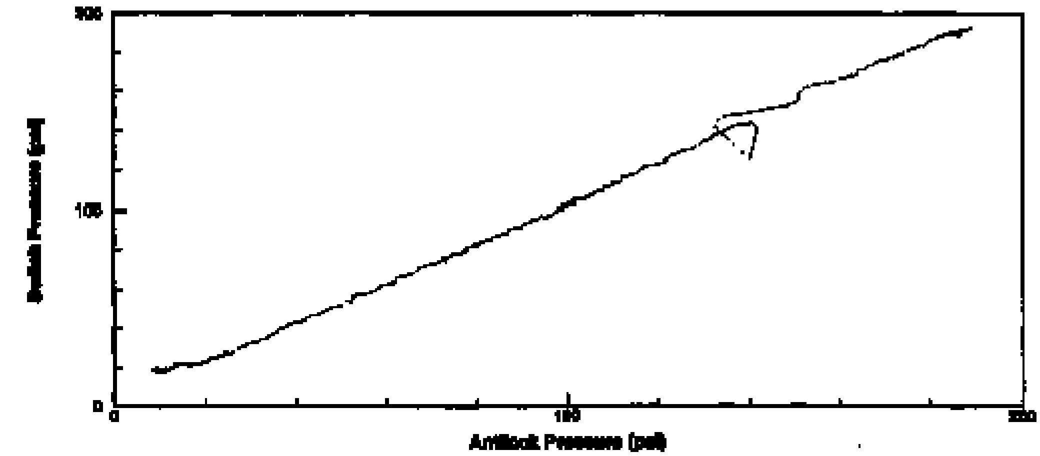
Design Research Engineering

30 mph 10 ft/s² LOW Mu | Ford Test Data: Lincoln Towncar | File Name: lLincol3.000

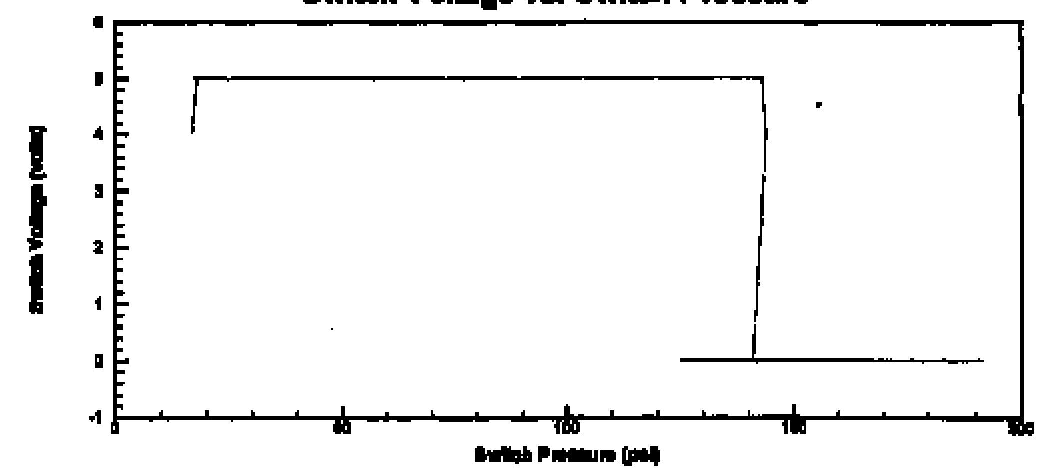
Time History Data



Switch Pressure vs. Antilock Pressure



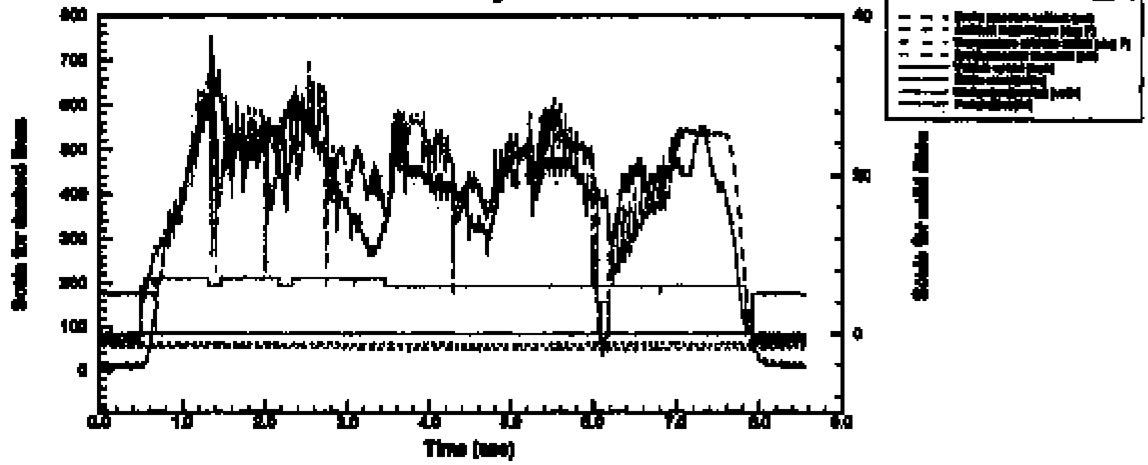
Switch Voltage vs. Switch Pressure



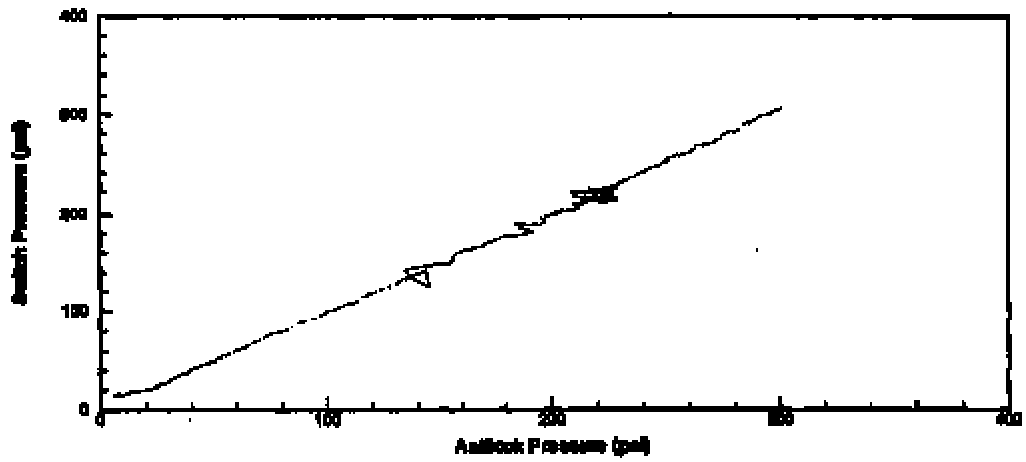
Design Research Engineering

40 mph 10 ft/s^2 LOW Mu | Ford Test Data: Lincoln Towncar | File Name: Lincol3.007

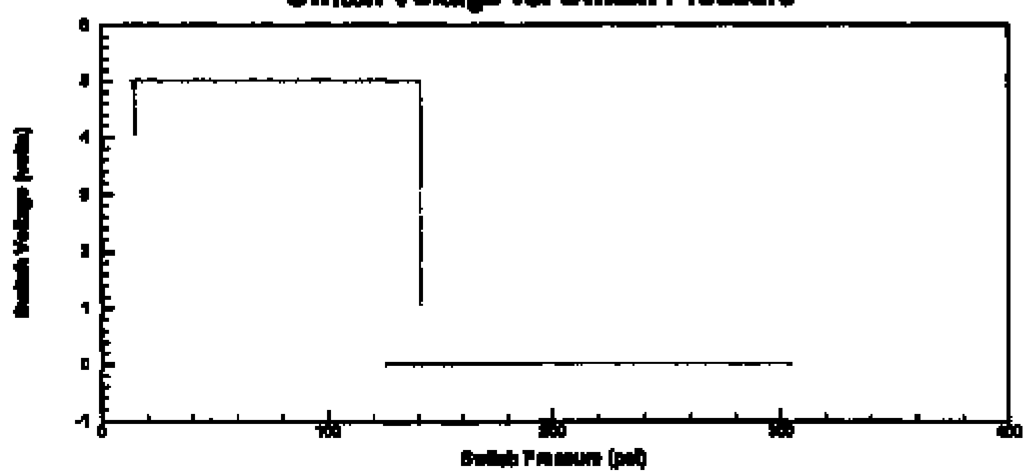
Time History Data



Switch Pressure vs. Antilock Pressure



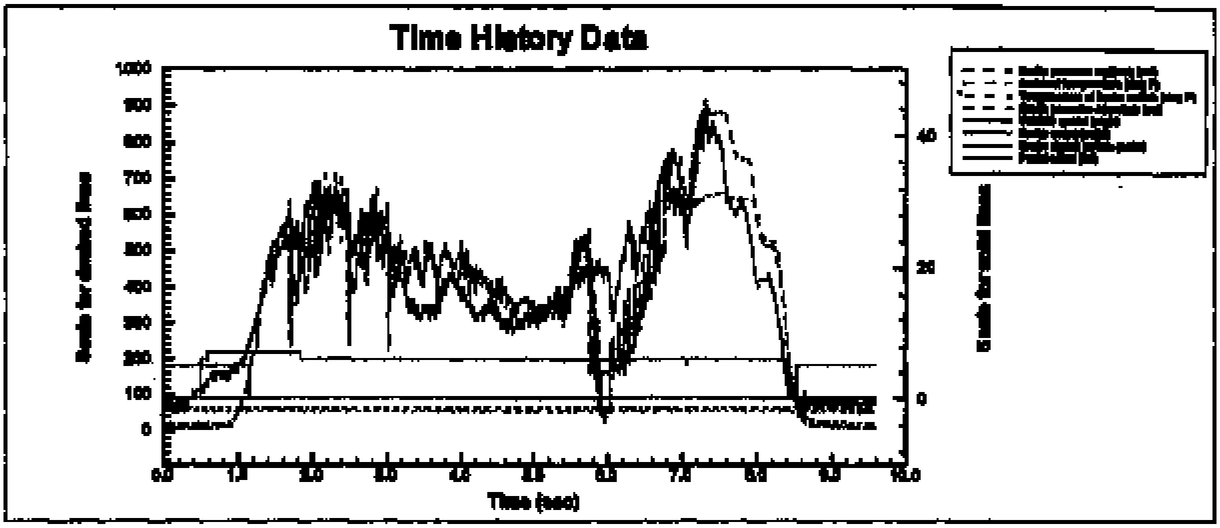
Switch Voltage vs. Switch Pressure

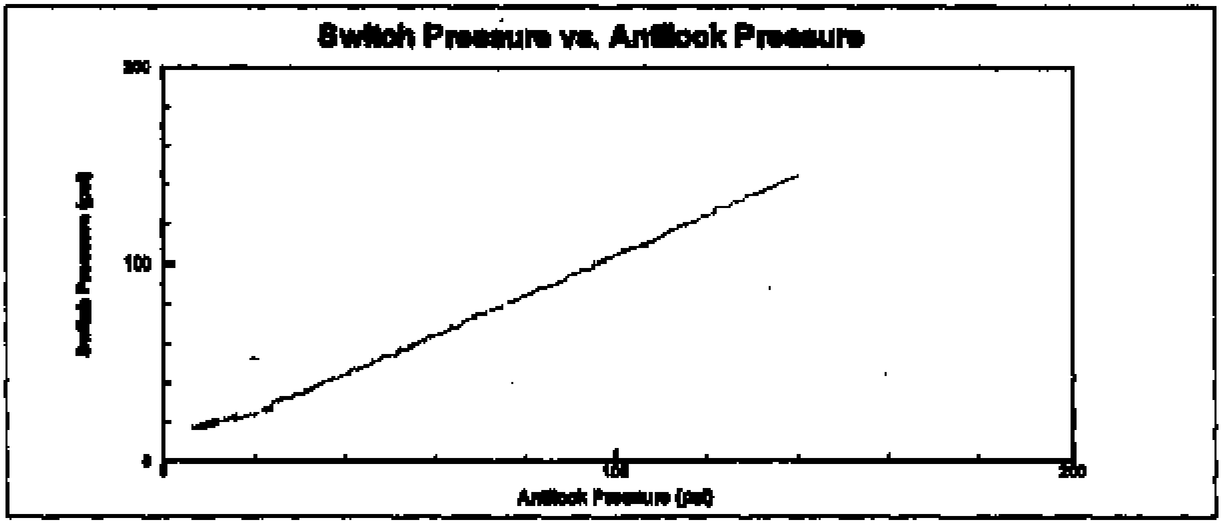


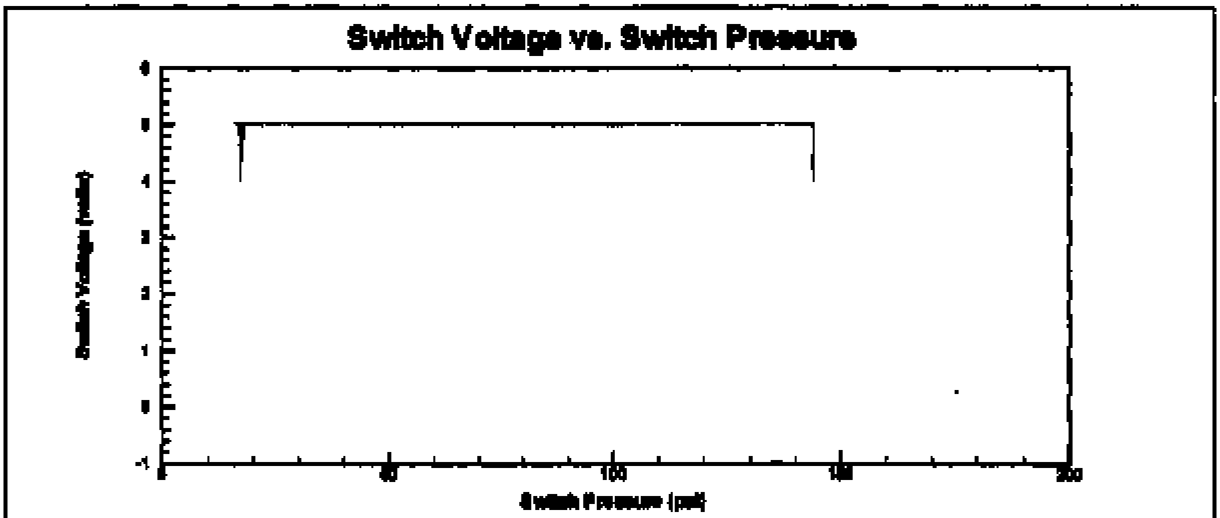
Design Research Engineering

TI-NHTSA 014953

40 mph 10 ft/s² LOW Mu	Ford Test Data: Lincoln Towncar	File Name: lLincol3.dat



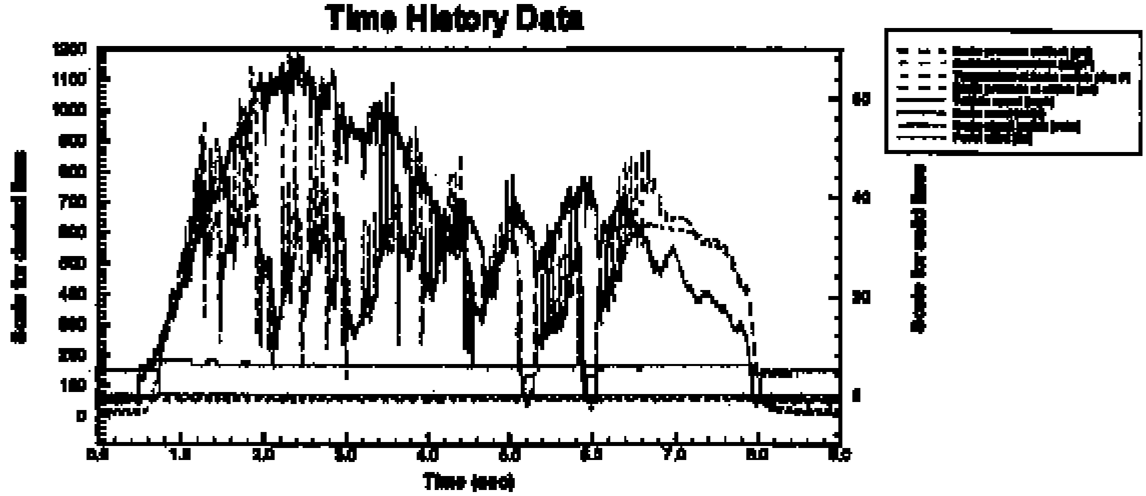




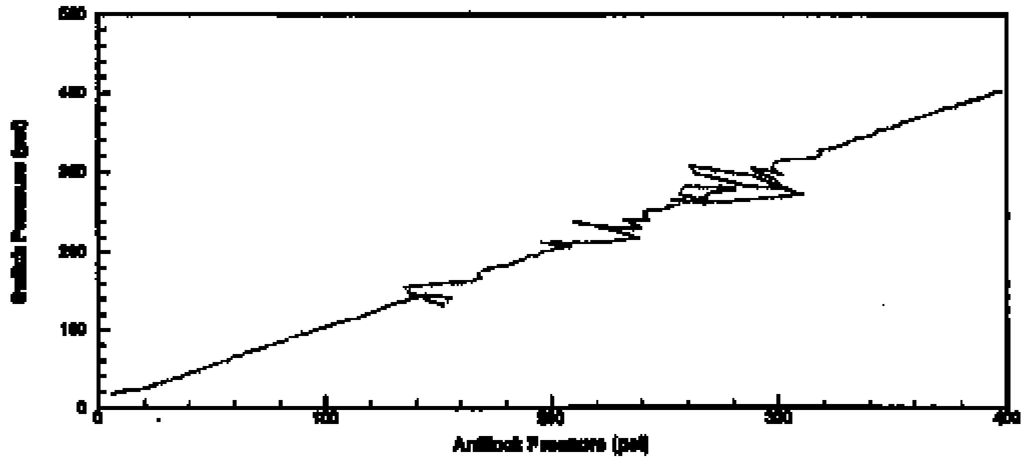
Design Research Engineering

40 mph 12 ft/s² LOW Mu	Ford Test Data: Lincoln Towncar	File Name: ILinco8.000

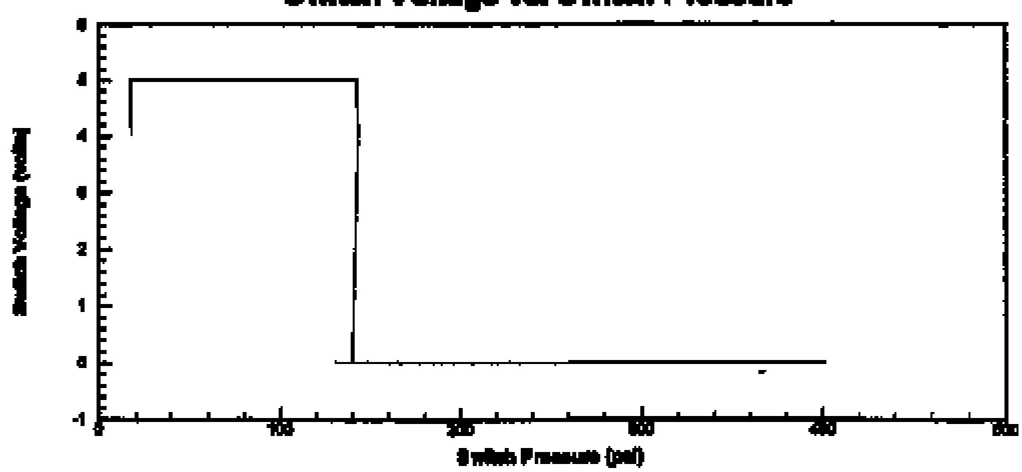
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure

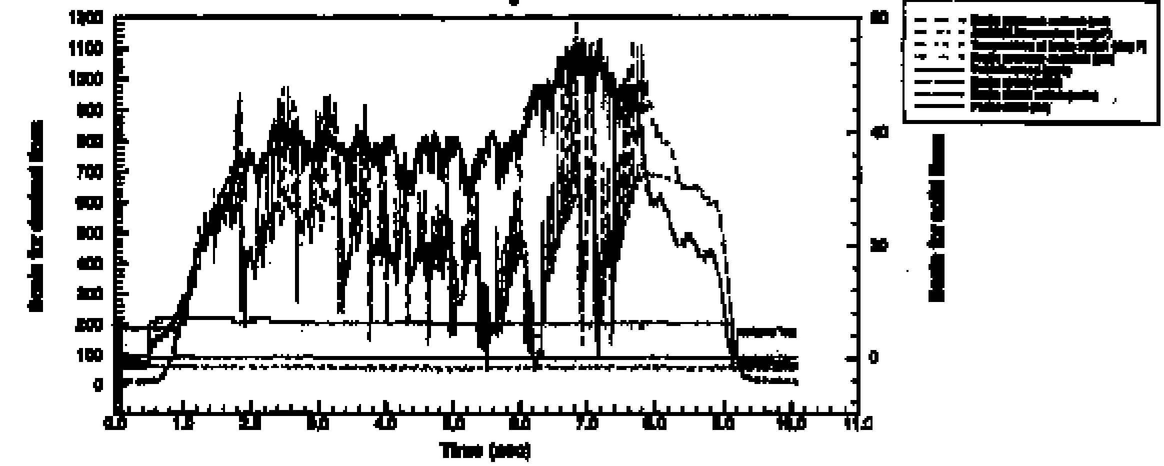


Design Research Engineering

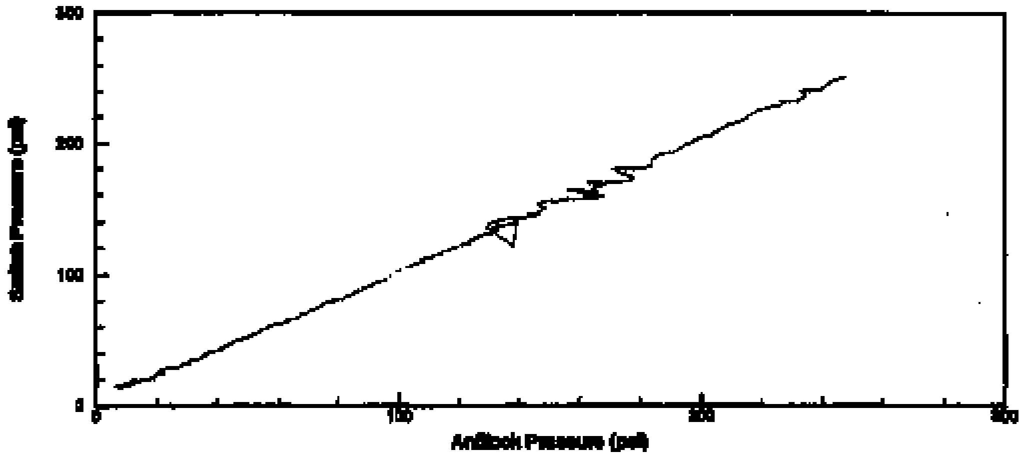
TI-NHTSA 014955

45 mph 10 ft/s² LOW Mu	Ford Test Data: Lincoln Towncar	File Name: T.lincol3.010

Time History Data



Switch Pressure vs. Antilock Pressure

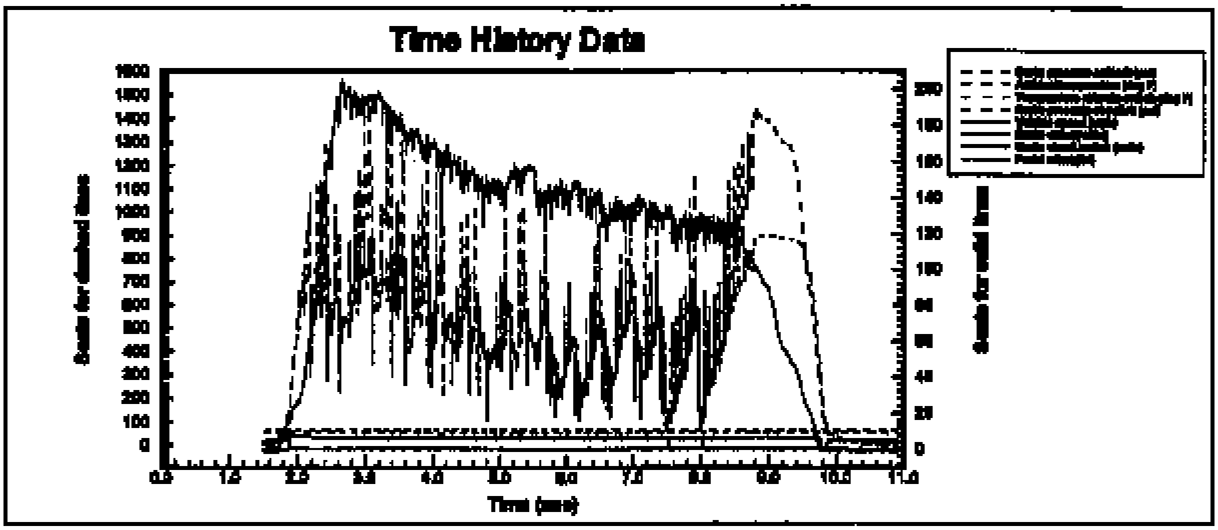


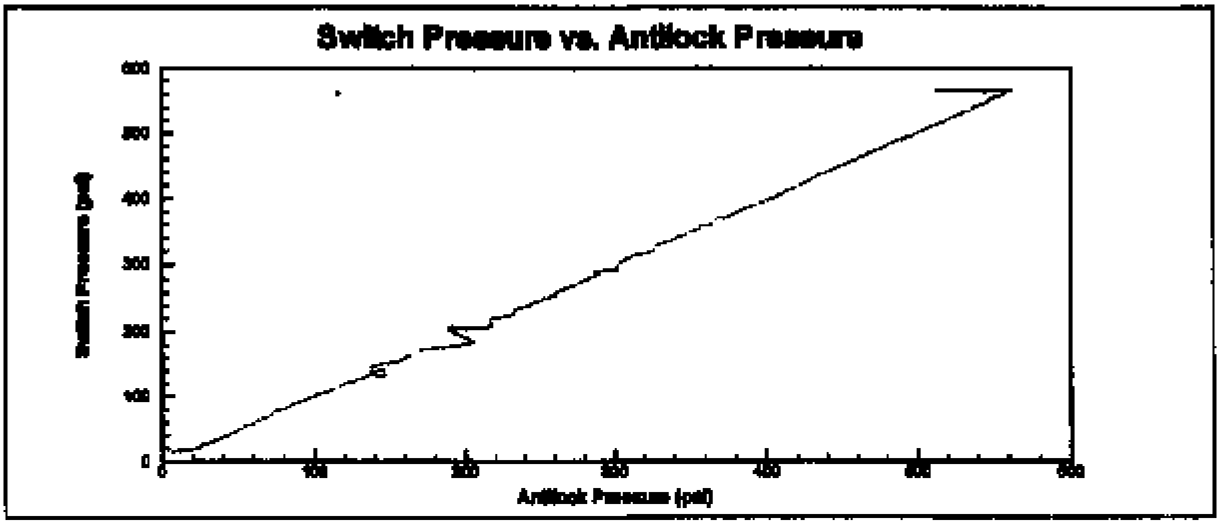
Switch Voltage vs. Switch Pressure

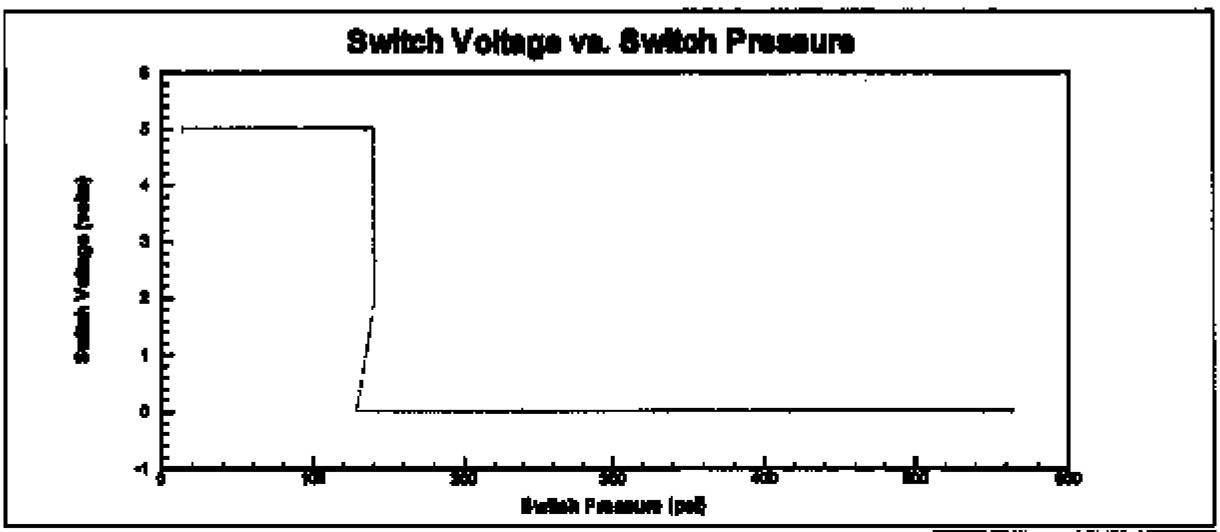
Design Research Engineering

TI-NHTSA 014956

45 mph panic/agressive ABS LOW Mu   Ford Test Data: Lincoln Towncar   File Name: lLincol3.011



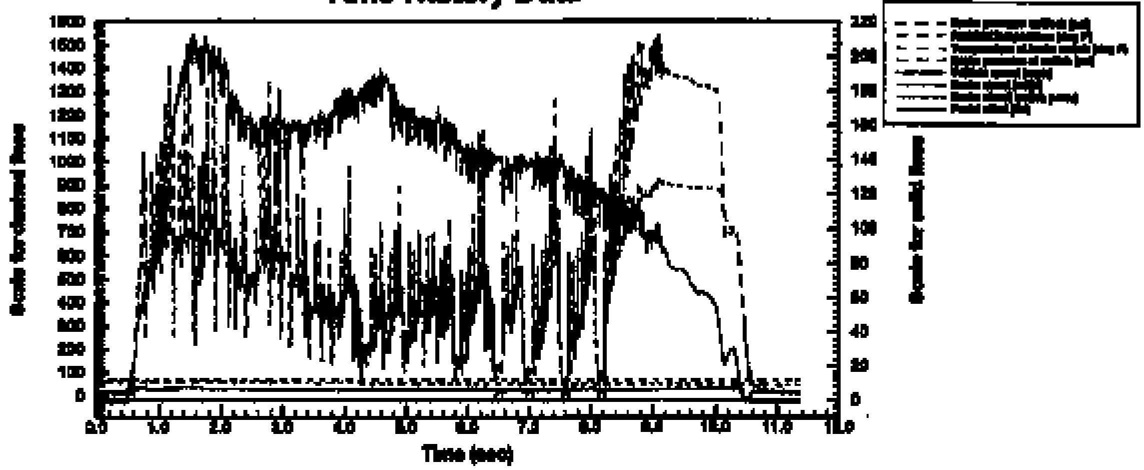




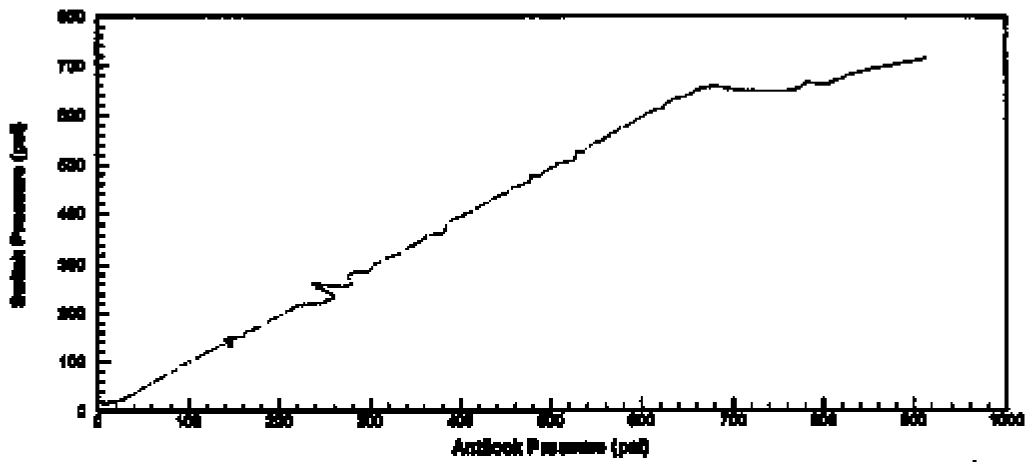
Design Research Engineering

50 mph panic/agressive ABS LOW Mu   Ford Test Data: Lincoln Towncar   File Name: lLinco3.013

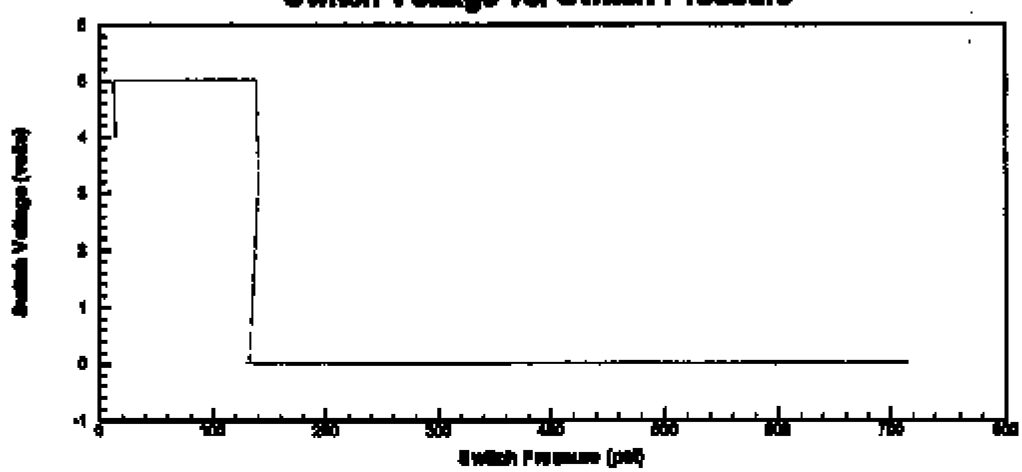
Time History Data



Switch Pressure vs. Antilock Pressure



Switch Voltage vs. Switch Pressure



Design Research Engineering

TI-NHTSA 014956

Customer 150,000 Miles Usage Correlation to Impulse Test Specification

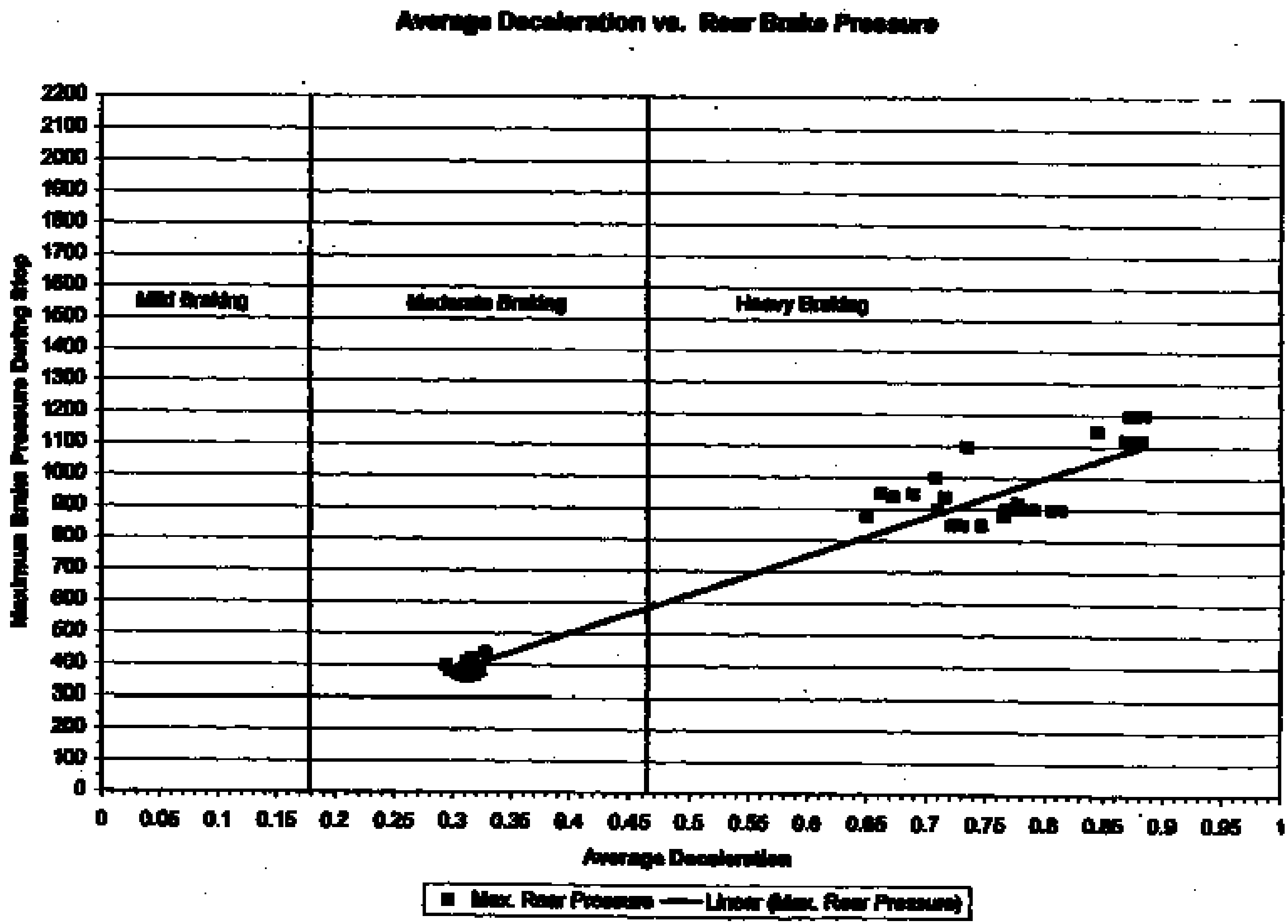
Brake Application Definition	Decleration (ft/sec2)	Deceleration (g)	Hours at Decel for 99% Values	Percent of Hours at Decel	Maximum Rear Line Pressure at Decel (psi)	Brake Applications at Decel	Durability Index (Applications x Pressure)
Mild Braking	0 - 6	0 - 0.186	2944	95.31%	225	1,701,204	382,770,917
Moderate Braking	6-15 ft/sec2	.0186 - .465	144	4.66%	575	83,211	47,846,365
Heavy Braking	>15 ft/sec2	>.465	1	0.03%	1200	578	693,426
Total			3089	100.00%		1,784,993	431,310,707

Impulse Test Specification = 500,000 cycles @ 1450 psi = 725,000,000

Sources:
1992 Crown Victoria North American Powertrain Customer Correlation Program; March 1996

1992 Lincoln Town Car Tests; 1LNLM81W3NY[illegible]

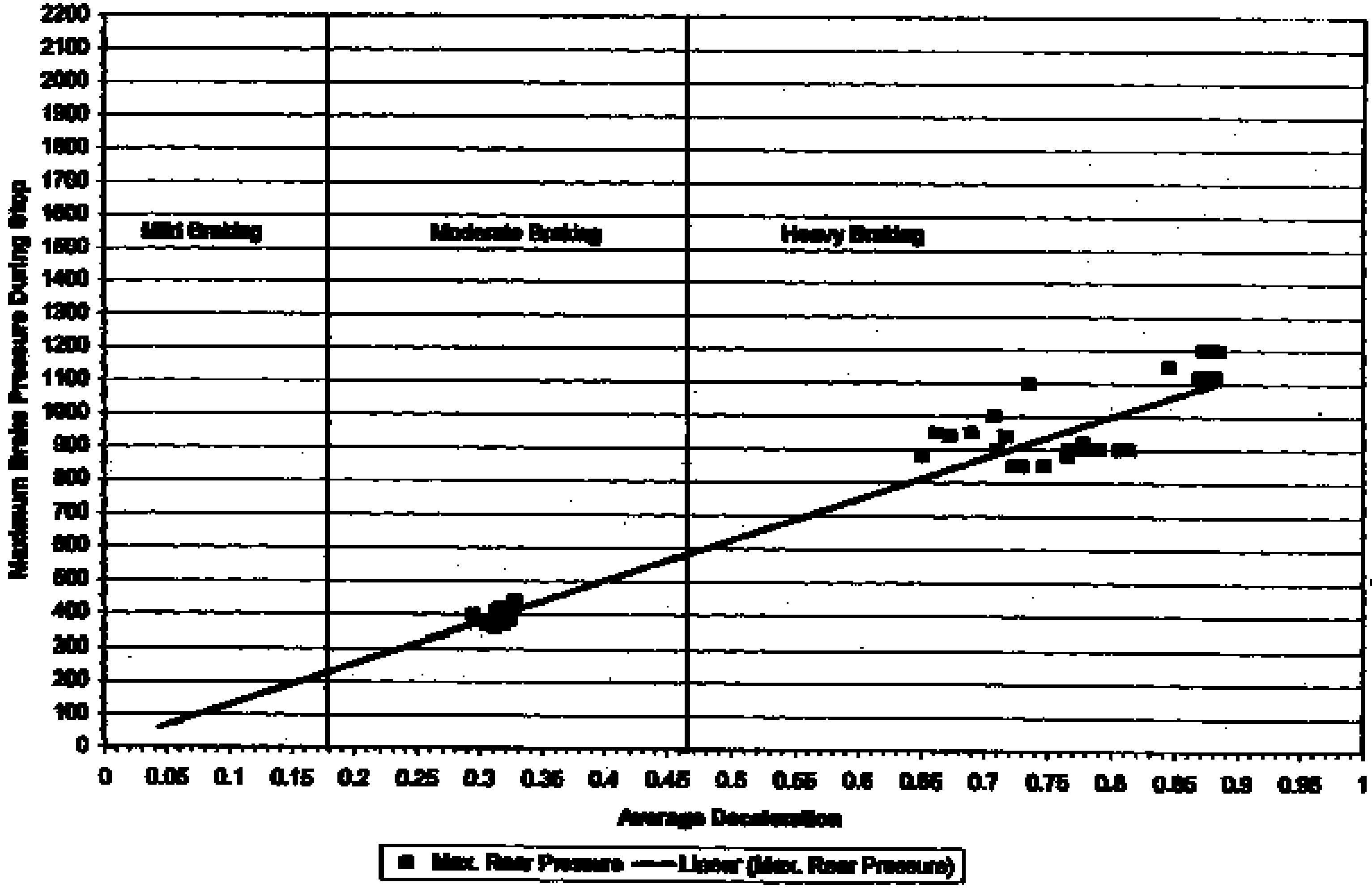
TL-NHTSA 014980



1992 Lincoln Town Car Tests; 1LNLM81W3NY600003

TI-NHTSA 014960

Average Deceleration vs. Rear Brake Pressure



Rear Brake Pressures Projected Rearward

1982 Lincoln Town Car Tests; 1LNBM81W3NY600093

T-NHTSA 014961

Average Deceleration vs. Rear Pressure Data

Test Number		Average Deceleration	Max. Rear Pressure
Lincol1	1	0.317	420
Lincol1	2	0.324	380
Lincol1	3	0.313	360
Lincol1	4	0.319	370
Lincol1	5	0.323	380
Lincol1	6	0.813	900
Lincol1	7	0.773	900
Lincol1	8	0.808	900
Lincol1	9	0.749	850
Lincol1	10	0.724	850
Lincol1	11	0.876	1200
Lincol2	1	0.326	440
Lincol2	2	0.295	400
Lincol2	3	0.299	380
Lincol2	4	0.313	410
Lincol2	5	0.306	370
Lincol2	6	0.766	900
Lincol2	7	0.767	850
Lincol2	8	0.792	900
Lincol2	9	0.771	900
Lincol2	10	0.731	850
Lincol2	11	0.814	900
Lincol2	12	0.809	900
Lincol2	13	0.851	880
Lincol2	14	0.783	900
Lincol2	15	0.717	940
Lincol2	16	0.711	900
Lincol2	17	0.779	920
Lincol2	18	0.736	1100
Lincol2	19	0.709	1000
Lincol2	20	0.873	940
Lincol2	21	0.862	950
Lincol2	22	0.890	980
Lincol2	23	0.846	1150
Lincol2	24	0.865	1200
Lincol2	25	0.882	1120
Lincol2	26	0.870	1120
Lincol2	27	0.873	1200

1992 Lincoln Town Car Tests; 1LNLM81W3NY699083

1998 CROWN VICTORIA NORTH AMERICAN POWERTRAIN CUSTOMER CORRELATION PROGRAM

Intent

- Record representative system measurements on a 1998 Crown Victoria while driving on public roads in North America.
- Generate the North American customer spectra.
- Project the Michigan Proving Ground North Atlantic Durability Test for Passenger Car Procedure, CTEP: 00.00-R-310, onto the North American customer spectra for customer percentile representation.

Public Road Data Acquisition Method

- A total of 5 sites were visited, these included:
  Boston, Denver, Phoenix, Pittsburgh — 27 data segments/sites in USA
  Yellowknife, Northwest Territories — 10 data segments total in Canada[1]

These sites were selected because of the following characteristics:
  - Boston provided heavy traffic conditions
  - Denver provided high altitude driving featuring mountainous grades on rural and expressway roads.
  - Phoenix was a hot weather site that also had expressway and rural grades, some of the rural roads were extremely rough.
  - Pittsburgh contributed hills, winding roads and moderately heavy traffic.
  - Yellowknife allowed operation in extremely cold weather.

- Roads were classified as follows:
  - City - Roads that are within major metropolitan areas, including residential areas. Speed limits are usually less than 40 mph. This road class typically has the lowest average speeds and the most frequent stops.
  - Rural - These are federal, state, secondary or unpaved roads which are located outside city limits but sometimes pass through small towns. In mountainous areas steep grades can be encountered. These roads will generally have a stop frequency of less than 1 per mile with average speeds higher than those found in the city class.
  - Expressway - Multilane, divided, and most often interstate highways. These limited access roads extend through and beyond major cities into rural areas. Speed limits are 55 mph or greater, however rush hour traffic congestion and passing through construction sites are also included.

- Driving styles were defined as follows:
  - Mild – Slower than traffic, conservative.
  - Moderate – Keeping up with average traffic.
  - Aggressive – Faster than average traffic, within laws.

- Each data segment possessed the attributes of road class and driving style and were collected in the following quantities at each site.

USA:	Road Class		
Driving Style	City	Rural	Expressway
Mild	3	3	3
Moderate	3	3	3
Aggressive	3	3	3

Total of 27 data segments per site

Canada:	Road Class		
Driving Style	City	Rural	Expressway
Mild	3	3	0
Moderate	0	0	0
Aggressive	2	2	0

Total of 10 data segments collected in Canada

1998 CROWN VICTORIA NORTH AMERICAN POWERTRAIN CUSTOMER CORRELATION PROGRAM

Data segments were 60 minutes (+/- 5 minutes) long.
SOMAT data acquisition hardware and software was used to collect data.

<u>North American Customer Spectra Generation Method</u>

- **Theory**

Several statistical concepts were used to combine the customer telephone survey results with the public road experimentally acquired data. The basic statistical concepts used to analyze the data were random sampling for survey results, linear extrapolation to project each data segment out to a common distance, median ranking to develop the individual road class spectrums, linear interpolation to achieve a specific customer representation, and Monte Carlo technique for combining the survey data and public road data.

- **Customer Telephone Survey**

The telephone survey was sourced to AutoPACE who drew the customer samples for R.L. Polk registrations for Ford Crown Victorias. AutoPACE randomly drew 402 samples roughly proportioned by market distribution using registrations from each state that permits telephone interviews. The survey had approximately 30 questions.

- **Data Analysis**

Data from the in-vehicle data acquisition system were uploaded to a PC type computer. The data segments were then processed to create the correlation parameters. Projections to the desired mileage (150,000) were made for each parameter. A statistical program that combines the projected results with customer survey data was executed. The output of the program was one set of data tables for each parameter. These tables contained linear interpolated values to represent each customer in the survey. One table exists for each parameter and is based on 150,000 miles of driving on North American roads.

- **Parameters**

The parameters were derived from the real-time data and were developed to quantify operation of the vehicle's system. This then allowed comparison of public road segments to test procedures. The parameters are defined as:

  - <u>Brake Applications [counts & hours]:</u> Number of brake application counts, and total time brakes are applied during the operation time. The brake light circuit in the vehicle is monitored to determine when the brakes are applied.
  - <u>Time at Brake Deceleration Classifications [hours]:</u> An accelerometer is located on the longitudinal axis of the vehicle and measures the rate at which the vehicle decelerates. If the vehicle deceleration is coincidental with the brakes being on then a brake deceleration is defined as occurring. Brake deceleration is classified into three ranges to determine the severity of braking.

Deceleration Rate	Classification
0 – 6 ft/sec²	Mild
6 – 15 ft/sec²	Moderate
> 15 ft/sec²	Heavy

  - <u>Brake Energy [ft-lb/mile]:</u> Brake energy is calculated as a function of vehicle; mass, velocity, and road load resistance during a brake application. The energy is calculated during each brake application as shown below. If the energy value is greater than zero then it is summed to the total energy. At the end of the data segment the total energy is divided by the distance covered during the drive time. Note, this vehicle did not have a method of measuring altitude included in its instrumentation list.

TI-NHTSA 014864

[illegible] CROWN VICTORIA NORTH AMERICAN POWERTRAIN CUSTOMER CORRELATION PROGRAM

Brake energy equation for one brake application:

$$W_{brake} = \frac{M\left(V_1^2 - V_2^2\right)}{2} - W_{roadload} - Mg\left(h_1 - h_2\right)$$

not used in this correlation

Where,
W_{brake} = Brake work during 1 brake application
M = Vehicle Mass
g = Gravity
V_1 = Vehicle velocity @ start of brake application
V_2 = Vehicle velocity @ end of brake application
$W_{roadload}$ = Work done due to the road load resistance covered during braking
h_1 = Relative altitude of the vehicle @ start of brake event
h_2 = Relative altitude of the vehicle @ end of brake event

Total brake energy during a data segment:

$$W_{total} = \sum_{first}^{last} W_{brake}\text{ , when } W_{brake} \geq 0$$

- **Brake Energy [illegible]:** Brake energy is calculated as shown above. At the end of the data segment the total energy is divided by the number of brake applications during the drive time.
- **Brake Power [illegible]:** Brake power is a function of brake energy and brake application time. The power is calculated during each brake application and is summed to total brake power providing calculated brake power is greater than zero. At the end of the data segment the total power is divided by the distance covered during the drive time.

Brake power equation for one brake application:

$$P_{brake} = \frac{W_{brake}}{\left(t_2 - t_1\right)}$$

Where,
P_{brake} = Brake power during 1 brake application
W_{brake} = Brake work done during 1 brake application
t_1 = Time @ start of brake application
t_2 = Time @ end of brake application

Total brake power during a data segment:

$$P_{total} = \sum_{first}^{last} P_{brake}\text{ , when } P_{brake} \geq 0$$

- **Brake Power [illegible]:** Brake power is calculated as described above. At the end of the data segment the total energy is divided by the number of brake applications during the drive time.

NOTE: Values determined for a particular parameter cannot be combined with values of others to for a new parameter. As an example consider the braking related parameters: *Total time braking* for the 90th percentile customer cannot be found by summing *time mild, moderate,* and *heavy* values.

- **Spreadsheet Table**

The spreadsheet table provides specific results for the Crown Victoria performing a complete R-310 procedure at MPG. Columns 2 & 3 are the 50th and 90th percentile North American customer usage values projected to 150,000 miles of driving on North American Roads. Column 4 contains the MPG R-310 parameter values. Column 5 is the projected North American customer severities for the procedure.

[illegible] CROWN VICTORIA NORTH AMERICAN POWERTRAIN CUSTOMER CORRELATION PROGRAM

[P]UBLIC ROAD SUMMARY – [illegible] Crown Victoria

	MILES	
BOSTON		City data were recorded in the greater metropolitan area of Boston. Rural and expressway roads were recorded in Massachusetts, New Hampshire and Rhode Island. (Recorded in November [illegible])
CITY	144	
RURAL	312	
EXPRESSWAY	313	
TOTAL	[illegible]	
DENVER		City data were recorded in the greater metropolitan areas of Denver and Colorado Springs; while the topography of both cities is basically flat, they are at 5000 and 6000 feet elevations, respectively. Rural and expressway roads were recorded in the mountainous areas west and north of Denver. (Recorded in September [illegible])
CITY	211	
RURAL	318	
EXPRESSWAY	567	
TOTAL	1096	
PHOENIX		Data were collected in Arizona and Nevada. City data were recorded in the greater metropolitan areas of Las Vegas and Phoenix. Rural road data included driving from Kingman to Las Vegas via Hoover Dam plus rural areas surrounding Phoenix. Expressway data were recorded while driving from Kingman to Phoenix via Flagstaff and driving on expressways that service Phoenix including areas south east and west of the city. Ambient temperatures ranged up to [illegible] ([illegible]). (Recorded in August [illegible])
CITY	351	
RURAL	[illegible]	
EXPRESSWAY	[illegible]	
TOTAL	1148	
PITTSBURGH		The vehicle was driven from Detroit to Pittsburgh and back with rural and expressway data recorded in Michigan, Ohio and Pennsylvania. City data were recorded in Cleveland, Akron and Pittsburgh metropolitan areas. Rural data also included the mountainous area of Jamestown, Pa. (Recorded in October [illegible])
CITY	170	
RURAL	339	
EXPRESSWAY	537	
TOTAL	1046	
YELLOWKNIFE, NWT		The Yellowknife area was intended to capture Canadian cold weather conditions. Ambient temperatures ranged down to [illegible] ([illegible]) during data acquisition. City roads were paved but snow and ice covered. Gravel was used by the city to increase traction. Rural roads included driving between Hay River and Yellowknife plus additional roads surrounding Yellowknife. Rural Roads consisted of two lane paved and packed gravel. All rural roads were ice covered to some degree. No expressway roads existed in this part of Canada. Topography was rolling hills. (Recorded in February [illegible])
CITY	70	
RURAL	471	
TOTAL	541	
GRAND TOTAL	4621 MILES	

Vehicle Specifications

[illegible] Crown Victoria 4.6L 2V, AODE Transmission, Air-conditioning

VIN: [illegible]

Final Drive Ratio: [illegible] : 1

Test Weight:
Approximate throughout public road and test track data acquisition

Front: [illegible] lb.
Rear: [illegible] lb.
TOTAL: 4612 lb.

Test Wt = Curb Wt + 50% Payload Wt

Tires: Michelin XGT4 P215/70 R15

Rolling radius: [illegible] inches

1992 CROWN VICTORIA NORTH AMERICAN POWERTRAIN CUSTOMER CORRELATION PROGRAM

1992 CROWN VICTORIA 4.6L, AODE PARAMETERS	BASED ON 150,000 MILES OF NORTH AMERICAN CUSTOMER USAGE			
	NORTH AMERICAN CUSTOMER		Michigan Proving Ground	
	95%	50%	[illegible] Procedure	
	VALUES	VALUES	VALUES	PERCENTILE
BRAKING RELATED PARAMETERS				
Number of brake applications	71[illegible]1	17[illegible]	144[illegible]	6
Total time braking (h)	12[illegible]	[illegible]	241	[illegible]
Time mild braking (<[illegible]) (h)	122	2944	137	3
Time med. braking ([illegible]) (h)	[illegible]	144	79	61
Time heavy braking (>=[illegible]) (h)	0	1	7	100
Brake energy ([illegible])	21[illegible]	400[illegible]1.87	475[illegible]7	99
Brake energy ([illegible]-application)	37718	73[illegible]	166[illegible]	100
Brake Power ([illegible])	78.0[illegible]	[illegible]	13[illegible]	87
Brake Power ([illegible]-application)	14.[illegible]	[illegible].47	54	100

Customer Sample: [illegible] Crown Victoria/[illegible]

[illegible]

** TOTAL PAGE.02 **

02/03/00 THU 14:19 [TX/RX NO 8412]

TI-NHTSA 014967

Lincoln Test Data Maximum Rear Pressures by Test Run

Filename	Run #	Description	Max. Rear Pressure	Brake Pedal Effort at Max (lbs)	Pressure at Switch Deactivation	
[illegible]	27	40 mph panic/aggressive ABS	1200	[illegible]	140	
[illegible]	11	40 mph ABS [illegible]	1200	[illegible]	140	
[illegible]	24	40 mph panic/aggressive ABS	1200	[illegible]	140	
[illegible]	23	40 mph panic/aggressive ABS	1150	[illegible]	140	
[illegible]	[illegible]	40 mph panic/aggressive ABS	11[illegible]	[illegible]	140	
[illegible]	[illegible]	40 mph panic/aggressive ABS	1125	[illegible]	140	
[illegible]	16	40 mph panic/aggressive NO ABS	1100	[illegible]	140	
[illegible]	6	static brake effort	1000	174	140	
[illegible]	4	static brake effort	1000	[illegible]	140	
[illegible]	[illegible]	40 mph panic/aggressive NO ABS	1000	[illegible]	140	
[illegible]	21	40 mph panic/aggressive NO ABS	[illegible]	[illegible]	140	
[illegible]	22	40 mph panic/aggressive NO ABS	[illegible]	76	140	
[illegible]	[illegible]	40 mph panic/aggressive NO ABS	[illegible]	71	140	
[illegible]	[illegible]	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	12	[illegible] mph panic/aggressive ABS	[illegible]	210	140	LOW Mu
[illegible]	17	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	11	40 mph panic/aggressive ABS	[illegible]	[illegible]	140	LOW Mu
[illegible]	3	30 mph panic/aggressive ABS	[illegible]	134	140	LOW Mu
[illegible]	2	40 mph panic/aggressive ABS	[illegible]	[illegible]	140	LOW Mu
[illegible]	1	30 mph panic/aggressive ABS	[illegible]	145	140	LOW Mu
[illegible]	8	30 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	8	30 mph ABS	[illegible]	[illegible]	140	
[illegible]	7	30 mph ABS	[illegible]	74	140	
[illegible]	5	40 mph ABS	[illegible]	70	140	
[illegible]	3	30 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	14	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	5	30 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	11	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	13	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	40 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	7	30 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	40 mph ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	35 mph normal ABS	[illegible]	[illegible]	140	
[illegible]	10	30 mph ABS	[illegible]	[illegible]	140	
[illegible]	4	40 mph panic/aggressive ABS	[illegible]	[illegible]	140	LOW Mu
[illegible]	[illegible]	40 mph [illegible]	[illegible]	[illegible]	140	LOW Mu
[illegible]	10	40 mph [illegible]	[illegible]	[illegible]	140	LOW Mu
[illegible]	1	static brake effort	[illegible]	[illegible]	140	
[illegible]	2	static brake effort	[illegible]	44	140	
[illegible]	3	static brake effort	720	[illegible]	140	
[illegible]	7	40 mph [illegible]	[illegible]	[illegible]	140	LOW Mu
[illegible]	[illegible]	40 mph [illegible]	[illegible]	44	140	LOW Mu
[illegible]	[illegible]	30 mph [illegible]	[illegible]	[illegible]	140	LOW Mu
[illegible]	[illegible]	30 mph [illegible]	[illegible]	[illegible]	140	LOW Mu
[illegible]	1	40 mph normal NO ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	30 mph normal	[illegible]	17	140	
[illegible]	4	40 mph normal NO ABS	415	[illegible]	140	
[illegible]	[illegible]	40 mph normal NO ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	30 mph normal	[illegible]	[illegible]	140	
[illegible]	[illegible]	30 mph normal	[illegible]	14	140	
[illegible]	[illegible]	40 mph normal NO ABS	[illegible]	[illegible]	140	
[illegible]	4	30 mph normal	[illegible]	14	140	
[illegible]	6	40 mph normal NO ABS	[illegible]	[illegible]	140	
[illegible]	[illegible]	30 mph normal	[illegible]	[illegible]	140	
		MAX PRESSURE=	1200	[illegible]		

Channel #	Description
1	Time (sec)
2	ambient temperature (deg F)
3	temperature at brake switch (deg F)
4	brake pressure at switch (psi)
5	brake pressure at [illegible] (psi)
6	vehicle speed (mph)
7	[illegible]
8	pedal effort (lbf)
9	brake circuit switch (volt)

Pressures are Values from Data Graphs

Engineering Specification

PART NAME	PART NUMBER
SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE	∇ [illegible]-F2VC-9F924-AA

DATE	LTR	FR	REVISIONS	DR	CK	REFERENCE
			AMEND DATA TO COMPLETE			
			SPEC. & RETYPED			
[illegible]			[illegible]			[illegible]

FRAME 1 OF 13 REV ∇ [illegible]-F2VC-9F924-AA

FD 3947-a1

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, as 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

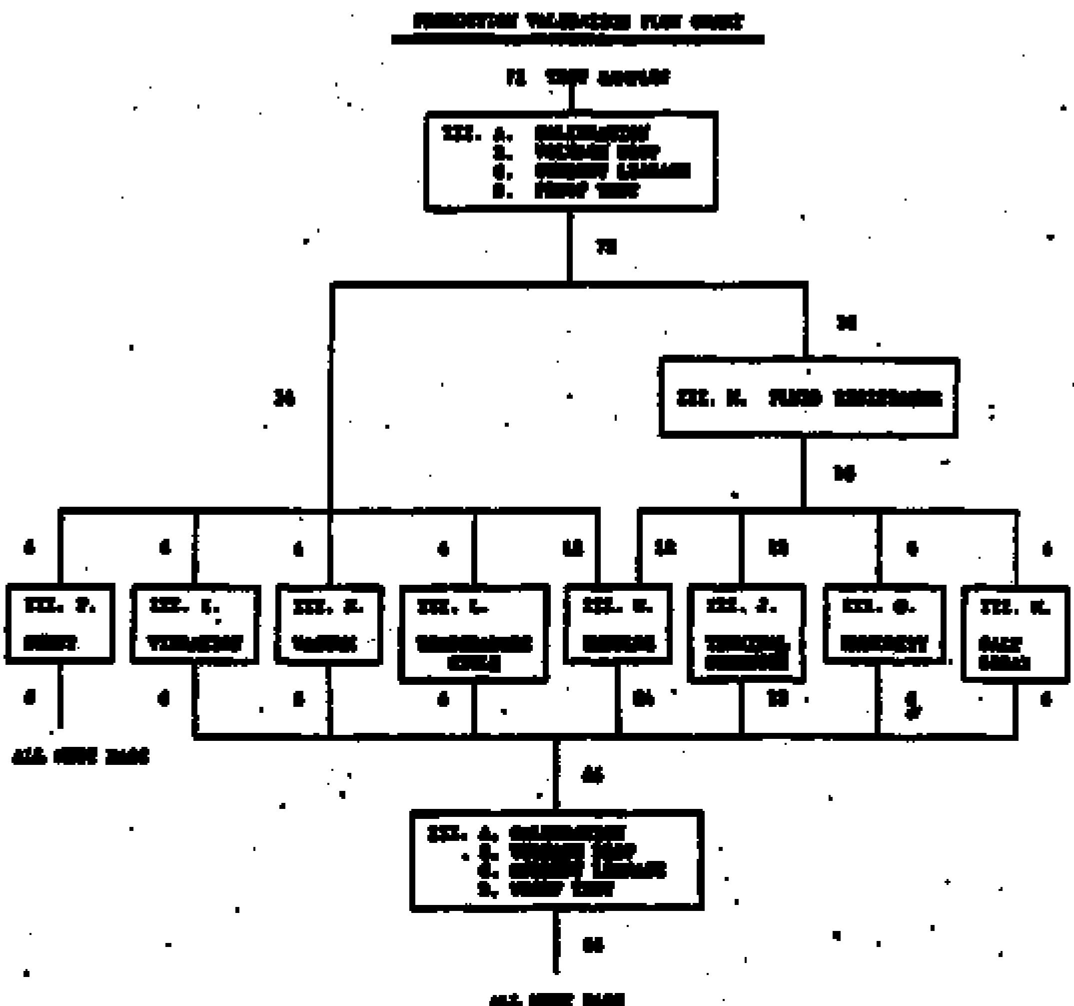
Item	Test Item Functional Tests	ENGINEERING VALIDATION Minimum Sample Size	ENGINEERING VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS TP-? Minimum Sample Size	IN-PROCESS TP-? Statistical Test Acceptance Criteria	IN-PROCESS TP-1 Minimum Sample Size	IN-PROCESS TP-1 Statistical Test Acceptance Criteria
III.							
A	Calibration	72	P90-.95	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.95	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.95	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.95	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
G	Vibration	6	P90-.72	3/Mo.	P90-.56	4/6 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	4/6 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

Stability Tests

Item	Test						
III.							
E	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
G	Humidity	6	P90-.72	3/Mo.	P90-.56	4/6 Mo.	P90-.72
H	Salt Spray	6	P90-.72	3/Mo.	P90-.56	4/6 Mo.	P90-.72

Engineering Specification

Engineering Specification



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.

II. 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) microampere.

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.

II. TEST PROCEDURES AND REQUIREMENTS (cont'd)

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.

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.

II. TEST PROCEDURES AND REQUIREMENTS (cont'd)

I. 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 3 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.

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 end, 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.

K. 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

d. 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.

[illegible] 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.

Engineering Specification

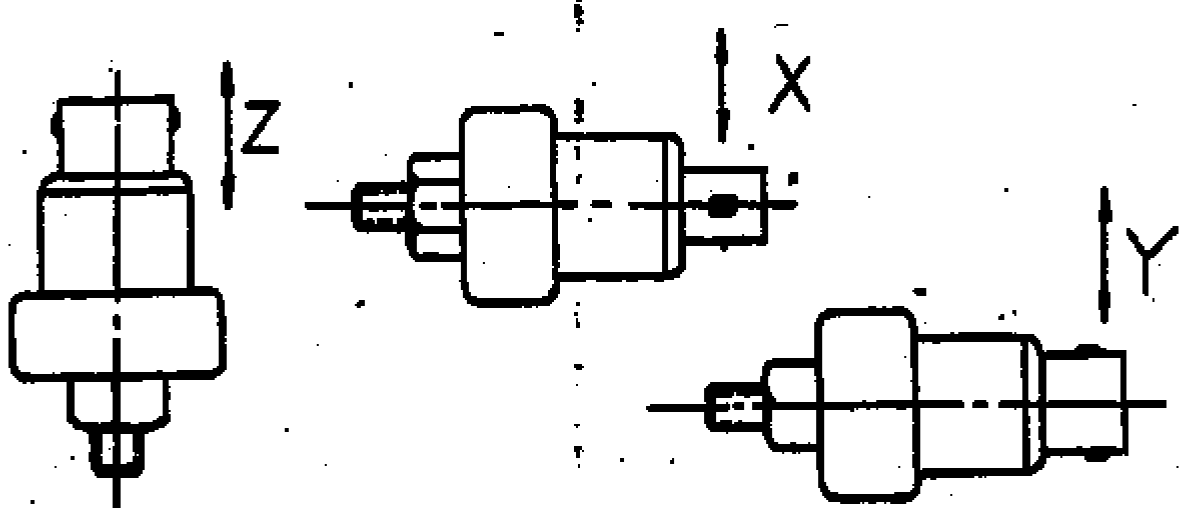
IX. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1990 Edition

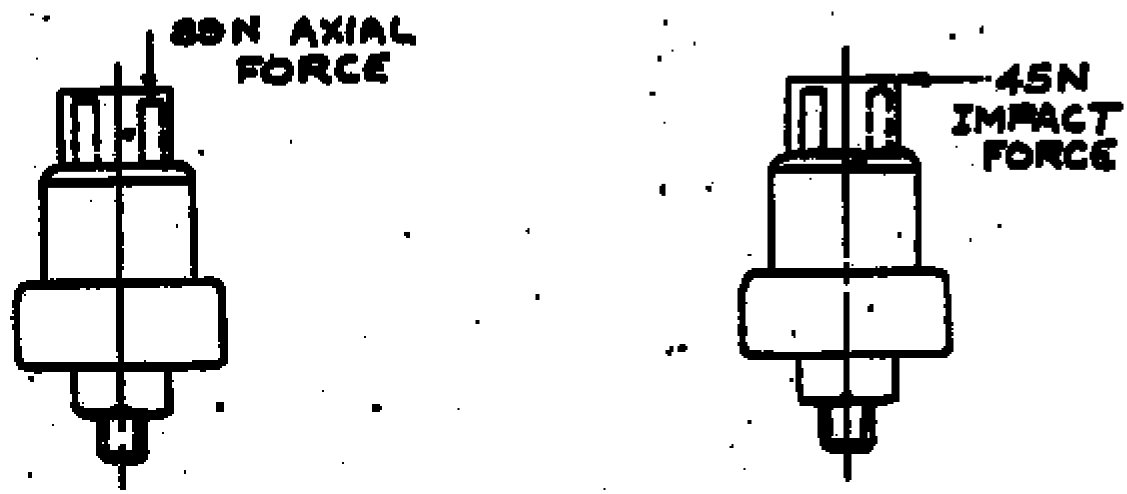
ES-F0EB-14A464-AA, Specification - SLV Assy - Wire Connector

ES-F2VF-9C735-AA, Specification - Servo Assembly Speed Control



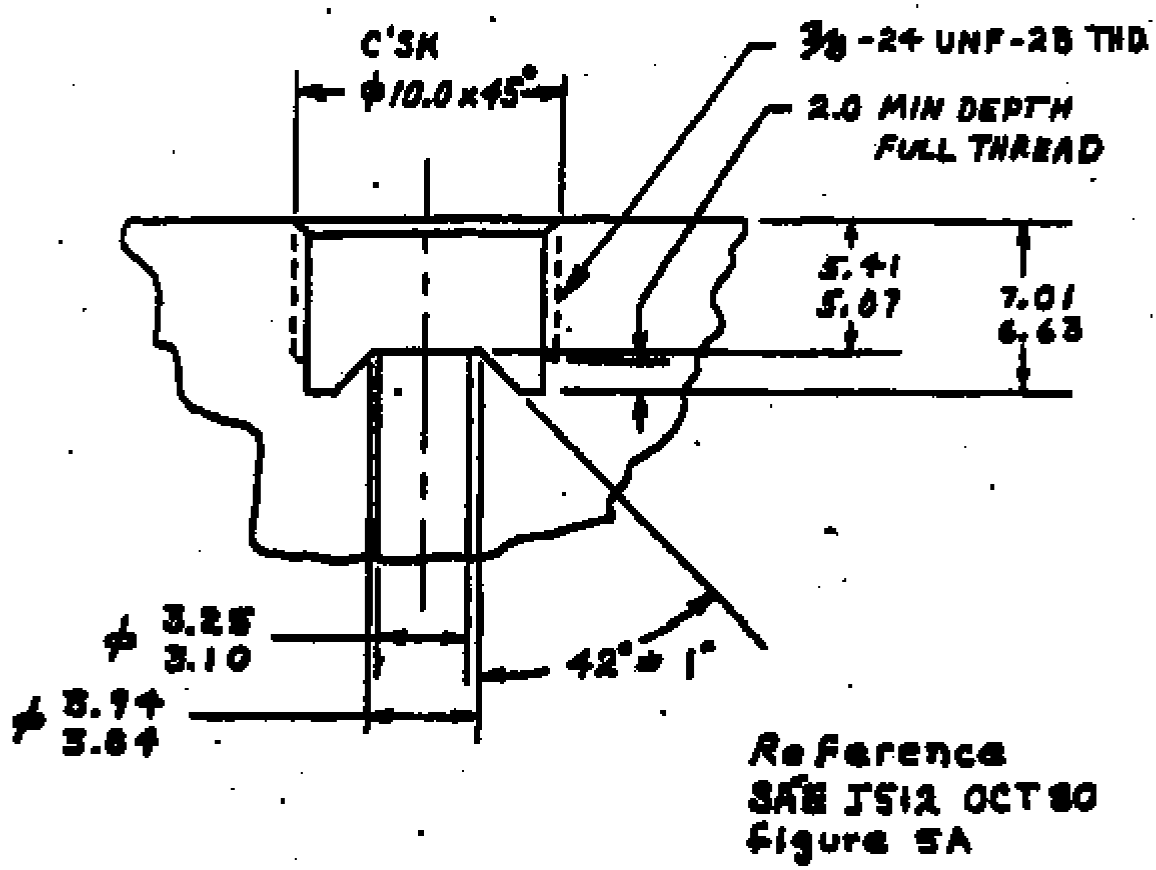
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



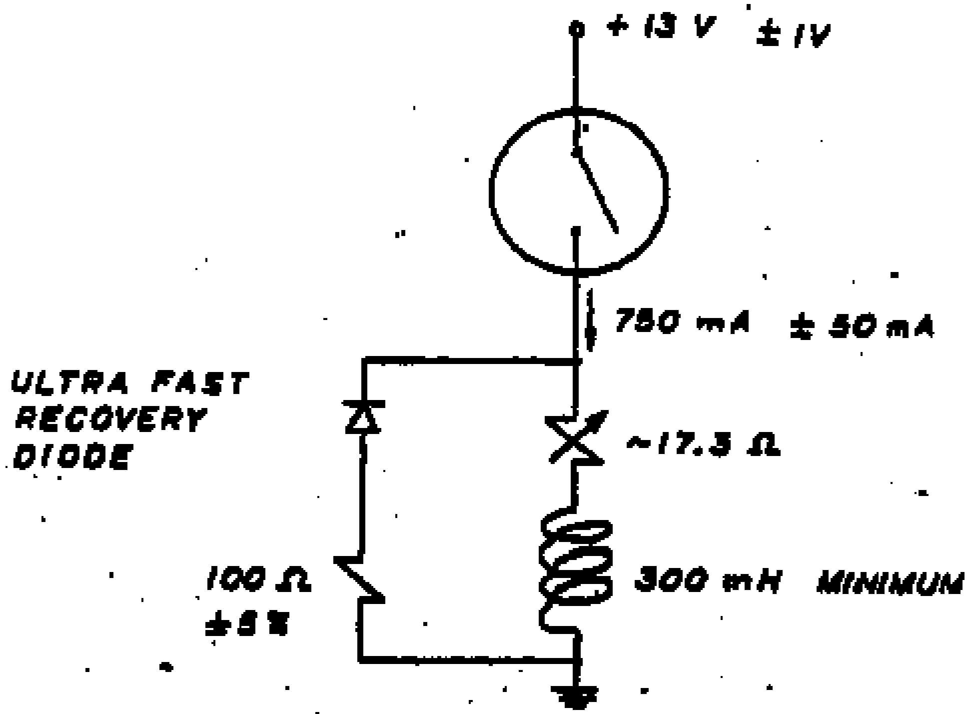
TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2



TEST FIXTURE PORT CONFIGURATION

FIGURE 3



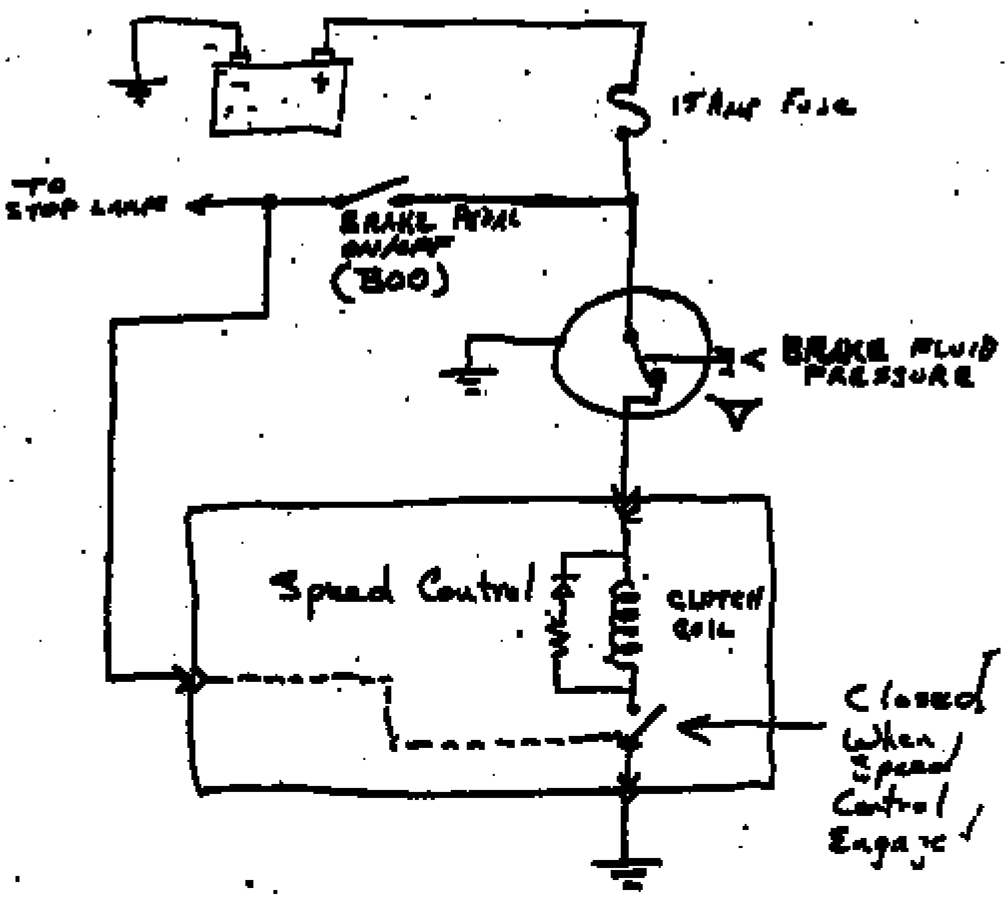
DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

D

Brake Pressure Switch Function-

- **Provide power to Speed Control Clutch circuit. Clutch engages servo-motor to pull throttle cable.**
- **Provide redundant sensing of brake application independent of the primary system deactivation mode by disconnecting power to clutch circuit causing servo-motor to release throttle cable.**
  - **Under Hard Braking only**
  - **Stop lamp signal is primary (normal braking)**



U

F2VC-[illegible]924-AB

MATERIAL ANALYSIS

PARTS LIST

	PART NAME	PART #	CERTIFIED
1	BASE	46515-2	YES
2	STA. TERM.	34806-1	YES
3	MOVE. CONTACT	74409-1	YES
4	RIVET	74171-1	YES
5	MOVE. TERM.	34807-1	YES
6	SPRING ARM	34809-1	YES
7	JS12 HEXPORT	34900-1	YES
8	GASKET	74083-1	YES
9	CUP	27713-1	YES
10	SEAL	74176-1	YES
11	KAPTON STRIP	27228-1	YES
12	WASHER	27689-1	YES
13	CONVERTER	27404-1	YES
14	KAPTON TAPE	74224-1	YES
15	SPACER	73988-2/-3	YES
16	CRIMP RING	74797-1	YES
17	TRANSFER PIN	74078-SEL	YES
18	ENVIO. SEAL	74247-~~X~~	YES
19	THREAD CAP	~~74177-X~~ 74754	YES

submitted - 4 cert.
JAN. '92

TI-NHTSA 014989

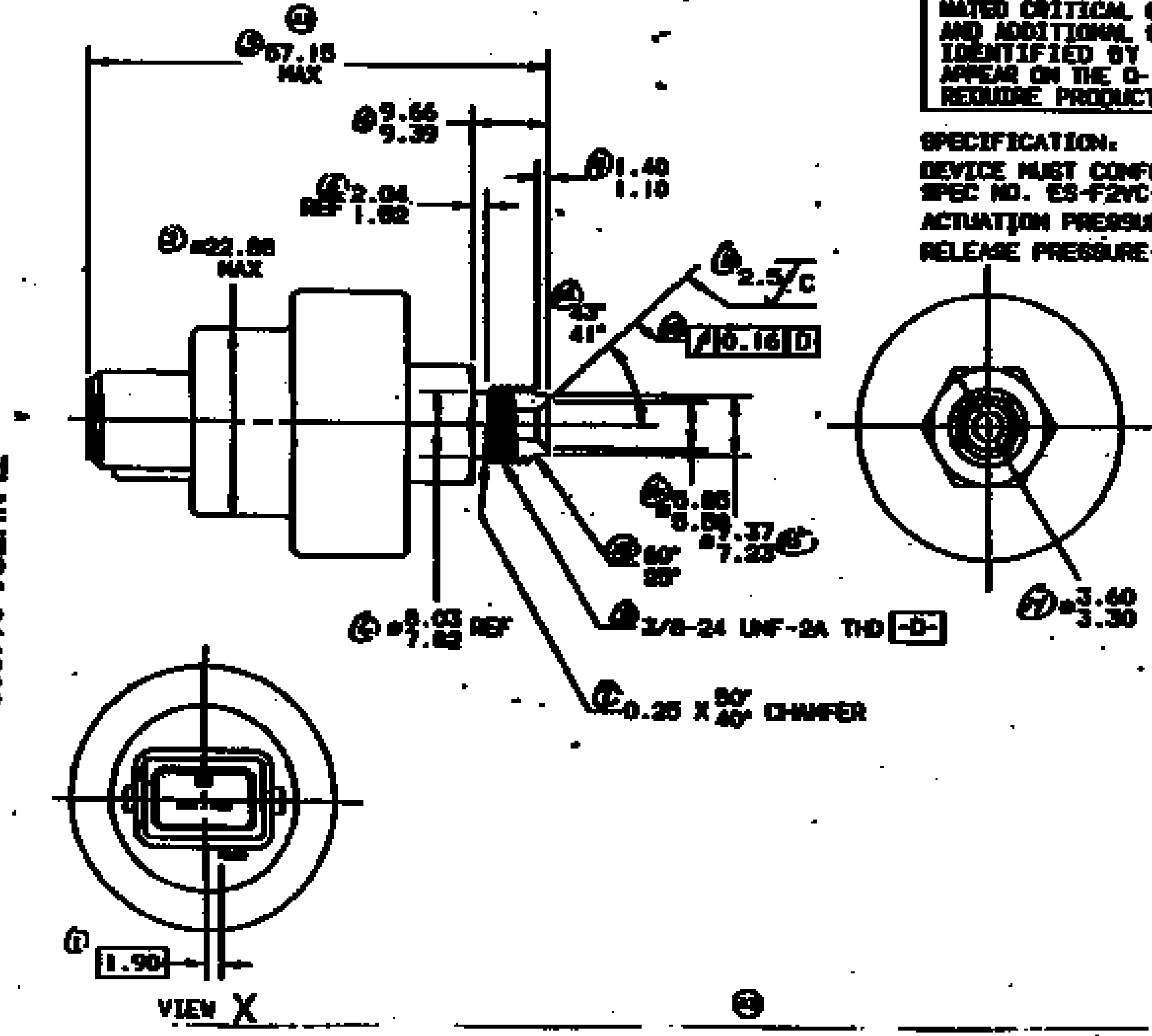
FORD PART NO. F2VC-9F924-AA

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

SPECIFICATION:

DEVICE MUST CONFORM TO FORD MOTOR CO.
SPEC NO. ES-F2VC-9F924-A

ACTUATION PRESSURE---- 862 ±241 kPag (125 ±35 psig).
RELEASE PRESSURE------ 138 kPag MIN. (20 psig)



METRIC

ASSY-PRESSURE SWITCH

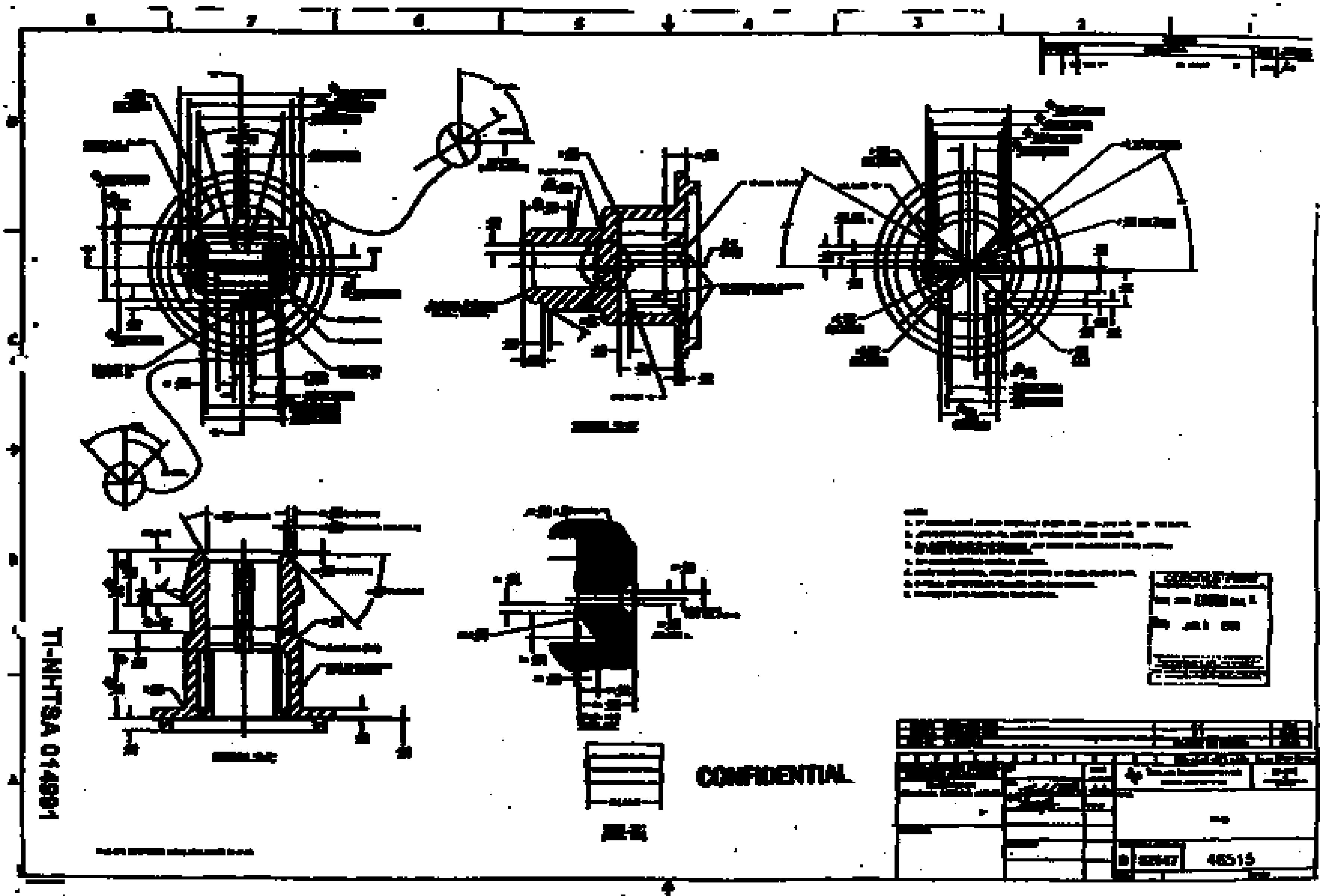
NO MANUAL CHANGE

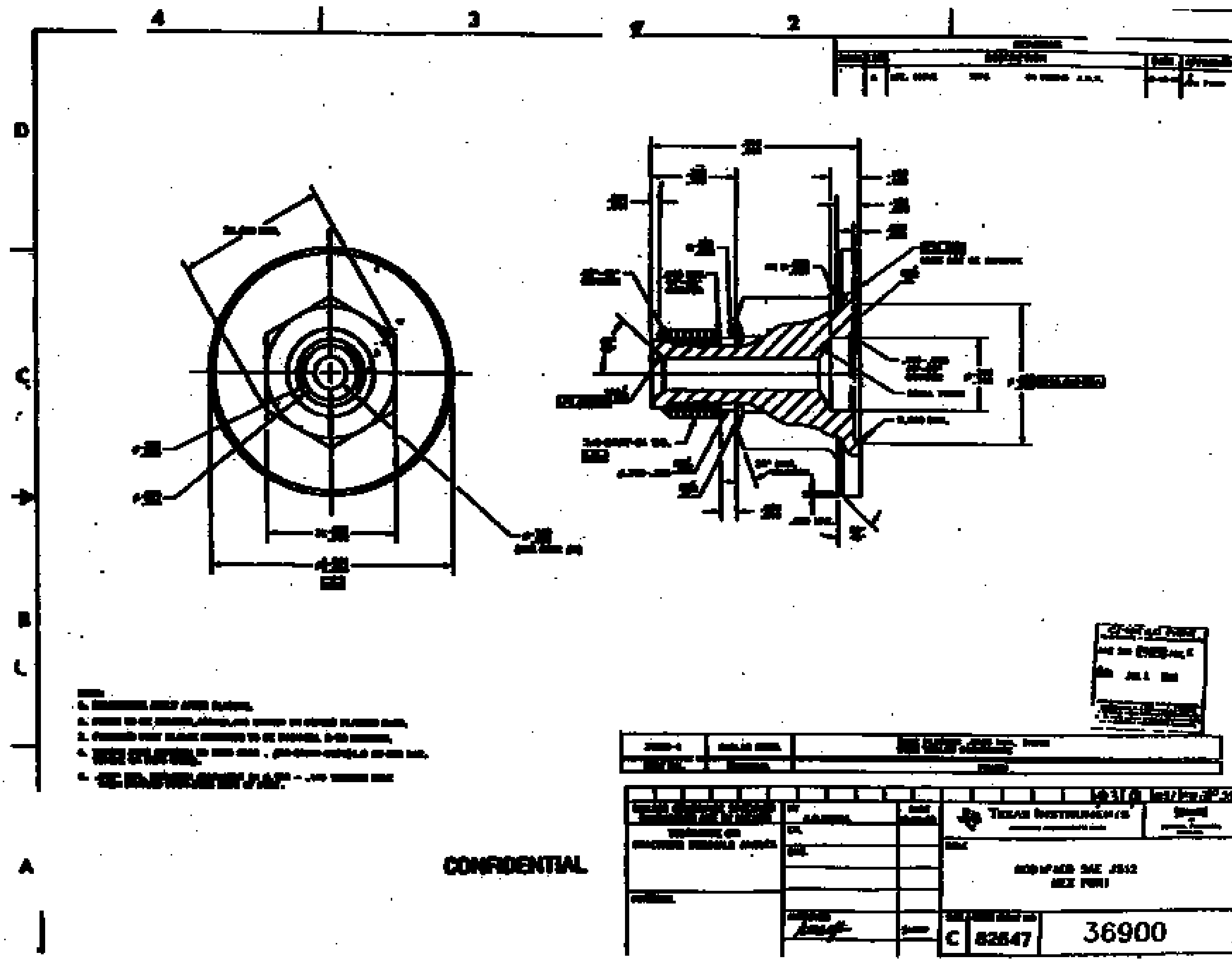
C

D-12590701-A

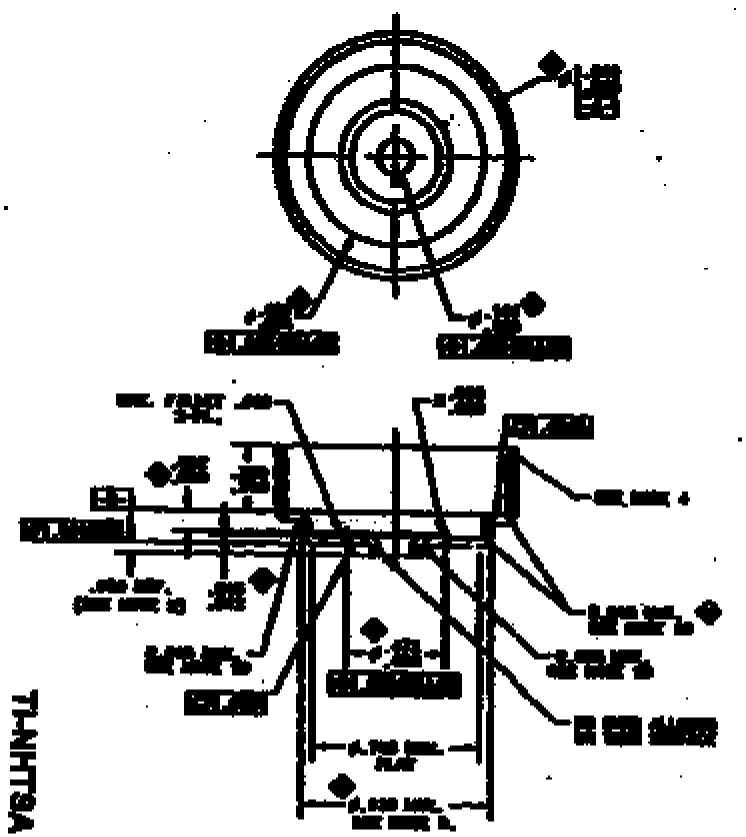
TI-NHTSA 014880

CONFIDENTIAL


CONFIDENTIAL
46515



TI-NHTSA 014992



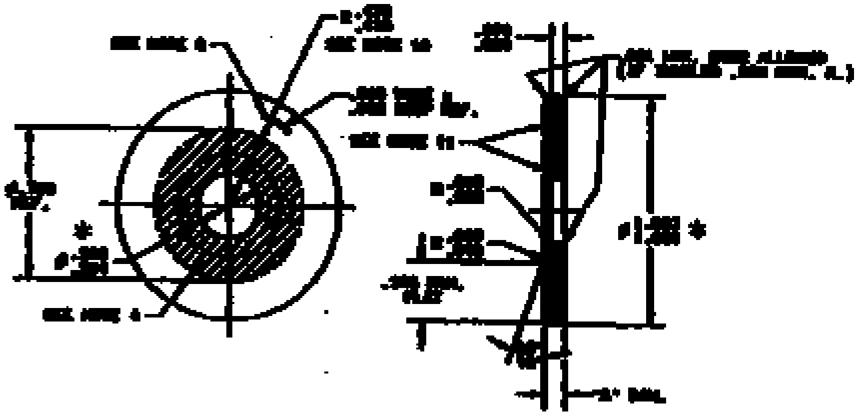
CONFIDENTIAL

TI-NHTSA 014993

TEXAS INSTRUMENTS

CUP

B	82647	27713



NOTES:

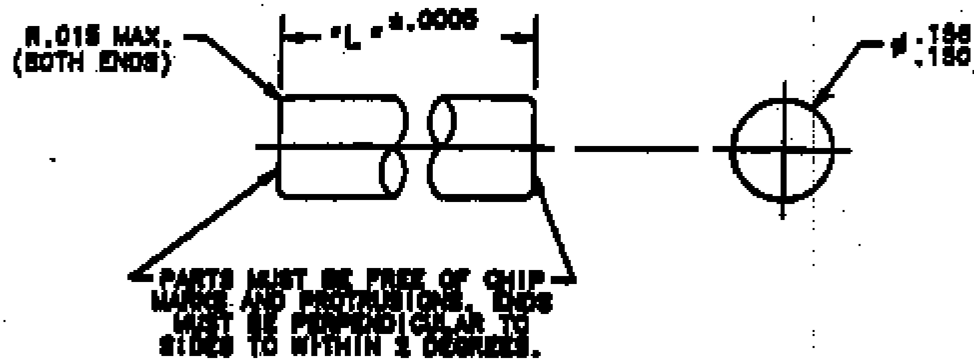
TEXAS INSTRUMENTS

WASHER

B 82647 27639

TI-NHTSA 014694

TRANSFER PIN 74078



"L" LENGTH IS DETERMINED BY THE SUFFIX OF THE PART NUMBER IN THOUSANDTHS OF AN INCH. I.E.:

PART NO.	"L"
74078-156	.156
74078-210	.210

VENDOR WILL BE PREPARED TO FURNISH PINS .130 - .250 LONG.

NOTES:

1. FINISHED PARTS TO BE SHIPPED, ISSUED AND STORED IN SEALED PLASTIC BAGS. SEALED PLASTIC BAGS TO CONTAIN 25,000 PINS (OR LESS FOR PARTIAL BAGS). BAGS MUST BE CLEARLY LABELED WITH THE PART NO. AND THE QUANTITY OF PARTS IDENTIFIED ON THE OUTSIDE OF EACH BAG.
2. MATERIAL CERTIFICATION REQUIRED WITH EACH SHIPMENT.

MATERIAL: L-3 GRADE STEATITE (DC-1652) OR
L-3 GRADE STEATITE (DC-1448)

CURE PER SPEC.------ 50802-2

SHRINKAGE SPEC.----- 50801-1

CERTIFIED PRINT

ENG. STD. E9898 REV. E

Date JUL 1 1991

TI-NHTSA 014895

THIS DWG. SUPERSEDES 74078 REV. "E" DATED [illegible]

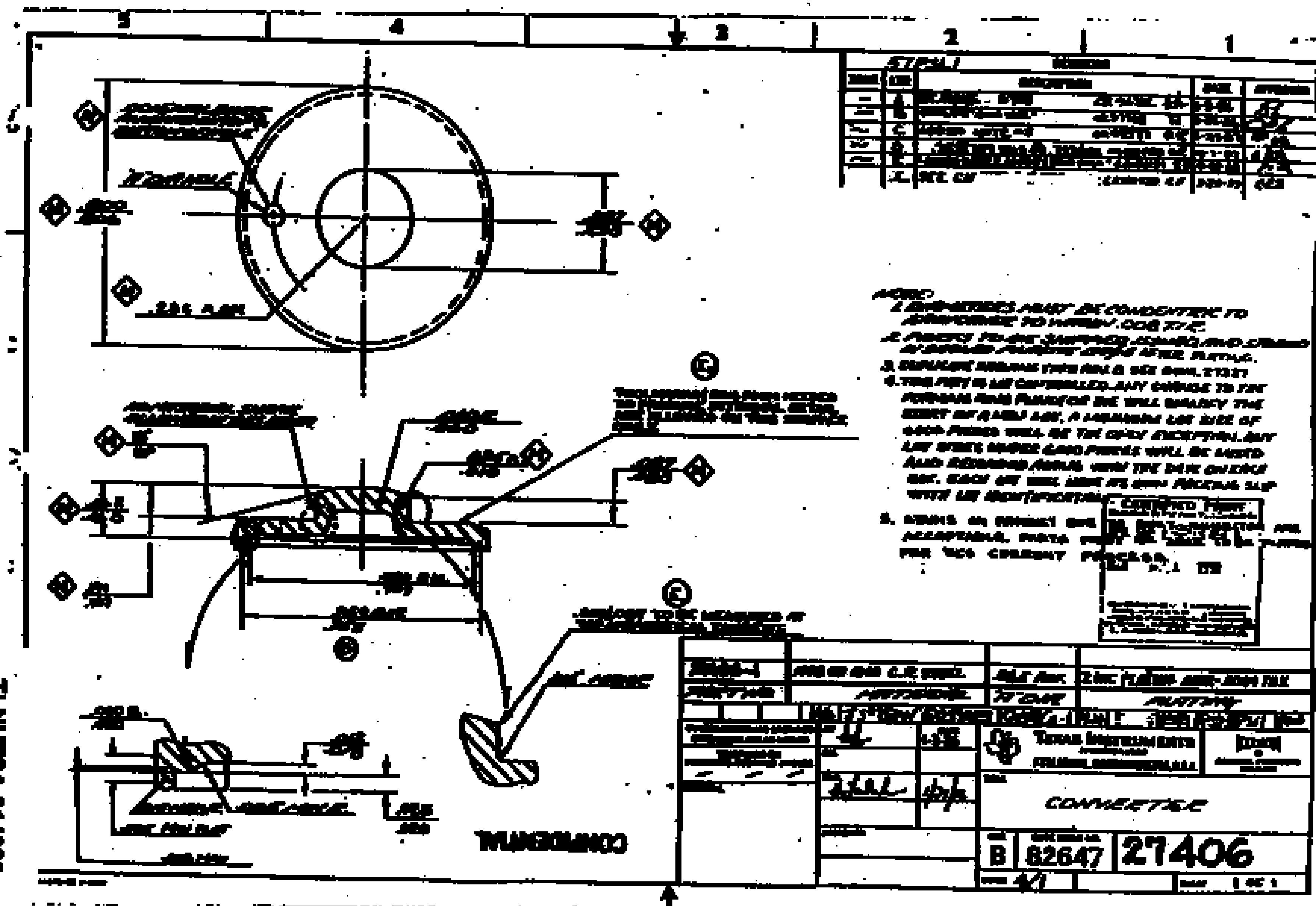
TEXAS INSTRUMENTS

KLIXON

A

74078

CODE IDENT NO. [illegible]

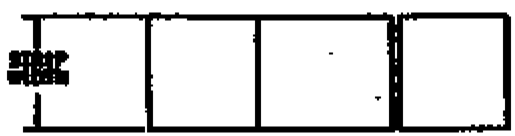


TI-NHT8A 014986

5	4	3	2	1

REVISIONS

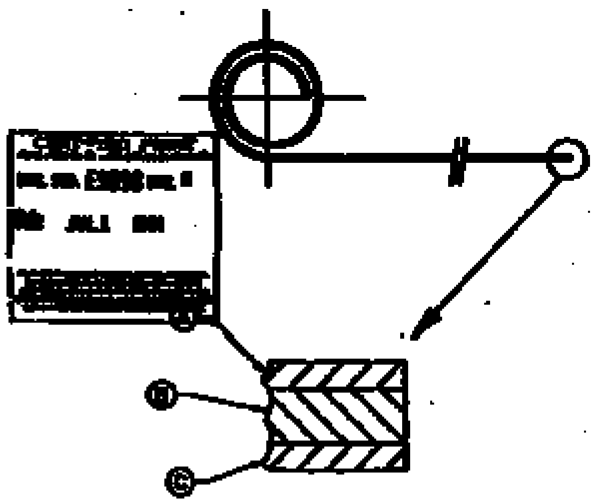
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	[illegible]	[illegible]	[illegible]	[illegible]



NOTES:

1. STRIP TO BE INSPECTED FOR TEFLON COATING, THICKNESS, DEFORMITIES, BUBBLES, AND LAMINATE SEPARATION.
2. EACH KAPTON STRIP ROLL MUST BE LABELED WITH T.I. PART NO. ON INSIDE OF CORE.
3. NO MORE THAN 2 SPLICES PER COIL PERMITTED. SPLICES TO BE CLEARLY MARKED WITH YELLOW MYLAR.
4. MATERIAL CERTIFICATION REQUIRED WITH EACH SHIPMENT.
5. ROLLS SLITTED FROM END OF MASTER COIL NOT ACCEPTABLE.
6. [illegible] OF THE CORE ALLOWED UP TO 1/4" MEASURED RADIALLY AWAY FROM THE CORE.
7. [illegible] OR JAGGED EDGES ON MATERIAL NOT ALLOWED.
8. ROLLS ARE TO BE SHIPPED WITH PROTECTIVE [illegible] IN THE PACKING BOX.

THIS DWG. SUPERSEDES [illegible] REV. "[illegible]" DATED [illegible]

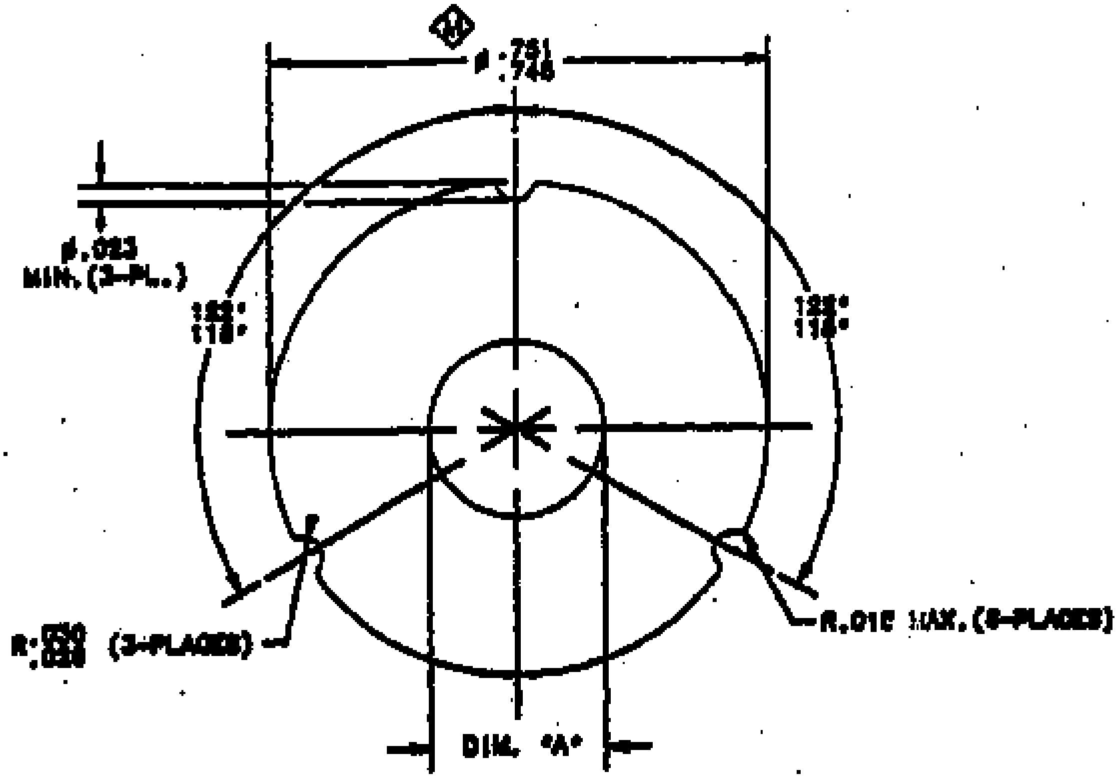


[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3 x 8 1/2	PLASTIC [illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	CARDBOARD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CARDBOARD
PART NO.	MATERIAL	[illegible]	A / B / C (THICKNESS TOLERANCE NOTE [illegible])			STRIP WIDTH (REF.)	[illegible] (REF.)	CORE MATERIAL	

[illegible]	[illegible]	[illegible]	TEXAS INSTRUMENTS
	[illegible]	[illegible]	KAPTON STRIP SPECIFICATION
			B 82647 27225

TI-NH7SA 014897

	SPACER	0	73958



NOTES:

1. .001 MAX. [illegible] ALLOWABLE.
2. PARTS TO BE [illegible], [illegible], AND STORED IN SEALED PLASTIC BAGS.
3. ALL [illegible] OF PARTS [illegible] DATE [illegible] CODE [illegible] TO REFLECT ANY MATERIAL LOT, [illegible] OR PROCESS CHANGE.
5. MATERIAL CERTIFICATION REQUIRED WITH EACH LOT.

CERTIFIED PRINT
ENG. STD. E9898 REV. E
Date JUL 1 1991

PART NO.	MATERIAL	DIM "A"
73958-3	MADE FROM 74824-1 (KAPTON TAPE)	NO HOLE
73958-2	DUPONTS. KAPTON 200H, .0017 - .0023 THICK	NO HOLE
73958-1	KAPTON .0017 - .0023 THICK	.250/.270

THIS DWG. SUPERSEDES 73958 REV. "F" DATED 10-14-88

TEXAS INSTRUMENTS
A
DWG. NO. 73958
CODE IDENT NO.

73958

TI-NHTSA 014898

Texas Instruments

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

NA Hydraulic Switch History

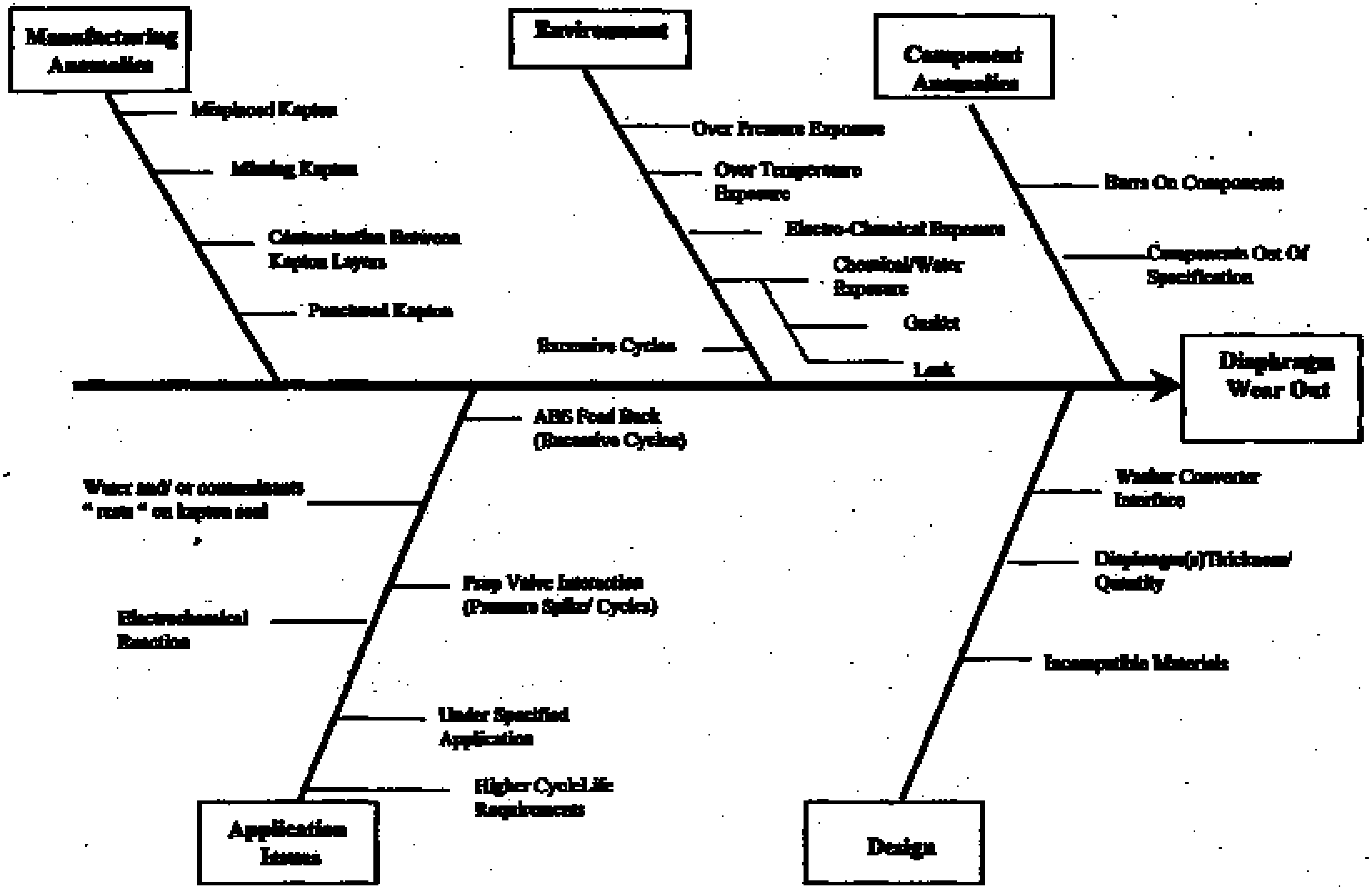
Time Period:	'83	'87	'90	'91	'98	'99
Application:	Power Steering	Power Steering Suspension	Power Steering Suspension Transmission	Power Steering Suspension Transmission Cruise	Power Steering Suspension Transmission Cruise Clutch	Power Steering Suspension Transmission Cruise Clutch
Fluid:	Power Steering Fluid					
		Brake Fluid				
			Transmission Fluid			

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

Texas Instruments

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

[redacted]



Process Controls

Operation	Fault	Process Control	Control Method
Hexport Feed	Fails to Load	100% Check with LVDT	Set-Up block
	Wrong/Mixed Hexport		
Gasket	Fails to Load	100% reflective sensor check	Set-Up Masters
	Misplaced		SPC P-Chart
Kapton #1 & #2	Fails to Load	100% Continuity Check	SPC P-Chart
	One seal only		
	Improperly cut seal		
Kapton #3	Fails to Load	100% Continuity Check	SPC P-Chart
(If Necessary)	Improperly cut seal		
Washer	Fails to Load	100% Presence Check	100% Pressure Test
	Upside down	Orientation control on feed bowl	
Converter	Fail to load onto washer	100% Presence Check	100% Pressure Test
Spacer	Fails to Load	100% presence check with continuity probe	SPC P-Chart
Disc	Fails to Load	100% Height probe	Operator set-up 100% Pressure Test
	Upside down		
	Two Discs		
Cup Feed	Fails to Load	Height Probe	Operator set-up
Pre-Crimp	Trapped Disc	Low Pin Probe	SPC P-Chart
45 & 90 degree crimp	Fails to Crimp	Stroke made sensors	SPC X-Bar & R
	Improper crimp		Poka-Yoke
Over Pressure	Drift over life	Minimum pressure gauge	Controlled by PLC
	Calibration Change		
Unload good devices	Fails to unload good devices	Empty nest sensor	Controlled by PLC

Process Controls

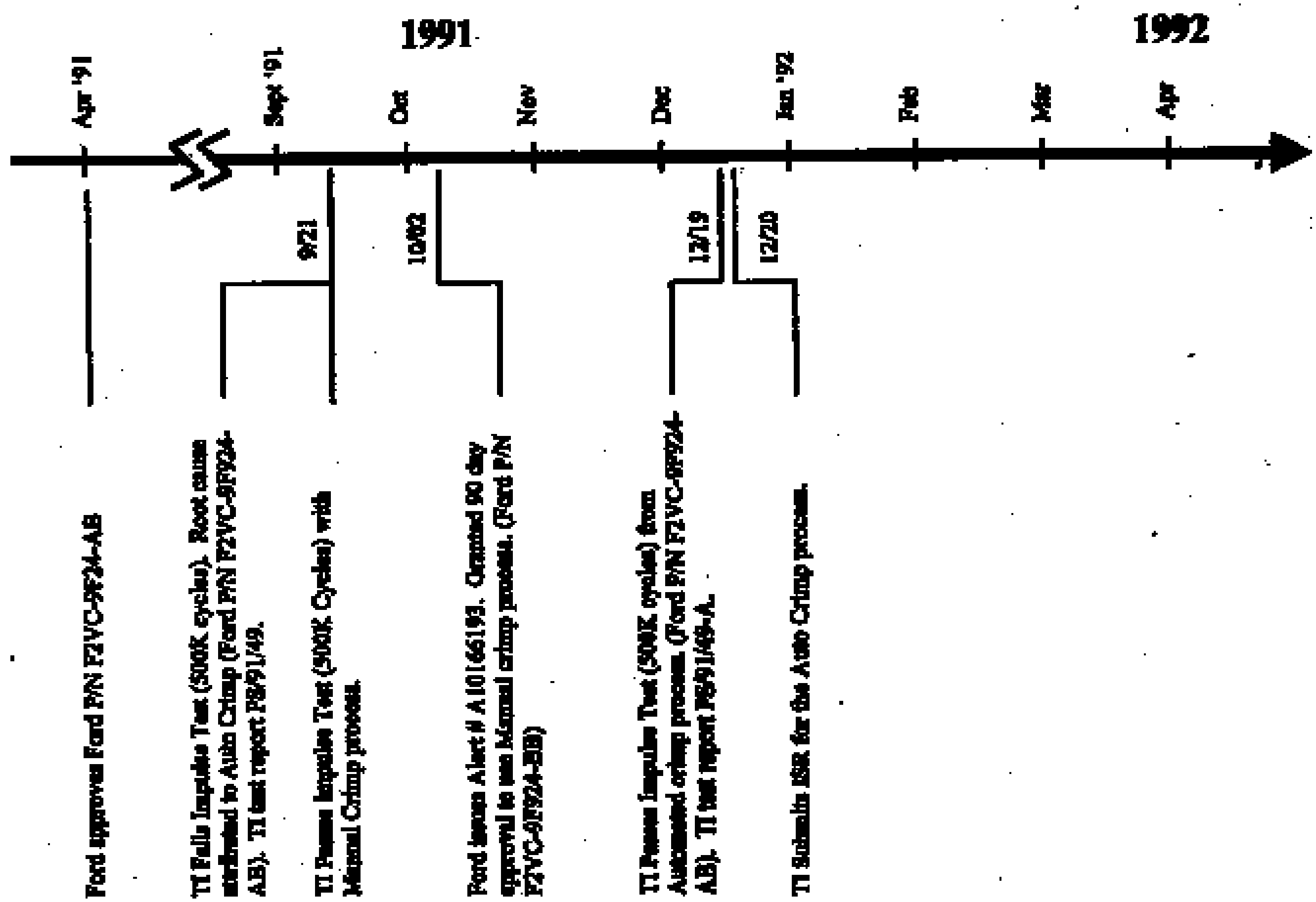
Operation	Fault	Process Control	Control Method
Assemble sensor &	Machine error	100% height check	Controlled by PLC
crimp ring in nest	Out of round sensor		
Assemble Environmental	Missing seal	100% height check	Controlled by PLC
seal & check	Misplaced seal		
	Multiple seals		
Assemble Pin	Creep	100% Check with LVDT	SPC P-Chart
	Calibration shift		
Assemble Base Assembly	Wrong base assembly	100% part presence	SPC P-Chart
	No base		100% Pressure Test
Crimp Final Device	Wrong Crimp Height	Crimp pressures	SPC X-Bar & R
	Wrong Crimp Diameter	Cylinder adjustments	Poka-Yoke
	Torque		SPC P-Chart
Function Test	Actuation Failure	Actuation Masters	SPC X-Bar & R
	Release Failure	Ramp Masters	SPC X-Bar & R
	Differential Failure		
	Actuation Creep	Custome Pressure Tester	Vax System
	Release Creep		Program
	Coarse Leak		
	Millivolt Drop		

TEXAS INSTRUMENTS

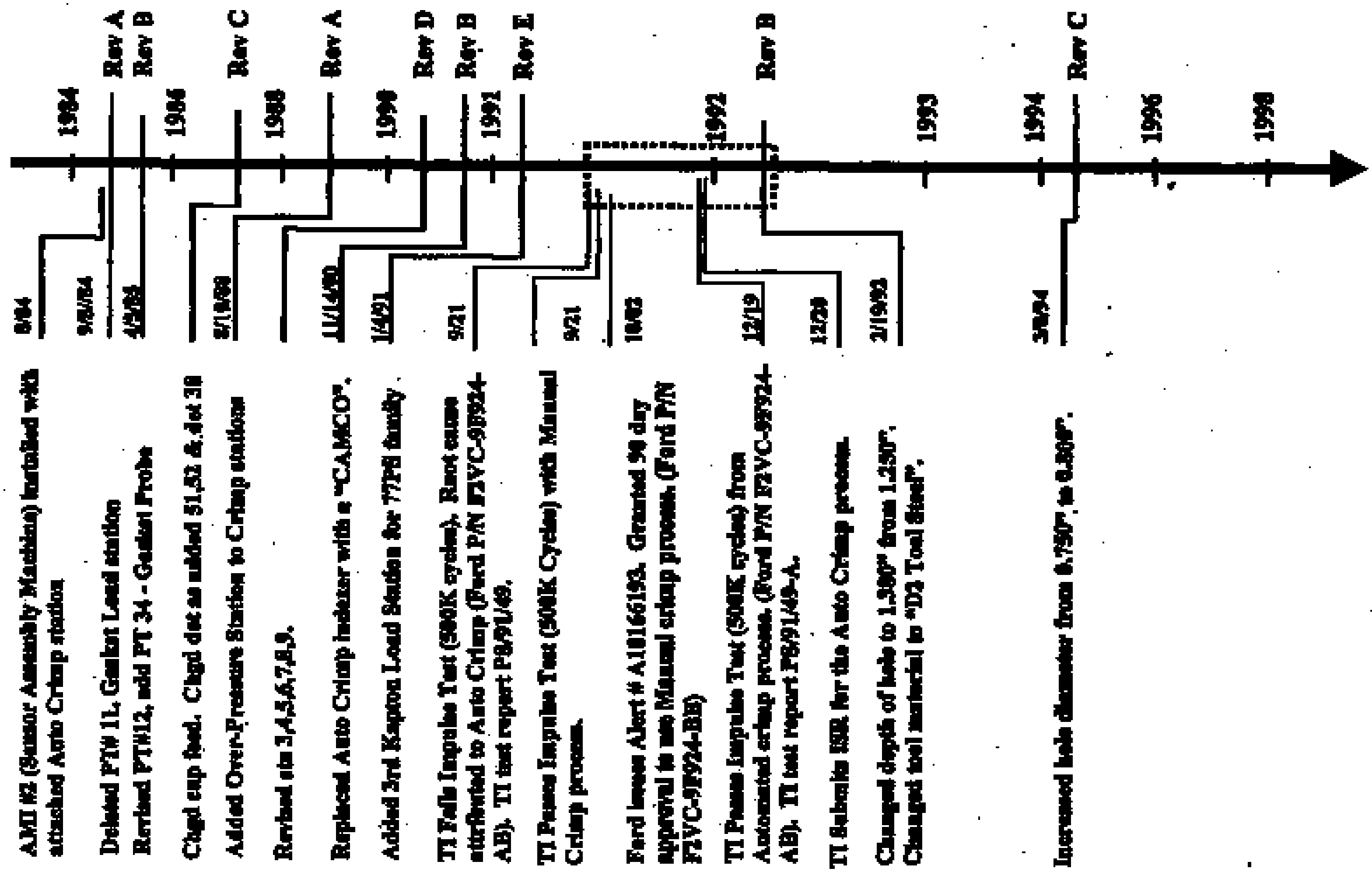
Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

TI-NHTSA 015003

Timeline: F2VC-9F924-AB (TI P/N 77PSL2-1)



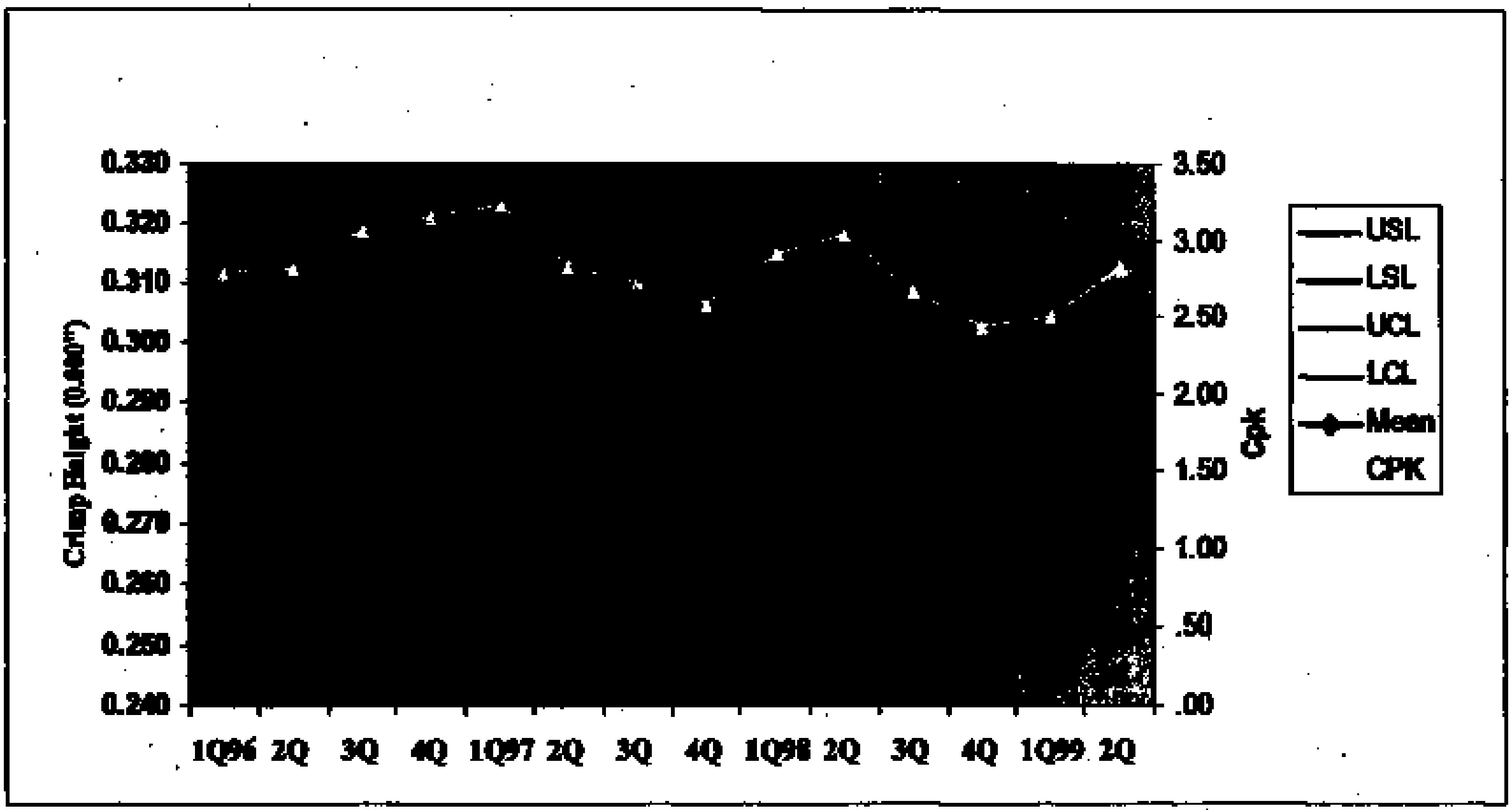
Timeline: Equipment / Process Evolution



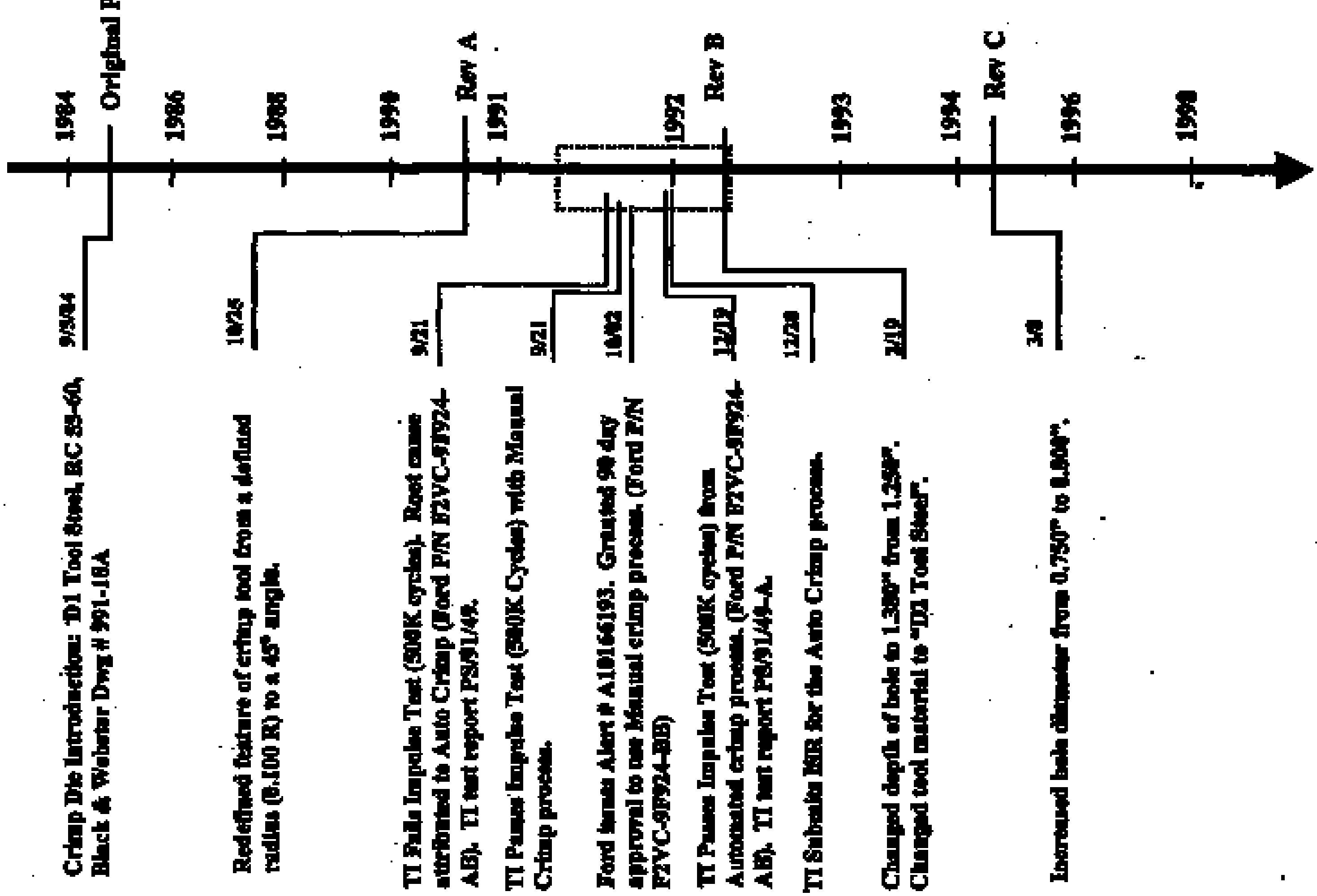
TEXAS INSTRUMENTS

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

Crimp Height SPC History ('96 - Current)

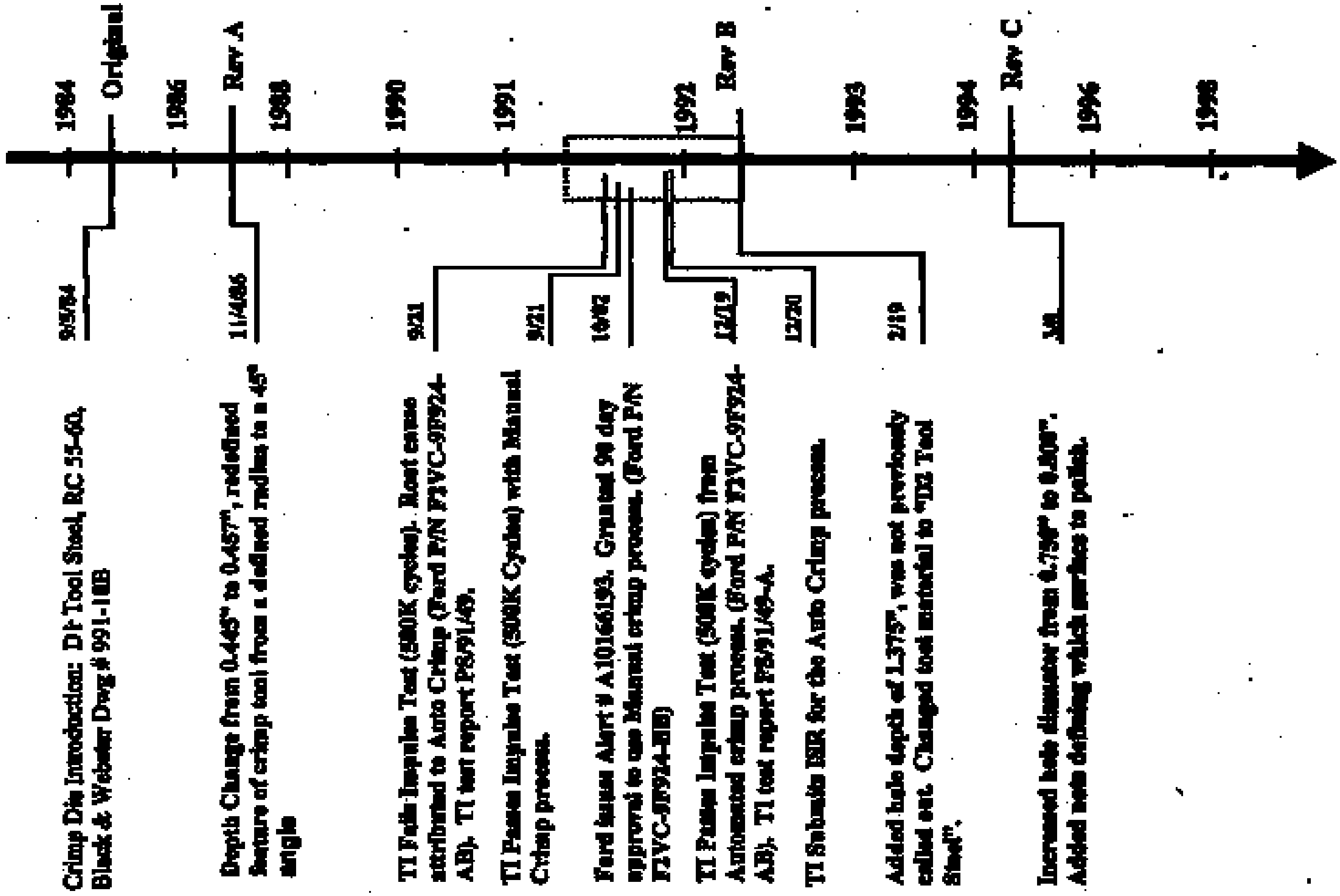


Timeline: Crimp Tool #1 (P/N 140421-2)



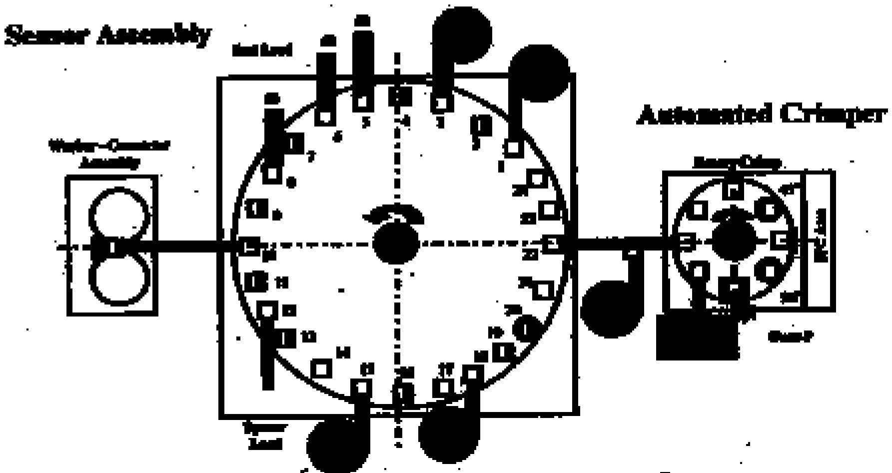
TI-NHTSA 016007

Timeline: Crimp Tool #2 (P/N 140422-2)

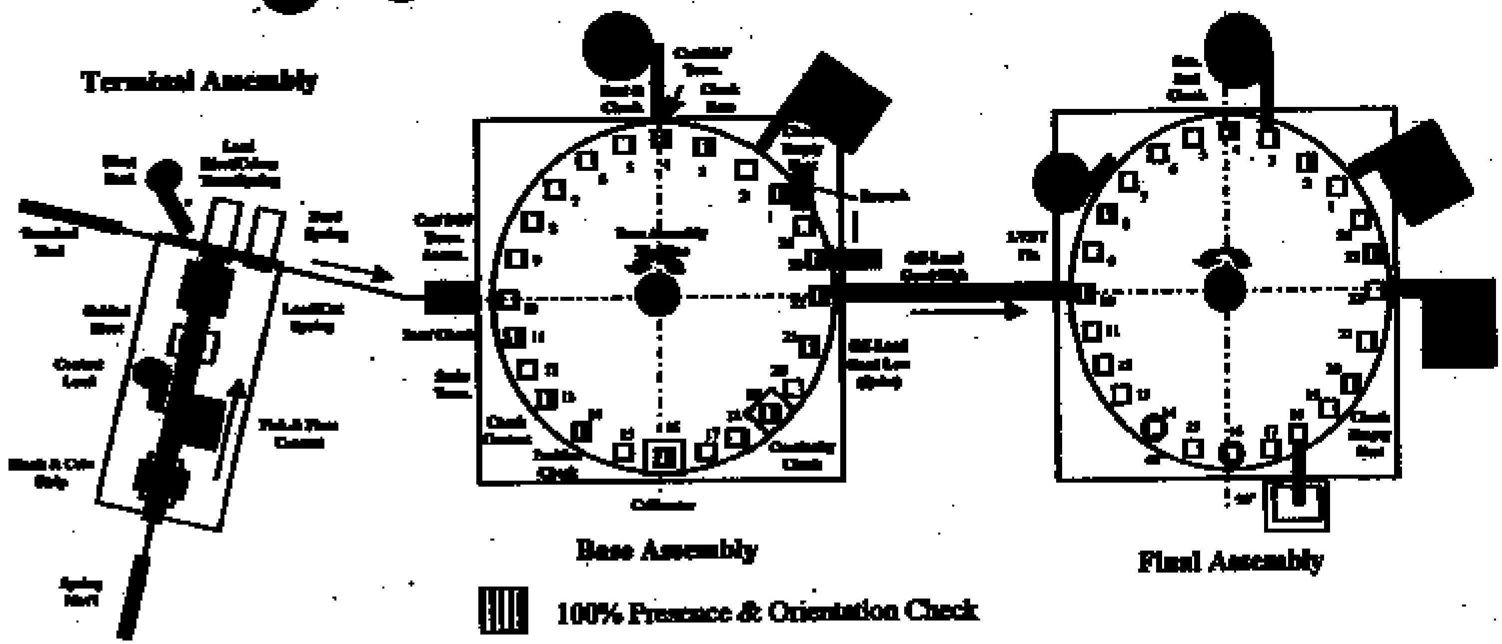


TEXAS INSTRUMENTS

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series



77PS Product Line



AMI Sensors & Checks

2) **Hexport Check**
- LVDT that measures the depth of the fluid path hole to determine if the correct hexport is being used.
- The part # and corresponding hexport are bar coded into the PLC.
- The fluid path hole of each hexport has a unique depth.
- The limits for each hexport are programmed into the PLC.
- The AMI stops on (1) fault.
- A master set up block is used to "0" out the LVDT.

4) **Gasket Check**
- 4 reflective sensors check to see if there is a gasket and that it is in place.
- None of the 4 is allowed to receive a reflection or the nest is called bad.
- The shift register is set bad on one fault, the AMI stops on two faults.
- There are 5 set-up masters to ensure the reflective sensors are in the correct positions.
- Under SPC control using a P-Chart.

7) **Kapton Check #1 & #2**
- 4 pogo pins are used to make a continuity check on the nest. The 4 pins must touch the 4 corners of the kapton (two corners of each piece) to ensure that two pieces are present.
- If one of the pogo pins goes to ground the nest is called bad.
- The shift register is set bad on one fault and the AMI stops on two faults.
- There is a set-up block to ensure the pins are in the correct position.
- Under SPC control using a P-Chart.

9) **Kapton Check #3**
- 2 pogo pins are used to make a continuity check. The 2 pins must touch the two corners of the third piece of Kapton to ensure the third piece has been placed in the nest.
- If one of the pogo pins goes to ground the nest is called bad.
- The shift register is set bad on one fault and the AMI stops on two faults.
- There is a set-up block to ensure the pins are in the correct position.
- Under SPC control using a P-Chart.

11) **Washer/Converter**
- The washer and converter are checked for part presence using a height probe sensor utilizing two micro switches. The height probe fixture comes down into the nest and if the micro switches are not broken the PLC indicates the parts are present. If the micro switches are broken the PLC assumes there are no components and calls the nest bad.

13) **Spacer Check**
- This station consist of three pogo pins, two continuity pins, and a hold down pin. The continuity pins come down and make contact with the spacer and if they do not go to ground the part is considered good. If there is a ground the part is considered bad.
- The shift register is set bad on one fault and the AMI stops on two faults.

16) **Disc Load Check**
- This check is done with a LVDT. It is checking to make sure that there is not more than one disc, and the disc is not upside down.

19) **Cup Load Check**
- The cup is checked for part presence using a micro switch. The height check fixture comes down into the nest and if the micro switch is not broken the PLC believes there is a cup present. If the micro switch is broken the PLC believes there is no cup.
- The shift register is set bad on one fault and the AMI stops on two faults.

20) **Low Pin Check**
- The low pin check uses a LVDT to ensure the disc has not moved out of the converter and become trapped.

BAM Controls

3) **Base Presence**
   - Uses a through beam to ensure a base has placed in the nest.

4) **Stationary terminal presence and position**
   - Two micro switches are used to ensure there is a terminal present and it is the proper position.
   - This station is also used to seat the terminal in the base cavity. If the terminal is not in place or in the wrong position the arm will travel too far and break the micro switches.

11) **Moveable terminal presence and position**
   - Two micro switches are used to ensure there is a terminal present and it is the proper position.
   - This station is also used to seat the terminal in the base cavity. If the terminal is not in place or in the wrong position the arm will travel too far and break the micro switches

13) **Check for contact**
   - A reflective sensor is used to ensure a contact is in place.

14) **Part Presence**
   - A through beam sensor is used to ensure there is a base in the nest before proceeding to the crimp station.

16) **Calibrate Base**
   - This station sets the distance between the contact on the moveable arm and the stationary contact. This distance is predetermined and programmed into the PLC.

19) **Check Station**
   - Checks to ensure the calibrator calibrated the base to the proper dimension. Measuring the distance until the contacts meet and continuity is made does this.

21) **Off-Load/Good Low**
   - When running split lots the bases on the low end of the specification are off loaded at this station.

22) **Off-Load/Good High**
   - When running split lots the bases on the high end of the specification are off loaded at this station.
   - When running normal lots all bases are off loaded at this station or they are allowed to go directly into F.A.M.

23) **Rework**
   - Any base that is not calibrated to the correct dimension and identified as so by the check station is off loaded at this station.

1) **Check Empty Nest**
   - Uses a height probe and a micro switch to ensure the nest has been unloaded before loading another base into the nest.

FAM Controls

22) **Crimp Ring Presence**
- A height check probe is used to insure a part has been loaded. The height check fixture is attached to a micro switch and when the height check fixture comes down if the part is present the micro switch will not break contact. If it is not present it will break contact and send a signal to the PLC to stop the machine.

2) **Sensor Presence**
- A height check probe is used to insure a part has been loaded. The height check fixture is attached to a micro switch and when the height check fixture comes down if the part is present the micro switch will not break contact. If it is not present it will break contact and send a signal to the PLC to stop the machine.

4) **Environmental Seal Presence**
- A height check probe is used to insure a part has been loaded. The height check fixture is attached to a micro switch and when the height check fixture comes down if the part is present the micro switch will not break contact. If it is not present it will break contact and send a signal to the PLC to stop the machine.

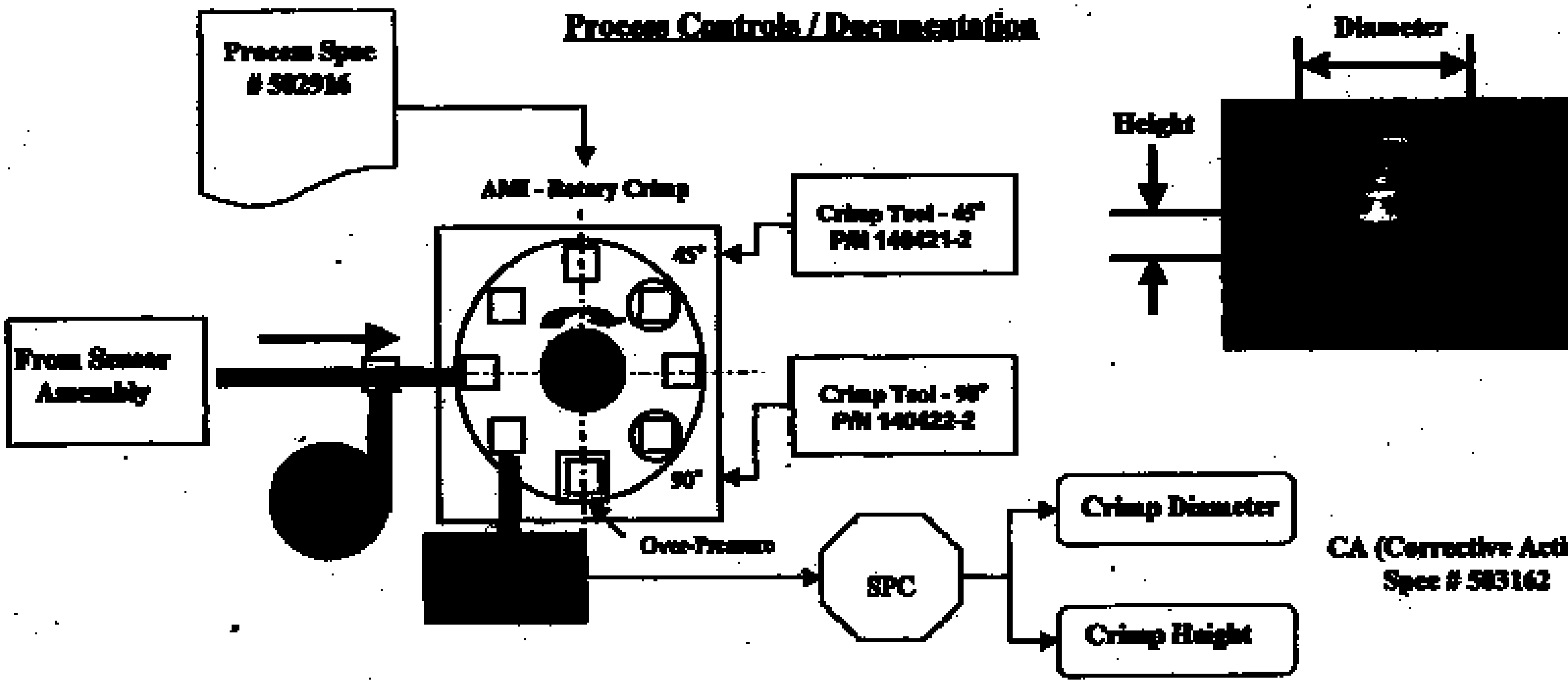
8) **Pin Check**
- This station uses a LVDT to measure the height of the pin. The upper and lower limits of the pin size are loaded into the PLC and the machine stops if the measurement falls out of these limits.

10) **Base Presence**
- A height check probe is used to insure a part has been loaded. The height check fixture is attached to a micro switch and when the height check fixture comes down if the part is present the micro switch will not break contact. If it is not present it will break contact and send a signal to the PLC to stop the machine.

20) **Empty Nest Check**
- A height check probe comes down to check and make sure the nest is empty before loading another crimp ring into the nest.

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

Process Controls / Documentation



CA (Corrective Action)
Spec # 503162

Crimp Logic / Sequence of Events:

- All tooling home
- Part presence sense
- Send cylinder down until down stroke sensor is activated
- Hold cylinder down
- Send cylinder home
- Repeat cycle

TEXAS INSTRUMENTS

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

Sensor Assembly Process

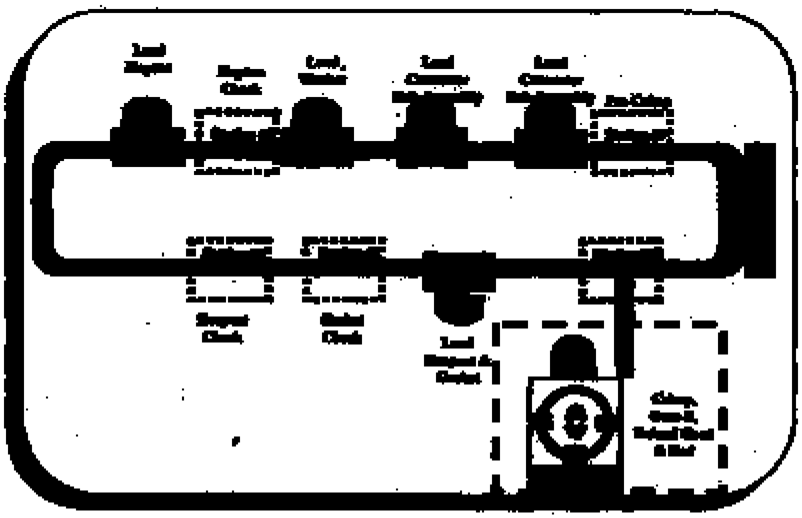
TEXAS INSTRUMENTS

Ford - Electronic Speed Control Deactivation Pressure Switch
TI P/N 77PSL Series

Automatic vs. Hand Line Equipment

	Auto Crimper	Hand Line
Equipment Manufacturer	Black & Webster	Black & Webster
Load Method	Auto	Manual
Control Unit	5TI PLC	A/B PLC
Crimp Cylinders	American Cylinder	American Cylinder
Pressure Medium	Air	Air
Sensors (Up & Down)	Canfield Sensors	Canfield Sensors
Crimp Tool P/N:		
- 45°	140421-2	140421-2
- 90°	140422-2	140422-2
Process Controls Used:	Up & Down stroke sensors PLC control Over-Pressure Verification Crimp Height Crimp Diameter	Up & Down stroke sensors PLC control Over-Pressure Verification Crimp Height Crimp Diameter

Manual Sensor Assembly - TI Mexico



Hand Line - Crimp Equipment

45° Station

90° Station

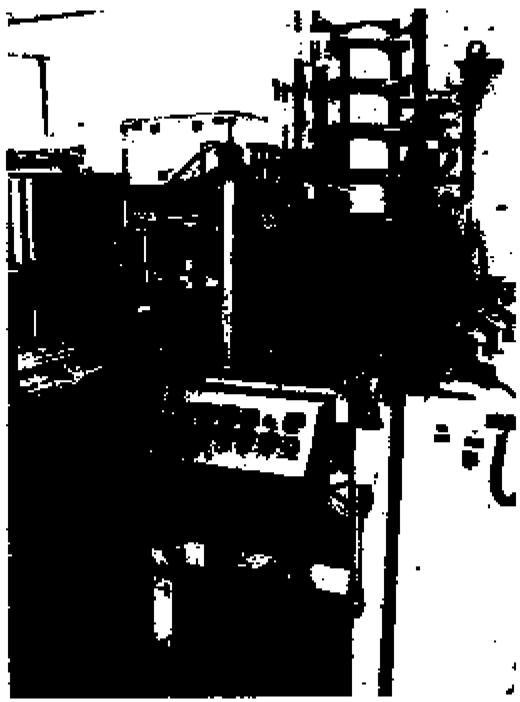
Dial Nest: Operator loads pre-crimped sensor into nest

O-ring Station

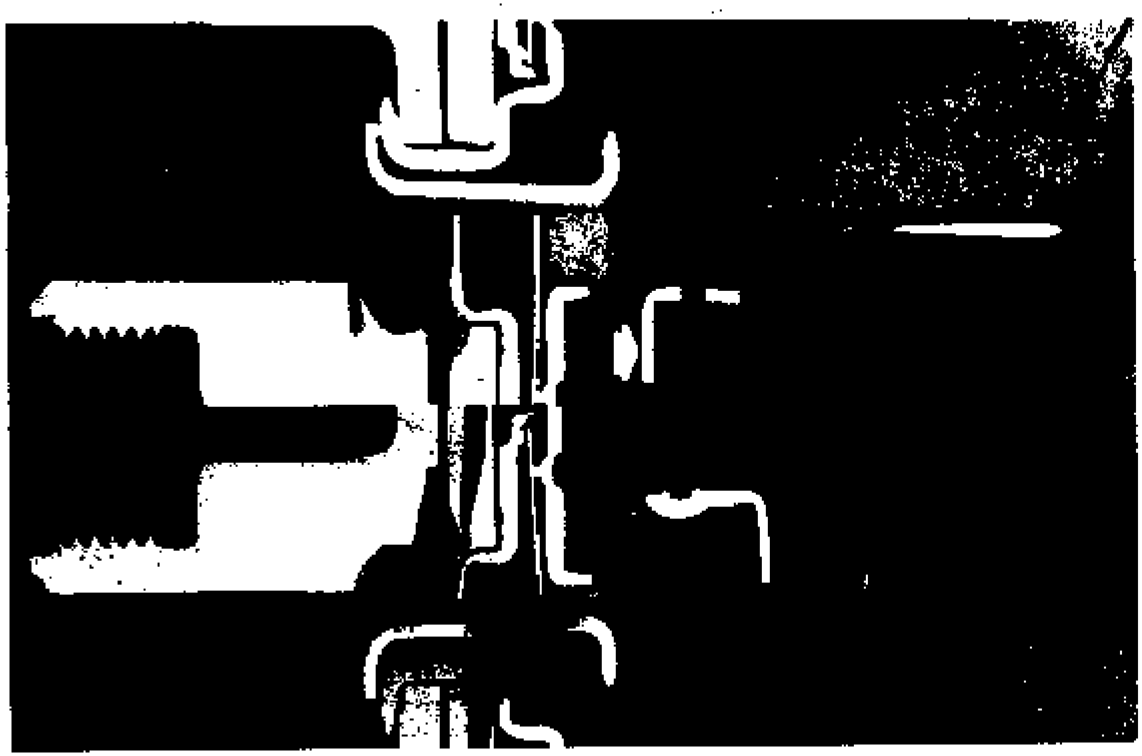
Operator Station - Operator places O-ring on sensor and feeds into sensor nest

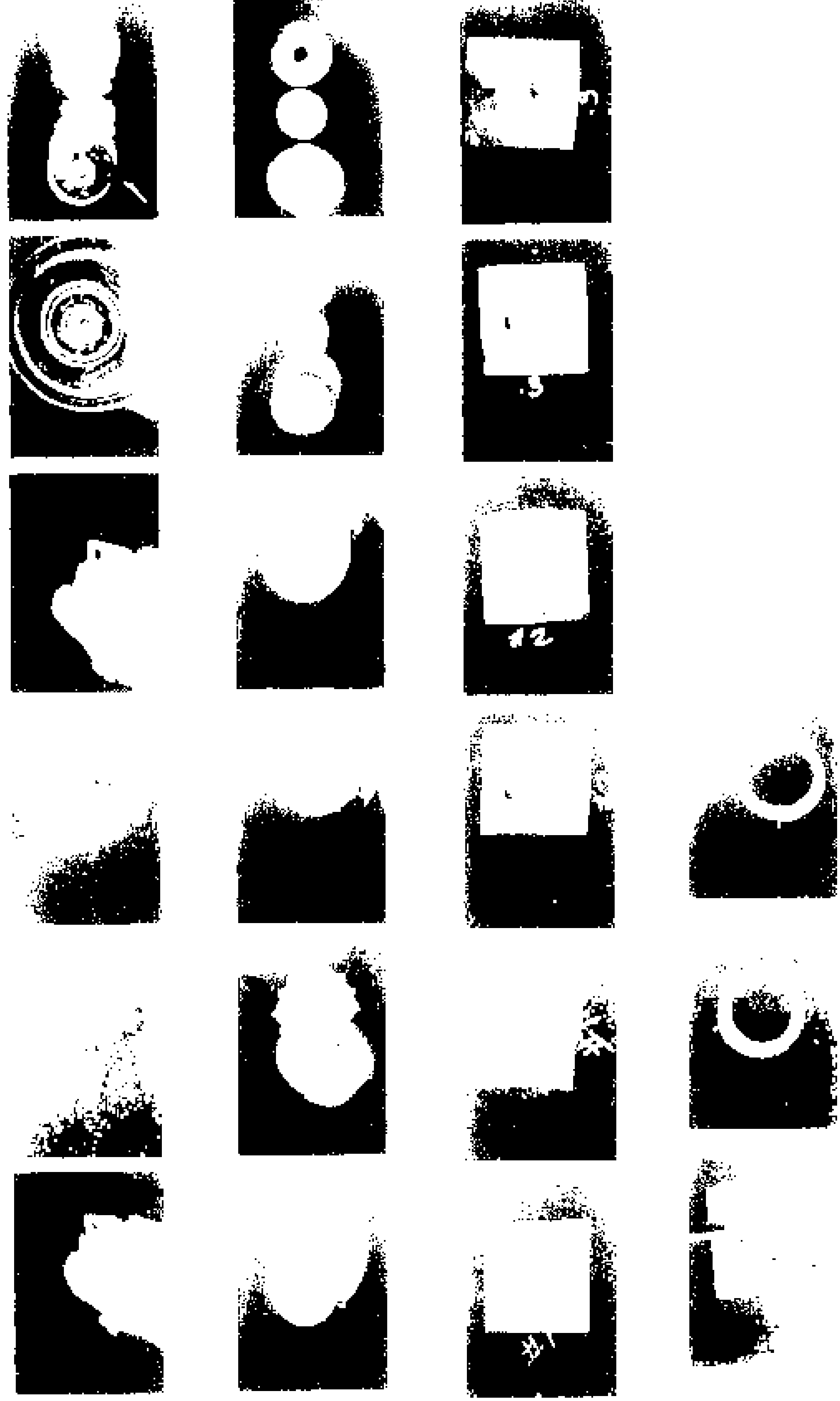
Conveyor from Sensor Assembly Belt

Automated Crimp Equipment



Switch X-Section





TL-NHTSA 010618