EA02025

TEXAS INSTRUMENTS, INC.'S

09/10/03 LETTER TO ODI

REQUEST 13

BOX 13

PART A – E

PART A

EA02-025
TEXAS INSTRUMENTS, INC.'S

Response to NHTSA Request No. 13

Subsystem/Name: Hood Control Receptacle Presence Switch
Design Responsibility: Stephen E. Gettler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by:
2000 Sales Target: Other:

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	SEV	CLASS	Potential Cause(s) of Failure	OCC	Design Verification	DET	RPN	Recommended Actions	Resp./Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	SEV	OCC	DET	RPN
[illegible] (86616) Provides fastener which locates and affix the movable and stationary terminals Protects/insulates the electrical elements from the environment Provides a reference surface which locates the electrical elements relation to the pressure sensor Provides a flange to preserve the environmental seal Provides geometry of electrical connector	Terminals out of proper location	Difficulty installing mating electrical connector			Terminal locating features in base are out of spec.		PPAI; in-process checks; Final Insp.								
	Terminals loose	Intermittent continuity Shift/Fluctuation in switch outputs			Terminal locking features in base are out of spec.		PPAI; in-process checks; Final Insp.								
	Connector dimensions improper	Difficulty installing mating connector			Broken/Worn mold		PPAI; in-process checks; Final Insp.								
	Low insulation resistance	Current leakage causes switch from location circuit			Contamination/Wrong material		Mat'l certification								
	Leakage of environmental substrate past connector	Excessive current leakage High contact resistance Contacts stuck open Contacts stuck closed			Improper geometry of environmental seal surfaces caused by broken/worn mold Handling damage to seal surface		PPAI; in-process checks; Final Insp. In-process visual checks								
	Lock tabs too small	Mating conn. falls off			Broken mold repaired improperly		PPAI								
	Lock tabs too big	Difficulty installing mating connector			Broken/worn mold		PPAI; in-process checks; Final Insp.								
	Seal gland between base and pressure sensor too small	Base and sensor do not mate properly, causing shift in outputs			Broken mold repaired improperly		PPAI								
	Seal gland too big	Buckling seal squeeze leading to leakage			Broken/worn mold		PPAI; in-process checks; Final Insp.								
	Improper polarity key location	Mating connector will not fit			Molding error		PPAI; in-process checks; Final Insp.								
[illegible] Provides a beam blade for interconnection Provides a slide/relay surface for electrical contact Provides a feature for device calibration Provides a feature for staking into base	High contact resistance/no continuity at blade	Device appears open-circuit w/ mating connector installed			Mat'l too thin		Supplier process controls and II Receiving Inspection								
	Blade dimensions improper	Device appears open-circuit w/ mating connector installed Difficulty installing conn.			Wear/broken stamping tools, or improper material thickness		Supplier process controls and II Receiving Inspection								
	Terminal loose in base	Intermittent continuity Shift/Fluctuation in switch outputs			Improper insert Improper basis Mat'l too hard Mat'l too soft		Supplier process controls and II Receiving Inspection Supplier process controls and II Receiving Inspection Mat'l certification Mat'l certification								
	High resistance at contacts	Apparent open circuit Intermittent continuity			Films/contamination		Mat'l certification								
	Contact resistance increases over life	Performance degradation over time			Silver relay shrinkage too thin		HTC and material certification								
	Improper calibration	Mfg. yield loss (bad cal. detected at pressure tester)			Wear/broken tools Wrong material		Supplier process controls and II Receiving Inspection Mat'l certification								
[illegible] (2000) Provides a beam blade for interconnection Provides a mounting point for the spring/movable contact Provides a feature for staking into base	High contact resistance/no continuity at blade	Device appears open-circuit w/ mating connector installed			Mat'l too thin		Supplier process controls and II Receiving Inspection								
	Blade dimensions improper	Device appears open-circuit w/ mating connector installed Difficulty installing conn.			Wear/broken stamping tools, or improper material thickness		Supplier process controls and II Receiving Inspection								
	Terminal loose in	Intermittent continuity			Improper insert		Supplier process								

TI-NHTSA 0190428

Subsystem/Name: Speed Control Dashpot Pressure Switch
Design Responsibility: Stephen R. Griffin
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by:
Key Date (Orig.): Rev.:

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	D e t.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS Actions Taken	Sev.	Occ.	Det.	R.P.N.
	Beam	Shift/fluctuation in switch setpoints			Improper bends		controls and IT Receiving Inspection									
							Supplier process controls and IT Receiving Inspection									
					Mat'l too hard		Mat'l certification									
					Mat'l too soft		Mat'l certification									
	High resistance at spring interface	Apparent open circuit			Files/contamination		Mat'l certification									
		Intermittent continuity														
	Loose spring	Erratic operation			Rivet hole oversize		Supplier process controls and IT Receiving Inspection									
		Shift/drift in setpoints														
	Rivet hole size/ location bad	Will not assemble to spring properly			Stamping tool worn or broken		Supplier process controls and IT Receiving Inspection									
SPRING CHARGE Provides contact force Provides continuity between terminals Provides feature to interface with transfer pin Provides mounting location for movable contact Provides feature for attachment to stationary contact	Low contact force	High milliohmic drop across contacts			Incorrect geometry											
					Incorrect material		Mat'l certification									
	High contact force	Change in setpoints			Incorrect geometry											
		Dimp fractures			Incorrect material		Mat'l certification									
	High resistance at movable terminal interface	Apparent open circuit			Files/contamination		Mat'l certification									
	Rivet hole size/ location bad	Will not assemble to terminal properly			Stamping tool worn or broken		Assembly equipment current spring performance/tolerance									
	Transfer pin keep out of position or missing	Spring failure over life			Broken stamping tool		SPC									
RIVET (7871) Holds spring and movable terminal together	Length undersize	Spring falls off assembly tool			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Length oversize	Loose spring			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Diameter undersize	Loose spring			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Diameter oversize	Assembly difficulty			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Head undersize	Loose spring			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Head oversize	Assembly difficulty			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Hollow point oversize	Shank rivet — spring falls off			Supplier tooling		Supplier process controls and IT Receiving Inspection									
	Hollow point undersize	Difficult to rivet — loose spr			Supplier tooling		Supplier process controls and IT Receiving Inspection									
DOUBLE CONTACT (7881) Provides electrical switching interface with stationary terminal	High contact resistance/no continuity															
	Resistance increases over life															
	Contacts weld															

TI-NHT8A 019043

Subsystem/Element: Speed Control Hydraulic Pressure Switch
Design Responsibility: Stephen H. Griffin
Other Areas Involved:

Suppliers and Plants Affected:
Key Dates(Milestones):
Engineering Release Date:

Prepared by:
FMEA Date (Orig):

Rev:

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	SEV	CLASS	Potential Cause(s) of Failure	OCC	Design Verification	DET	RPN	Recommended Actions	Responsible Engineering Responsible & Completion Date	ACTION RESULTS Actions Taken	SEV	OCC	DET	RPN
HOUSING (BODY) Provides a hydraulic cavity for [illegible] Provides external thread for installation into mating part Provides hex features for 5/8" wrench Provides fluid passage to pressure-sensing diaphragm Provides gland for internal gasket Provides flange which interfaces with other components to form pressure-sensor structure	Improper geometry of .312 section	Leakage of brake fluid			Broken, worn or improperly set-up tooling Misdrilling											
	Improper thread	Will not install properly in mating part Excessive strength in mating part during installation			Mating connection bad Misdrilling											
	Incorrect hex size	Damage to hex flats during wrenching			Broken or worn out/misaligned tooling Incorrect tooling parameters											
	Fluid passage is blocked	Switch will not actuate Discharge leakage, downgrade switch or other brake system component			Broken drill Improper process set-up Worn drill											
	Fluid passage too large	This section results in breakage of housing and system leak			Worn drill size											
	Gasket gland geometry is incorrect	Excessive gasket squeeze distorts gasket, results in leak Excessive squeeze results in improper assembly and reduced life of gasket leading to leak Insufficient squeeze results in leak Gland diameter too small, results in assembly difficulty Gland diameter too large, results in leak			Broken, worn, or improperly set-up tooling											
	Gasket gland surface is irregular	Immediate leak path Damage to gasket results in reduced life leading to leak			Broken, worn, or improperly set-up tooling Misdrilling											
	Flange geometry is incorrect	Dia. too large results in assembly difficulties Dia too small results in bad component alignment leading to leak Too thick or thin results in part order, leads to reduced diaphragm life or reduced burst capacity			Broken, worn, or improperly set-up tooling											
	Strong material	Weak processor cavity leads to reduced proof/burst capacity			Supplier error											
GASKET (SEAL) Provides fluid seal between housing and diaphragm	Strong atm	Excessive gasket squeeze distorts gasket, results in leak Excessive squeeze results in improper assembly and reduced life of gasket leading to leak Insufficient squeeze results in leak Gasket diameter too large, results in assembly difficulty Gasket diameter too small, results in leak			Improperly set-up cutting tools Strong extension tool											
	Strong material	Reduced gasket life, leading to leak Permanent set after temperature exposure leads to leak			Supplier error											

TI-NHTSA 019044

Subsystem/Element: Hood Control Pneumatic Pressure Switch
Design Responsibility: Stephen H. Griffin
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by:
FMEA Date (Orig.): (Rev.):

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	SEV	CLASS	Potential Cause(s) of Failure	OCC	Design Verification	DET	RPN	Recommended Action	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	SEV	OCC	DET	RPN
[illegible] (C175) Forms flexible element of fluid containment casing Transfers pressure from fluid to pressure-sensing elements	Insufficient material properties	Reduced life leading to leak			Baseline error											
[illegible] (C2510) Provides a portion of the support surface for diaphragm Provides support for compression of gasket Locates convolution and disc with respect to cap	Surface roughness	Reduced diaphragm life leading to leakage			Improper heat-treat Chips in tool											
	Incorrect chamfer	Shift in setpoints Reduced diaphragm life leads to leakage			Broken/worn tool											
	Bent	Reduced disc envelope. Improper diaphragm loading Reduced gasket squeeze results in leak			Broken, worn, or improperly set-up tools											
	Wrong material	Improper hardness and/or strength leading to leaking			Supplier error											
	Wrong heat-treatment	Improper hardness and/or strength leading to leaking			Supplier error											
	Incorrect ID	Too small results in difficult assembly to connector Too small results in friction between washer and connector, leading to shift in setpoints over life Too large results in poor location of connector, shift in setpoints or inoperative Too large results in reduced diaphragm life			Broken, worn, or improperly set-up tools											
	Incorrect OD	Too large results in difficult assembly Too small results in poor location of connector, shift in setpoints or inoperative			Broken or worn tools											
	Incorrect thickness	Too thick results in poor crimp, leads to reduced diaphragm life or reduced burst capacity Too thin leads to leaking			Wrong mat'l thickness, supplier error											
	Burrs	Reduced diaphragm life			Broken, worn, or improperly set-up tools											
[illegible] (C2485) Transfers pressure from fluid side diaphragm to a force on pressure-sensing disc Provides alignment and support to spacer and disc	Irregularities on surfaces mating with diaphragm	Reduced diaphragm life			Broken, worn, or improperly set-up tools											
	Incorrect button dia	Too large results in difficult assembly to washer Too large results in friction between washer and connector, leading to shift in setpoints over life Too small results in poor location of connector, shift in setpoints or inoperative Too small results in reduced diaphragm life			Broken or worn tools											
	Button out of concentricity relative to disc locate feature	Difficult assembly Poor location of disc leading to inoperable device or shift in setpoints			Broken, worn, or improperly set-up tools											

TI-NHTSA 019046

Subsystem/Phase: Speed Control Electronic Pressure Switch
System Responsibility: Stephen R. Miller
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by:
FMEA Date (Orig.): (Rev.):

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S e v.	C l a s s	Potential Cause(s) of Failure	O c c.	Design Verification	D e t.	R P N	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	S e v.	O c c.	D e t.	R P N
	Improper geometry of Disc Inside Features	Disc shifts relative to nut-quarter shaft in actuation or Inoperable device Connector between quadrant cups and disc cups connects do not open or contact gap too small			Broken, worn, or improperly set-up tools											
	Incorrect material	Unknown flaw causes device inoperation			Supplier error											
	Incorrect thickness	Too thick leads to assembly difficulty and/or disc pre-snap and inoperable device Too thin leads to excessive flex, device inoperation			Supplier error											
	No vent hole	Trapped pressure behind disc leads to leakage in actuation in combination with temperature			Broken or improperly set-up tool											
	Improper geometry of OD	Too small causes difficulty with disc locations inoperable device Too large causes interference with snap actuation or inoperable device			Broken, worn, or improperly set-up tool											
[illegible] (CF8M) Reduce friction between disc and connector	OD too large	Causes disc to locate for-preventing to connector; or-cycle device operation, shift in actuation or inoperable			Worn punch											
	OD too small	Excess friction in press with-sent proper center disc snap, and shift in actuation over life			Worn punch											
	Incorrect thickness	Excessive thickness causes re-duced disc snapping; possible inoperable device Too thin leads to early snap-out, leading to excess disc friction and shift in setpoint			Supplier error											
	Improper Teflon coating	Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint														
[illegible] (CF8M) Controls actuation and re-leases set-point of switch relative to applied force	Incorrect diameter	Windows assembly Inspection device Incorrect calibration			Wear stamping tool Worn stamping tool											
	Excessive vantage	Windows assembly Inspection device Incorrect calibration			Worn or improperly set-up tool											
	Material composition	Shift in setpoint over life Reduced proof capability Thin Fatigue Failure			Supplier error Improper heat-treat											
	Excessive Rust	Shift in setpoint over life			Worn tools											
	Snap thickness	Too thin requires increased force to achieve setpoint; results in reduced life Too thick requires decreased force to achieve setpoint; reduced throw, inadequate cor-rosion gap														
[illegible] and [illegible] Provides retainable area which holds pressure-sensor together Provides support for disc Locates washer relative to other components Provides guide for transfer pin	Crimp area quantity incorrect	Plate crimp leads to reduced proof/burst capability, re-duced diaphragm life			Incorrect pin-draft Broken, worn, or improperly set-up tools											
	Screw material thickness	Too thick will not fit in as-sembly tooling slot Too thin leads to reduced proof/burst capability, re-duced diaphragm life			Supplier error											

TI-NHTSA 018046

Subsystem/Product: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen R. Offsitar
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by:
FMEA Date (Orig): (Rev):

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) of Failure	O c c.	Design Verification	D e t.	R P N	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION R E S U L T S Actions Taken	S e v.	O c c.	D e t.	R P N
	Wrong material	Too soft or hard leads to poor crimp, reduced proof/burst capability, reduced diaphragm life			Supplier error											
	Disc support base geometry incorrect	Incorrect calibration Disc fatigue Inoperative device			Broken, worn, or improperly set-up tools											
	Geometry of washer locating step for contact	Too high - excessive disc overlap; leads to increased diaphragm strain, incorrect calibration Too low - insufficient disc overlap; premature disc and inoperative device Dia small results in difficult assembly Dia large results in poor location of component, shift in setpoint or inoperative			Broken, worn, or improperly set-up tools											
	Geometry of pin guide incorrect	Dia small results in pins shielding - may plus erratic operation at temperature extremes Dia large results in shift in pin position, erratic electrical characteristics Too short provides poor guidance, results in crooked pins, inoperative or erratic device Too long may short casing to housing			Broken, worn, or improperly set-up tools											
[illegible] (74267) Seal pins assembly to sensor assembly TI-NHTSA 018047	Thickness incorrect	Too thin results in poor seal; leakage of materials from environment Too thick causes difficulty in final crimp, results in loose fingers, or inoperative/erratic device operation			Tooling set-up error											
	ID incorrect	Too large - may not squeeze uniformly around circumference Too small - won't assembly			Broken, worn, or wrong supplier											
	OD incorrect	Too small - insufficient seal area			Broken, worn, or wrong setscrew											
	Wrong material	Long-term degradation results in leakage			Supplier error											
	Porosity in material	May result in leakage if combined with insufficient squeeze			Supplier error											
[illegible] PIN (74270) Transfers disc motion to movable electrical contact Insulates electrical components from switch housing	Diameter incorrect	Dia large results in pins shielding - may plus erratic operation at temperature extremes Dia small results in shift in pin position, erratic electrical characteristics			Broken or worn tool											
	Length incorrect	Too short - low setpoints or device open-circuited Too long - high setpoints, increased contact pin, contacts won't open			Mislabeled / interchange error											
	Material incorrect	Shift in setpoints with temp Current leakage to housing Premature/skips; erratic or inoperable device			Supplier error											
[illegible] (74277) Weld together base assembly and sensor assembly	ID incorrect	Too large results in poor crimp Too small hinders assembly			Broken, worn, or improperly set-up tooling											

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen E. Griffin
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Approved by:
OEM Date Req'd: Orig(s): Rev(s):

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Design Verification	D E T	R.P.N.	Recommended Action	Resp./Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	S E V	O C C	D E T	R.P.N.
	Length Incorrect	Too long or short wrapps pass bridge; Low resistance to rotation of Spec rel. to sensor nominal body			Broken, worn, or inappropriate set-up fixture											
	Material Incorrect	Difficult or sonic crimp Corrosion (if Ferrous not SS)			Supplier error											
	Thickness Incorrect	Too thin results in poor crimp Too thick results in difficult crimp or begins			Supplier error											

Part/Process Name/No.: CRIMP/ASSEMBLY
Design Responsibility: CRIMP WORKER/SENSOR MATCH
Other Areas Involved: BLADDER HOSE

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by:
FMEA Date (Orig.): 1991 (Rev.): 8
Key Production Date:

Process Failure Mode and Effects Analysis

	Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	S e v.	C l a s s.	Potential Cause(s) of Failure	O c c.	Current Controls	D e t.	R P N.	Recommended Actions	Area/Individual Responsible	ACTION RESULTS: Actions Taken	S e v.	O c c.	D e t.	R P N.
1	CRIMP PART #, CUSTOMER NAME AND DATE CODE ON PART	WRONG PART #	WRONG PART # ON CRIMP RING	5		OPERATOR SET-UP	3	QC SAMPLE	1	15							
2																	
3		WRONG DATE CODE	LOSS OF LOT CONTROL	3		OPERATOR SET-UP	3	VISUAL & QC SAMPLE	1	9							
4																	
5		WRONG PLATING	IMPROPER DEVICE	7		PART ISSUING ERROR	1	VISUAL & QC SAMPLE	1	7							
6																	
7						OPERATOR ERROR											
8																	
9		NO CODE	LOSS OF PART IDENTITY AND LOT CONTROL	7		MACHINE ERROR	1	VISUAL & QC SAMPLE	1	7							
10																	
11						CODE BLOCK WORN											
12		ILLEGIBLE CODE	LOSS OF PART IDENTITY AND LOT CONTROL	5		MACHINE ERROR	3	VISUAL & QC SAMPLE	1	15							
13						CODE BLOCK WORN		PREVENTATIVE MAINTENANCE									
14																	
15	PLACE SENSOR INTO CRIMP RING	INCORRECT DATE CODE	LACK OF LOT INTEGRITY FOR FIELD RETURNS	3		SUPPLY INSPECTION	1	QC SAMPLE AT PACKING	1	3							
16						OPERATOR ERROR		LEAD OPERATOR CHECKS AND APPROVES SET-UP									
17		NO SENSOR	FAILS TO ASSEMBLE			OPERATOR ERROR		VISUAL AIDS									
18		NO CRIMP RING	FAILS TO ASSEMBLE			OPERATOR ERROR		VISUAL AIDS									
19																	
20								JUST-IN-TIME MANUFACTURING SYSTEM									
21																	
22	PLACE SENSOR/ENVIRONMENTAL SEAL OVER CLAMP ON SENSOR	MISPLACED	INTERNAL CORROSION OVER LIFE	7		OPERATOR ERROR	3	SPC ON BASE-TO-SENSOR TORQUE	1	21							
23																	
24		MISSING	INTERNAL CORROSION OVER LIFE	7		OPERATOR ERROR	1	SPC ON BASE-TO-SENSOR TORQUE									
25								P-CHART ON AIR LEAK									
26		TWO SEALS	INTERNAL CORROSION OVER LIFE	7		OPERATOR ERROR	1	SPC ON BASE-TO-SENSOR TORQUE	1	7							
27								P-CHART ON AIR LEAK									
28	PLACE TRANSFER PIN ON SENSOR CIP PIN GUIDE	WRONG SIZE PIN	CREEP	7		MIXED PINS	3	100% FUNCTION TEST	1	21							
29			MARGINAL TRANSFER TIME			OPERATOR ERROR		PINS GAUGED FOR LENGTH PRIOR TO TESTING TO FLOOR									
30			CONTINUITY														
31								ROUTE CHECK									
32																	
33		PIN NOT IN PLACE	NO CONTINUITY-DEVICE WON'T FUNCTION	7		OPERATOR ERROR	1	100% FUNCTION TEST	1	7							
34																	
35	ASSEMBLE BASE TO SENSOR WITH CRIMP RING, PIN AND ENVIRONMENTAL SEAL	WRONG BASE	CREEP	7		OPERATOR ERROR	1	100% FUNCTION TEST	1	7							
36			NO FUNCTION														
37		DISLODGE PIN	NO FUNCTION	7		ROUGH HANDLING	1	100% FUNCTION TEST	1	7							
38			INTERMITTENT CONTINUITY														
39		MISALIGNED ENVIRONMENTAL SEAL	INTERNAL CORROSION	7		OPERATOR ERROR	1	AIR LEAK SAMPLE	3	21							
40								BASE-TO-SENSOR TORQUE SPC									
41																	
42	CRIMP FINAL SQUICK ASSEMBLY	CRIMP DIAMETER OUT OF SPECIFICATION	INTERNAL CORROSION	7		HIGH CRIMPER PRESSURE	1	100% VISUAL	1	7							
43								AIR LEAK SAMPLE									
44			CREEP			WORN TOOL		TORQUE SPC									
45								100% FUNCTION TEST									

TI-NHTSA 019049

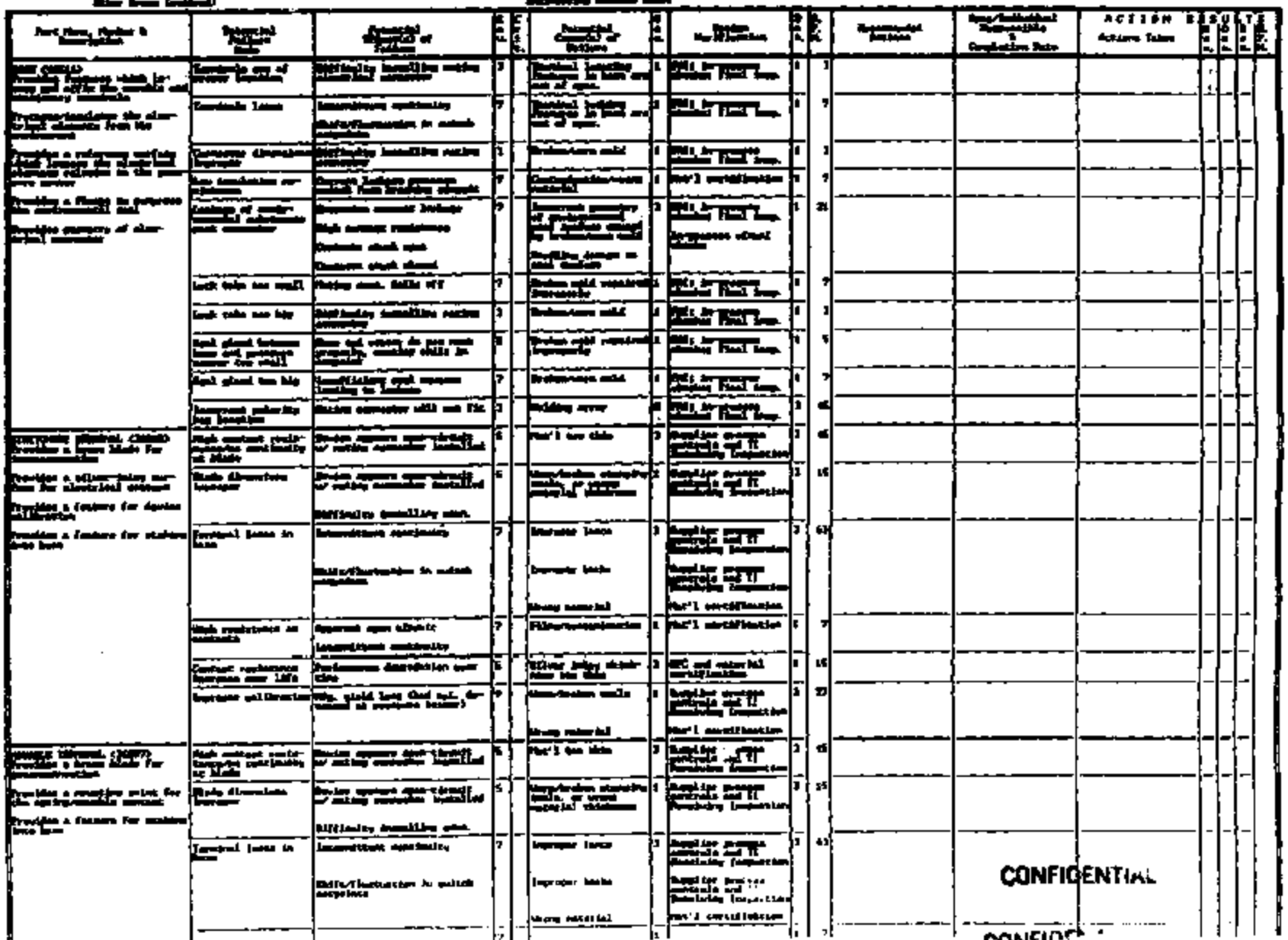
Part/Process Name/No: STARTER/ASSEMBLY
Design Responsibility: CHRIS BRONER/DENNIS MATULE
Other Areas Involved: ELAINE ROSS

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared By:
FMEA Date (Orig)r 1771 (Rev): A
Key Production Date:

Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Current Controls	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible	Action Results: Actions Taken	Sev.	Occ.	Det.	R.P.N.
							PLANNED PREVENTIVE MAINTENANCE CRIMP TO A STOP									
	CRACKED BASE	INTERNAL CORROSION	7		HIGH CYLINDER PRESSURE	1	100% VISUAL	1	7							
							AIR LEAK SAMPLE									
					COMPONENT MIS-ALIGNMENT		CRIMP TO A STOP									
					HIGH PART STACK-UP		PLANNED PREVENTIVE MAINTENANCE									
					WORN TOOL											
	CRIMP HEIGHT OUT OF SPECIFICATION	PIN DISLODGES	7		REGULATION CYLINDER PRESSURE	1	CRIMP TORQUE ON EPC	1	7							
		ENVIRONMENTAL LEAK														
		DAMAGED BASE			INADEQUATE PART TOOLING		AIR LEAK SAMPLE									
		LACK OF ENVIRONMENTAL SEAL COMPRESSION			WORN TOOL		PART CERTIFICATION PROCESS									
					MIS-ALIGNMENT											
		INTERNAL CORROSION			BASE/CUP/SEAL OUT OF											
	NO PRECRIMP	INTERNAL CORROSION DUE TO PART BUCKLING CAUSE, NOTED AT FINAL CRIMP PROVIDING LEAK PATH	7		MID CYCLE STOP & RE-START ALLOWING INCOMPLETE PRECRIMP	3	100% VISUAL AT PACK CRIMP TORQUE EPC	4	84	RE-WRITE PROGRAM LOGIC TO CRIMP AT CYCLE START.	MFG ENG	COMP	7	2	1	14
										ADD REDUNDANT CRIMP CHECK	MFG ENG	COMP	7	2	1	14
	NO FINAL CRIMP	INTERNAL CORROSION DUE TO POTENTIAL LEAK PATH	7		MID CYCLE STOP AND RE-START ALLOWING INCOMPLETE CRIMP	2	100% VISUAL CRIMP TORQUE ON EPC MERT DIMENSIONS	3	42	RE-WRITE PROGRAM LOGIC	MFG ENG	COMP	7	2	1	14
										ADD PERMANENT CRIMP CHECK	MFG ENG	COMP	7	2	1	14
	CRIMPS SLIVERS	CONTAMINATION CAUSING LEAKS AT SEAL INTERFACE	7		WRONG CRIMP DIES OR UNWORN CRIMP RINGS	1	ROUTE SLIDE INSPECTOR CRIMP TOOL DESIGN 100% VISUAL AT PACK 100% VACUUM CLEAN	2	14							
FINISHED DEVICE FUNCTION TEST	IMPROPER CALIBRATION	SHIP UNACCEPTABLE DEVICE	7		INDUCTION OUT OF CALIBRATION	2	CALIBRATION MASTERS ON SPC	1	14							
		THROW AWAY GOOD DEVICES			INCORRECT RAMP RATE		PREVENTIVE MAINTENANCE AND TRACKING									
					LEAKS IN EQUIPMENT		FUNCTION TESTER EST									
MISSING O-RING SENSOR	DOES NOT DETECT MISSING O-RING	POTENTIAL LEAK IN APPLICATION	7		SENSOR MALFUNCTIONS OR IMPROPERLY DESIGNED	1	O-RING DETECTION MASTER STATION P.M.	2	14							
INSPECT AND PACK FINISHED DEVICES	WRONG PARTS IN BOX	DEVICE SHIPPED TO WRONG LOCATION	5		INCORRECT PACKING LABEL	1	PACK AUDIT	1	5							
					OPERATOR ERROR		VISUAL STANDARDS									
							PACKING ON DAY-DAY SYSTEM									

TI-NHTSA 019050



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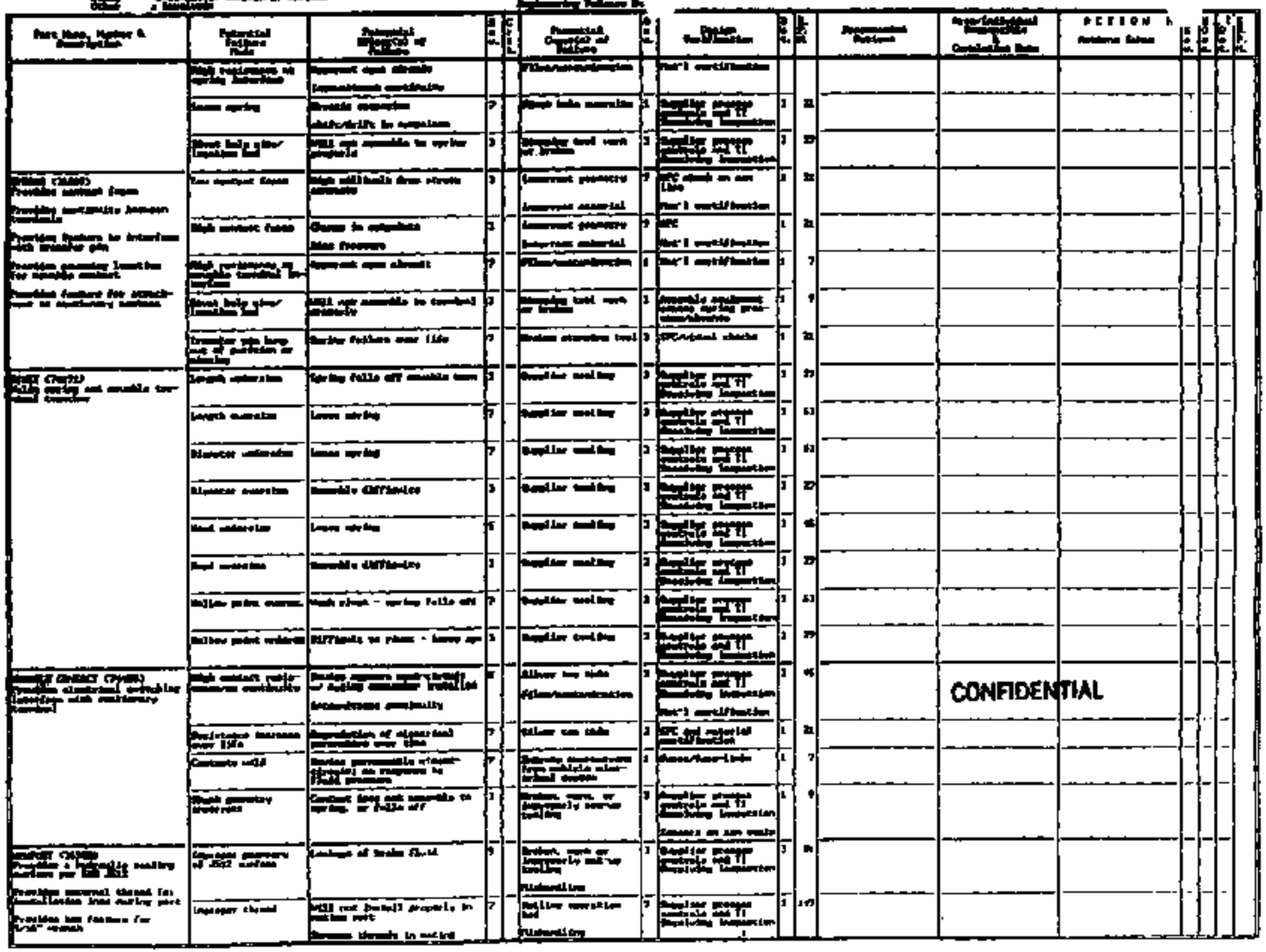
TI-NHTSA 019064

Part Name, Number & Description	Potential Failure Mode	Potential Effects of Failure	S E V.	C L A S S	Potential Cause(s) of Failure	O C C.	Design Verification	D E T.	R P N	Recommended Actions	Responsibility & Completion Date	ACTION R Actions Taken	S E V.	O C C.	D E T.	R P N
Shoulder fluid coupler to pressure-sensing element Shoulder gland for internal sealing Shoulder flange with internal seal which mates with corresponding surface on pressure-sensor assembly		pore during installation														
	Incorrect box size	Change to box fluid during assembly O-ring seals does not fit	6		Broken or worn cold-heading tooling Incorrect heading instructions	1	Supplier process controls and IT Shoulder Inspection	3	18							
	Fluid passage is blocked	Outside will not activate Displays hesitancy, damaging seals or other brake system components	9		Broken drill Improper pressure setup Worn drill	3	Supplier process controls	3	81							
	Fluid passage too large	Side pressure results in breakage of support and excess leak	9		Wrong drill size	1	QC/Supplier gage pass controls	4	9							
	Coupler gland geometry is incorrect	Excessive axial pressure distorts gasket, results in leak Excessive stress results in premature cracking and reduced life of gasket leading to leak Insufficient squeeze results in leak Gland diameter too small, results in assembly difficulty Gland diameter too large, results in leak	9		Broken, worn, or improperly set-up cooling	2	Supplier process controls and IT Shoulder Inspection	3	81							
	Sealing gland surface is irregular	Inadequate leak path Results in excessive stress in radiused into leading to leak	9		Broken, worn, or improperly set-up cooling Undercutter	5	Supplier process controls and IT Shoulder Inspection	3	81							
	Flange geometry is incorrect	Hole, too large results in assembly difficulty Hole too small results in bolt misalignment leading to leak Too much or thin results in over stress, leads to reduced diaphragm life or reduced thrust capacity	9		Broken, worn, or improperly set-up cooling	2	Supplier process controls and IT Shoulder Inspection	3	81							
	Wrong material	High pressure gasket leads to premature overstress cracking	8		Supplier error	1	Mat'l certification	1	65							
[illegible] (CAUSE) Provide fluid seal between coupler and diaphragm	Wrong size	Excessive gasket squeeze distorts gasket, results in leak Excessive squeeze results in premature cracking and reduced life of gasket leading to leak Insufficient squeeze results in leak Gasket diameter too large, results in assembly difficulty Gasket diameter too small, results in leak	9		Improperly set-up cooling tools Wrong extension tool	3	Supplier process controls and IT Shoulder Inspection	3	81			CONFIDENTIAL					
	Wrong material	Reduced gasket life, leading to leak Permanent set after temperature exposure leads to leak	9		Supplier error	1	Mat'l certification	1	9							
[illegible] (FAIL) Provide fluid element of fluid containment system Transfer pressure from fluid to pressure-sensor element	Insufficient material properties	Reduced life leading to leak	9		Supplier error	1	Mat'l certification	1	9							
[illegible] (CAUSE) Provides a location at the mating surface for diaphragm Provides support for compression of gasket Location between and fits with respect to cup	Surface roughness	Reduced diaphragm life leading to leakage	9		Improper tool-travel	4	Supplier process controls and IT Machining Inspection	3	27							
	Excessive chamfer	Shift in sensitive Reduced diaphragm life leading to leakage	9		Undercutter tool	4	Supplier process controls and IT Undercutter Inspection	3	27							



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Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S E V	Potential Cause(s) of Failure	O C C	Design Verification	D E T	R P N	Recommended Actions	Responsibility & Completion Dates	ACTION RESULTS Actions Taken	S E V	O C C	D E T	R P N
	Short	Reduced disc revolutions, torque converter shudder Reduced gasket squeeze results in leak	3	Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	27							
	Wrong material	Improper hardness and/or strength leading to bending	3	Supplier error	1	Part certification	1	3							
	Wrong heat-treatment	Improper hardness and/or strength leading to bending	3	Supplier error	3	Shortcut QA at TI Receiving Inspection	3	27							
	Undersize ID	Too small results in difficult assembly or connector Too small results in friction between washer and connector, leading to shaft to rotational wear time Too large results in poor lip sealing of connector, leads to contamination or temperature Too large results in reduced disc/torque life	5	Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
	Undersize OD	Too large results in difficult assembly Too small results in poor lip sealing of connector, leads to contamination or temperature	3	Broken or worn tools	3	Supplier process controls and TI Receiving Inspection	3	27							
	Incorrect thickness	Too thick results in poor sealing, leads to reduced disc/torque life or reduced torque capacity Too thin leads to bending	3	Wrong part / thickness; supplier error	3	Supplier process controls and TI Receiving Inspection	3	27							
	Burrs	Reduced disc/torque life	3	Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
CONNECTOR ASSEMBLY Transfers pressure from shaft hole deployment ring & forces on pressure-controlled disc Provides alignment and support to upper end disc	Irregularities on surfaces mating with diaphragm	Reduced disc/torque life	5	Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
	Undersize bottom dia	Too large results in difficult assembly in cavity Too large results in friction between washer and connector, leading to shaft to rotational wear time Too small results in poor lip sealing of connector, leads to contamination or temperature Too small results in reduced disc/torque life	5	Broken or worn tools	3	Supplier process controls and TI Receiving Inspection	3	45	CONFIDENTIAL						
	Excess out of round/ irregularities on other bearing surfaces	Difficult assembly Poor location of disc leading to improper friction or shaft to rotation	3	Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	27							
	Improper geometry of disc locator chamfers	Poor shaft-to-retainer to connector fit leading to misalignment or irregular friction Connector bottoms against rest on disc cannot compress to seal upper or contact gap too small	3	Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	27							
	Incorrect material	Dimensions fixed causes friction degradation	3	Supplier error	1	Part certification	1	3							
	Improper thickness	Too thick leads to assembly difficulty, reduced disc/torque life, poor seal and irreparable damage Too thin leads to excessive flex, shorter lifetime	3	Supplier error	1	TI Rec. Inspection	3	9							
	No vent hole	Trapped pressure behind disc leads to leakage in conjunction with temperature	6	Broken or improperly set-up tool	3	Supplier process controls and TI Receiving Inspection	3	54							
	Incorrect geometry of ID	Too small causes difficulty with shaft insertion; irreparable	3	Broken, worn, or improperly set-up	3	Supplier and TI controls and TI	3	27							

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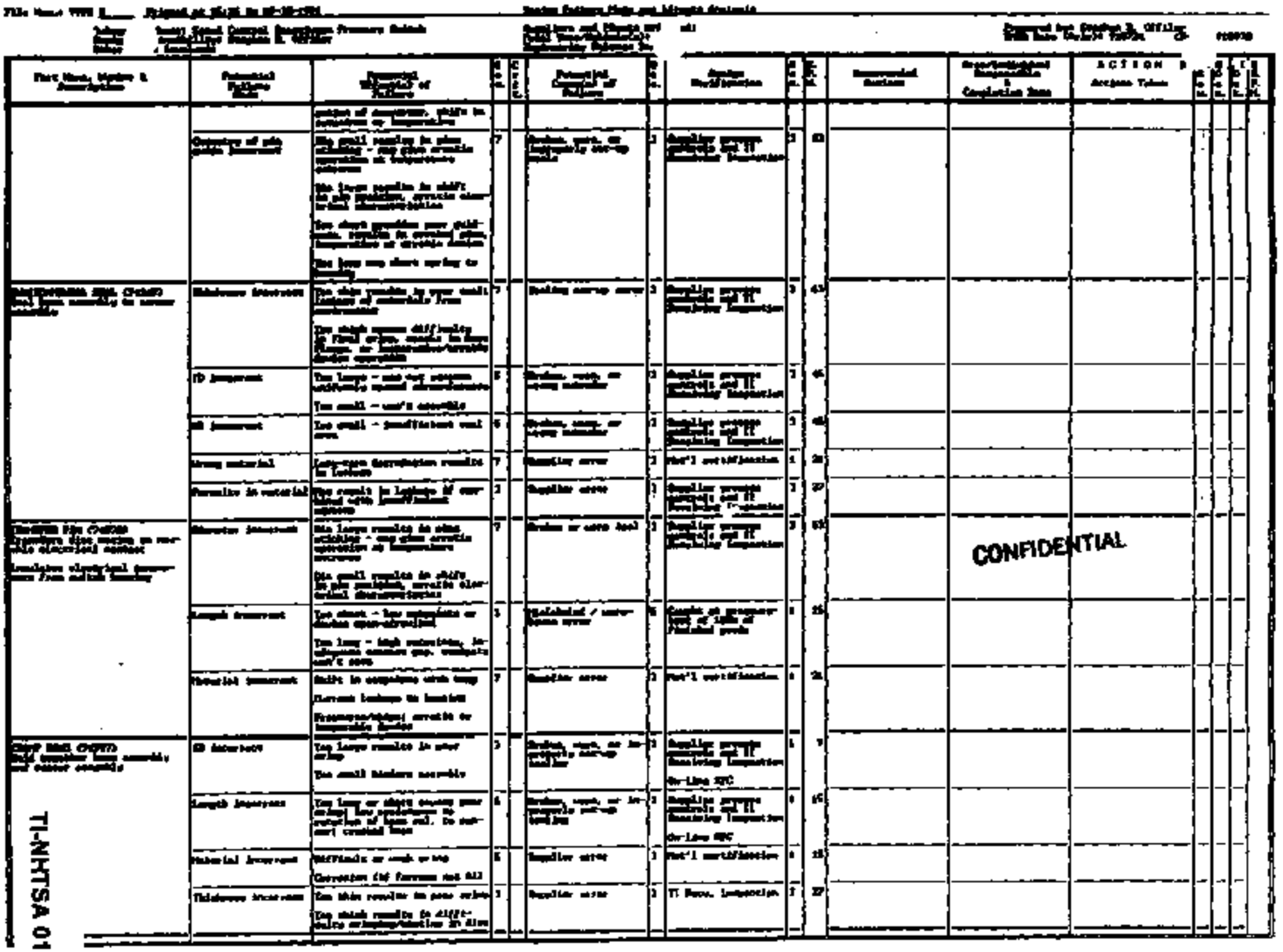

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Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Current Controls	D E T	R P N	Recommended Actions	Responsible/Indicated Responsible	ACTION R E S U L T S Actions Taken	S E V	O C C	D E T	R P N
							MIN. FUNCTION TEST									
							CONTINUITY PROBE									
							MAINTAIN LOOP									
							CYCLING ADAPTR									
							PRE-CROP									
	NO DEFECT	None	9		PROCESS ERROR	1	MIN. FUNCTION TEST	1	9							
							CONTINUITY PROBE									
							MAINTAIN LOOP									
							CYCLING ADAPTR									
							PRE-CROP									
CUT AND PLACE 3 PIECES OF TAPE ON HOUSING/CONNECTOR ASSEMBLY	ONLY 1 OR 2 PIECES	OPERATOR CONFUSION	9		OPERATOR DOES NOT FOLLOW WI	1	PROCESS AUDIT	1	9							
							HOUSING SET-UP									
							MANUAL, WIRING									
					Misaligned Labels		PROCESS AUDIT									
							HOUSING SET-UP									
							MANUAL, WIRING									
	NO TAPING	None	9		PROCESS ERROR	1	100% x FUNCTION TEST	1	27							
							CONTINUITY PROBE									
							MAINTAIN LOOP									
							CYCLING ADAPTR									
	INSUFFICIENT TAPE COVERAGE	None	9		PROCESS ERROR	3	100% x FUNCTION TEST	1	27							
							CONTINUITY PROBE									
							MAINTAIN LOOP									
							CYCLING ADAPTR									
							THERMOFORM HEAT.									
MATERIAL WIDTH AND CONTOUR TO HOUSING ASSEMBLY	WRONG ROAD WIDTH	LOSS OF CALIBRATION DUE TO OPERATOR	9		PROCESS ERROR	3	TAPE WIDTH CHECK (CONTINUOUS)	1	27							
							100% x FUNCTION TEST									
	WRONG ROAD WIDTH	GOOD CALIBRATION REDUCED LIFE	9		PROCESS ERROR	3	TAPE WIDTH CHECK (CONTINUOUS)	1	27							
							CYCLING ADAPTR									
	NO OPERATION	NO DEVICE OPERATION	9		PROCESS ERROR	3	100% x ASSEMBLY CHECK	1	27							
							100% x FUNCTION CHECK									
	NO ADHESIVE	NO DEVICE OPERATION	9		PROCESS ERROR	3	100% x HOUSING CHECK	1	27							
							100% x FUNCTION CHECK									

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Process Failure Mode and Effects Analysis

Part/ [illegible] Potential Age [illegible] Prepared by: PETE CONTRERAS

Suppliers and Plants # [illegible] Model Year/Vehicle(s): [illegible]

Engineering Release Date: [illegible] Key Production Date: [illegible]

Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	S e v.	C l a s s	Potential Cause(s) of Failure	O c c.	Current Controls	D e t.	R P N	Recommended Action	Responsible Individual/ Organization	ACTION RESULTS Actions Taken	S e v.	O c c.	D e t.	R P N
[illegible]	REPLACED SPACER	BROKEN DISC LIFE	9		FRICTION ERROR	5	100% FUNCTION TEST CONTINUITY FROM Stationary Lugs CYCLED ASSYS	3	135							
	REPLACED SPACER	CONTINUITY FAILURE	9		FRICTION ERROR	5	TORQUED DISC FROM	3	135							
	REPLACED SPACER	LOSS OF CALIBRATION	9		FRICTION ERROR	5	100% FUNCTION TEST CONTINUITY FROM Rotation LOSS CYCLED ASSYS	3	135							
	NO SPACER	BROKEN DISC LIFE	9		FRICTION ERROR	5	100% FUNCTION TEST CONTINUITY FROM Rotation LOSS CYCLED ASSYS	3	135							
	NO SPACER	LOSS OF CALIBRATION	9		FRICTION ERROR	5	100% FUNCTION TEST CONTINUITY FROM Rotation LOSS CYCLED ASSYS	3	135							
	[illegible]	BROKEN DISC LIFE	9		FRICTION ERROR	5	100% FUNCTION TEST CONTINUITY FROM Rotation LOSS CYCLED ASSYS	3	135							
	[illegible]	LOSS OF CALIBRATION	9		FRICTION ERROR	5	100% FUNCTION TEST CONTINUITY FROM Rotation LOSS CYCLED ASSYS Thermocouple Error.	3	135							
[illegible] DISC	[illegible] DISC	CONTINUITY FAILURE	9		FRICTION ERROR	3	PERFORM FROM Torqued DISC Assys 100 % FUNCTION TEST	1	27							
	[illegible] DISC	Continuity Failure	9		FRICTION ERROR	3	100 % DISC FROM Torqued DISC Assys 100 % FUNCTION TEST	1	27							
	[illegible] DISC	CONTINUITY FAILURE	9		FRICTION ERROR	3	100 % DISC FROM Torqued DISC Assys 100 % FU .ION TEST	1	27							
	[illegible] DISC	ACTUATION FAILURE	9		FRICTION ERROR	3	100 % DISC FROM 100 % FUNCTION TEST	1	27							
	[illegible] DISC	LOSS OF CALIBRATION	9		TORQUE	3	100 % FUNCTION TEST DISC SLIPS	1	27							

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Process Failure Mode and Effects Analysis

Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Current Controls	D E T	R P N	Recommended Actions	Area/Individual Responsible	ACTION RESULTS Actions Taken	S E V	O C C	D E T	R P N
							Shield Plate									
[illegible] Cup Weld Assembly	Missing Cup	No Heater Operation	7		Welding Arm Error	1	100 % Pressure Check 100 % Function Test	1	7							
	Damaged Cup	Loss of Calibration	7		Stuck Jaw	1	100 % Function Test	1	7							
	[illegible] of Cup Not Welded	No Heater Operation	7		Welding Arm Jammed	1	Inspect Weld Prior to 100% Function Test	1	7							
Pre-Clean Sensor Assembly	Insufficient Clean	[illegible]	7		Broken or Worn Tools	3	Preventative Maint.	3	63							
					Wheel Mis-Aligned		100 % Function Test									
	Oring Damaged	Inoperable Product	7		[illegible]	2	Pre-Lip Inspection 100 % Function Test Preventative Maint.	3	42							
[illegible] Pre-Clean Assembly to Post Cleaner	Damaged, Missing, Contaminated	Loss of Calibration	7		Insufficient Pre-Clean	3	Pre-Lip Inspection 100 % Function Test Preventative Maint.	3	63							
Pin Stage Final Clean	Insufficient Clean	Insert Rejection Increased	7		Tool Wear Tool Alignment Improper Set-up Loss of Air Pressure	1	Inspection SPC Alarm SPC Preventative Maint. Improper SPC Sensor SPC Preventative Maint.	1	7							
	Oring Damaged	[illegible]	7		Improper Oring Installation	1	Inspection SPC Alarm SPC Set-up Procedures	1	7		CONFIDENTIAL					
		Improper Material Substituted			Incorrect Oring Supplied		Inspection SPC Alarm SPC Set-up Procedures									
[illegible] and Weld Assembly	Incorrect Parts	Loss of Lot Control or Customer Problems	7		Incorrect Set-up	1	Q.C. Sample Operator Monitor	1	7							
	Missing Parts	Loss of Lot Control or Customer Problems	7		Parts Order Incorrect Set-up	1	Q.C. Sample Operator Monitor	1	7							
	Clamp Head Disassembly	Weld not Output when not Used	7		Improper Control Program	5	Planned-in Set-up Files in SPC Q.C. Sample Operator Monitor	3	105							
Weld Assembly																
Set-up Electronic Terminal and Output Into Weld	Set not Centered	Weld not Sent Into Weld	5		Welding Parts and Order Error	3	100 % Pilot Probe Check	3	75							
		Terminal Position Out of Spec.			Machine Parts and		100 % Pilot Probe									

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Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Current Controls	D E T	R P N	Recommended Actions	Responsible Individual(s)	ACTION RESULTS Actions Taken	S E V	O C C	D E T	R P N
	TOO MUCH SEAL	DEFECTIVE CONNECT	10		INCORRECT SEE-UP METHOD	3	VISUAL EXAMINED ON SPC	1	30		CONFIDENTIAL					
							SEE-UP INSPECTION PERFORMATION PHASE.									
	NOZZLE CONTACT	CONTACT RESISTANCE INCREASED OVER LIFE	9		NOZ-FOR	3	SPC + FEEDBACK CONTROL	1	27							
DOWN STREAM ANGLE	ANGLE TOO HIGH	HIGH CONTACT FORCE	8		HIGH TORQ.	3	CHECK SPC	1	24							
					INCORRECT SEE-UP		SEE-UP INSPECTION PERFORMATION PHASE.									
	ANGLE TOO LOW	LOW CONTACT FORCE	8		LOW TORQ.	3	ANGLE SPC	1	24							
					INCORRECT SEE-UP		SEE-UP INSPECTION PERFORMATION PHASE.									
CNT-OFF FEATURES TERMINAL NOT PROPERLY CRIMPED	CNT NOT CENTERED	WILL NOT MEET PULL TEST	8		INCORRECT SHAPED WIRE CRIMP TOOL	6	SPC + PULL TENSILE STRENGTH	3	144							
		TERMINAL POSITION OUT OF SPEC.			INCORRECT SHAPED WIRE CRIMP TOOL		SPC + PULL FORCE STRENGTH									
							TERMINAL POSITION SPC									
	TERMINAL NOT FULLY CRIMPED INTO WIRE	TERMINAL DAMAGE OUT OF SPEC	8		CNT-OFF HIGH	3	SPC + INSPECTION STRENGTH GAUGE	1	24							
		FAILURE OF CALIBRATION			CNT-OFF BROKEN		INSPECTION PHASE.									
					INSPECTION DEVICE WORN		TERMINAL, CRIMP SPC									
					INSPECTION DEVICE BROKEN		SPC + PULL FORCE STRENGTH									
CRIMP TERMINALS TERMINAL DAMAGED	INSUFFICIENT CRIMP	CRIMP TERMINAL	8		BROKEN TOOL	3	CNT-OFF INSPECTION	1	27							
					INSUFFICIENT WIRE STRENGTH		Material Attributes SPC									
							TERMINATION PHASE.									
	TERMINAL CRIMPED INCORRECT	TERMINAL POSITION OUT OF SPEC.	6		INCORRECT SEE-UP	3	TERMINAL POSITION SPC	1	18							
					TOOL DAMAGED		SEE-UP INSPECTION									
CALIBRATED WIRE STRIPPER	CALIBRATED WIRE STRIPPER CRIMP WIRE SIZE	REMOVES CRIMP LINE	9		OPERATOR SEE-UP	3	SPC + SEE OF CHECK STRIPPER	1	27							
		CRIMP ACTUATION					SPC + FUNCTION TEST CRIMPING AUDITS PULLING									
					INCORRECT CALIBRATION SETUP		SPC + SEE OF CHECK STRIPPER SPC + FUNCTION TEST CRIMPING AUDITS PULLING									
	CALIBRATED WIRE STRIPPER CRIMP WIRE SIZE	CRIMP FAILURE	7		OPERATOR SEE-UP	3	SPC + SEE OF CHECK STRIPPER SPC + FUNCTION TEST CRIMPING AUDITS PULLING	1	21							

File Name: [illegible] Printed [illegible]

Process Failure Mode and Effects Analysis

Page [illegible] of [illegible]

Part: [illegible]
Name: [illegible] / [illegible]
Other: [illegible]

Suppliers and Plants: [illegible]
[illegible]
Engineering [illegible]

Prepared by: [illegible]
[illegible]
[illegible]

Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) of Failure	Occ	Current Controls	Det	R.P.N.	Recommended Actions	Area/Individual Responsible	Action Results: Actions Taken	S	O	D	R.P.N.
	[illegible] NOT [illegible]	CRIMP [illegible]	7		[illegible] SET-UP	3	[illegible] x [illegible] OF CHECK [illegible] [illegible] x FRICTION TEST CYCLING [illegible] [illegible]	1	21							
[illegible] BASE ASSEMBLY CALIBRATION	CHECK STATION [illegible]	HIGH BASE ASSEMBLY [illegible]	5		STATION WEAR	1	OFF LINE SPC CHECK	1	5							
	[illegible] MALFUNCTION	LOW BASE ASSEMBLY [illegible]	5		STATION [illegible] INCORRECT SET-UP	1	[illegible] x FRICTION TEST CYCLING [illegible] PILOTING PREVENTATIVE MAINT.	1	5							
FINAL ASSEMBLY 1																
ASSEMBLE [illegible] TO CRIMP [illegible]	WRONG CRIMP [illegible]	LOSS OF [illegible] CONTROL INCORRECT [illegible]	9		OPERATOR ERROR MIXING	3	[illegible] CHECK Q.C. AUDIT SET-UP INSPECTION	3	81							
ASSEMBLE [illegible] SEAL TO CLIP [illegible]	MISSING SEAL	INTERNAL CORROSION [illegible] LIFE	9		MACHINE ERROR	5	LMD x [illegible] AIR LEAK SPC [illegible] TORQUE SPC	3	135							
	MIS-PLACED SEAL	INTERNAL CORROSION [illegible] LIFE	9		MACHINE ERROR	5	LMD x [illegible] AIR LEAK SPC [illegible] TORQUE SPC	3	135							
	MULTIPLE [illegible]	LOSS OF CALIBRATION	9		[illegible] CHECK [illegible]	1	[illegible]	1	9							
ASSEMBLE TRANSFER PIN AND CLIP [illegible]	WRONG SIZE PIN	CRIMP [illegible]	5		OPERATOR ERROR MIXING	1	[illegible] CHECK PILOT [illegible] LMD x FRICTION TEST	1	5							
	[illegible] PIN	NO [illegible] OPERATION	9		MACHINE ERROR	1	[illegible] TEST LMD x FRICTION TEST	1	9							
ASSEMBLE BASE ASSEMBLY TO [illegible] ASSEMBLY	WRONG BASE ASSEMBLY	LOSS OF [illegible] CONTROL WRONG CALIBRATION	9		OPERATOR ERROR MIXING	1	[illegible] CHECK VISUAL INSPECTION Q.C. AUDIT LMD x FRICTION TEST	1	9							
	DISLODGEMENT OF PIN	[illegible] SHIFT [illegible]	9		PICK AND PLACE ERROR	1	LMD x FRICTION TEST PREVENTATIVE MAINT.	1	9							
	DISLODGEMENT OF SEAL	INTERNAL CORROSION [illegible] LIFE	9		PICK AND PLACE ERROR	1	LMD x FRICTION TEST PREVENTATIVE MAINT. [illegible] TORQUE SPC AIR LEAK SPC	1	9							
[illegible] STAGE FINAL CRIMP	CRIMP [illegible] OUT OF SPEC.	VIOLATION OF CUSTOMER [illegible] INTERNAL CORROSION	9		INCORRECT [illegible] [illegible] CRIMP [illegible] [illegible] CRIMP [illegible]	3	AIR LEAK [illegible] [illegible] SPC CRIMP [illegible] SPC	1	27							

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TI-NHTSA 019063

Process Description/ Purpose	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential Cause(s) of Failure	O c c	Current Controls	D e t	R P N	Recommended Actions	Responsible Individual/ Responsibility	ACTION RESULTS Actions Taken	S e v	O c c	D e t	R P N
						[illegible]									
	[illegible]	[illegible]		[illegible]		[illegible]									
		[illegible]		[illegible]		[illegible]									
						[illegible]									
						[illegible]									
	[illegible]	[illegible]		[illegible]		[illegible]									
				[illegible]		[illegible]									
						[illegible]									
						[illegible]									
[illegible]	[illegible]	[illegible]		[illegible]		[illegible]									
		[illegible]		[illegible]		[illegible]									
				[illegible]		[illegible]									
				[illegible]											

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Subsystem/Harness: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 910726 (Rev): 910930

	Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	SEV	CLASS	Potential Cause(s) of Failure	OCC	Design Verification	DET	RPN	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS Actions Taken	SEV	OCC	DET	RPN
1	BASE (46616)	Terminals out of	Difficulty installing mating	7		Terminal locating	1	SPC; in-process	1	7							
2	Provides features which lo-	proper location	electrical connector			features in base are		checks; Final insp.									
3	cate and affix the movable and					out of spec.											
4	stationary terminals																
5		Terminals loose	Intermittent continuity	7		Terminal locking	1	SPC; in-process	2	14							
6	Protects/insulates the elec-					features in base are		checks; Final insp.									
7	trical elements from the		Shift/fluctuation in switch			out of spec.											
8	environment		setpoints														
9																	
10	Provides a reference surface	Connector dimensions	Difficulty installing mating	3		Broken/worn mold	1	SPC; in-process	1	3							
11	which locates the electrical	improper	connector					checks; Final insp.									
12	elements relative to the pres-																
13	sure sensor	Low insulation re-	Current leakage prevents	7		Contamination/wrong	1	Mat'l certification	1	7							
14		sistance	switch from breaking circuit			material											
15																	
16	Provides a flange to compress	Leakage of environ-	Excessive current leakage	7		Improper geometry	3	SPC; in-process	1	21							
17	the environmental seal	mental subsystem				of environmental		checks; Final insp.									
18		mast connector	High contact resistance			seal surface caused											
19	Provides geometry of elec-					by broken/worn mold		In-process visual									
20	trical connector		Contacts stuck open					checks									
21						Handling damage to											
22			Contacts stuck closed			seal surface											
23																	
24		Lock tabs too small	Mating conn. falls off	7		Broken mold repaired	1	SPC; in-process	2	14							
25						improperly		checks; Final insp.									
26																	
27		Lock tabs too big	Difficulty installing mating	3		Broken/worn mold	1	SPC; in-process	1	3							
28			connector					checks; Final insp.									
29																	
30		Seal gland between	Base and sensor do not mate	5		Broken mold repaired	1	SPC; in-process	1	5							
31		base and pressure	properly, causing shift in			improperly		checks; Final insp.									
32		sensor too small	setpoint														
33																	
34		Seal gland too big	Insufficient seal pressure	7		Broken/worn mold	1	SPC; in-process	1	7							
35			leading to leakage					checks; Final insp.									
36																	
37		Incorrect polarity	Mating connector will not fit	3		Molding error	5	SPC; in-process	3	45							
38		key location						checks; Final insp.									
39																	
40	STATIONARY CONTACT (26888)	High contact resis-	Device appears open-circuit	5		Mat'l too thin	2	Supplier process	3	45							
41	Provides a beam blade for	tance/no continuity	w/ mating connector installed					controls and TI									
42	interconnection	at blade						Receiving Inspection									
43																	
44	Provides a silver inlay sur-	Blade dimensions	Device appears open-circuit	5		Worn/broken stamping	1	Supplier process	3	15							
45	face for electrical contact	improper	w/ mating connector installed			tools, or wrong		controls and TI									
46						material thickness		Receiving Inspection									
47	Provides a feature for device		Difficulty installing conn.														
48	calibration																
49																	
50	Provides a feature for staking	Terminal loose in	Intermittent continuity	7		Improper lance	3	Supplier process	3	63							
51	into base	base						controls and TI									
52								Receiving Inspection									
53			Shift/fluctuation in switch			Improper barbs		Supplier process									
54			setpoints					controls and TI									
55								Receiving Inspection									
56						Wrong material		Mat'l certification									
57																	
58		High resistance at	Apparent open circuit	7		Films/contamination	1	Mat'l certification	1	7							
59		contacts															
60			Intermittent continuity														
61																	
62		Contact resistance	Performance degradation over	5		Silver inlay thick-	3	SPC and material	1	15							
63		increase over life	time			ness too thin		certification									
64																	
65		Improper calibration	Mfg. shield leaks (leak rel. de-	9		Worn/broken tools	1	Supplier process	3	27							
66			tected at pressure testing)					controls and TI									
67								Receiving Inspection									
68						Wrong material											
69								Mat'l certification									
70																	
71																	
72																	
73	GROUND TERMINAL (26887)	High contact resis-	Device appears open-circuit	5		Mat'l too thin	2	Supplier process	3	45							
74	Provides a beam blade for	tance/no continuity	w/ mating connector installed					controls and TI									
75	interconnection	at blade						Receiving Inspection									
76																	
77	Provides a mounting point for	Blade dimensions	Device appears open-circuit	5		Worn/broken stamping	1	Supplier process	3	15							
78	the spring/movable contact	improper	w/ mating connector installed			tools, or wrong		controls and TI									
79						material thickness		Receiving Inspection									
80	Provides a feature for staking		Difficulty installing conn.														
81	into base																
82																	
83		Terminal loose in	Intermittent continuity	7		Improper lance	3	Supplier process	3	63							
84		base						controls and TI									
85								Receiving Inspection									
86			Shift/fluctuation in switch			Improper barbs		Supplier process									
87			setpoints					controls and TI									
88								Receiving Inspection									
89						Wrong material											
90								Mat'l certification									
91																	
92				7			1		1	7							
93																	
94																	

TI-NHTSA 019065

Subsystem/Vehicle: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen B. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen B. Offiler
NHSA Date Orig): 910720 (Rev): 910930

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S e v.	C l a s s.	Potential Cause(s) of Failure	O c c.	Design Verification	D e t.	R P N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION R e s u l t s Actions Taken	S e v.	O c c.	D e t.	R P N.
	High resistance at spring interface	Apparent open circuit Intermittent continuity			Film/contamination		Mat'l certification									
	Loose spring	Erratic operation shift/drift in setpoints	7		Rivet hole oversize	1	Supplier process controls and TI Receiving Inspection	3	21							
	Rivet help slow/ location tool	Will not assemble to spring properly	3		Stamping tool worn or broken	3	Supplier process controls and TI Receiving Inspection	3	27							
SPRING (36809) Provides contact force Provides continuity between terminals Provides feature to interface with transfer pin Provides mounting location for movable contact Provides feature for attachment to stationary contact	Low contact force	High millivolt drop across contacts	9		Incorrect geometry Incorrect material	7	SPC check on set line Mat'l certification	1	21							
	High contact force	Change in setpoints Disc fracture	3		Incorrect geometry Incorrect material	7	SPC Mat'l certification	1	21							
	High resistance at movable terminal interface	Apparent open circuit	7		Film/contamination	1	Mat'l certification	1	7							
	Rivet help slow/ location tool	Will not assemble to terminal properly	3		Stamping tool worn or broken	3	Assembly equipment senses spring presence/absence	1	9							
	Transfer pin jumps out of position or slipping	Spring failure over life	7		Broken stamping tool	3	SPC/visual checks	1	21							
RIVET (74171) Holds spring and movable terminal together	Length undersize	Spring falls off movable term	3		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	27							
	Length oversize	Loose spring	7		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	63							
	Diameter undersize	Loose spring	7		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	63							
	Diameter oversize	Assembly difficulty	3		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	27							
	Head undersize	Loose spring	5		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	45							
	Head oversize	Assembly difficulty	3		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	27							
	Hollow point overex.	Weak rivet - spring falls off	7		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	63							
	Hollow point underex	Difficult to rivet - loose spr	3		Supplier tooling	3	Supplier process controls and TI Receiving Inspection	3	27							
MOVABLE CONTACT (74480) Provides electrical switching interface with stationary terminal	High contact resistance/no continuity	Device appears open-circuit w/ mating connector installed Intermittent continuity	5		Silver too thin Film/contamination	3	Supplier process controls and TI Receiving Inspection Mat'l certification	3	45							
	Resistance increases over life	Degradation of electrical parameters over time	9		Silver too thin	2	SPC and material certification	1	21							
	Contacts weld	Device permanently closed-circuit; no response to fluid pressure	7		Extreme overcurrent from vehicle electrical system	1	Fuses/fuse-links	1	7							
	Shank geometry incorrect	Contact does not assemble to spring, or falls off	9		Broken, worn, or improperly set-up tooling	3	Supplier process controls and TI Receiving Inspection	1	9							

TI-NHTSA 019066

Subsystem/Vehicle: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 910701 (Rev): 910728

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Action	Resp./Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
HOUSING (3938B) Provides a hydraulic sealing surface per SAE J512 Provides external thread for installation into mating part Provides hex feature for 9/16" wrench Provides fluid passage to pressure-sensing element Provides gland for internal gasket Provides flange which interfaces with other components to form pressure-sensing structure	Fails to seal	Leakage of brake fluid			Incorrect surface finish specification Incorrect material specification Incorrectly specified geometry Excessive pressure		Cross check of print dimensions vs SAE standard Comprehensive evaluation of design at tolerance limits Burst testing to customer specified limits									
	Fails to properly install in mating part	Damages threads in mating part during installation Does not allow installation			Threads specified improperly Threads specified correctly but not ensured per established shop spec's Plating building											
	Improperly installed but fails to properly seat and seal	Brake fluid leakage			Threads specified improperly Threads specified correctly but not ensured per established shop spec's Plating buildup											
	Incorrect hex size	Damage to hex flats during servicing 9/16" wrench does not fit			Hex features improperly specified per established shop spec's											
	Fluid passage is too small	Electrical signal from switch is delayed vs. pressure signal especially at very low temp. Subject to blockage by foreign matter			Inadequate size of fluid passage specified Inadequate review of Ford standard practices											
	Fluid passage is too large	Resulting thin wall section causes breakage: - during installation - during underhood service operations			Fluid passage specified excessively large											
	Fails to seal internal gasket properly	Leakage of brake fluid			Gland dimensions improperly specified Surface finishes improperly specified											
	Gasket gland surface is irregular	Constitutes leak path Damage to gasket results in reduced life leading to leak			Mismachining											
	Flareum geometry is incorrect	Dia. too large results in assembly difficulty Dia too small results in bad component alignment leading to leak Too thick or thin results in poor crimp, leads to reduced disengage life or reduced burst capacity														
	Wrong material	Weak pressure cavity leads to reduced proof/burst capacity														
GASKET (7a351) Provides fluid seal between	Wrong size	Excessive gasket squeeze distorts gasket, results in leak	9		Improperly set-up cutting tools	3	Supplier process controls and II	7	91							

Subsystem/Phase: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 910704 (Rev): 910930

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S e v.	C l a s s.	Potential Cause(s) of Failure	O c c.	Design Verification	D e t.	R. P. N.	Recommended Action	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	S e v.	O c c.	D e t.	R. P. N.
Bonnet and diaphragm		Excessive squeeze results in improper assembly and reduced life of gasket leading to leak Insufficient squeeze results in leak Gasket diameter too large, results in assembly difficulty Gasket diameter too small, results in leak			Wrong extrusion tool		Receiving Inspection									
	Wrong material	Reduced gasket life, leading to leak Permanent set after temperature exposure leads to leak	9		Supplier error	1	Mat'l certification	1	9							
DIAPHRAGM (P8176) Forms flexible element of fluid containment cavity Transfers pressure from fluid to pressure-sense element	Insufficient material properties	Reduced life leading to leak	9		Supplier error	1	Mat'l certification	1	9							
BUSHING (Z7639) Provides a portion of the support surface for diaphragm Provides support for compression of gasket Locates connector and disc with respect to cup	Surface roughness	Reduced diaphragm life leading to leakage	9		Improper heat-treat Chips in tool	1	Supplier process controls and TI Receiving Inspection	3	27							
	Incorrect chamfer	Shift in setpoints Reduced diaphragm life leading to leakage	9		Broken/worn tool	1	Supplier process controls and TI Receiving Inspection	3	27							
	Burr	Reduced disc armature, inoperative device Reduced gasket squeeze results in leak	3		Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Assembly Inspection	3	27							
	Wrong material	Improper hardness and/or strength leading to bending	3		Supplier error	1	Mat'l certification	1	3							
	Wrong heat-treatment	Improper hardness and/or strength leading to bending	3		Supplier error	3	Hardness add at TI Assembly Inspection	3	27							
	Incorrect ID	Too small results in difficult assembly to connector Too small results in friction between washer and connector, leading to shift in setpoints over life Too large results in poor location of connector, shift in setpoints or inoperation Too large results in reduced diaphragm life	5		Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
	Incorrect OD	Too large results in difficult assembly Too small results in poor location of connector, shift in setpoints or inoperation	3		Broken or worn tools	3	Supplier process controls and TI Assembly Inspection	3	27							
	Incorrect thickness	Too thick results in poor crimp, leads to reduced diaphragm life or reduced burst capacity Too thin leads to bending	3		Wrong mat'l thickness, supplier error	3	Supplier process controls and TI Assembly Inspection	3	27							
	Burrs	Reduced diaphragm life	5		Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
CONNECTOR (Z7685) Transfers pressure from fluid (via diaphragm) to a force on pressure-sensing disc Provides alignment and support to spacer and disc	Irregularities on surface mating with diaphragm	Reduced diaphragm life	5		Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
	Incorrect button dia	Too large results in difficult assembly to washer Too large results in friction between washer and connector, leading to shift in setpoints over life Too small results in poor lo-	5		Broken or worn tools	3	Supplier process controls and TI Assembly Inspection	3	45							

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen R. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen R. Offiler
FMEA Date (Orig): 910726 (Rev): 930920

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
		cation of converter, shift in setpoints or inoperative Too small results in reduced diaphragm life														
	Bottom out of transmitter relative to disc locate feature	Difficult assembly Poor location of disc leading to inoperable device or shift in setpoints	3		Broken, worn, or improperly set-up tools	3	Supplier process controls and II Receiving Inspection	3	27							
	Incorrect geometry of disc locate features	Disc shifts relative to converter; shift in setpoints or inoperable device Converter bottoms against cup or disc warp contacts do not open or contact gap too small	3		Broken, worn, or improperly set-up tools	3	Supplier process controls and II Receiving Inspection	3	27							
	Incorrect material	Reopening flow causes device inoperation	3		Supplier error	1	Mat'l certification	1	3							
	Incorrect thickness	Too thick leads to assembly difficulty and/or disc warp and inoperable device Too thin leads to excessive flow, device inoperation	3		Supplier error	1	II Meas. Inspection	3	9							
	No vent hole	Trapped pressure behind disc leads to increase in setpoints & variations with temperature	5		Broken or improperly set-up tool	2	Supplier process controls and II Receiving Inspection	3	45							
	Incorrect geometry of OD	Too small causes difficulty with disc location; inoperable device Too large causes interference with cup; erratic operation or inoperable device	3		Broken, worn, or improperly set-up tool	3	Supplier process controls and II Receiving Inspection	3	27							
EPDM (72958) Reduce friction between disc and converter	OD too large	Causes disc to locate improperly to converter; erratic device operation, shift in setpoints or inoperable	5		Wrong punch	1	II process controls	3	15							
	OD too small	Excess friction in areas without copper causes disc wear, and shift in setpoints over life	5		Wrong punch	1	II process controls	3	15							
	Incorrect thickness	Excessive thickness causes reduced disc envelope possible inoperable device Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint	5		Supplier error	3	Supplier process controls and II Receiving Inspection	1	15							
	Improper Teflon coating	Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint	5		Supplier error	3	Mat'l certification	1	15							
DISC (88886) Controls actuation and provides contiguity of switch relative to applied force	Incorrect diameter	Hinders assembly Inoperative device Incorrect calibration	1		Worn stamping tool Wrong stamping tool	3	SPC	1	3							
	Excessive wastage	Hinders assembly Inoperative device Incorrect calibration	1		Worn or improperly set-up tool	3	SPC	1	3							
	Material composition	Shift in setpoints over life Reduced proof capability Disc fatigue failure	5		Supplier error Improper heat-treat	3	Mat'l certification II process controls	3	45							
	Excessive burr	Shift in setpoints over life	5		Worn tools	3	SPC	1	15							
	Wrong thickness	Too thin requires increased force to achieve setpoints; results in reduced life Too thick requires decreased force to achieve setpointer reduced throw, inadequate contact gap	3		Supplier error	3	SPC	1	9							
CUP (27288 and 27713)	Crimp area geometry	Poor crimp leads to reduced	5		Incorrect pinch-off	3	Supplier process	3	45							

TI-NHTSA 000690

Subsystem/Names: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 910724 (Rev): 910730

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Responsible Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
Provides crimpable area which holds pressure-sensor together Provides support for disc Locates washer relative to other components Provides guide for transfer pin	Incorrect	proof/burst capability, reduced diaphragm life			Broken, worn, or improperly set-up tools		controls and II Receiving Inspection									
	Wrong material thickness	Too thick will not fit in assembly tooling dies Too thin leads to reduced proof/burst capability, reduced diaphragm life	3		Supplier error	3	Supplier process controls and II Receiving Inspection	3	27							
	Wrong material	Too soft or bent leads to poor crimp, reduced proof/burst capability, reduced diaphragm life	3		Supplier error	3	Mat'l certification	1	9							
	Disc support bump geometry incorrect	Incorrect calibration Disc failure Inoperative device	5		Broken, worn, or improperly set-up tools	3	Supplier process controls and II Receiving Inspection	3	45							
	Geometry of washer locating step incorrect	Too high - excessive disc envelope; leads to increased diaphragm strain. Incorrect calibration Too low - insufficient disc envelope; pre-stressed disc and inoperative device Dia small results in difficult assembly Dia large results in poor location of connector, shift in setpoints or inoperative	3		Broken, worn, or improperly set-up tools	3	Supplier process controls and II Receiving Inspection	3	27							
	Geometry of pin guide incorrect	Dia small results in pins sticking - may give erratic operation at temperature extremes Dia large results in shift in pin position, erratic electrical characteristics Too short provides poor guidance, results in crooked pins, inoperative or erratic device Too long may short spring to housing	7		Broken, worn, or improperly set-up tools	3	Supplier process controls and II Receiving Inspection	3	63							
ENVIRONMENTAL SEAL (74247) Seal base assembly to sensor assembly	Thickness incorrect	Too thin results in poor seal; leakage of materials from environment Too thick causes difficulty in final crimp, cracks in base flange, or inoperative/erratic device operation	7		Tooling set-up error	2	Supplier process controls and II Receiving Inspection	3	63							
	ID incorrect	Too large - may not squeeze uniformly around circumference Too small - won't assemble	5		Broken, worn, or wrong extruder	3	Supplier process controls and II Receiving Inspection	3	45							
	OD incorrect	Too small - insufficient seal area	5		Broken, worn, or wrong extruder	3	Supplier process controls and II Receiving Inspection	3	45							
	Wrong material	Long-term degradation results in leakage	7		Supplier error	3	Mat'l certification	1	21							
	Porosity in material	May result in leakage if combined with insufficient squeeze	3		Supplier error	3	Supplier process controls and II Receiving Inspection	3	27							
TRANSFER PIN (74859) Transfers disc motion to movable electrical contact Insulates electrical components from switch housing	Diameter incorrect	Dia large results in pins sticking - may give erratic operation at temperature extremes Dia small results in shift in pin position, erratic electrical characteristics	7		Broken or worn tool	3	Supplier process controls and II Receiving Inspection	3	63							
	Length incorrect	Too short - low setpoints or device open-circuited Too long - high setpoints, inadequate contact gap, contacts	3		Mislabeled / wrong-house error	5	Caught at pressure-test of 100% of finished goods	1	15							

T1-NHTSA 019070

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 910704 (Rev): 910708

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
		won't open														
	Material incorrect	Shift in setpoints with temp Current leakage to housing Fracture/chips creates or inoperable device	7		Supplier error	3	Mat'l certification	1	21							
ORIFF BUSH (79977) Hold together base assembly and sensor assembly	ID incorrect	Too large results in poor crimp Too small hinders assembly	3		Broken, worn, or improperly set-up tooling	3	Supplier process controls and II Receiving Inspection On-Line SPC	1	9							
	Length incorrect	Too long or short causes poor crimp; low resistance to rotation of base rel. to sensor; cracked base	5		Broken, worn, or improperly set-up tooling	3	Supplier process controls and II Receiving Inspection On-Line SPC	1	15							
	Material incorrect	Difficult or weak crimp Corrosion (if ferrous not UL)	5		Supplier error	3	Mat'l certification	1	15							
	Thickness incorrect	Too thin results in poor crimp Too thick results in difficulty crimping/resting in dies	3		Supplier error	3	TI Recv. Inspection	3	27							

TI-NHTSA 019071

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) of Failure	O c c	Current Controls	D e t	R P N	Recommended Action	Area/Individual Responsible & Completion Date	ACTION TAKEN	S e v	O c c	D e t
		motion of connector, shift in orientation or temperature													
	Diameter of pin terminal incorrect	Pin could result in plug misfeed - may also require excessive or temperature extreme Pin large results in shift in pin position, erratic electrical characteristics Too short provides poor weld-ment, results in terminal pull, temperature or corrosion damage Too long may short spring to housing	7		Broken, worn, or improperly setup tools	3	Supplier process controls and IT Receiving Inspection	3	63						
	Thickness Incorrect	Too thin results in poor weld, leakage of materials from environment Too thick causes difficulties in final crimp, results in loose fitment, or temperature/corrosion failure operations	7		Tooling set-up error	3	Supplier process controls and IT Receiving Inspection	3	63						
	ID Incorrect	Too large - may not maintain reliability, avoid circumferences Too small - won't assemble	6		Broken, worn, or wrong material	3	Supplier process controls and IT Receiving Inspection	3	45						
	OD Incorrect	Too small - insufficient seal area	5		Broken, worn, or wrong material	3	Supplier process controls and IT Receiving Inspection	3	45						
	Wrong material	Long-term degradation results in leakage	7		Supplier error	1	Mat'l certification	1	21						
	Porosity in material	May result in leakage if combined with humidity/heat exposure	3		Supplier error	1	Supplier process controls and IT Receiving Inspection	3	27						
	Diameter Incorrect	Too large results in plug misfeed - may also require excessive or temperature extreme Too small results in shift in pin position, erratic electrical characteristics	7		Broken or worn tool	3	Supplier process controls and IT Receiving Inspection	3	63						
	Length Incorrect	Too short - low connection or device over-insulated Too long - high cure-time, increased contact pin, connector won't open	7		Mislocated / over-bend error	8	Caught on process-set of lots of finished goods	8	15						
	Material Incorrect	Shift in connection with temp Current leakage to housing Electrochemical attack or irreversible failure	7		Supplier error	3	Mat'l certification	1	21						
	ID Incorrect	Too large results in poor crimp Too small hinders assembly	9		Broken, worn, or improperly setup tooling	3	Supplier process controls and IT Receiving Inspection On-line SPC	1	9						
	Length Incorrect	Too long or short causes poor crimp, low resistance or retention of lock nut, to cover crushed lead	8		Broken, worn, or improperly setup tooling	7	Supplier process controls and IT Receiving Inspection On-line SPC	4	15						
	Material Incorrect	Difficult or weak crimp Corrosion (If Various not Ni)	6		Supplier error	1	Mat'l certification	1	15						
	Thickness Incorrect	Too thin results in poor crimp Too thick results in difficult-ies crimping/seating in dies	3		Supplier error	3	IT Rec. Inspection	3	27						

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Design Verification	D E T	R P N	Recommended Actions	Responsible Individual & Completion Date	ACTION RESULTS Actions Taken	S E V	O C C	D E T	R P N
[illegible] provides [illegible] which [illegible] and [illegible] the [illegible] and [illegible] [illegible] Protects/insulates the electrical elements from the environment Provides a relatively smooth [illegible] which [illegible] the electrical [illegible] relative to the [illegible] mount Provides a [illegible] to [illegible] the [illegible] Provides [illegible] of electrical connector	Insufficient seal of proper location	Difficult/impossible [illegible] connector	7		Terminal location [illegible] is [illegible] out of spec.	1	[illegible] [illegible]	1	7							
	Terminals loose	Intermittent continuity Shift/fluctuation in [illegible] [illegible]	7		Terminal locking [illegible] is [illegible] out of spec.	1	[illegible] [illegible]	1	7							
	Connector dimensions improper	Difficult/impossible [illegible] connector	3		Breakaways mold	1	[illegible] [illegible]	1	3							
	Poor insulation resistance	Current leakage path-may result from [illegible] [illegible]	7		Contamination/process [illegible]	1	Mat'l certification	1	7							
	Leakage of environmental [illegible] [illegible] connector	Excessive current leakage High contact resistance Contacts stuck open Contacts stuck closed	7		Improper assembly of environmental seal system caused by installation tool Pooling damage to seal material	3	[illegible] [illegible] [illegible] Dimensional visual checks	4	84							
	Leak tube too small	Piston seen. falls off	7		Broken mold registered improperly	1	[illegible] [illegible]	4	7							
	Leak tube too thin	Difficult/impossible [illegible] connector	3		Breakaways mold	1	[illegible] [illegible]	1	3							
	Seal sized between [illegible] and [illegible] cannot [illegible]	Shaft not mating do not meet [illegible]. causing shift in [illegible]	5		Broken mold registered improperly	1	[illegible] [illegible]	1	5							
	Seal sized too big	Insufficient seal [illegible] [illegible] to leakage	7		Breakaways mold	1	[illegible] [illegible]	1	7							
	Improper polarity key location	Mating connector will not fit	3		Molding error	5	[illegible] [illegible]	3	45							
[illegible] (terminal, [illegible]) [illegible] a [illegible] blade for [illegible] Provides a silver [illegible] surface for electrical contact Provides a feature for device calibration Provides a feature for [illegible] [illegible] base	High contact resistance/poor continuity at blade	Device appears open circuit w/ mating connector installed	6		Mat'l too thin	3	Supplier process controls and TI [illegible] inspection	3	45							
	Blade dimensions improper	Device appears open circuit w/ mating connector installed Difficult/impossible conn.	6		Wear/fracture stamping tools, or wrong material thickness	1	Supplier process controls and TI [illegible] inspection	3	15							
	Terminal loose in base	Intermittent continuity Shift/fluctuation in [illegible] [illegible]	7		Improper force Improper hole Wrong material	3	Supplier process controls and TI [illegible] inspection Supplier process controls and TI [illegible] inspection Mat'l certification	3	63							
	High resistance or contacts	Apparent open circuit Intermittent continuity	7		Plating/contamination	1	Mat'l certification	1	7							
	Contact resistance increases over life	Performance degradation over time	5		Silver delay thickness too thin	3	SPC and material certification	5	75							
	Improper calibration	Sig. yield less than 6% opt. terminal or programs tester)	7		Wear/fracture tools Wrong material	1	Supplier process controls and TI [illegible] inspection Mat'l certification	3	21							
[illegible] (terminal, [illegible]) [illegible] a [illegible] blade for [illegible] Provides a reaction point for the mating/[illegible] [illegible] Provides a feature for [illegible] [illegible] base	High contact resistance/poor continuity at blade	Device appears open circuit w/ mating connector installed	6		Mat'l too thin	3	Supplier process controls and TI [illegible] inspection	3	45							
	Blade dimensions improper	Device appears open circuit w/ mating connector installed Difficult/impossible conn.	6		Wear/fracture stamping tools, or wrong material thickness	1	Supplier process controls and TI [illegible] inspection	3	15							
	Terminal loose in base	Intermittent continuity Shift/fluctuation in [illegible] [illegible]	7		Improper force Improper hole Wrong material	3	Supplier process controls and TI [illegible] inspection Supplier process controls and TI [illegible] inspection Mat'l certification	3	63							

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Design Validation	D E T	R P N	Recommended Action	Area/Individual Responsible & Completion Date	ACTION Actions Taken	S E V	O C C	D E T	R P N
	High resistance at spring terminus	Apparent open circuit Intermittent continuity			Wire/termination		Mat'l certification									
	Loose spring	Erratic operation Light-out-OFF to intensity	7		Short into overdrive	1	Supplier process controls and IT Assembly Inspection	1	21							
	Short hole plug/ location bad	Will not assemble to spring properly	3		Incomplete tool core or broken	1	Supplier process controls and IT Assembly Inspection	1	27							
SPRING CHARGE Provides contact force Provides continuity between contacts Provides feature to assemble with another pin Provides grounding function for movable contact Provides feature for attachment to stationary contact	Low contact force	High milliohit drop across contacts	3		Incorrect geometry Incorrect material	7	QPC check on set line Mat'l certification	1	21							
	High contact force	Change in setpoints Pin fracture	7		Incorrect geometry Incorrect material	7	QPC Mat'l certification	1	21							
	High resistance at movable contact to surface	Apparent open circuit	7		Wire/termination	1	Mat'l certification	1	7							
	Short hole plug/ location bad	Will not assemble to terminal properly	3		Incomplete tool core or broken	7	Assembly equipment checks during pre-use/shutdown	1	21							
	Incomplete pin have out of position or missing	Spring follows over life	7		Broken stainless tool	1	QPC/visual checks	1	21							
SHAFT CHARGE Shaft carries and provides terminal function	Length undersize	Spring falls off capable core	3		Shoulder tooling	2	Supplier process controls and IT Assembler Inspection	3	27							
	Length oversize	Loose spring	7		Supplier tooling	3	Supplier process controls and IT Assembler Inspection	3	63							
	Diameter undersize	Loose spring	7		Shoulder tooling	3	Supplier process controls and IT Assembler Inspection	3	63							
	Diameter oversize	Assembly difficulties	3		Supplier tooling	3	Supplier process controls and IT Assembly Inspection	3	27							
	Head undersize	Loose spring	5		Supplier tooling	3	Supplier process controls and IT Assembly Inspection	3	45							
	Head oversize	Assembly difficulty	3		Supplier tooling	3	Supplier process controls and IT Assembly Inspection	3	27							
	Hollow point oversize	Weak rivet - spring falls off	7		Supplier tooling	3	Supplier process controls and IT Assembly Inspection	3	63							
	Hollow point undersize	Difficult to rivet - loose spr	3		Supplier tooling	3	Supplier process controls and IT Assembly Inspection	3	27							
CONTACT CHARGE Provides electrical continuity between shaft and stationary contact	High contact resistance/ contact	Spring operates open circuit or making intermittent installed Intermittent continuity	5		Dilver too thin Wire/termination	3	Supplier process controls and IT Assembly Inspection Mat'l certification	3	45							
	Electromagnet increases over life	Degradation of electrical parameters over life	7		Silver too thin	3	QPC and material certification	1	21							
	Contacts weld	Spring momentarily closed/ circuit no response to shaft movement	7		Unknown overstresses from vehicle electrical system	1	Room/hour-limits	1	7							
	Shaft excessive movement	Contact chrg not available to spring, or falls off	3		Broken, worn, or improperly set-up tooling	3	Supplier process controls and IT Assembly Inspection Inspect on run ends	1	9							
TERMINAL CHARGE Provides a terminal mating surface per [illegible] Provides external charge for installation into mating part Provides key feature for [illegible]	Improper geometry of .250 surface	Leakage of brake fluid	7		Broken, worn or improperly set-up tooling Misbuffing	3	Supplier process controls and IT Assembly Inspection	3	81							
	Improper thread	.250 not install properly in mating part Improper threads in mating	7		Rolling operation tool Misbuffing	7	Supplier process controls and IT Assembler Inspection	3	147							

TL-NHTSA 0190074

File Name: 7___ 2 Printed at [illegible] On [illegible]-1991

Design Failure Mode and Effects Analysis

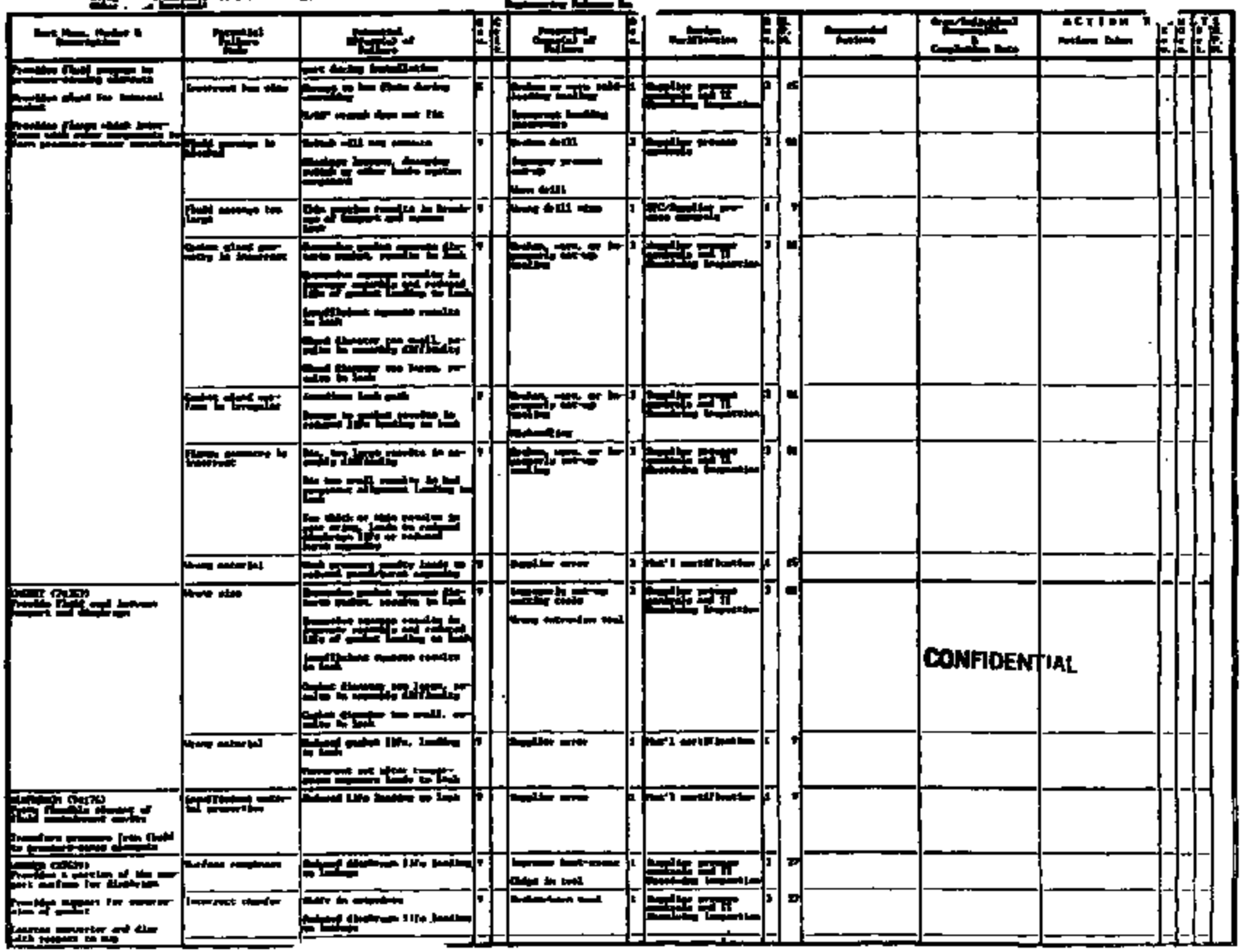
System / Subsystem / Component: Speed Control Deactivation Pressure Switch
Design Responsibility: Stephen [illegible] Offiler
Other Areas Involved: [illegible]

Suppliers and Plants Affected: [illegible]
Model Year/Vehicle(s): [illegible]
Engineering Release Date: [illegible]

Prepared by: Stephen [illegible] Offiler
FMEA Date (Orig.): [illegible] (Rev.) [illegible]

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) of Failure	Occ	Design Verification	Det	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	Action Results: Actions Taken	Sev	Occ	Det	R.P.N.
		device Too large causes interference with mating [illegible] operation or inoperable device			[illegible]		Receiving Inspection									
DISC CARRIER Reduces friction between disc and converter	OD too large	Causes disc to locate improperly in converter; erratic device operation, shift in setpoint or inoperable	5		Wrong punch	1	TI process controls	3	15							
	OD too small	Excess friction in areas with [illegible] causes disc wear, and shift in setpoint over life	5		Wrong punch	1	TI process controls	3	15							
	Improper thickness	Excessive thickness causes reduced disc overlap; possible inoperable device Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint	5		Supplier error	3	Supplier process controls and TI Receiving Inspection	1	15							
	Improper Teflon coating	Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint	5		Supplier error	3	Mat'l certification	1	15							
DISC [illegible] Controls actuation and release set-points of switch relative to applied force	Incorrect diameter	[illegible] assembly Inoperative device Incorrect calibration	1		Worn stamping tool Wrong stamping tool	3	SPC	1	3							
	Excessive [illegible]	[illegible] assembly Inoperative device Incorrect calibration	1		Worn or improperly set-up tool	3	SPC	1	3							
	Material composition	Shift in setpoint over life Reduced proof capability Disc fatigue failure	5		Supplier error Improper heat-treat	3	Mat'l certification TI process controls	3	45							
	Excessive burr	Shift in setpoint over life	5		Worn tools	3	SPC	1	15							
	Wrong thickness	Too thin requires increased dome to achieve setpoint; results in reduced life Too thick requires decreased dome to achieve setpoint; reduced [illegible]; inadequate contact gap	3		Supplier error	3	SPC	1	9							
CUP [illegible] and [illegible] Provides crimpable area which holds pressure-sensor together Provides support for disc Locates washer relative to other components Provides guide for transfer pin	Crimp area geometry incorrect	Poor crimp leads to reduced proof/burst capability, reduced diaphragm life	5		Incorrect blank-off Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
	Wrong material thickness	Too thick will not fit in assembly tooling dies Too thin leads to reduced proof/burst capability, reduced diaphragm life	3		Supplier error	3	Supplier process controls and TI Receiving Inspection	3	27							
	Wrong material	Too soft or hard leads to poor crimp, reduced proof/burst capability, reduced diaphragm life	3		Supplier error	3	Mat'l certification	1	9							
	Disc support [illegible] geometry incorrect	Incorrect calibration Disc fatigue Inoperative device	5		Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	45							
	Geometry of washer forming step incorrect	Too high - [illegible] disc [illegible] leads to increased diaphragm stress, incorrect calibration Too low - insufficient disc [illegible] disc and inoperative device [illegible] small results in difficult assembly [illegible] large results in poor [illegible]	3		Broken, worn, or improperly set-up tools	3	Supplier process controls and TI Receiving Inspection	3	27							

TI-NHTSA 019077



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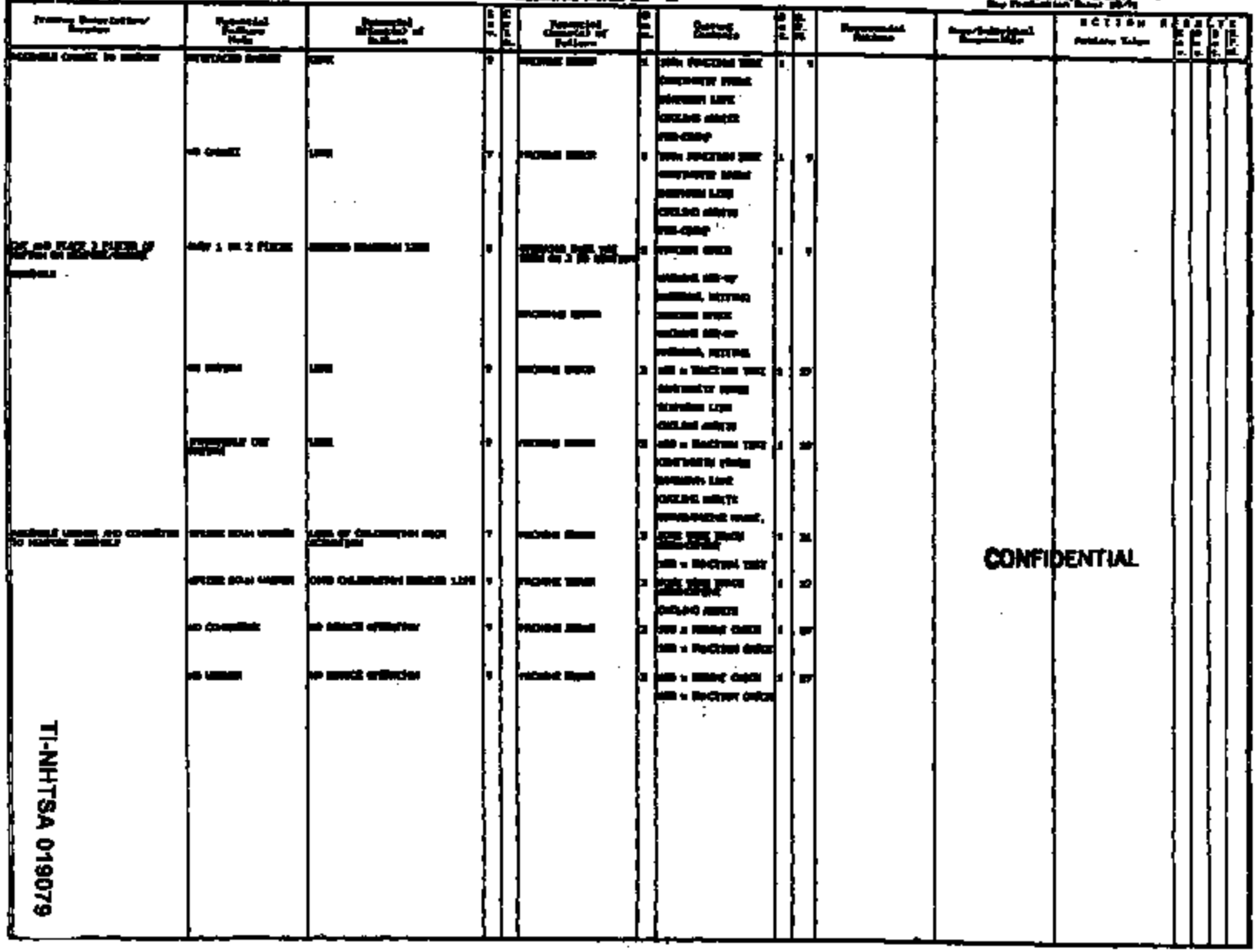

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TI-NHTSA 019079

[illegible]

[illegible]	[illegible]	[illegible]			[illegible]		[illegible]			[illegible]	[illegible]	ACTION R[illegible] Actions Taken			
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						

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POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503795
Revision Level 0
Revision Date 4-May-95

Original (Initial) Date 28-Dec-93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
DIAPHRAGM (OR SEAL) (SR) (2x178) Forms flexible element of fluid containment cavity	Fails to contain fluid.	Fluid leakage.	9		Gradual rupture over life due to improper design of supporting elements. Gradual rupture over life due to excessive flexure/displacement. Gradual rupture over life due to stress concentrations caused by asymmetric strain distributions. Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm installed. Insufficient thermocharging of diaphragm.	1	Burst, impulse, and thermal cycle tests. Material mfg recommendations. Comparison of design with similar products.	1	9	CONFIDENTIAL						
Transfers pressure from fluid to pressure-sensing elements.	Change in area of pressure transfer over life. Excessive change of pressure transfer area versus pressure.	Shift in setpoints over life. Excessively high pressures needed to adequately flex pressure transfer area; wide algins on setpoints due to unpredictability at lower pressures.	9 6		Diaphragm too stiff. Incorrect material specified. Diaphragm too soft. Incorrect material specified	1 1	Life testing of characteristics at intermediate points. Force and pressure versus deflection testing to calculate effective areas.	1 1	9 6							

TI-NHTSA 019081

DESIGN - FAILURE MODES AND EFFECTS ANALYSIS

F2AC-18B091-HA

PROPORTIONING BRAKE VALVE
WITH SPEED CONTROL SWITCH

1992 EN-53,FN-56

Prepared for

FORD

By

SUBFACTS

Division of JIRLITE Industries Inc.

October 10, 1991

SURFACES - DESIGN FAILURE MODES & EFFECT ANALYSIS (D.F.M.E.A.)

PRODUCT FAMILY: Brake Valves PRODUCT TYPE: PROPORTIONING WITH SPEED CONTROL SWITCH

CUSTOMER: FORD / DRIVER VEHICLE: EN-53,EW-36 D.F.M.E.A. NO.: 6870 REVISED:
DATE:
PAGE: 26 of 29

ASSEMBLY: VALVE ASSEMBLY
ASSEMBLY PART NO.: 806076 CHANGE LEVEL: 01
FORD ASSEMBLY PART NO.: F2AC-2009J CHANGE LEVEL: BA

D.F.M.E.A. INDICES CODES
P.O. - PROBABILITY OF OCCURRENCE F.S. - FAILURE SEVERITY
P.D. - PROBABILITY OF NON-DETECTION R.P. - RISK PRIORITY

ANALYSIS BY: J. HUTCHESON

PART: SWITCH PHASE: DRIVE CHANGE LEVEL: 01

FEATURE & FUNCTION	FAILURE MODE	FAILURE MECHANISM	EFFECT OF FAILURE ON: ASSEMBLY	SYSTEM	VEHICLE	D.F.M.E.A. INDICES P.O.	F.S.	P.D.	R.P.	DESIGN VERIFICATION PLAN	CORRECTIVE ACTION REQUIRED YES/NO COMPL. DATE		
1. Threads	a. Strip threads	a. Pitch too fine - end plug ejected.	Sudden pressure loss.	Sudden loss of rear brakes.	Longer stopping distance without warning.	1	10	1	10	U.S. Strength test			
		b. Engagement length too short.	External leak.	No pressure to rear brakes.	Longer stopping distance	1	10	1	10	U.S. Strength test			
2. 45° Cone Seat, sealing surface.	Leak	a. Corrosion b. Erosion c. Undercut	Leak	Sudden pressure loss.	Sudden longer stopping distance	1	10	1	10	U.S. Environmental test cat 2000 PSI	No		
			Switch left loose	Sudden pressure loss.	Sudden longer stopping distance	1	10	1	10	U.S. Durability, Leak Test	No		
			Dimensional incompatibility leak	Sudden pressure loss.	Sudden longer stopping distance	1	10	1	10	U.S. Low pressure leak test	Yes		
3. Seals	Leak through diaphragm	Fatigue	External Leak	No pressure to rear brakes	Longer stopping distance	1	10	1	10	U.S. Durability	No		
4. Electrical	Switch fails		None	None	Improper speed control	1	5	1	5	U.S. Durability	No		

Potential
Failure Mode and Effects Analysis
(Design FMEA)

System
Subsystem
Component Automotive vehicle speed Control Subsystem FMEA

Design Responsibility Vehicle Speed Control System Engineering

Key Date

FMEA Number
Page 1 of 55
Prepared by
FMEA date (orig.) 1993 03 19 (Rev.) 1997 10 15

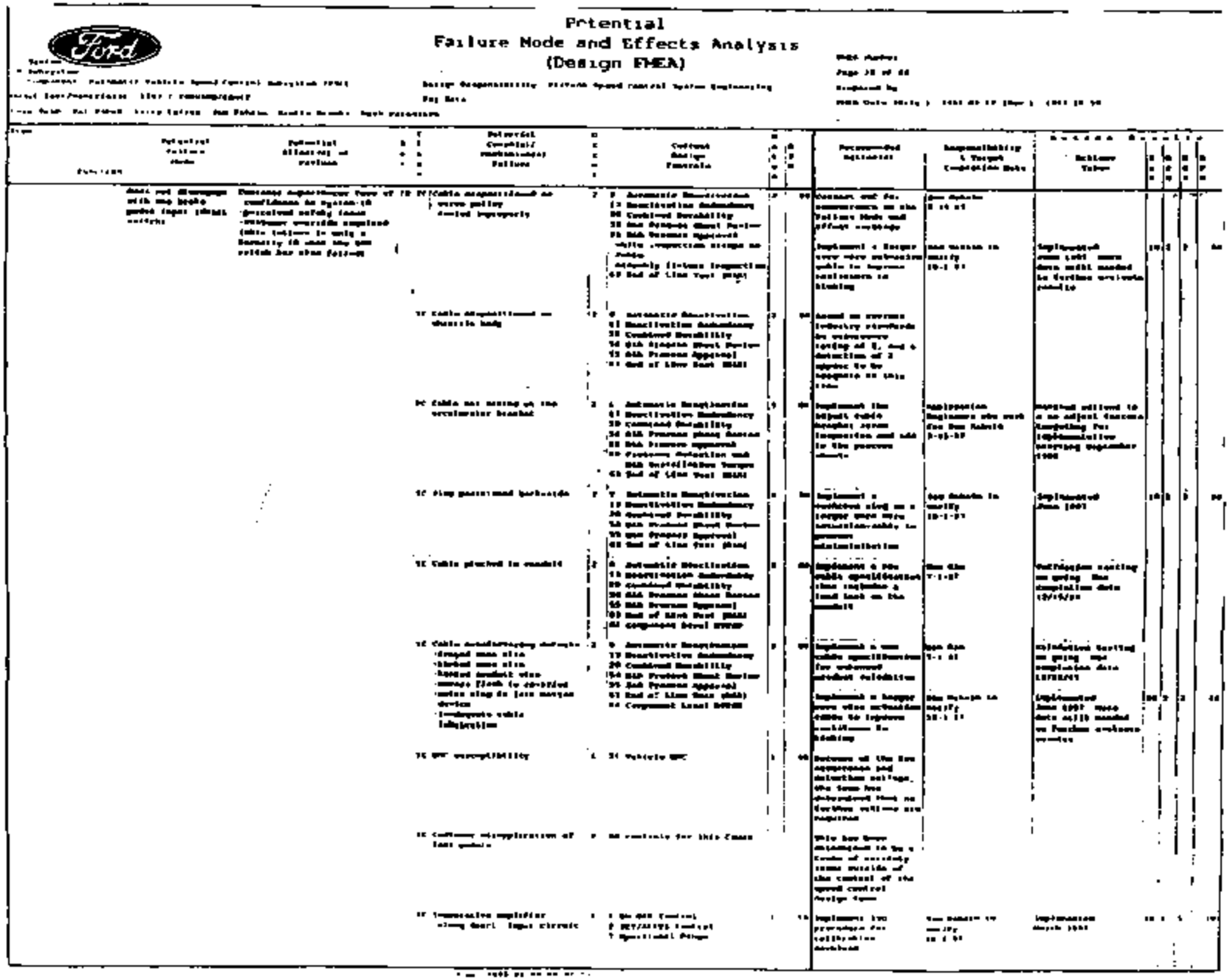
Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential Cause(s)/ Mechanism(s) of Failure	O c c	Current Design Controls	D e t	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken	S e v	O c c	D e t	R P N
	Scope: The scope of this FMEA includes the Speed control Assembly, Subsystem that speed control system, Accelerator pedal system, Accelerator cable, Mounting Check switches, Interfacing wiring and Assembly Locations														
Inability to deactivate/activate control for speed speed on driver command. The vehicle is allowed to accelerate past safety HFM	Does not maintain the set speed reliably (inoperative)	Loss of speed control (complete)	6	No power supplied to unit	2	1 Off-HFT Cue of 2 HET/ACCEL Control 3 Operational Range	1	12	Establish the specifications for this function and write on the FMEA	Ford Vehicle 12-1-97					
				Open circuit -Deactivation switch -Instrument connections -Fuse -Cracked switches -Brake lamps -Cruse relay	3	1 On-HFT Control 2 HET/ACCEL Control 3 Operational Range	1	18	No further actions required						
				Cable not connected - servo -Throttle body -Deflection -Broken	7	1 On-HFT Control 2 HET/ACCEL Control 3 Operational Range	1	18	No further actions required						
				No speed signal	1	1 On-HFT Control 2 HET/ACCEL Control 3 Operational Range	1	6	No further actions required						
			6	Inoperative amplifier -No calibration -Calibration process -Open adjustin -Shorted elements Inoperative responses -Transducers -Disc -Pot -Component placement	1	1 On-HFT Control 2 HET/ACCEL Control 3 Operational Range	1	24	Implement the procedures for calibration Overhead	Ken Johnson 12-1-97 Trevor Williams to verify 6-1-97 Trevor Williams to verify 8-1-97	Implemented March 1997 Implemented April 1997 Implemented February 1997	6	1	1	6
				Inoperative servo -Damaged motor -Open pulse phase in the circuit -Open motor phases -Clutch the pop too large -Propped gears -Bearings out of place	2	1 On-HFT Control 2 HET/ACCEL Control 3 Open Local Range	1	12	No further actions required						
			5	Value improve this failure at Preshop comparisons	1	1 On-HFT Control 2 HET/ACCEL Control 3 Open Local Range	5	70	Value assessment view the acceptance criteria for the motor test (DV and EOL to modified to include an inspection of the cable alloy motor test	Applications engineers who work for Ken Johnson 6 to 97	Generic DVP&R updated to reflect new procedure	5	1	2	10

TI-NHTSA 019084

Potential
Failure Mode and Effects Analysis
(Design FMEA)

TI-NHTSA 019085

Potential
Failure Mode and Effects Analysis
(Design FMEA)



Potential
Failure Mode and Effects Analysis
(Design FMEA)

Occurrence, Continued

Occurrence Rating Table

The following table is used to estimate the failure rate and/or criteria to develop a rating for each cause.

PROBABILITY OF FAILURE	POSSIBLE FAILURE RATES	RANKING
Very High: Failure is almost inevitable.	≥ 1 in 2	10
	1 in 3	9
High: Repeated failures.	1 in 8	8
	1 in 20	7
Moderate: Occasional failures.	1 in 80	6
	1 in 400	5
	1 in 2,000	4
Low: Relatively few failures.	1 in 15, 000	3
	1 in 150,000	2
Remote: Failure is unlikely.	≤ 1 in 1,500,000	1

1. The Criteria column may be augmented by the FMSA Team to meet local requirements only if:
   - The table is used consistently throughout the engineering offices.
   - Supporting rationale for changes are documented and attached to the FMEA
   - Changes have been approved by local Ford Management and Quality Office.
2. The criteria for rating "1" cannot be changed without prior approval of Environmental & Safety Engineering.

TABLE 7

EFFECT OF TEMPERATURE ON INSTRON TEAR STRENGTH

1 Mil, H Film

Temp., °C	g/mil MD	TD
22	6.0	10.6
50	7.5	9.3
100	7.5	7.9
150	7.4	8.1
200	7.2	9.1
250	7.3	9.7

LEA:cam

TABLE 8

BENDING RECOVERY OF FILMS FROM 180° BEND

	% Recovery 15 sec.	30 sec.	60 sec.	120 sec.	300 sec.
H Film (.002")	59	60	62	63	64
100 "Mylar"	43	50	51		
300 Cellophane	15	26	30		

2. Two mil H film (Roll 70-1-1) samples were stretched 1, 3 and 5% on the Instron Tester and both the work recovery and form recovery were measured in each case with and without a 30 second delay before recovery. Rate of deformation was 100%/minute and recovery permitted at the same rate. Summarized in Table 9 are the work and tensile form recovery data.

TABLE 9

WORK AND FORM RECOVERY FROM TENSION

H Film (.002") Roll 70-1-1

% Stretch		Work Recovery Instantaneous	30 sec. delay	Form Recovery Instantaneous	30 sec. delay
1%	MD	97	76	100+	100+
	TD	98	66	100+	100+
3%	MD	78	50	100+	91+
	TD	78	50	100+	91
5%	MD	59	44	88	80
	TD	58	41	87	78

H. Dynamic Mechanical Measurements

Dynamic mechanical measurements made by the Plastics Department up to 500°C have failed to reveal the presence of a glass transition temperature. This appears to be verified by the fact that the mechanical properties measured over wide temperature ranges have failed to indicate any discontinuities or changes in slope as in the case at the glass transition temperature.

R. M. Ikeda ** has found a mechanical loss peak at -60°C by use of the torsional pendulum. The height of the peak is nine times greater than the base value. This peak corresponds to the dielectric loss peaks found in this temperature range. After peaking at -60°C the loss value remains constant out to 250°C, the maximum temperature used by Ikeda.

I. Abrasion Resistance

H film has shown a high degree of resistance to abrasion suggesting its utility as a bearing material. The rate of abrasion for one mil H film with the Ball Sand Blast Abrader was 7.7 minutes/mil as compared to 4-5 minutes/mil for "Tedlar"* PVF Film.

III. Dimensional Stability

H film offers a high degree of dimensional stability at temperatures above the melting point of most polymers. As shown in Figure 11 the shrinkage is less than 1% at 300°C on belt cast film. Typical data are given in Table 10 where the shrinkage was measured after five minutes exposure to the indicated temperature.

TABLE 10

SHRINKAGE OF H FILM AT VARIOUS TEMPERATURES

	% Shrinkage					
Roll No.	130-1-2		134-1-1		100-1-1	
Temp.°C	MD	TD	MD	TD	MD	TD
200	0.25	0.66	0.14	0.14	0.00	0.43

** "H Film Infra Red Studies II" FWR-62-8 RM Ikeda

*Du Pont Registered Trademark

LEA:cam

TABLE 7

EFFECT OF TEMPERATURE ON INSTRON TEAR STRENGTH

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LEA:cam

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2. Two mil H film (Roll 70-1-1) samples were stretched 1, 3 and 5% on the Instron Tester and both the work recovery and form recovery were measured in each case with and without a 30 second delay before recovery. Rate of deformation was 100%/minute and recovery permitted at the same rate. Summarized in Table 9 are the work and tensile form recovery data.

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WORK AND FORM RECOVERY FROM TENSION

H Film (.002") Roll 70-1-1

% Stretch		Work Recovery Instantaneous	30 sec. delay	Form Recovery Instantaneous	30 sec. delay
1%	MD	97	76	100+	100+
	TD	98	66	100+	100+
3%	MD	78	50	100+	91+
	TD	78	50	100+	91
5%	MD	59	44	88	80
	TD	58	41	87	78

LEA:cam

TABLE XVI

CHEMICAL RESISTANCE OF 1 AND 2 MIL KAPTON®

Chemical Resistance	Conditions Time	Temp.	% Prop. Retained Tens.	Elong.	Mod.	Conditions Time	Temp.	% Prop. Retained Tens.	Elong.	Mod.
Benzene	1 yr.	Rm.	100	82	100	56 days	60°C.	100	100	101
Hexane	1 yr.	Rm.	92	89	100	56 days	66°C.	100	100	114
Toluene	1 yr.	Rm.	95	66	97	28 days	110°C.	82	32	99
DMF	1 yr.	Rm.	81	65	90	1 "	152°C.	0	0	0
Chloroform	1 yr.	Rm.	93	79	96	56 "	60°C.	100	100	100
Methanol	1 yr.	Rm.	100	73	100	56 "	64°C.	100	100	105
Chlorobenzene	1 yr.	Rm.	86	59	106	56 "	130°C.	100	100	98
Acetone	1 yr.	Rm.	97	78	100	56 "	80°C.	100	100	100
H_2O + Dupanol® (5%)	1 yr.	Rm.	91	38	130	7 "	100°C.	82	18	124
Sulfuric Acid (10%)	191 days	Rm.	78	71	93					
"Skydrol" (1)	191 days	Rm.	91	96	95					
Decomposed "Skydrol"						16 "	200°C.	76	93	78
JP-4 Jet Fuel	191 days	Rm.	86	92	91	2 "	225°C.	51	10	52
Ferric Chloride Etch. Soln.(3)						336 "	100°C.	96	70	112
Glacial Acetic						336 "	50°C.	98	94	96
Aniline						56 "	110°C.	95	62	102
Dimethyl Aniline						6 "	184°C.	0	0	0
p-Cresol						22 "	100°C.	81	59	102
Water						168 "	200°C.	108	77	109
Cellosolve						28 "	100°C.	52	26	120
"Aroclor" (4)						1 yr.	135°C.	108	53	102
"Transil" Oil (5)						6 mo.	200°C.	108	53	102
Water PH=10						168 hr.	150°C.	100	100	100
Water PH=1						100 hr.	100°C.		79	
Sodium Hydroxide 10%	5 days	Rm.	Dissolves			100 hr.	100°C.		51	
Ammonia Hydroxide [conc.]	2 days	Rm.	Dissolves							
Dow-Corning Silicone Varnish [1802]						48 hr.	250°C.	Varnish decomposes		
Dow-Corning Silicone Varnish [6051]						96 hr.	250°C.	100	96	114

*In air and "in vitro" presence of water. If water and air are excluded the film has considerably longer life. (3 weeks, 150°C.).

(1) Hydraulic Fluid (Phosphate) (2) Government specified Jet Fuel (3) Saturated solution of $FeCl_3$ (0.3% $FeCl_3$)

(4) Chlorinated biphenyl [Transformer Oil] (5) Hydrocarbon transformer oil (6) Copper Powder

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*Report No. YR-63-11

H. Dynamic Mechanical Measurements

Dynamic mechanical measurements made by the Plastics Department up to 500°C have failed to reveal the presence of a glass transition temperature. This appears to be verified by the fact that the mechanical properties measured over wide temperature ranges have failed to indicate any discontinuities or changes in slope as in the case at the glass transition temperature.

R. H. Ikeda **- has found a mechanical loss peak at -60°C by use of the torsional pendulum. The height of the peak is nine times greater than the base value. This peak corresponds to the dielectric loss peaks found in this temperature range. After peaking at -60°C the loss value remains constant out to 250°C, the maximum temperature used by Ikeda.

I. Abrasion Resistance

H film has shown a high degree of resistance to abrasion suggesting its utility as a bearing material. The rate of abrasion for one mil H film with the Bell Sand Blast Abrader was 7.7 minutes/mil as compared to 4-5 minutes/mil for "Tedlar"* PVF Film.

III. Dimensional Stability

H film offers a high degree of dimensional stability at temperatures above the melting point of most polymers. As shown in Figure 11 the shrinkage is less than 1% at 300°C on belt cast film. Typical data are given in Table 10 where the shrinkage was measured after five minutes exposure to the indicated temperature.

TABLE 10

SHRINKAGE OF H FILM AT VARIOUS TEMPERATURES

	% Shrinkage					
Roll No.	130-1-2		134-1-1		100-1-1	
Temp.°C	MD	TD	MD	TD	MD	TD
200	0.25	0.66	0.14	0.14	0.00	0.43

** "H Film Infra Red Studies II" PWR-62-8 RH Ikeda

*Du Pont Registered Trademark

LEA:cam

Subsystem/Name: Speed Control Deactivate Pressure Switch
System Responsibility: Stephen B. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen B. Offiler
FMEA Date (Orig): 110794 (Rev): 911188

	Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	RPN	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS Actions Taken	Sev.	Occ.	Det.	RPN
1	SPACE (465146)	Fails to properly locate terminals	Terminals out of position			Incorrect dimensions and/or tolerances between slots and terminals											
2	Provides a system of slots which guide, locate, and physically support terminals																
3																	
4																	
5	Provides features to enhance the effectiveness of terminal staking	Fails to properly guide the terminals -difficult insertion	Device will not assembly properly; yield loss in mfg.			Incorrect dimensions and/or tolerances between slots and terminals											
6																	
7																	
8																	
9																	
10	Provides a dielectric medium for the electrical elements					Insufficient lead-in											
11																	
12																	
13	Provides physical isolation of the switch components	Fails to properly support the terminals	Terminals move relative to each other or the base (such as under physical or thermal loadings)			Excessively large dimensions of the terminal slots											
14																	
15																	
16	Provides a reference surface which locates the electrical elements relative to the pressure sensor					Incorrect material specified											
17																	
18																	
19																	
20																	
21	Provides a flange to compress the internal environmental seal																
22		Terminal staking is insufficient	Loose terminals			Incomplete understanding of staking operation/process											
23																	
24	Provides interference tabs to locate and temporarily hold the base in relation to the crimp ring prior to crimp		Shift/fluctuation in switch setpoints														
25																	
26																	
27		Current leakage between terminals	Clutch of speed control system does not disengage			Low insulation resistance											
28	Provides a flange surface for the crimp ring					Incorrect material specified											
29																	
30	Provides lock tabs, keys, and features which mate to electrical connector	Fails to physically isolate: ingress of matter from external environment	High current leakage			Incorrect material specified											
31																	
32	Provides compression to environmental seal in connector		High millivolt drop														
33																	
34			Erratic or inoperative switch action														
35																	
36		Fails to properly locate the switch elements relative to the pressure sensor	Shift in setpoints			Warpage of the reference surface											
37																	
38			Erratic or inoperative switch														
39						Intrusion of other design elements into the plane of the reference surface												
40																	
41						Excessive clearance between mating features allows shift												
42																	
43		Leakage of environmental substances into switch cavity	Excessive current leakage														
44																	
45			High contact resistance														
46																	
47			Contacts stuck open														
48																	
49			Contacts stuck closed														
50																	
51		Lock tabs too small	Mating conn. falls off														
52																	
53																	
54		Lock tabs too big	Difficulty installing mating connector														
55																	
56																	
57		Seal gland between base and pressure sensor too small	Base and sensor do not seat properly, causing shift in setpoint														
58																	
59																	
60		Seal gland too big	Insufficient seal squeeze leading to leakage														
61																	
62																	
63		Incorrect polarity key location	Mating connector will not fit														
64																	
65																	
66																	
67																	
68	STATIONARY TERMINAL (36888)	High contact resistance/no continuity at blade	Device appears open-circuit w/ mating connector installed														
69	Provides a brass blade for interconnection																
70																	
71																	
72	Provides a silver-inlay surface for electrical contact	Blade dimensions improper	Device appears open-circuit w/ mating connector installed														
73																	
74	Provides a feature for device calibration		Difficulty installing conn.														
75																	
76	Provides a feature for staking into base	Terminal loose in base	Intermittent continuity														
77																	
78			Shift/fluctuation in switch setpoints														
79																	
80																	
81																	
82																	
83																	
84																	
85																	
86																	
87																	
88																	
89																	
90																	
91																	
92																	
93																	
94																	

Subsystem/Views: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen B. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen B. Offiler
FMEA Date (Orig): 910726 (Rev): 711188

	Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS Actions Taken	Sev.	Occ.	Det.	R.P.N.
95																	
96																	
97																	
98		High resistance at contacts	Apparent open circuit														
99			Intermittent continuity														
100																	
101		Contact resistance increase over life	Performance degradation over time														
102																	
103																	
104		Improper calibration	Mfg. yield loss (bad cal. detected at pressure tester)														
105																	
106																	
107																	
108																	
109																	
110																	
111	FEMALE TERMINAL (36897)	High contact resistance/no continuity at blade	Device appears open-circuit w/ mating connector installed														
112	Provides a brass blade for interconnection																
113																	
114																	
115	Provides a mounting point for the spring/movable contact	Blade dimensions improper	Device appears open-circuit w/ mating connector installed														
116																	
117																	
118	Provides a feature for staking into base		Difficulty installing conn.														
119																	
120																	
121		Terminal loose in base	Intermittent continuity														
122																	
123																	
124																	
125			Shift/fluctuation in switch setpoints														
126																	
127																	
128																	
129																	
130																	
131																	
132																	
133		High resistance at spring interface	Apparent open circuit														
134																	
135			Intermittent continuity														
136																	
137		Loose spring	Erratic operation														
138																	
139			shift/drift in setpoints														
140																	
141		Rivet hole size/ location bad	Will not assemble to spring properly														
142																	
143																	
144																	
145	SPRING (36899)	Low contact force	High millivolt drop across contacts														
146	Provides contact force																
147																	
148	Provides continuity between terminals																
149																	
150		High contact force	Change in setpoints														
151	Provides feature to interface with transfer pin																
152			Disc fracture														
153																	
154	Provides mounting location for movable contact	High resistance at movable terminal interface	Apparent open circuit														
155																	
156	Provides feature for attachment to stationary contact	Rivet hole size/ location bad	Will not assemble to terminal properly														
157																	
158																	
159																	
160																	
161																	
162		Transfer pin bumo out of position or missing	Spring failure over life														
163																	
164																	
165																	
166	RIVET (74171)	Length undersize	Spring falls off movable term														
167	Holds spring and movable terminal together																
168																	
169		Length oversize	Loose spring														
170																	
171																	
172																	
173		Diameter undersize	Loose spring														
174																	
175																	
176																	
177		Diameter oversize	Assembly difficulty														
178																	
179																	
180																	
181		Head undersize	Loose spring														
182																	
183																	
184																	
185		Head oversize	Assembly difficulty														
186																	
187																	
188																	

TI-NHTSA 019084

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen B. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen B. Offiler
FMEA Date (Orig): 9/18/96 (Rev): 9/11/97

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
	Hollow point coarse.	Weak rivet - spring falls off														
	Hollow point undersize	Difficult to rivet - loose spr														
DOUBLE CONTACT (79488) Provides electrical switching interface with stationary terminal	High contact resistance/no continuity	Device appears open-circuit w/ mating connector installed Intermittent continuity														
	Weldscreen increases contr life	Degradation of electrical parameters over time														
	Contacts weld	Device permanently closed-circuit; no response to fluid pressure														
	Weak geometry interroot	Contact does not assemble to spring, or falls off														
SEMPER CASED Provides a hydraulic sealing surface per SAE J512 Provides external thread for installation into mating part Provides hex feature for 9/16" wrench Provides fluid passage to pressure-sensing elements Provides gland for internal gasket Provides flange which interfaces with other components to form pressure-tensor structure	Fails to seal	Leakage of brake fluid	9		Incorrect surface finish specification Incorrect material specification Improperly specified gasketing Excessive pressure	1	Cross-check of print dimensions vs SAE standard Comprehensive evaluation of design at tolerance limits Burst testing to customer-specified limits	1	9							
	Fails to properly install in mating port	Damages threads in mating port during installation Does not allow installation	7	8 1 B.	Threads specified improperly Threads specified correctly but not gaged per established SAE spec's Plating buildup	7	Cross-check of applicable SAE and ANSI standards	5	245	Comprehend and reassess J1 and customer gaging practices relative to actual good versus bad threads	David Cason (Design Engineering Supervisor) & Andrew McGuirk (QEA Manager) Completion Date: none assigned yet					
	Apparently installs but fails to properly seat and seal	Brake fluid leakage	7	8 1 B.	Threads specified improperly Threads specified correctly but not gaged per established SAE spec's Plating buildup	7	Cross-check of applicable SAE and ANSI standards	5	245	Comprehend and reassess J1 and customer gaging practices relative to actual good versus bad threads	David Cason (Design Engineering Supervisor) & Andrew McGuirk (QEA Manager) Completion Date: none assigned yet					
	Incorrect hex size	Damage to hex flats during wrenching 9/16" wrench does not fit	5		Hex features improperly specified per established SAE/ANSI spec's	1	Cross-check of applicable SAE and ANSI standards	1	5							
	Fluid passage is too small	Electrical signal from switch is delayed or, pressure signal especially at very low temp. Subject to blockage by foreign matter	1		Inadequate size of fluid passage specified Inadequate review of Ford standard practices	1	Review of Ford standard practices Review of industry practices	1	9							
	Fluid passage is too large	Resulting thin wall section causes breakage: - during installation - during underhood service operations	7		Fluid passage specified excessively large	1	Torque testing	1	7							
	Fails to seal be-	Leakage of brake fluid	9		Gland dimensions	1	Cross-check with	1	9							

Subsystem/Area(s): Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen M. Offiler
Other Areas Involved:

Suppliers And Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared By: Stephen M. Offiler
FMEA Date (Orig): 7/07/94 (Rev): 9/11/00

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	RPN	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	RPN
	Coated gasket improperly				Improperly specified Surface finishes improperly specified Gland geometry improperly designed		recommendations of gasket supplier Comprehensive testing									
	Flange fails to mate properly with other components of pressure sensor	Dia. too large results in assembly difficulty Dia too small results in bad component alignment Flange too thick results in poor crimp Flange too thin results in reduced burst capacity Improper edge chamfer results in stress concentration which weakens crimp	9		Improper or incomplete specification of dimensions and tolerances	1	Experiments and analysis to determine proper thickness for req'd strength Tolerance stack-up analysis Print review	1	9							
	Material too soft or weak	Inadequate burst capacity Damage/breakage during installation or subsequent service Threads prone to damage, leads to assembly difficulties	9		Improper material selection	1	Comprehensive evaluation of physical properties	1	9							
	Material creeps	Loosening of crimp leads to leakage	9		Improper material selection	1	Review of material properties	1	9							
	Material degrades in presence of working fluid(s)	Leakage	9		Improper material selection	1	Cross-check with similar products	1	9							
	Insufficient environmental protection	Long-term attack causes weakening of key areas which leads to leakage or breakage Cosmetic problems	9		Improper or insufficient plating specification	1	Comprehensive environmental testing Review of plating specimens	3	27							

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen R. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen R. Offiler
FMEA Date (Orig): 910724 (Rev): 911108

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
GASKET (74352) Provide fluid seal between support and diaphragm	Wrong size	Excessive gasket squeeze distorts gasket, results in leak														
		Excessive squeeze results in improper assembly and reduced life of gasket leading to leak														
		Insufficient squeeze results in leak														
		Gasket diameter too large, results in assembly difficulty														
		Gasket diameter too small, results in leak														
	Wrong material	Reduced gasket life, leading to leak														
		Permanent set after temperature exposure leads to leak														
DIAPHRAGM (74175) Forms flexible element of fluid containment cavity Transfers pressure from fluid to pressure-sensing elements	Insufficient material properties	Reduced life leading to leak														
HOUSING (27637) Provides a portion of the support surfaces for diaphragm	Surface roughness	Reduced diaphragm life leading to leakage														
Provides support for compression of gasket Locates converter and disc with respect to cap	Incorrect diameter	Shift in setpoints														
		Reduced diaphragm life leading to leakage														
	Hunt	Reduced disc envelope, inoperative device														
		Reduced gasket squeeze results in leak														
	Wrong material	Improper hardness and/or strength leading to bending														
	Wrong heat-treatment	Improper hardness and/or strength leading to bending														
	Incorrect ID	Too small results in difficult assembly to converter														
		Too small results in friction between washer and converter,														

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Years/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 9/08/96 (Rev.): 9/11/98

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
		Leading to shift in setpoints over life														
		Too large results in poor location of connector, shift in setpoints or inoperative														
		Too large results in reduced diaphragm life														
	Incorrect OD	Too large results in difficult assembly														
		Too small results in poor location of connector, shift in setpoints or inoperative														
	Incorrect thickness	Too thick results in poor crimp, leads to reduced diaphragm life or reduced burst capacity														
		Too thin leads to leaking														
	Burrs	Reduced diaphragm life														
CONNECTOR (27986) Transfers pressure from fluid (via diaphragm) to a force on pressure-sensing disc Provides alignment and support to spacer and disc	Irregularities on surface mating with diaphragm	Reduced diaphragm life														
	Incorrect button dia	Too large results in difficult assembly to washer														
		Too large results in friction between washer and connector, leading to shift in setpoints over life														
		Too small results in poor location of connector, shift in setpoints or inoperative														
		Too small results in reduced diaphragm life														
	Button not of true-position relative to disc locate feature	Difficult assembly														
		Poor location of disc leading to inoperable device or shift in setpoints														
	Incorrect geometry of disc locate features	Disc shifts relative to connector; shift in setpoints or inoperable device														
		Connector bottoms against cup; no disc snap; contacts do not open or contact gap too small														
	Incorrect material	Excessive flex causes device inoperation														
	Incorrect thickness	Too thick leads to assembly difficulty and/or disc pre-snap and inoperable device														
		Too thin leads to excessive flex, device inoperation														
	No vent hole	Trapped pressure behind disc leads to increase in setpoints & variations with temperature														
	Incorrect geometry of OD	Too small causes difficulty with disc location; inoperable device														
		Too large causes interference with cup; erratic operation or inoperable device														
SPACER (27988) Reduce friction between disc and connector	OD too large	Causes disc to locate improperly to connector; erratic device operation, shift in setpoints or inoperable														
	OD too small	Excess friction in areas without spacer causes disc wear, and shift in setpoints over life														
	Incorrect thickness	Excessive thickness causes re-														

TI-NHTSA 019098

Subsystem/Name: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen R. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen R. Offiler
FMEA Date (Orig): 718724 (Rev): 911108

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS: Actions Taken	Sev.	Occ.	Det.	R.P.N.
		Axial disc envelope; possible irreparable device														
		Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint														
	Improper Teflon coating	Too thin leads to early wear-out, leading to excess disc friction and shift in setpoint														
DISC (E6456) Controls actuation and release set-points of switch relative to applied force	Incorrect diameter	Hinders assembly														
		Inoperative device														
		Incorrect calibration														
	Excessive wedge	Hinders assembly														
		Inoperative device														
		Incorrect calibration														
	Material composition	Shift in setpoints over life														
		Reduced proof capability														
		Disc fatigue failure														
	Excessive burr	Shift in setpoints over life														
	Wrong thickness	Too thin requires increased force to achieve setpoints; results in reduced life														
		Too thick requires decreased force to achieve setpoints; reduced chrom. inadequate contact gap														
CUP (27208 and 27713) Provides retainable area which holds pressure-sensor together	Crimp area geometry incorrect	Poor crimp leads to reduced proof/burst capability, reduced diaphragm life														
Provides support for disc																
Locates washer relative to other components	Wrong material thickness	Too thick will not fit in assembly tooling disc														
Provides guide for transfer pin		Too thin leads to reduced proof/burst capability, reduced diaphragm life														
	Wrong material	Too soft or hard leads to poor crimp, reduced proof/burst capability, reduced diaphragm life														
	Disc support bump geometry incorrect	Incorrect calibration														
		Disc fatigue														
		Inoperative device														
	Geometry of washer locating step incorrect	Too high - excessive disc envelope; leads to increased diaphragm strain, incorrect calibration														
		Too low - insufficient disc envelope; pre-wrapped disc and inoperative device														
		Dia small results in difficult assembly														
		Dia large results in poor location of converter, shift in setpoints or inoperation														
	Geometry of pin guide incorrect	Dia small results in pins sticking - may give erratic operation at temperature extremes														
		Dia large results in shift in pin position, erratic electrical characteristics														
		Too short provides poor guidance, results in crooked pins, inoperative or erratic device														
		Too long may short spring to														

TI-NHTSA 018099

Subsystem/Assem: Speed Control Deactivate Pressure Switch
Design Responsibility: Stephen H. Offiler
Other Areas Involved:

Suppliers and Plants Affected:
Model Year/Vehicle(s):
Engineering Release Date:

Prepared by: Stephen H. Offiler
FMEA Date (Orig): 910724 (Rev): 911208

	Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev.	Class.	Potential Cause(s) of Failure	Occ.	Design Verification	Det.	R.P.N.	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS Actions Taken	Sev.	Occ.	Det.	R.P.N.
659			housing														
660																	
661	SEAL/COMPRESSOR HOUSE (74247) Seal base assembly to sensor assembly	Thickness incorrect	Too thin results in poor seal; leakage of materials from environment Too thick causes difficulty in final crimp, cracks in base flange, or inoperative/erratic device operation														
668		ID incorrect	Too large - may not squeeze uniformly around circumference Too small - won't assemble														
675		OD incorrect	Too small - insufficient seal area														
679		Wrong material	Long-term degradation results in leakage														
682		Porosity in material	May result in leakage if combined with insufficient squeeze														
686	TERMINAL PIN (74248) Transfers disc motion to movable electrical contact Insulates electrical components from switch housing	Diameter incorrect	Dia large results in pins sticking - may give erratic operation at temperature extremes Dia small results in shift in pin position, erratic electrical characteristics														
695		Length incorrect	Too short - low setpoints or device open-circuited Too long - high setpoints, inadequate contact gap, contacts won't open														
702		Material incorrect	Shift in setpoints with temp Current leakage to housing Fractures/ridges: erratic or inoperable device														
707	CRIMP RING (74727) Hold capacher base assembly and sensor assembly	ID incorrect	Too large results in poor crimp Too small hinders assembly														
715		Length incorrect	Too long or short causes poor crimp; low resistance to rotation of base rel. to sensor; cracked base														
720		Material incorrect	Difficult or weak crimp Corrosion (if ferrous not 41)														
724		Thickness incorrect	Too thin results in poor crimp Too thick results in difficulty crimping/mating in dies														
729																	

TI-NHTSA 019100

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503788
Revision Level C
Revision Date 6-Nov-96

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 95

Model Year(s)/Vehicle(s) Viridian

Key Date 1998

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Assembly, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
GATE [PS] (46518) Provides a system of slots which guide, locate, and physically support terminals.	Fails to properly locate terminals.	Terminals out of position.	3		Incorrect dimensions and/or tolerances specified between slots and terminals. Inadequate casing design concept.	1	Comparison with dimensions of similar 57PS product.	1	3							
	Fails to properly guide the terminals without insertion.	Devices will not assemble properly; yield loss in mfg.	5		Incorrect dimensions and/or tolerances specified between slots and terminals. Insufficient lead-in	1	Review with assembly equipment designers to determine correct clearances and lead in.	1	5							
	Fails to properly support the terminals.	Terminals move relative to each other or the base (push on under physical or thermal loadings).	6		Incorrect material specified. Excessively large dimensions specified on terminal slots.	1	Comparison with design of similar 57PS product.	1	6							
Provides features to enhance the effectiveness of terminal locking.	Terminal locking is insufficient.	Loose terminals. Misapplication in switch assembly	5		Incomplete understanding of design of locking features.	1	Comparison with design of similar 57PS product. Testing limitations.	1	5							
Provides a dielectric medium for the electrical terminals.	Current leakage between terminals or terminal-to-housing.	Improper switching action.	8		Low insulation resistance. Incorrect material specified.	1	Comparison with design of similar 57PS product. Material evaluation	1	8							

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TI-NHTSA 019101

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503788
Revision Level C
Revision Date 4 Nov-96
Original (Initial) Date 20 Dec-93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Prepared By C Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
BASE [PS] (485 M) Provides physical location of the switch components.	Fails to physically isolate: ingress of matter from external environment.	High current leakage. High millivolt drop. Erratic or inoperative switch action.	8		Inconsistent material specified. Poor molded part design i.e. wall sections too thin, etc.	1	Comparison with design of similar 57PSI product. Design review with molder. Mold flow analysis.	1	8							
Provides a reference surface which locates the electrical elements relative to the pressure sensor.	Fails to properly locate the switch elements relative to the pressure sensor.	Shift in setpoints. Erratic or inoperative switch.	5		Warpage of the reference surface. Intrusion of other design elements into the plane of the reference surface. Excessive clearance specified between mating features.	1	Specification of flatness on print. Raise the surface to prevent intrusion of other elements. Tolerance stackup analysis.	1	5							
Provides a flange to compress the external environmental seal.	Improper compression of external environmental seal.	Inadequate compression may lead to ingress of matter. Excessive compression may prevent switch from passing correctly to sensor assembly.	7		Incorrect seal gland design. Warpage.	1	Review of standard gland design practice. Comparison to similar products. Flatness specified on print.	1	7							

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TI-NHTSA 019102

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document number 5033768
Revision Level C
Revision Date 4-Nov-96

___System
___Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Resp. & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
BASE (PE) (46815) Provides interference tabs to locate and temporarily hold the base in relation to the crimp ring prior to crimp	Fails to properly locate/hold prior to crimp.	Too large may cause difficulty in assembly, base cracking, or prevent switch from seating to sensor. Too small provides no effect; possibly effecting subsequent assembly operations.	5		Design of interference tabs is insufficient	1	Calculation and superimposition to determine limits of tabs Tolerance stackup analysis	1	5							
Provides a flange surface for the crimp ring.	Fails to provide adequate geometry for crimp ring.	Base loose or insufficient torque withstand. Base cracked.	7		Incorrect design of flange for crimp ring.	1	Comparison with design of similar ESPS product.	1	7							
Provides lock tabs, keys, and features which mate to electrical connector.	Mating electrical connector doesn't fit properly.	Connector difficult to install. Connector falls off.	8		Connector geometry improperly specified.	1	Review of dimensions relative to mating connector prints	1	8							
Provides compression to environmental seal in connector.	Mating connector seal is not properly compressed.	Ingress of matter into switch cavity. Connector difficult to install and/or falls off.	7		Connector geometry and/or surface conditions/finishes is improperly specified. Incorrect material specified.	1	Review of dimensions relative to mating connector prints. Material evaluation	1	7							

CONFIDENTIAL

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503786 — Page 1
Revision Level D
Revision Date 28-May-98
Original (Initial) Date 20-Dec 93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
STATIONARY TERMINAL (36888 & 36729) Provides a brass blade for interconnection.	Poor interconnection.	Device appears open-circuit when mating connector installed.	7		Contamination of brass blade. Material specified too thin	1	Review design and dimensions of mating connector to assure proper interference and wiping action	1	7							
	Blade geometry improper	Difficult to install mating connector	5		Location chamfers on terminal are insufficiently specified Material specified too thick	1	Review design and dimensions of mating connector Comparison with design of similar 57P5 product	1	5							
Provides a silver alloy surface for electrical contact	Fails to provide adequate electrical current.	Device appears open-circuited. Intermittent continuity High voltmeter drop	7		Incorrect contact material specified Contamination Silver layer specified too thin.	1	Review of TI proprietary and general contact design info Examine paths for degree of contamination	1	7		CONFIDENTIAL					
	Excessive loss of contact height dimension (mechanical loads)	Shift in set points over life.	7		Silver layer specified too thick	1	Review of TI proprietary and general contact design info Life Tagging	1	7							
	Erosion of contacts due to electrical loads.	Shift in setpoints over life. Intermittent or no continuity	7		Incorrect material specified for particular electrical loading	1	Review of TI proprietary and general contact design info Review and testing with actual electrical loads	1	7							

TI-NHTSA 019104

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 103768
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___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
STATIONARY TERMINAL (35855 & 35728) Provides feature for device calibration	Poor calibration	Mfg. yield loss Shift in setpoints over life.	5		Design is excessively stiff. Design has excessive spring back Material hardness is incorrectly specified Initial process requires excess deformation to calibrate Design has inadequate tolerance to maintain calibration over life	1	Mechanical (and/or FEA) analysis Force deflection springback testing Testing with actual production calibration equipment	1	5							
Provides features to ensure adequate seating into base.	Terminal is inadequately seated into base	Loose terminals Shifts/backouts in switch setpoints.	7		Incomplete understanding of design of locking features	1	Comparison of design with similar STPS product Mating evaluations	1	7		CONFIDENTIAL					
Provides features which mate with slots in base for location of terminal	Fails to properly locate terminal.	Terminals out of position.	7		Incorrect dimensions and/or tolerances specified between slots and terminals Inadequate locking design concept	3	Comparison of design with similar STPS product	1	9							
Provides electrical path from silver inlay contact to mating connector	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified. Inadequate contact area	1	Calculations of resistance Testing	1	5							

TI-NHTSA 019105

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503750
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Revision Date 4-Nov-98

___ System
___ Subsystem
_X_ Component(s) Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 28 Dec 94

Model Year(s)/Vehicle(s) Verbier

Key Date 1997

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
MOVABLE TERMINAL (36557) Provides a force blade for interconnection	Poor interconnection	Device appears open-circuit following connector installed.	7		Material specified too thin.	1	Review design and dimensions of mating connector to ensure proper interference and wiping action	1	7							
	Blade geometry improper.	Difficult to install mating connector.	5		Lead-in chamfers on terminal are insufficiently specified Material specified too thick	1	Review design and dimensions of mating connector Comparison with design of similar STPS product	1	5							
Provides a mounting point for the spring via rivet	Fails to allow proper spring/rivet installation	Shift/fluctuation in switch setpoints (loose rivet). Inoperative device (rivet falls out completely) Mfg. yield loss.	7		Rivet hole size is specified incorrectly Rivet hole position is specified incorrectly Support surface for riveting is incorrectly specified -Choice of fastener style incorrect	1	Comparison with design of similar products Check with recommendations of rivet manufacturer Testing	1	7		CONFIDENTIAL					
Provides features to permit adequate staking wire base.	Tightened or inadequately staked into base.	Loose terminals. Shift/fluctuation in switch setpoints.	7		Incomplete understanding of design of staking features.	1	Comparison of design with similar STPS product Staking evaluation	1	7							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: 883790
Revision Level: C
Revision Date: 4-Nov-96

___System
___Subsystem
X Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Initial) Date: 20-Dec-90

Model Year(s)/Vehicle(s): Various

Key Date: 1993

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
MOVABLE TERMINAL (34887) Provides latching which mate with slots in base for location of terminal	Fails to properly locate terminal.	Terminals out of position.	3		Incorrect dimensions and/or tolerances specified between pilot and terminals. Inadequate staking design concept	3	Comparison of design with similar STPS product	1	9		CONFIDENTIAL					
Provides electrical path from movable contact via spring to mating connector	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified Inadequate cross-section area	1	Calculations of resistance Testing	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503791
Revision Level C
Revision Date 4 Nov 96
Original (Initial) Date 20 Dec 93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Prepared By C. Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
SPRING (3688) Provides contact force	Low contact force	High millivolt drop across contacts.	8		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	15							
	High contact force.	Shift in setpoints. Disc cracking over life	7		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	21							
Provides electrical path from movable contact to movable terminal	Fails to provide adequate conductivity	High resistance shown as high millivolt drop.	8		Incorrect material specified Inadequate cross-section area	1	Calculations of resistance using R = (Rho)(L) / A Testing	1	8							
Provides feature to interface with transfer pin	Fails to interface correctly with transfer pin	Spring failure overlife Shift in setpoints over life. Sticking transfer pin causes intermittent operation.	7		Inadequate height of feature specified Inadequate shape of feature specified. Improper position of feature specified.	1	Comparison of design with similar product Dimension and tolerance stack-up analysis Actual measurement Testing	1	7		CONFIDENTIAL					
Provides feature for attachment to provide contact	Fails to provide adequate mounting for movable contact.	Intermittent or erratic operation Open circuit.	8		Hole size/position incorrectly specified. Flames inadequate	1	Riveting recommendations Comparison of design with similar product Testing	1	8							
Latches movable contact	Fails to adequately locate movable contact relative to stationary contact.	High millivolt drop over life. Excessive contact erosion over life.	7		Spring geometry incorrectly specified	1	Dimension and tolerance stack-up analysis. Testing	1	7							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Page 1

___System
___Subsystem
_X_Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Key Date: 1993

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Document Number: 801752
Revision Level: C
Revision Date: 4-Nov-96

Original (Initial) Date: 20 Dec 93

Model Year(s)/Vehicle(s): Various

Prepared By: C Hyogo

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R. P. N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
SPRING (30889)																
Provides moment to ensure disc rotates with shaft	Fails to properly attach to provide specified	Erratic / intermittent operation. Shift in setpoint Open or short circuit	8		Rivet not into or position incorrectly specified. Flatness inadequate Choice of fastener style incorrect	1	Plant mfg recommendations Comparison of design with similar product Testing	1	8							
Allows disc overtravel	Fails to allow disc overtravel	Shift in setpoint. Disc cracking Device inoperative at assembly. Poor calibration	8		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	16							
Provides force to open contacts	Inadequate force to open contacts	Insufficient resistance to mechanical vibration. Short circuit.	4		Incorrect geometry specified. Incorrect material specified.	1	Beam deflection equations Force/deflection testing	1	4							
	Excessive force to open contacts.	Shift in setpoint. Disc cracking. Device inoperative at assembly. Poor calibration	7		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing	1	21							

CONFIDENTIAL

TI-NHTSA 019109

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: 403784
Revision Level: C
Revision Date: 4-Nov-96

___System
___Subsystem
X Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Initial) Date: 20 Dec-93

Model Year(s)/Vehicle(s): Various

Key Date: 1993

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
GASKET (#483): Provides fluid seal between flanged and diaphragm	Fails to provide adequate fluid seal	Degree fluid leakage	9		Insufficient compression specified. Very excessive compression specified, leading to displacement from gland Incorrect ID and/or OD causing to displacement from gland Incorrect cross-section shape specified Incorrect material specified, dust incompatibility Incorrect design of sealing mechanism	1	Review of general seal design principles Manufacturer's recommendations Burst, impulse and thermal cycle tests Comparison with design of similar products	1	9		CONFIDENTIAL					

TL-NHTSA 019110

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503795
Revision Level C
Revision Date 4-Nov-96
Original (orig) Date 20-Dec-93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Years/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
CUP (27713 OR 27264) Provides crimpable area which holds armature assembly together.	Fails to provide a suitable geometry for crimp.	Leakage. Low burst	9		Crimp wall thickness incorrectly specified Crimp wall height incorrectly specified Incorrect material specified	1	Burst and impulse testing Comparison of design with similar product	1	9							
Locates bearpost, diaphragm, and orifice	Fails to correctly locate bearpost, diaphragm, or orifice	Difficult assembly.	5		ID specified incorrectly	1	Tolerance stackup analysis	1	5							
Provides support and location for disc	Fails to support and locate the disc/converter correctly.	Shift in setpoints. Erratic operation Stuck open at assembly. Reduced disc life.	7		Incorrect disc or keeper specified Bump size/position incorrectly specified Poor surface condition at bump, no control specified	1	Tolerance stackup analysis Impulse testing	1	7							
Provides guide for transfer pin.	Fails to guide transfer pin correctly.	Erratic operation. Device stuck short-circuit.	7		Pin guide geometry is incorrectly specified.	1	Tolerance stackup analysis	1	7							
Provides portion of environmental seal gland.	Fails to allow a proper environmental seal.	Ingress of water. Switch does not seal correctly to cup.	7		Surface condition required for good seal not understood or not correctly specified Geometry incorrectly specified	1	Environmental testing. Switch cavity pressurization testing Review of standard gland design rules	1	7							

CONFIDENTIAL

TI-NHTSA 019111

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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Original (Initial) Date 20-Dec-93

___System
___Subsystem
_X_Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Prepared by C. Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CLIP (2713 OR 2728) Provides surface to interface with pressure switch assembly.	Fails to properly locate relative to switch.	Shift in setpoint. Erratic or inoperative switch.	6		Incorrect geometry of mating surface specified.	1	Tolerance stackup analysis. Cross-section actual devices for inspection of interface	1	6	CONFIDENTIAL						
(Post-upset-crimp) provides geometry for final assembly with crimp ring	Fails to allow proper final assembly with crimp ring.	Erratic operation. Ingress of water. Cracked base	7		Post-crimp geometry is not controlled per design intent. Cup diameter incorrectly specified.	1	Tolerance stackup analysis Base torque testing.	1	7							

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

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Revision Level D
Revision Date 4 Feb 98

___System
___Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Feb 92

Model Year(s)/Vehicle(s) Viceroy

Key Date 1992

Prepared By [illegible]

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
DIAPHRAGM (OR SEAL) (SP) (741Tb) Fomt. flexible element at fluid containment cavity	Fails to contain fluid.	Fluid to plunger.	9		Gradual rupture over life due to improper design of supporting elements Gradual rupture over life due to excessive deformation/displacement Gradual rupture over life due to stress concentrations caused by asymmetric strain distributions Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm material. Insufficient tension/crimping of diaphragm	1	Burst, impulse, and thermal cycle tests Material mfg recommendation Comparison of design with similar products	1	9	CONFIDENTIAL						
Transfers pressure from fluid to pressure-sensing elements.	Excessive change in area of pressure transfer over life Excessive change of pressure transfer area versus pressure.	Shift in setpoints over life. Excessively high pressures needed to adequately form pressure transfer area; wide signal on setpoints due to unpredictability at lower pressures.	8 8		Diaphragm too stiff. Incorrect material specified. Diaphragm too stiff Incorrect material applied	1 1	Life testing w/ characterization of intermediate points Force and pressure versus deflection testing to calculate effective areas	1 1	8 8							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Page 1

Document Number 503757
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Revision Date 4-Nov-96

___System
___Subsystem
_X_Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 29 Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
WASHER (PS) (23639) Provides a portion of the support surface for diaphragm.	Fails to correctly support the diaphragm	Reduced diaphragm life results in leakage.	8		Contours of diaphragm support surface are specified incorrectly Condition of edges of support surface specified incorrectly Clearance between washer I.D. and nonmetal bump is specified too wide	1	Burst, Impulse, and Thermal Cycle tests Comparison of design with similar products	1	8							
Provides support for compression of gasket	Fails to allow proper gasket compression.	Leakage.	8		Washer flatness is incorrectly specified or unspecified Washer thickness is specified too small Washer material and/or heat-treat is incorrectly specified	1	Burst, Impulse, and Thermal Cycle tests Comparison of design with similar products	1	8							
Locates and guides connector with respect to cup.	Connector is not properly located relative to cup	Shift in setpoints. Erratic behavior.	5		Incorrectly specified button guide I.D. Incorrectly specified washer O.D.	1	Comparison of design with similar products. Tolerance stackup analysis	1	5							
	Connector travel is restrained by washer.	Disc cannot release: results in stuck open circuit.	7		Washer flatness is incorrectly specified or unspecified. Washer thickness is specified too small Washer material and/or heat-treat is incorrectly specified I.D. of button guide is too small	1	Burst, Impulse, and Thermal Cycle tests. Comparison of design with similar products Tolerance stackup analysis	1	7							

CONFIDENTIAL

TI-NHTSA 019114

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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Revision Level: C
Revision Date: 4-Nov-94

___System
___Subsystem
_X_Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Initial) Date: 20 Dec-93

Model Year(s)/Vehicle(s): Various

Key Date: 1995

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Prepared By: C. Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
WASHER [PG] (27539) Interfaces with cup feature and connector, a portion of component which lies crimp.	Fails to interface correctly with cup.	Difficult assembly (adapter O.D. too large). Poor weld/connector (variation relating to cup (oversize O.D. too small).	7		Washer O.D. specified incorrectly	1	Comparison of design with similar products. Tolerance stackup analysis	1	7							
	Fails to allow proper crimp.	Reduced burst capability/leads to leakage. Reduced fatigue resistance leads to leakage.	8		Thickness incorrectly specified O.D. incorrectly specified Edge condition incorrectly or unspecified	1	Tolerance stackup analysis Burst, impulse, and Thermal Cycle tests	1	8							

CONFIDENTIAL

TI-NHTSA 018116

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 303756
Revision Level E
Revision Date 13-May-96

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Issue) Date 20 Dec 93

Model Year(s)/Vehicle(s) Viviano

Key Date 1993

Prepared By Drake

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CONVERTER (PSI (27468) Transfers pressure from fluid (via diaphragm) to a force on pressure-sensing disc	Fails to correctly provide fluid pressure to force on disc	Shift in setpoints	5		Button O.D. incorrectly specified relative to washer I.D. Converter major O.D. incorrectly specified relative to cup I.D. Converter thickness incorrectly specified Incorrect material specified.	1	Tolerance stackup analysis Force/deflection analysis to determine strength and resistance to plastic deformation Burst, impulse, and Thermal cycle tests	1	5	CONFIDENTIAL						
Provides alignment and support to disc.	Fails to properly align and support disc.	Loose clearances allow misalignment which may cause shift in setpoints or erratic operation. Disc-out-of-plane relative to converter may cause erratic operation or inoperative device, stuck open/closed.	5		Button O.D. incorrectly specified relative to washer I.D. Converter major O.D. incorrectly specified relative to cup I.D. Disc support bump incorrectly specified Disc retaining wall incorrectly specified	1	Tolerance stackup analysis. Comparison of design with similar product	1	5							

TI-NHTSA 019116

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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Revision Level E
Revision Date 13-May-08
Original (Initial) Date 20-Dec-01

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1853

Prepared By D. Ha

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CONVERTER (PSI (3749) Provides a portion of the support surface for diaphragm.	Fails to properly support diaphragm.	Reduced diaphragm life results in leakage.	8		Contours of surfaces in contact with diaphragm are specified incorrectly Condition of edges in contact with diaphragm are specified incorrectly Clearance between converter bump and washer I.D. are specified too wide.	1	Burst, Impulse, and Thermal cycle tests. Comparison of design with similar product	1	8							
Provides disc support during over pressure (proof/burst)	Fails to properly support disc during over pressure	Disc deformation results in shift in setpoints. Reduced disc travel if disk motion is restricted prematurely. Reduced disc life	6		Features which control disc motion during over pressure are incorrectly specified	3	Pre-and post-proof characterization Pressure-deflection measurements of disc motion.	1	18							
Vent in converter prevents pressure buildup from altering setpoints.	Does not vent properly.	Shift in setpoints over temp. Ruptured disc seals.	5		Vent hole incorrectly specified	1	Comparison of design with similar product. Temperature characterizations	1	5							

CONFIDENTIAL

TI-NHTSA 019117

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

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Revision Level C
Revision Date 4-Nov-96
Original (Initial) Date 20-Dec 93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1999

Prepared By C Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
SPACER (13856) Reduce friction between diaphragm disc and connector	Fails to effectively reduce friction.	Shift in setpoints over life. Reduced disc life.	8		Incorrect material specified. Incorrect dimensions specified.	1	Impulse And Thermal Cycle tests. Pre- and Post-life characterizations Tolerance pickup analysis	1	8		CONFIDENTIAL					
Allow venting of chamber formed by disc and connector	Fails to allow venting.	Shift in setpoints over temp. Reduced disc action	8		Vent hole incorrectly specified	1	Comparison of design with similar product Temperature characterization	1	8							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503600
Revision Level C
Revision Date 4-May-98

___System
___Subsystem
_X_ Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Initial) Date: 20-Dec-93

Model Year(s)/Vehicle(s): Various

Key Date: 1995

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

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

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503801 | Page 1
Revision Level C
Revision Date 4-Nov-96

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Issue) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date FEB3

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CRIMP RING (74787) Hold together base assembly and sensor assembly.	Fails to hold base to sensor correctly.	Erratic switch operation. Crushed base. Shift in setpoint. Low base torque strength.	5		Incorrect geometry of crimping area specified. Incorrect geometry of formed ring. Incorrect material specified	3	Impulse, thermal cycle, base torque, and base/terminal impact tests	1	15							
Provide a surface for part identification/traceability code	ID characters illegible	Improperly identified parts on assembly plans	2		Geometry/flatness not properly specified Wrong material specified	1	Coding tests Environmental tests	1	2							
Impart electrochemical protection and resistance to device	Inability to withstand environment.	Corrosion causes material consumption, loss of mechanical properties, switch eventually fails off sensor. Possible cracks.	7		Wrong material specified	1	Environmental tests.	1	7							
Provide lubrication to crimp area via wax coating	Insufficient lubrication.	Metal flakes/particles on actuated device surfaces.	3		Incorrect or insufficient wax specified.	1	Crimping tests	1	5							

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TI-NHTSA 019120

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: 503802 Page 1
Revision Level: C
Revision Date: 4-Nov 96
Original (Issue) Date: 20 Dec 93

___System
___Subsystem
_X_ Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Vantage

Key Date: 1993

Prepared By: C. Wiggins

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
TRANSFER PIN (24078) Transfers disc motion to movable electrical contact	Fails to properly transfer disc motion.	Contacts stuck open. Contacts stuck closed. Erratic operation.	7		Diameter incorrectly specified. Chips/fragments cause pin to lodge	1	Tolerance stackup between pin and pin guide in cup Check with supplier for material properties regarding chips	1	7		CONFIDENTIAL					
Transfers electrical components from switch housing	Fails to insulate	Continuity between assembly terminal and housing to ground.	5		Wrong material specified.	1	Check with supplier for material properties. Check with customer for electrical logic of grounded terminal	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503402
Revision Level C
Revision Date 4-Nov-96

___System
___Subsystem
_X_Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
TRANSFER PIN (74078) Transfers disc assembly to movable electrical contact	Fails to properly transfer disc motion.	Contacts stuck open. Contacts stuck closed. Erratic operation.	7		Diameter incorrectly specified. Chips/fragments cause pin to lodge	1	Tolerance stackup between pin and pin guide in cup Check with supplier for material properties regarding chips	1	7	CONFIDENTIAL						
Insulates electrical components from switch housing	Fails to insulate.	Connectivity between movable terminal and housing to ground.	6		Wrong material specified	1	Check with supplier for material properties Check with customer for electrical logic of movable terminal	1	6							

TL-NHTSA 019122

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503803
Revision Level C
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___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
ENVIRONMENTAL SEAL (74247) Prevents ingress of water to switch cavity.	Contaminants enter switch cavity.	High current leakage High millivolt drop. Erratic or inoperative switch operation.	7		Gasket thickness is specified too small Lubricant not properly not specified Incorrect material	1	Review of standard practice for gland design Review with gasket manufacturer Comparison of design with similar product	1	7	CONFIDENTIAL						
Prevents friction between mating base surfaces	Base rotates too freely	Perceived as inadequate by assembly plant and/or service personnel.	5		Gasket thickness improperly specified	1	Review of standard practice for gland design Torque-to-rotate testing Comparison of design with similar product	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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Revision Level C
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Original (Initial) Date 20 Dec 93

___System
___Subsystem
_X_Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Prepared By C. Wiggins

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

TI-NHTSA 019124

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503804
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___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Vantage

Key Date 1998

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

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

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TI-NHTSA 019125

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: 503105
Revision Level: C
Revision Date: 30-Oct-98

___System
___Subsystem
X Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Initial) Date: 20-Dec-93

Model Year(s)/Vehicle(s): Various

Key Date: 1999

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
REPORT (36900) Provides a hydraulic sealing surface per SAE J512.	Fails to seal.	Leakage of brake fluid.	9	FF	Incorrect surface finish specification. Incorrect material specification incorrectly specified geometry. Excessive pressure	1	Cross-check of print dimensions vs. SAE standard. Comprehensive evaluation of design as necessary tests. Burst testing to customer specified levels.	1	9							
Provides external thread for installation into mating part	Does not properly mount in mating part	Deshreads threads in mating part during installation. Does not allow installation.	7	FF	Threads specified improperly. Threads not gauged per ANSI spec's. Plating / buildup	3	Cross-check of applicable SAE and ANSI standards	3	63							
	Apparently installs, but fails to properly seal stat seal.	Brake fluid leakage	9	FF	Threads specified improperly. Threads not gauge per ANSI spec's. Plating buildup	1	Cross-check of applicable SAE and ANSI standards	3	27							
Provides hex feature for 9/16" wrench.	Incorrect hex size.	Damage to hex fails during connecting 9/16" ermale brass nut to	8		Hex features improperly specified per established SAE/ANSI spec's.	1	Cross-check of applicable SAE and ANSI standards	1	8							
Provides fluid passage to pressure-sensing element.	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp. Subject to blockage by foreign matter.	7	FF	Inadequate size of fluid passage specified. Inadequate review of Ford standard practices	1	Review of Ford standard practices. Review of industry practices.	1	7							
	Fluid passage is too large.	Resulting fills will section causes breakage: during installation during unscheduled service disruptions	7	FF	Fluid passage specified excessively large	1	Torque testing.	1	7							

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TI-NHTSA 019126

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1995

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
HEXPORT (36808) Provides gland for wiring/ gasket.	Fails to seal internal gasket properly.	Leakage of brake fluid.	9		Gland dimensions inappropriately specified. Surface finishes inappropriately specified. Gland geometry inappropriately designed	1	Cross-check with recommendations of gasket supplier. Comprehensive sealing	1	9							
Provides flange which interfaces with other components to form pressure-sensor structure.	Flange fails to mate properly with other components of pressure sensor.	Dia. too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor crimp. Flange too thin results in reduced burst capacity. Improper edge diameter results in crimp consolidation which maintains crimp.	8		Improper or incomplete specification of dimensions and tolerances	1	Experiments and analyses to determine proper thickness for required strength. Tolerance stack-up analysis. Print review	1	8							
	Material too soft or weak.	Inadequate burst capacity. Damage/breakage during installation or subsequent service. Threads prone to damage, leads to apparently obscure	8		Improper material selection.	1	Comprehensive evaluation of physical properties	1	8							
	Material creeps.	Loosening of clamp leads to leakage.	6		Improper material selection.	1	Review of material properties	1	6							
	Material degrades in presence of working fluid(s)	Leakage	8		Improper material selection	1	Cross-check with similar products	1	8							
	Insufficient environmental protection.	Long-term attack causes weakening of key areas which leads to leakage or failure/rupture	9		Improper or insufficient plating specification	1	Comprehensive environmental testing	2	27							

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TI-NHTSA 019127

___System
___Subsystem
X Component Pressure Switch

Model Year(s)/Vehicle(s) Various

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Design Responsibility Pressure Switch Group

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

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Prepared By C. Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
REXPORT (503609) Provides flange which mates with other components to form pressure-tight/ structural		Cosmetic problems.	8			1	Review of piping practices	3	27							

Movable Contact

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TI-NHTSA 019129

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

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___System
___Subsystem
_X_ Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Issue) Date: 20-Dec-93

Model Year(s)/Vehicle(s): Various

Key Date: 1993

Prepared By: D. Ha

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
RIVET (74815) Fastens spring to movable terminal	Fails to adequately retain spring to movable terminal.	Spring retains about axis of rivet. Spring falls off movable terminal	6		Improper rivet diameter for given hole sizes. Improper rivet length for given material thickness Improper head size Improper tubular feature Improper materials	1	Rivet manufacturer recommendations Comparison with similar products Testing to determine torque to rotate spring	1	6							
Provides a force between movable terminal and spring which causes intimate contact for current flow	Inadequate force between spring and movable terminal	High resistance or no continuity at interface of spring and movable terminal	6		Improper rivet diameter for given hole sizes. Improper rivet length for given materials thicknesses Improper head size Improper tubular feature Improper materials	1	Rivet manufacturer recommendations Comparison with similar products Testing to determine torque to rotate spring	1	6							

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TI-NHTSA 019130

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 503788
Revision Level C
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___System
___Subsystem
X Component - Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
BASE [PS] (48515) Provides a system of slots which guide, locate, and physically support terminals	Fails to properly locate terminals	Terminals out of position	3		Incorrect dimensions and/or tolerances specified between slots and terminals Inadequate staking design concept	1	Compliance with dimensions of similar STPS product	1	3							
	Fails to properly guide the terminals during insertion	Device will not assemble properly, yield loss or mfg	6		Incorrect dimensions and/or tolerances specified between slots and terminals Insufficient lead-in	1	Review with assembly equipment designers to determine correct clearances and lead in	1	5							
	Fails to properly support the terminals	Terminals could rotate in each other or the base (such as under physical or thermal loadings)	5		Incorrect material specified Excessively large dimensions specified on terminal slots	1	Comparison with design of similar STPS product	1	5							
Provides features to enhance the effectiveness of terminal staking	Terminal staking is insufficient	Loose terminals Electrical open in switch components	5		Incomplete understanding of design of staking features	1	Comparison with design of similar STPS product Staking investigation	1	5							
Provides a dielectric medium for the electrical elements	Contact fail-age between terminals or terminal-to-housing	Improper switching action.	5		Low insulation resistance Incorrect material specified	1	Comparison with design of similar STPS product Material evaluation	1	5							

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TI-NHTSA 019131

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1998

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
BASE [PS] (46518) Provides physical isolation of the switch components	Fails to physically isolate: ingests all engine base external environment.	High current leakage. High solvent drop. Erratic or inoperative switch action.	5		Incorrect material specified. Poor molded part design i.e. wall sections too thin, etc	1	Comparison with design of similar STPS product Design review with molder Mold flow analysis	1	5							
Provides a reference surface which locates the electrical elements relative to the pressure sensor	Fails to properly locate the switch elements relative to the pressure sensor	Shift in setpoints Exists as inoperative switch.	5		Warpage of the reference surface Intrusion of other design elements into the plane of the reference surface Excessive clearance specified between mating features	1	Specification of filament as pure Raise the surface to prevent intrusion of other elements Tolerance stackup analysis	1	5							
Provides a flange to compress the external environmental seal	Improper compression of internal environmental seal	Inadequate compression may lead to ingress of matter. Excessive compression may prevent switch from seating correctly to sensor assembly.	7		Incorrect seal gland design Warpage	1	Review of standard gland design practice Comparison to similar products Flatness specified on print	1	7							

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TI-NHTSA 019132

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date ___ (96)

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
BASE [P6] (46515) Provides interference tabs to locate and temporarily hold the base in position so the clamp ring prior to crimp	Fails to properly locate/hold prior to crimp	Too large may cause difficulty in assembly, base cracking, or percent switch trips sealing to sensor. Too small provides no relief; possibly affecting subsequent assembly operations	8		Design of interference tabs is insufficient	1	Calculation and experimentation to determine levels of fit/tr Tolerance stack-up analysis.	1	8							
Provides a flange surface for the clamp ring	Fails to provide adequate geometry for clamp ring	Base loose or insufficient torque withstand Base cracked	7		Incorrect design of flange for clamp ring	1	Comparison with design of similar STPS product	1	7							
Provides lock tabs, keys, and apertures which mate to electrical connector	Mating electrical connector doesn't fit properly.	Connector difficult to install. Connector falls off.	8		Connector geometry improperly specified	1	Review of dimensions relative to mating connector pinouts	1	8							
Provides compression to environmental seal in connector	Mating connector seal is not properly compressed	Ingress of water into switch cavity. Connector difficult to install and/or fall off.	7		Connector geometry and/or surface conditions/flatness is improperly specified Incorrect material specified	1	Review of dimensions relative to mating connector pinouts Material evaluation	1	7							

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TI-NHTSA 019133

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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Revision Level D
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___System
___Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1999

Prepared By L. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
STATIONARY TERMINAL (38686 & 38728) Provides a solid blade for interconnection	Poor interconnection	Device appears open-circuit, vibrating connector installed	7		Contamination of base blade Material specified too thin	1	Review design and dimensions of mating connector to ensure proper interference and wiping action	1	7							
	Blade geometry improper.	Difficult to install mating connector	5		Load-in chamfers on terminal are not defined/not specified Material specified too thick	1	Review design and dimensions of mating connector Comparison with design of similar 57PS product	1	5							
Provides a silver alloy surface for electrical contact	Fails to provide adequate electrical contact	Device appears open-circuited Intermittent continuity High millivolt drop	7		Incorrect contact material specified Contamination Silver layer specified too thin	1	Review of TI proprietary and general contact design info. Eliminate paths for ingress of contamination	1	7							
	Excessive loss of contact height dimension (mechanical loads)	Shift in set points over life.	7		Silver layer specified too thick	1	Review of TI proprietary and general contact design info Life Testing	1	7							
	Erosion of contacts due to electrical loads.	Shift in setpoints over life. Intermittent or no continuity.	7		Improper material specified for particular electrical loading	1	Review of TI proprietary and general contact design info Review and testing with actual electrical loads	1	7							

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TI-NHTSA 018134

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: S3 Key
Revision Level: D
Revision Date: 28 May 98
Original (Initial) Date: 20 Dec 93

___ System
___ Subsystem
X Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Various

Key Date: 1999

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
STATIONARY TERMINAL (38184 & 38726) Provides latching for device calibration	Poor calibration	Mfg. yield loss Shift in setpoints over life.	8		Design is excessively stiff Design has excessive spring back Material hardness is incorrectly specified Initial position requires excess deformation to calibrate Design has inadequate strength to maintain calibration over life	7	Mechanical (and/or FEA) analysis Force deflection springback testing Tensing with actual production calibration equipment	1	56							
Provides materials to ensure adequate sliding with base	Terminal is inadequately stuffed into base.	Loose terminals Shift/fluctuation in switch setpoints	7		Incomplete understanding of design of stuffing features.	1	Comparison of design with similar 57PS product Stuffing evaluations.	1	7							
Provides features which mate with slots in base for location of terminal	Fails to properly locate terminal	Terminals out of position.	3		Exposed dimensional and/or tolerances specified between stuffing terminals. Inadequate stuffing design concept	3	Comparison of design with similar sTPS product	1	9							
Provides electrical path from silver inlay contact to mating connector	Fails to provide adequate conductivity	High resistance shown as high millivolt drop	5		Incorrect material specified Inadequate cross-section area	1	Calculations of resistance Testing	1	5							

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TI-NHTSA 019136

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 29 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wilgus

Core Team Design Engineers, Manufacturing Engineers, Manufacturers, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
MOVABLE TERMINAL (36887) Provides a blade for wire connection	Poor wire connection	Device appears open-circuit when mating connector inserted	7		Material specified too thin	1	Review design and dimensions of mating connector to ensure proper interference and mating action	1	7							
	Rapid gas/humidity response	Difficult to unplug mating connector	5		Lead-in chamfers on terminal are insufficiently specified Material specified too thick	1	Review design and dimensions of mating connector Comparison with design of similar STPS product	1	5							
Provides a mounting post for one spring rivet	Fails to allow proper spring/rivet installation	Shift/fluctuation in switch setpoints (faulty rivet) Inoperative device (rivet falls out completely) Mfg. yield loss	7		Rivet hole size is specified incorrectly Rivet hole position is specified incorrectly Support surface for spring is incorrectly specified. Choice of fastener style incorrect	1	Comparison with design of similar products. Check with recommendations of rivet manufacturer Testing	1	7							
Provides features to ensure adequate staking and base	Terminal is inadequately staked into base.	Loose terminals Shift/fluctuation in switch setpoints	7		Incomplete understanding of design of staking feature	1	Comparison of design with similar STPS product Staking evaluations	1	7							

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POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

___System
___Subsystem
X Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Various

Key Date: 1993

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Document Number: 503790
Revision Level: C
Revision Date: 4-Nov 96

Original (Initial) Date: 20 Dec 93

Prepared By: C Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
MOVABLE TERMINAL (36887) Provides features which mate with slots in base for location of terminal	Fails to properly locate terminal	Terminals out of position	3		Incorrect dimensions and/or tolerances specified between mating and grommets. Inadequate sizing design concept	3	Comparison of design with similar 83P6 product	1	9							
Provides electrical path from movable contact via spade to wiring connector	Fails to provide adequate conductivity	High resistance shown as high millivolt drop.	5		Incorrect material specified Inadequate cross-section area	1	Calculations of resistance Testing	1	5							

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TI-NHTSA 019137

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 501*92 Page 1
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___System
___Subsystem
_X_Component Prndaye Switch

Design Responsibility Prndaye Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1999

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Actions	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
(P-Point) (Middle) Provides contact force	Low contact force	High mid/exit drop across contacts	6		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	18							
	High contact force	Shift in setpoints. Disc cracking over life	7		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	21							
Provides electrical path from movable contact to moveable terminal	Fails to provide adequate conductivity	High angle/amps shown as high mid/exit drop	5		Incorrect material specified Inadequate cross-section area	1	Calculations of resistance using R = ρ(ℓ/w)(L) / A Testing	1	5		CONFIDENTIAL					
Provides feature to interface with transfer pin	Fails to interact correctly with transfer pin	Spring failure over life Shift in setpoints over life. Sticking transfer pin causes intermittent operation.	7		Inadequate height of feature specified Inadequate shape of feature specified. Improper position of feature specified	1	Comparison of design with similar product Dimension and tolerance stackup analysis Actual measurement Testing	1	7							
Provides feature for attachment to moveable contact	Fails to provide adequate retaining for moveable contact	Intermittent or erratic operation Open circuit	8		Hole size/position incorrectly specified Flatness inadequate	1	Riveting recommendations Comparison of design with similar product Testing	1	8							
Locates moveable contact	Fails to adequately locate moveable contact relative to stationary contact	High mid/exit drop over life Excessive contact erosion over life	7		Spring geometry incorrectly specified	1	Dimension and tolerance stackup analysis Testing	1	7							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 1337XX
Revision Level C
Revision Date 4-Nov-96
Original (Initial) Date 20 Dec 93

___System
___Subsystem
X Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Various

Key Date: 1800

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
SPRING (Metal)																
Provides feature for attachment to movable terminal	Fails to properly attach to movable terminal	Erratic or intermittent operation Shall in sequence Open or short circuit	8		Rivet hole size or position incorrectly specified Flatness inadequate Choice of fastener style incorrect	4	Rivet mfg recommendations Comparison of design with similar product Testing	3	96							
Allows disc overtravel	Fails to allow disc overtravel	Shall in sequence Disc cracking Device inoperative at assembly Poor calibration	5		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	15							
Provides base to open contacts	Inadequate force to open contacts	Insufficient resistance to mechanical vibration Short circuit	8		Incorrect geometry specified Incorrect material specified	1	Beam deflection equations Force/deflection testing	7	56							
	Excessive force to open contacts	Shall in sequence Disc cracking Device inoperative at assembly Poor calibration	7		Incorrect geometry specified Incorrect material specified	3	Beam deflection equations Force/deflection testing	1	21							

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TI-NHTSA 016139

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 5037pt
Revision Level C
Revision Date 4 Nov 96
Page 1

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Design Responsibility Pressure Switch Group
Original (Issue) Date 20 Dec 93

Key Date 1993

Core Te

Prepared By C Wayne

Engineering, Manufacturing, Quality

Item / Function	Mode	Effect of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
GASKET (74339) Provides fluid seal between header and diaphragm	Fails to provide adequate fluid seal	Entire fluid leakage.	8		Installed with compression specified Very excessive compression specified, leading to displacement from gland Incorrect ID and/or OD leading to displacement from gland Incorrect cross-section shape specified Incorrect material specified, fluid incompatibility Incorrect design of sealing arrangement	1	Review of general seal design principles Manufacturer's recommendations Build, inspection and thermal cycle tests Comparison with design of similar products	1	8		CONFIDENTIAL					

TI-NHTSA 018140

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 501745
Revision Level C
Revision Date 4 Nov 96

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1998

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
CSP (27713 OR 27288) Provides changable area which holds pressure sensor together	Fails to provide a suitable geometry for crimp.	Leakage Low burst	6		Crimp wall thickness incorrectly specified Crimp wall height incorrectly specified Incorrect material specified	1	Burst and impulse testing Comparison of design with similar product	1	6							
Provides header, diaphragm, and washer	Fails to correctly locate header, diaphragm, or washer	Difficult assembly	5		I.D. specified incorrectly	1	Tolerance stack-up analysis	1	5							
Provides support and locates for [illegible]	Fails to support and locate the electroinverter correctly	Shift in setpoints Erratic operation Stuck spool at assembly Reduced data life	7		Incorrect disc envelope specified Bump true position incorrectly specified Poor surface condition of bump, no control specified	1	Tolerance stackup analysis Impulse testing	1	7							
Provides guide for transfer pin	Fails to guide transfer pin correctly	Erratic operation Device sends short-circuit	7		Pin guide geometry is incorrectly specified	1	Tolerance stackup analysis	1	7							
Prevents portion of environmental seal gland.	Fails to allow a proper environmental seal	Ingress of water Switch does not seal correctly to cup.	7		Surface condition required for good seal not understood or not correctly specified Geometry incorrectly specified	1	Environmental testing Switch cavity pressurization testing Review of standard gland design rules	1	7							

CONFIDENTIAL

TI-NHTSA 019141

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503795
Revision Level C
Revision Date 4 Nov 96

___System
___Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Viper

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CUP (3771 OR 3728B) Provides surface to interface with base/switch assembly	Fails to properly locate relative to switch	Shift in setpoints. Erratic or inoperative switch.	6		Incorrect geometry of mating surface specified	1	Tolerance stackup analysis. Cross-section actual devices to inspection of drawings	1	6							
(Post sensor-crimp) provides geometry for final assembly with crimp ring	Fails to allow proper final assembly with crimp ring	Erratic operation Ingress of water Cracked base	7		Post-crimp geometry is not controlled per design intent Cup diameter incorrectly specified	1	Tolerance stackup analysis. Base torque testing	1	7							

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TI-NHTSA 019142

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number: 503750
Revision Level: D
Revision Date: 4 Nov 98
Original (Issue) Date: 20 Dec 93

___System
___Subsystem
_X_Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Various

Key Date: 1999

Prepared By: C Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
DIAPHRAGM (OR SEAL) [RR] [7s17S] Forms flexible element of fluid containment cavity	Fails to contain fluid.	Fluid leakage	8		Gradual rupture over life due to improper design of supporting elements Gradual rupture over life due to excessive repeat/displacement Gradual rupture over life due to stress concentrations caused by asymmetric strain deflections Chemical attack due to incorrect material specified Incorrect thickness (or # of layers) of diaphragm material Insufficient torque/crimping of diaphragm	1	Burst, impulse, and thermal cycle tests Material mfg recommendation Comparison of design with similar products	1	9		CONFIDENTIAL					
Transfers pressure from fluid to pressure-sensing elements	Change in area of pressure transfer with life. Excessive change of pressure transfer area versus pressure.	Shift in setpoints over life Excessively high pressures needed to adequately fulfill pressure transfer area, with signs on setpoints due to unpredictability of lower pressures.	6 6		Diaphragm too stiff Incorrect material specified Diaphragm too soft Incorrect material specified	1 1	Life testing of characteristics of intermediate parts Force and pressure versus deflection testing to calculate effective areas	1 1	6 6							

TI-NHTSA 019143

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

Document Number 505797
Revision Level C
Revision Date 4 Nov 96

Original (Initial) Date 29 Dec 93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C Wetzler

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
WASHER (P/S 27839) Provides a portion of the support surface for diaphragm	Fails to correctly support the diaphragm	Reduced diaphragm life results in leakage.	8		Contact of diaphragm support surface are specified incorrectly Condition of edges of support surface specified incorrectly Clearance between washer I.D. and connector bump is specified too wide	1	Burst, Impulse, and Thermal Cycle tests Comparison of design with similar products	1	8							
Provides support for compression of gasket	Fails to allow proper gasket compression	Leakage	8		Washer flatness is incorrectly specified or unspecified Washer thickness is specified too small Washer material and/or heat-treat is incorrectly specified	1	Burst, Impulse, and Thermal Cycle tests Comparison of design with similar products	1	8							
Locates and guides connector with respect to cup	Connector is not properly located or guided in cup	Shift in setpoints Erratic behavior	8		Incorrectly specified button guide I.D. Incorrectly specified washer O.D.	1	Comparison of design with similar products Tolerance stackup analysis	1	8							
	Connector travel is restricted by washer.	Disc cannot release, device is stuck open-circuit	7		Washer flatness is incorrectly specified or unspecified Washer thickness is specified too small Washer material and/or heat-treat is incorrectly specified I.D. of button guide is too small	1	Burst, Impulse, and Thermal Cycle tests. Comparison of design with similar products Tolerance stackup analysis	1 1	7							

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TI-NHTSA 019144

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: 5U3737
Revision Level: C
Revision Date: 4 Nov 96

___System
___Subsystem
_X_Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (mod) Date: 20 Dec 93

Model Year(s)/Vehicle(s): Various

Key Date: 1997

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) (Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
WASHER (PS) (37638) interfaces with cup feature and provides a portion of component stops for clamp	Fails to interface correctly with cup	Difficult assembly (washer O.D. too large). Poor weld/crimp/rivet footprint relative to cup (washer O.D. too small).	7		Washer O.D. specified incorrectly	1	Comparison of design with similar products Tolerance stackup analyses	1	7		CONFIDENTIAL					
	Fails to allow proper crimp	Reduced burst capability leads to leakage Reduced fatigue resistance leads to leakage	9		Thickness incorrectly specified O.D. incorrectly specified Edge condition incorrectly or unspecified	1	Tolerance stackup analysis Burst, impulse, and Thermal Cycle tests	1	9							

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

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

___System
___Subsystem
_X_Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Ventura

Key Date: 1993

Prepared By: Delna

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CONVERTER (PS) (27406) Translates pressure from fluid (via diaphragm) to a force on pressure sensing disc	Fails to correctly translate fluid pressure to force on disc	Shaft re-setpoints	5		Button O.D. incorrectly specified relative to washer I.D. Converter major O.D. incorrectly specified relative to cup I.D. Converter thickness incorrectly specified Incorrect material specified	1	Tolerance stackup analysis Force/deflection analysis to determine strength and safe levels to prevent deformation Burst, impulse, and Thermal cycle tests	1	5		CONFIDENTIAL					
Provides alignment and support to disc	Fails to properly align and support disc.	Loose alignment allow misalignment which may cause shift in setpoints or erratic operation. Out-out-of place relative to converter may cause erratic operation or inoperative device, result open-circuit.	5		Button O.D. incorrectly specified relative to washer I.D. Converter major O.D. incorrectly specified relative to cup I.D. Disc support bump incorrectly specified Disc fastening wall incorrectly specified	1	Tolerance stackup analysis Comparison of design with sample product	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 501796
Revision Level E
Revision Date 13-May 96
Original (Initial) Date 28 Dec 93

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By D Ha

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
CONVERTER (PS) (27488) Provides a portion of the support surface for diaphragm	Fails to properly support diaphragm	Reduced diaphragm life results in leakage.	8		Contours of surface in contact with diaphragm are specified incorrectly Contours of edges in contact with diaphragm are specified incorrectly Clearance between converter bump and washer I.D. are specified too wide	1	Burst, impulse, and Thermal cycle tests Comparison of design with similar product	1	8							
Provides disc support during over pressure (procedure)	Fails to properly support disc during over pressure	Disc deformation results in shift in setpoints. Reduced disc travel if disc motion is restricted prematurely. Reduced disc life.	8		Features which control disc motion during over pressure are incorrectly specified	2	Pre-and post-proof characterization Pressure-deflection measurements of disc motion	1	16							
Vent in converter prevents pressure buildup from affecting setpoints	Does not vent properly	Shift in setpoints over temp Reduced disc travel	5		Vent hole incorrectly specified	1	Comparison of design with similar product Temperature characterization	1	5							

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TI-NHTSA 019147

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503799
Revision Level C
Revision Date 4-Nov-06

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 01

Model Year(s)/Vehicle(s) Various

Key Date 1962

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
SPACER (730B) Reduce friction between disc and conveyor	Fails to effectively reduce friction	Shift is subjected over life. Reduced disc life.	5		Incorrect material specified Incorrect dimensions specified	1	Impulse and Thermal Cycle test. Pre- and Post-life characterizations Tolerance stackup analysis	1	5							
Allow welding of chamber forward by disc and diaphragm	Fails to allow welding	Shift is subjected over temp. Reduced disc action	5		Weld hole incorrectly specified	1	Comparison of design with similar product Temperature characterization	1	5							

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TI-NHTSA 019148

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503809
Revision Level C
Revision Date 4 Nov 96
Original (Initial) Date 20 Dec 93

___ System
___ Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1997

Prepared By C Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
OSC (3858) Controls actuation and selected set-points of switch relative to applied force	Fails to actuate and/or returns at the proper points in assembly	Mfg. yield loss.	5		Disc material improperly specified Dimensions and tolerances improperly specified	1	Characterization requirements Comparison of design with similar product	1	5							
Fails component life requirement causing usable service life of device	Disc actuation and/or return requires change in apparent load rate	Shift in device setpoints over life	5		Disc material improperly specified Inadequate heat treat improperly specified Material thickness improperly specified Excessive force applied by spring	1	Impulse testing Pre- and post-characterizations	1	5	CONFIDENTIAL						
	Service life shorter than customer requirements	Chronic shift in setpoints over life. Device inoperative - open circuit	7		Disc material improperly specified. Disc heat-treat improperly specified Material thickness improperly specified Excessive force applied by spring	1	Impulse testing Pre- and post-characterizations	1	7							

TI-NHTSA 019149

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 103801
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Revision Date 4-Nov-96

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
Crimp Ring (74787) Hold together wire assembly and sensor assembly	Fails to hold base to sensor correctly	Erratic switch operation. Cracked base Shift in setpoint. Loss base torque retention	5		Incorrect geometry of crimpable area specified Incorrect geometry at formed ends Incorrect material specified	3	Impulse, thermal cycle, base torque and base-terminal impact tests	1	15							
Provide a surface for part identification/date code	ID characters illegible	Improperly identified parts at assembly plant.	2		Geometry/thickness not properly specified Wrong material specified	1	Coding tests Environmental tests	1	2							
Impart environmental protection and hermetic to device	Industry to withstand environment	Corrosion causes material consumption, loss of mechanical properties, switch eventually fails on output. Highly costly.	7		Wrong material specified	1	Environmental tests	1	7							
Provide lubrication to crimp diameter area	Insufficient lubrication	Metal flakes/particles on internal device surfaces.	6		Incorrect or insufficient was specified	1	Crimping tests	1	6							

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TI-NHTSA 019160

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 30392 Page 1
Revision Level C
Revision Date 4 Nov 96

___ System
___ Subsystem
X Component . Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20 Dec 93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
TRANSFER Pin (74074) Transfers disc motion to mate electrical contact	Fails to properly transfer disc motion	Contacts stuck open	7		Dimension incorrectly specified	1	Tolerance stackup between pin and pin guide in cup	1	7		CONFIDENTIAL					
		Contacts stuck closed			Chips/fragments cause pin to bind		Check with supplier for material properties regarding chips									
		Review appropriate														
Insulate electrical components from switch housing	Fails to insulate	Continuity between movable terminal and housing or ground	5		Wrong material specified	1	Check with supplier for material properties	1	5							
							Check with customer for electrical logic of movable terminal									

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 301602 Page 1
Revision Level C
Revision Date 4-Nov-96

___ System
___ Subsystem
_X_ Component: Pressure Switch

Design Responsibility: Pressure Switch Group

Original (Issue) Date: 20-Dec-93

Model Year(s)/Vehicle(s): Various

Key Date: 1998

Prepared By: C. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
TRANSFER PIN (74078) Transfers disc motion to movable electrical contact	Fails to properly transfer disc motion	Contacts stuck open. Contacts stuck closed Faulty operation	7		Diameter incorrectly specified Chips/fragments cause pin to lodge	1	Tolerance stackup between pin and pin guide in cup Check with supplier for material properties regarding chips	1	7		CONFIDENTIAL					
Provides electrical components from switch housing	Fails to insulate	Continuity between movable terminal and housing to ground	5		Wrong material specified	1	Check with supplier for material properties. Check with customer for electrical spec of movable terminal	1	5							

TI-NHTSA 019152

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number: 593603 — Page 1
Revision Level: C
Revision Date: 4-Nov 96
Original (Initial) Date: 20 Dec 93
Prepared By: C. Wagner

___System
___Subsystem
X Component: Passage Switch
Design Responsibility: Passage Switch Group
Model Year(s)/Vehicle(s): Various
Key Date: 1999
Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	S e v	O c c	D e t	R P N
ENVIRONMENTAL SEAL (74247) Prevents ingress of water to switch cavity	Contaminants enter switch cavity.	High current leakage High contact drop. Erratic or inoperative switch operation.	7		Gasket thickness is specified too small Limits are possibly not specified Incorrect material	1	Review of standard practice for gland design Review with gasket manufacturer Comparison of design with similar product	1	7		CONFIDENTIAL					
Prevents friction lock and in terminating back insertion	Base comes pre coated	Perceived as inadequate by assembly plant and/or service personnel.	5		Gasket thickness improperly specified	1	Review of standard practice for gland design Torque-to-rotate testing Comparison of design with similar product	1	5							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503833
Revision Level C
Revision Date 4 Nov 98
Original (Initial) Date 30-Dec-91

___System
___Subsystem
_X_Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1999

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Prepared By C. Wagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) (Mechanism(s)) of Failure	Occur	Current Design Controls	Detect	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
ENVIRONMENTAL SEAL (TQN7) Prevents ingress of moisture to switch cavity	Contaminants enter switch cavity	High current leakage High current drop Erratic or inoperative switch operation.	7		Gasket thickness is specified too small Lands are porosity not specified Incorrect material	1	Review of standard practice for gland design Review with gasket manufacturer Comparison of design with similar product	1	7		CONFIDENTIAL					
Provides friction to aid in preventing base rotation	Base rotates too easily	Perceived as inadequate by assembly plant and/or service personnel	5		Gasket thickness improperly specified	1	Review of standard practice for gland design Torque-to-rotate testing Comparison of design with similar product	1	5							

TI-NHTSA 018154

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503804
Revision Level C
Revision Date 9-Nov-95

___System
___Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Output (Input) Date 20 Dec 91

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
THREAD CAP (14888) Protects tamper threads from damage during shipping and install Prevents dust from entering the test cavity	Incorrect length	Does not protect threads sufficiently.	6		Length incorrectly specified	1	Dimensional stackup study	1	6		CONFIDENTIAL					
	Loose Cap	Allows dust to enter test cavity.	4		Incorrect diameter specified	1	Dimensional analysis	1	4							

TI-NHTSA 018155

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503405
Revision Level C
Revision Date 30-Oct-96

___System
___Subsystem
_X_ Component Pressure Switch

Design Responsibility Philippe Smich Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Viewing

Key Date 1997

Prepared By C. Hopper

Core Team Design Responsible, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
REPORT (38900) Provides a hydraulic sealing surface per SAE J517	Fails to seal	Leakage of brake fluid	8	FF	Incorrect surface finish specification. Incorrect material specification. Incorrectly specified geometry. Excessive pressure	1	Cross-check of part dimensions vs. SAE standard. Cad/pc/relative evaluation of design at pressure levels. Burst testing to customer specified limits.	1	8							
Provides internal thread for installation into sensing port	Fails to properly install in mating part	Damages threads in mating part during installation. Does not allow installation.	7	FF	Threads specified improperly. Threads not gauged per ANSI spec's. Plating buildup.	3	Cross-check of applicable SAE and ANSI standards	3	63							
	Apparently installed, but fails to properly seal and part.	Brake fluid leakage.	8	FF	Threads specified improperly. Threads not gauge per ANSI spec's. Plating buildup.	1	Cross-check of applicable SAE and ANSI standards	3	27							
Provides hex feature for 9/16" wrench	Incorrect hex size.	Damage to hex flats during wrenching. 9/16" wrench does not fit.	5		Hex features improperly specified per established SAE/ANSI spec's	1	Cross-check of applicable SAE and ANSI standards	1	5							
Provides fluid passage to pressure sensing elements	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp. Subject to blockage by foreign matter.	7	FF	Inadequate size of fluid passage specified Inadequate review of Ford standard practices	1	Review of Ford standard practices Review of industry practices	1	7							
	Fluid passage is too large	Rounding thin wall section causes breakage: during installation during unscheduled service operations.	7	FF	Fluid passage specified excessively large	1	Torque testing	1	7							

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TI-NHTSA 019159

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 503805
System Level C
Revision Date 30-Oct-96

___ System
___ Subsystem
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wisniewski

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detect	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
HEINER (3800) Provides gland for internal gasket	Fails to seal internal gasket properly	Leakage of brake fluid	8		Gland dimensions improperly specified. Groove finishes improperly specified. Gland geometry improperly designed	1	Cross-check with recommended internal gasket supplier. Compression testing	1	8							
Provides flange which interfaces with other components to form pressure-sensitive structure	Flange fails to seal properly with other components of pressure sensor	Die, too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor crimp Flange too thin results in reduced burst capacity. Improper edge chamfer results in sheet cut/crimp/seam which separates under	9		Improper or incomplete specification of dimensions and tolerances	1	Examination and analysis to determine proper thickness for required strength. Tolerance stack-up analysis. PWA system.	1	9		CONFIDENTIAL					
	Material too soft or weak	Inadequate burst capability. Too tight/too large during installation or subsequent service. Threads prone to damage, leads to assembly difficulties	9		Improper material selection	1	Comprehensive evaluation of physical properties	1	9							
	Material creeps	Loosening of crimp leads to leakage	9		Improper material selection	1	Review of material properties	1	9							
	Material degrades in presence of working fluid(s)	Leakage	9		Improper material selection	1	Cross-check with similar products	1	9							
	Insufficient environmental protection	Long-term attack causes weakening of key areas which leads to leakage or breakage	9		Improper or insufficient plating specification	1	Comprehensive environmental testing	3	27							

___System
___Subsystem
X Component: Pressure Switch

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Design Responsibility: Pressure Switch Group

Model Year(s)/Vehicle(s): Various

Key Date: 1997

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Document Number: 600666
Revision Level: C
Revision Date: 30 Oct 96
Original (Issue) Date: 20-Feb-97

Page 1

Prepared By: C. Hagner

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	SEV	CLASS	Potential Cause(s) Mechanism(s) of Failure	OCCUR	Current Design Controls	DET	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	SEV	OCC	DET	RPN
REPORT (36800) Provides flange which interfaces with other components in form process-fixture structure		Cosmetic problems.	9			1	Review of plating process	3	27							

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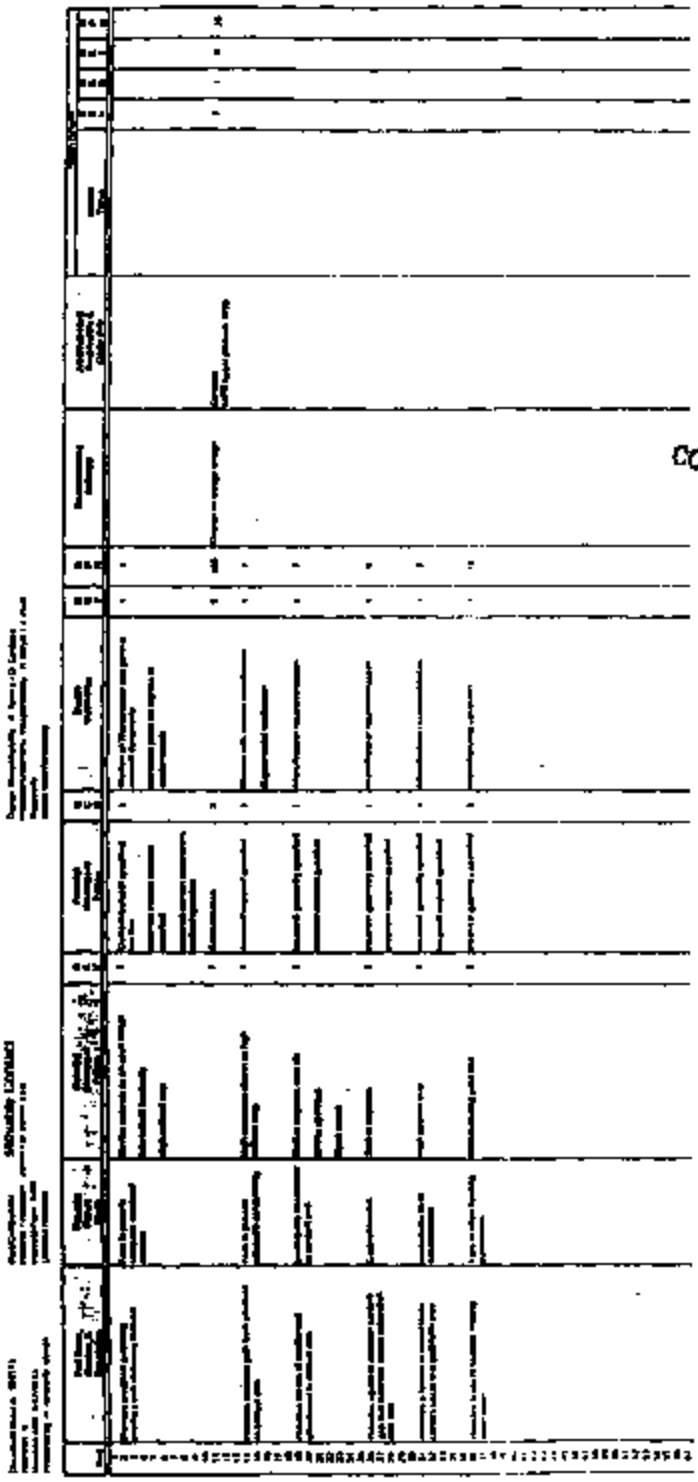

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POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

Document Number 508770
Revision Level B
Revision Date 5-May-98
Original (Initial) Date 20-Dec-93
Prepared By D. Ha

___System
___Subsystem
_X_ Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1993

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
RIVET (74918) Fastens spring to moveable terminal	Fails to adequately fasten spring to moveable terminal	Spring rotates about axis of rivet. Spring fails all moveable terminal.	6		Improper rivet diameter for given hole sizes. Improper rivet length for given material thickness. Improper head size. Improper tubular feature. Improper material.	1	Rivet manufacturer recommendations. Comparison with similar products. Testing to determine torque to rotate spring.	1	6							
Provides a path between moveable terminal and spring which causes intimate contact for current flow	Inadequate force between spring and moveable terminal.	High resistance or no continuity at interface of spring and moveable terminal.	6		Improper rivet diameter for given hole sizes. Improper rivet length for given material thicknesses. Improper head size. Improper tubular feature. Improper material.	1	Rivet manufacturer recommendations. Comparison with similar products. Testing to determine torque to rotate spring.	1	6							

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)

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___System
___Subsystem
_X_Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Vistaps

Key Date ____ Wks

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Document Number
Revision Level
Revision Date
Original (Initial) Date
Prepared By

Document #	Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken
303746	CLIP (27) FOR 27268 Provides adequate axial force to hold gasket together.	Fails to provide a sufficient geometry for crimp.	Leakage	4		Crimp wall thickness incorrectly specified.	1	Burst and impulse testing.	1	4			print specified
303780	GASKET-RADIAL (OR SEAL) (SP) (24178)												
	Forms flexible element of fluid containment cavity	Fails to contain fluid.	Fluid leakage.	8		Gradual rupture over life due to improper design of supporting elements. Gradual rupture over life due to excessive flange/displacement. Gradual rupture over life due to stress concentrations caused by asymmetric strain distributions. Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm material. Unutilized location/clamping of diaphragm.	1	Burst, impulse, and thermal cycle tests. Material adg. recommendation Comparisons of design with similar products.	1	8			
303797	HOUSING (PS) (27268) Provides a portion of the support surface for diaphragm.	Fails to correctly support the diaphragm.	Reduced diaphragm life results in leakage.	8		Contours of diaphragm support surface are specified incorrectly	1	Burst, Impulse and Thermal Cycle tests.	1	8			

Kaplun

industry usage comparison

Leakage

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	Washer					Condition of edges of support surface specified incorrectly. Clearance between washer I.D. and conveyor hump is specified too wide		Comparison of design with similar products.					
	Provides support for compression of gasket.	Fails to allow proper gasket compression.	Leakage.	8		Washer flatness is incorrectly specified or unspecified. Washer thickness is specified too small. Washer material and/or heat-treat is incorrectly specified.	1	Burst, Impulse, and Thermal Cycle tests. Comparison of design with similar products.	1	8			
	Interfaces with cup feature and provides a portion of compressive reach for crimp	Fails to interface correctly with cup.	Difficult assembly (washer O.D. too large). Poor washer/conveyor location relative to cup (washer O.D. too small).	7		Washer O.D. specified incorrectly	1	Comparison of design with similar products. Tolerance stackup analysis.	1	7			
	t: .097 .101	Fails to retain gasket crimp.	Reduced burst capability leads to leakage. Reduced fatigue resistance leads to leakage.	9		Thickness incorrectly specified. O.D. incorrectly specified. Edge condition incorrectly or unspecified.	1	Tolerance stackup analysis. Burst, Impulse, and Thermal Cycle tests.	1	9			
	CONVERTIBLE (27406)												
	Provides a portion of the support surface for diaphragm.	Fails to properly support diaphragm.	Reduced diaphragm life results in leakage.	8		Contours of surface in contact with diaphragm are specified incorrectly Condition of edges in contact with diaphragm are specified incorrectly. Clearance between conveyor hump and washer I.D. are specified too wide.	1	Burst, Impulse, and Thermal cycle tests. Comparison of design with similar product.	1	8			

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Report Sect 2 Item 4

583mb5	EXPORT (28800)											Page 3
	Provides a hydraulic sealing surface per SAE J512.	Fails to seal.	Leakage of brake fluid outside? switch	9	FF	Incorrect surface finish specification. Incorrect material specification. Incorrectly specified geometry. Excessive pressure.	1	Cross-check of joint dimensions vs. SAE standard. Comprehensive evaluation of design at tolerance limits. Burst testing to customer-specified limits.	1	9		
	Provides external thread for installation into mating port.	Fails to properly install in mating port.	Damages threads in mating port during installation. Does not allow installation.	7	FF	Threads specified improperly. Threads not gauged per ANSI spec's. Plating build-up.	3	Cross-check of applicable SAE and ANSI standards.	3	63		
		Apparently installs, but fails to properly seat web seal.	Brake fluid leakage.	8	FF	Threads specified improperly. Threads not gauge per ANSI spec's. Plating build-up	1	Cross-check of applicable SAE and ANSI standards	3	21		
	Provides flange which interfaces with other components to form pressure-bearing structure	Material creeps.	Loosening of screw leads to leakage	9		Improper material selection	1	Review of material properties	1	9		
		Material degrades in presence of sealing fluid(s)	Leakage	9		Improper material selection	1	Cross-check with similar products.	1	9		
		Insufficient environmental protection.	Long-term attack causes weakening of key areas, which leads to leakage or breakage.	9		Improper or insufficient plating specification	1	Comprehensive environmental testing	3	27		

EA02025

TEXAS INSTRUMENTS, INC.'S

09/10/03 LETTER TO ODI

REQUEST 13

BOX 13

PART A – E

PART B