

EA02-025

FORD
OCTOBER 27, 2003

APPENDIX N
BOOKS 59 OF 61

PART 1 OF 4

Ford ENGINEERING SPECIFICATION

PART NAME				PART NUMBER			
SPECIFICATION - BRAKE FLUID				EB-3000-1268-AA			
LET.	PR.	DATE	REVISIONS	DR.	CK.	REFERENCE	
		11-21-84	RELEASED CD02-610744-C				
		1-21-85	REVISED & RETIRED PG 4				
		1-21-85	REVISED & RETIRED PG 6				
		1-21-85	REVISED & RETIRED PG 6				
		2-23-86	CL 5 WAS DOT 4 BRAKE FLUID				
		2-23-86	CL 6 WAS 1500000				
		2-23-86	CL 7 WAS 1500000				
		2-23-86	CL 8 WAS 1500000				
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		2-23-86	CL 100 WAS 1500000				

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Job 2047-01 (Previous editions may not be used)

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ENGINEERING SPECIFICATION

CONFORM, ITEM - AFFIX COMPLIANCE TO FEDERAL REGULATIONS - AREAS MARKED ∇
ARE CRITICAL CHARACTERISTICS - CHANGES IN DESIGN, COMPOSITION, OR
PROCESSING FROM THE FIRST PREVIOUSLY APPROVED FOR FIRST PRODUCTION
REQUIRE ENGINEERING APPROVAL.

I. GENERAL

This specification is an extension of the related drawing or hose
hose assemblies. All requirements of this specification must be met in
addition to all other requirements of the part drawing. Minimum
measures necessary for demonstrating compliance are given in each
section.

The engineering test schedule contained within this specification
reflects the minimum values established to provide a regular evaluation
of conformance to design intent. The schedule is intended as a
supplement to normal material inspections, dimensional checking, and
in-process controls, and should in no way adversely influence adherence
to other statistically significant inspection operations.

The material used in the manufacture of hose assemblies must conform to
the following specifications:

A. Hose

1. Construction and Laboratory Properties - See ∇ HSA-10501-4 or 12
per detail drawing.
2. Identification - Each hose must have two clearly defined
1/16" minimum width longitudinal stripes approximately 180
degrees apart. Either or both stripes may be interrupted by
information required by this specification, SAE J1401, and
FMVSS Part 105. The date of manufacture, supplier's
identification, and the full Ford Motor Company part number
of the hose assembly must be metal stamped on either end
flaring or bracket. It is the supplier's responsibility to
keep complete records of date of manufacture, the hose lot
used in the assembly, and the tests conducted on the hose
stock and completed assemblies.

B. Fittings

1. Seal

- (a) Material
RL-10100-A (including 10110-11100-12114)
- (b) Plating
HSP-1010-A and Dichromate Dip

2. Nuts

HSP-1010-A

C. Brackets

Plating - Zinc plate per HSP-1010-A and Dichromate Dip

ENGINEERING SPECIFICATION

D. Protective Appendages

Grounds - Polypropylene per BSA-MATH-34-A
Slaves - EPCN per SAE J200 - 2AC630-325 C12 E1 E2

- E1 - C12 except 100 WRM at 72 hours
- E2 - Low temperature brittleness - no cracks on 180° bend specimen at -40° for 4 hours

E. Rating Slaves

Slaves - EPCN per J200 2AC630-325 C12 E1 E2

E1, E2 See above

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

Compliance with all of the requirements in this section must be demonstrated as follows:

- Production validation tests must be completed satisfactorily with initial production parts before IMA approval and authorization for shipment of production parts can be effected. Parts must be revalidated completely every 12 months in addition to complete revalidation, or per Section V, whenever any change is made which may affect part function or performance.
- In-process test must be completed with production parts prior to initial sample approval and at the specified frequency on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as such as possible. In the event that any portion of the tests is not met, Ford Q-101 section "Test Failure" shall be invoked.

A. Production Run Assembly Certification

DI	E1	Test	Production Validation		In-Process	
			Minimum Sample Size	Reliability Acceptance Criterion	Minimum Sample Size and Frequency per Assembly Line	Reliability Acceptance Criterion
Test		IMA	43	P.90=.84	100%	0-101
Expansion		IMA	43	P.90=.84	100%	0-101
Construction		*3.4.1	43	P.90=.84		
Expansion and				P.90=.61	2/lot	0-101
Test		*3.4.2	4		Test only	
Min.		*3.4.3	4	P.90=.61		
Max.		*3.4.4	4		2/lot	0-101
Water Absorption & Test		*3.4.6.1	1	P.90=.32		
Water Absorption & Test		*3.4.6.2	1	P.90=.32		

* 350 lb. min. tested less than 12 hours after coupling.

ENGINEERING SPECIFICATION

Test	Test Number	Production Validation		In-Process	
		Minimum Sample Size	Reliability Acceptance Criterion	Minimum Sample Size and Frequency per Assembly Line	Reliability Acceptance Criterion
Water Absorption & Whip	* 3.4.6.3	2	P.90-.45		
Low Temperature	* 3.4.7	2	P.90-.45		
Brake Fluid	* 3.4.8	4	P.90-.45		
Compatibility					
Salt Spray	* 3.4.12 1/	2	P.90-.45	2/lot	Q-101
Dynamic Gases	* 3.4.10	8	P.90-.75		
Heat Age and Cold Hard	* 3.4.11	2	P.90-.45		
Insulation	* 3.4.13	4	P.90-.45		
Front End Sim	1118 2/	12			

In addition to these requirements, one hose assembly must be retained for 5 years by the supplier. This hose is to undergo probe, pressure, and restriction testing only.

B. Production Under Hose Certification

Each shipment of hose must be certified by a test report from the hose manufacturer indicating the actual test results obtained on all tests conducted prior to shipment.

Test	Test Number	Production Validation		In-Process	
		Minimum Sample Size	Reliability Acceptance Criterion	Minimum Sample Size and Frequency per Assembly Line	Reliability Acceptance Criterion
Visual				12/lot	Q-101
Inspection for Identification					
Dimension	1112			12/lot	Q-101
Pressure	1118			12/lot	Q-101
Expansion and Burst	* 3.4.2			4/lot	Q-101
Whip	* 3.4.4			2/lot	Q-101
Heat Age and Cold Hard	* 3.4.11			4/month	Q-101
Insulation	* 3.4.13			2/lot	Q-101
Water Absorption & Burst	* 3.4.6.1			4/week	Q-101
Water Absorption & Flexile	* 3.4.6.2			4/week	Q-101
Water Absorption & Whip	* 3.4.6.3			4/week	Q-101

* HA-3004-A or A2 Section Number

* 3 data series, 2 pieces each

1/Salt spray must meet 48 hours.

2/Front End Simulator Test does not have to be run on yearly re-validation.

Only when there is a change in hose length, end orientation, hose material, hose crimp or other change that affects hose routing/stability does F.E.S. have to be re-run.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS

The assemblies for validation testing must be new and unused and at least 24 hours old. Left and right-hand hose assemblies need not be separately qualified when the fittings are symmetrically opposite and/or the only difference is in the mounting bracket. Periodic recuts must show an equal number of left and right-hand hoses tested. All applicable tests are to be conducted according to ASTM D571, standard method of testing automotive hydraulic brake hoses. In the event of the failure of any sample to successfully complete the following requirements, the entire hose lot is to be rejected. Salvaging is not permitted.

- A. **100 Percent Brake Test:** All brake hose assemblies must be checked by probing or with the use of an air gauge after pressure testing to insure that no obstructions are present in the inside diameter of the hose assembly.
- B. **100 Percent Pressure Check:** All brake hose assemblies must be checked, prior to shipment, using air or nitrogen as follows:

A minimum pressure of 2,000 psi (air or nitrogen) is to be maintained for a period of twelve to twenty seconds. Any indication of seepage or braid wicking, cover blistering, ballooning, or bursting shall be cause for rejection.
- C. **Hose Dimensional Inspection:** Random sampling of at least twelve (12) hoses from each lot. Cut length dimensions and concentricity of I.D. and O.D. must check within .025 T.I.R. Inspect outer cover for visual defects. The I.D. must be free from loose graphite, acetone, wax, and other foreign material.
- D. **Bracket Salt Spray:** Must be protected to withstand corrosion when tested to Ford Specification EBF-MLP4-A (ASTM B117-64 procedure to be used).
- E. **Fork End Simulator** (see attached sheet)

IV. RELIABILITY ACCEPTANCE METHOD

Following are the methods for reducing the test data to compute the reliability values:

250-X

1. Test the number of samples specified in Section II (column 3) per requirements in column 2.
2. If a failure occurs, stop the test; part fails to meet the reliability acceptance criterion (except as noted).
3. If no failures occur, the reliability acceptance criterion is met.

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ENGINEERING SPECIFICATION

FRONT END ASSEMBLY

I. Purpose

The purpose of this test is to evaluate the durability of twelve (12) hydraulic brake hose assemblies. The test is performed to determine the statistical fatigue life of a group of test samples by testing to failure.

II. Instrumentation

- Thermometer to monitor hose temperature.
- Pressure gauge.

III. Inspection

- Get applicable suspension travel layout from Ford Design Engineering.
- Set up hose fatigue test fixture to duplicate the relevant hose and suspension attachment points of the car line hose routing under investigation.
- Adjust the fixture to provide 80% of the suspension and steering travel.
- Install six (6) hose assemblies and proceed as outlined in the test method below.
- If a supplier has both a left and right brake hose for either the front and/or rear of a vehicle, then only the left hose part number need be tested.

IV. Test Method

- The hoses are to be tested at the ambient air temperature (100 + 10°F).
- The simulated suspension is moved up and down through 80% of the jounce and rebound travel at 90 cpm. Simultaneously, the simulated suspension is rotated through 80% of the steering travel at 12 cpm.
- The hose assemblies are to be pressure cycled (with FORD ESA-MEC25-A BRAKE fluid) between 0 and 1500 psi every 15 seconds; i.e., 15 seconds at 1500 psi then 15 seconds at 0 psi.
- Each sample is to be tested until failure or 1,000,000 cycles, whichever comes first.
- Repeat steps A thru D with the other (6) six samples.

V. Test Results

- A description of each test sample failure at the end of the test.
- A tabulation of each failure and a Weibull distribution of the failures.
- B-10 life must exceed 350,000 cycles. If hoses do not meet the above target, Ford Engineering will make the final determination of acceptance criteria.
- For rear brake hose assemblies, the steering travel is omitted.
- Six station test fixture is recommended. One to twelve station fixtures is optional.
- Data to be given to Engineering at time of Engineering Sample Approval.
- One cycle is defined as one complete jounce/rebound travel.

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ENGINEERING SPECIFICATION

Q-101

1. Test the number of samples specified in Section II (column 3) per the requirements set in column 2.
2. If any of these requirements are not met, invoke section "W Test Failure" of Q-101.

V. REVALIDATION REQUIREMENTS

The following revalidation is required for any change in process or material, new supplier qualification, or subsequent year production. Entries in the columns below refer to the IV test meter shown in Section II.

Existing Change Revalidation			
Component	Process Change	Material Change	New Supplier (1)
Base Assembly	*EIA-1962A-1 or A2	See Q-101	See Q-101
Base Material	*EIA-1962A-1 or A2	See Q-101	See Q-101
Fittings	*EIA-1962A-1 or A2	See Q-101	See Q-101
Brackets	XXX	See Q-101	See Q-101
Protective			
Appurtenances	Part Drawing	See Q-101	See Q-101
Working Elements	Part Drawing	See Q-101	See Q-101

Subsequent Year Re-validation	
Subsequent years, Carryover design, EXISTING EQUIPMENT	TEST 106 *EIA-1962A-1 or A2
*For part detail drawing	

VI. LOT DEFINITION

A lot is defined as ten (10) hours of production.

VII. RECORD RETENTION

Recording and record retention shall conform to Ford Q-101, Section 2.12. Forward all IV test results to the Product Engineering Office.

VIII. INSPECTION AND NOTES

- (1) Forty-three (43) samples of brake hoses fabricated with the newly sourced components must be submitted to the responsible Ford Motor Company department prior to their use in production. These samples must be equivalent in design, performance, and workmanship to production assemblies. Following evaluation by Ford Motor Company and successful completion of all appropriate testing, written approval will be granted by the responsible department.

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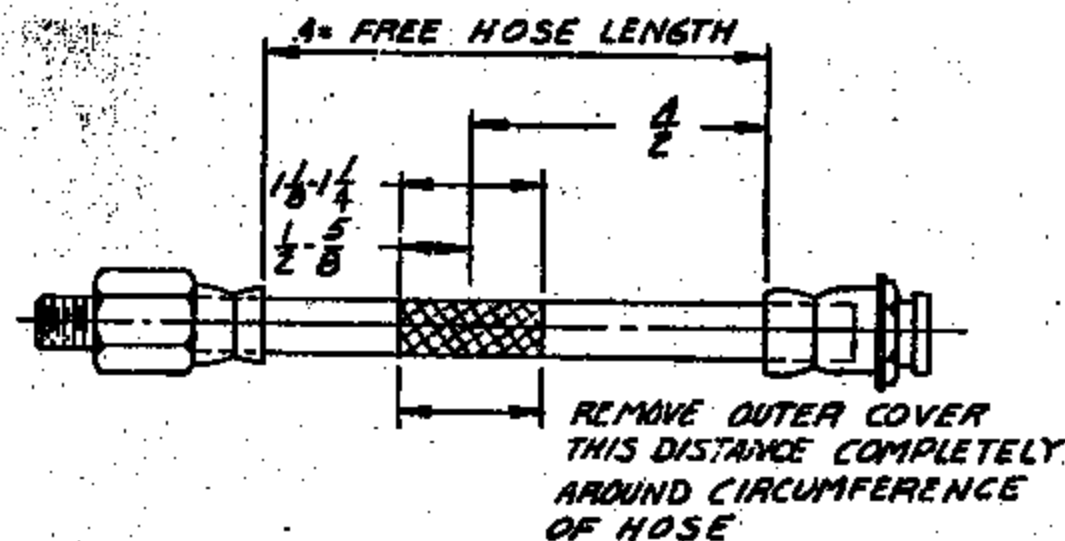
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OUTER COVER REMOVAL FOR WATER ABSORPTION TEST

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ENGINEERING SPECIFICATION

CONTROL ITEM-AFFECTS COMPLIANCE TO FEDERAL REGULATIONS-
AREAS MARKED ∇ ARE CRITICAL CHARACTERISTICS- CHANGE IN
DESIGN COMPOSITION OR PROCESSING FROM THE PART PREVIOUSLY
APPROVED FOR PART PRODUCTION REQUIRES PRIOR ENGINEERING
APPROVAL.

I. GENERAL

The booster/master cylinder assembly combined with an electric motor driven pump and accumulator converts brake pedal input force into hydraulic output pressure for automotive brake system actuation. The electric motor and pump assembly pressurizes the accumulator which in turn provides the boost hydraulic pressure to the master cylinder and the brake fluid to the rear brakes.

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

The engineering tests, sample sizes, and test frequencies contained within this engineering specification reflect the minimum requirements established to provide a regular evaluation of conformance to design intent. All laboratory production validation tests must be conducted using ESA-M6C25-A (Dew HD50-4) brake fluid. The engineering test program is intended as a supplement to normal external inspections, dimensional checking, and in-process controls, and should in no way adversely influence other inspection operations.

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

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

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

In-Process Tests Phase 2 (IP-2) - IP-2 test program may be implemented only after process capability has been established. Tests must be completed with production parts on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as much as possible. In the event that any portion of these tests are not met, the reaction plan specified in Ford Q-101 Section "ES Test Failure" shall be invoked.

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II. PRODUCTION VALIDATION AND IN-PROCESS TESTS (Cont'd.)

TABLE OF CONTENTS

Test Name	Test Number	Production Validation	In-Process IP-1	In-Process IP-2
		Minimum Sample Size	Minimum Sample Size * (and Frequency)	Minimum Sample Size & Frequency
<u>Durability</u>				
• Booster/Master Cylinder				
• Life Cycle at Room Temperature	A	8	4/mo	4/yr
• Life Cycle at Varying Temperature	B	8	4/mo	4/yr
• Life Cycle at High Temperature	C	8	4/mo	4/yr
• Vibration/Fatigue	D	4	2/mo	N/R
• Torque Limits	E	9	N/R	N/R
• Salt Spray	F	3	3/mo	1/yr
• Pump/Motor/Accumulator *				
• Life Cycle at Room Temperature	G	8	8/R	8/R
• Life Cycle at Various Temperatures	H	N/R	4/6 mo	4/yr.
• Fluid Level Indicator				
• Life Cycle at Room Temperature	I	9	8/mo	1/4,000 units
• Reservoir Cap				
• Latching Life	J	12	6/mo	4/6 mo

* See test number W1 for motor thermo protection switch durability test.



ENGINEERING SPECIFICATION

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II. PRODUCTION VALIDATION AND IN-PROCESS TESTS (Contd.)

TABLE OF CONTENTS

Test Name	Test Number	Production Validation Minimum Sample Size	In-Process IP-1 Minimum Sample Size * (and Frequency)	In-Process IP-2 Minimum Sample Size & Frequency
Functional				
• Leak Tests				
• Booster/Master Cylinder				
• Evacuator and FILL	K	45	First 3,000	2/s/hr
• Medium Pressure Hydraulic				
• Production Validation	L	27	N/R	N/R
• In-Process	M	N/R	100%	100%
• High Pressure Hydraulic				
• Production Validation	N	27	N/R	N/R
• In-Process	O	N/R	100%	100%
• High Pressure/Anti-Skid				
• Production Validation	P	27	N/R	N/R
• In-Process	Q	N/R	100%	100%
• Low Pressure/Anti-Skid	R	19	6/mo	4/6 mo
▽ • Burst Pressure				
• Hydraulic Unit	S	8	4/mo	2/6 mo
• Reservoir	T	20	4/mo	4/6 mo
• Master Cylinder	U	20	4/mo	4/6 mo
• Accumulator	V	20	4/mo	4/6 mo
• Hose	W	20	4/mo	4/6 mo

ENGINEERING SPECIFICATION

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1. PRODUCTION VALIDATION AND IN-PROCESS TESTS (Contd.)

TABLE OF CONTENTS

Test Name	Test Number	Production Validation	In-Process IP-1	In-Process IP-2
		Minimum Sample Size	Minimum Sample Size * (and Frequency)	Minimum Sample Size & Frequency
<u>Function I (Contd.)</u>				
. Attachment Strength				
. Hydraulic Unit to Dash	X	9	2/mo	1/yr
. Push Rod to Booster	Y	9	1/sht	1/sht
. Pump Assembly to Adapter	Z	9	N/R	N/R
. Reservoir to Booster	AA	3	N/R	N/R
7 . Internal Cleanliness				
. Hydraulic Components	BB	9	6/mo	6/mo
. Total Hydraulic Assembly	CC	9	6/mo	6/mo
<u>Performance</u>				
7 . Booster/Master Cylinder				
. Pressure-Force Characteristics				
. Production Validation	DD	27	N/R	N/R
. In-Process	EE	N/R	100%	100%
. Master Cylinder				
. Seal Repeating				
. Production Validation	FF	27	N/R	N/R
. In-Process	GG	N/R	100%	100%

ENGINEERING SPECIFICATION

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II. PRODUCTION VALIDATION AND IN-PROCESS TESTS (Cont'd.)

TABLE OF CONTENTS

Test Name	Test Number	Production Validation	In-Process (P-1)	In-Process (P-2)
		Minimum Sample Size	Minimum Sample Size * (and Frequency)	Minimum Sample Size & Frequency
Performance (Cont'd.)				
• Master Cylinder (Cont'd.)				
• Travel/Displacement				
• Production Validation	HH	27	N/R	N/R
• In-Process	II	N/R	100%	100%
• Compensation Restriction				
• Production Validation	JJ	27	N/R	N/R
• In-Process	KK	N/R	100%	100%
• Valve Body				
• Evacuate/FTH Valves	LL	27	N/R	N/R
7 • Reservoir				
• Fluid Level Indicator	MM	9	N/R	N/R
7 • Motor				
• Thermal Switch	NN	4	1/30.	1/30.



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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS

Usability

Booster/Master Cylinder

A. Life Cycle at Room Temperature

1. Production Validation and I.P. Tests

- Mount 4 new booster/master cylinder assemblies, less pump units and hoses, in service position with an external source of brake fluid pressure.
- Adjust external load cells so that a pressure of 68 ± 5 bar is reached in the master cylinder secondary chamber at a push rod travel of 60 to 75% of minimum stroke.
- Apply 500,000 strokes at a rate of $1,000 \pm 100$ strokes per hour.
- After the 500,000 strokes, the booster/master cylinder assembly shall be tested per the following ATEN spec. shown on assembly drawing, para. 3.3 group D, Sheet 142.

2. Acceptance Requirements

- No leakage is allowed at external sealing points other than wetting the casting and 15 cubic centimeters at the booster bore end.
- Must comply with acceptance requirements of tests listed in A.1.d, except leak rates may be twice as high as given in para. 10.6, 10.7, 10.8 and 10.9.

B. Life Cycle at Varying Temperature

1. Production Validation and I.P. Tests

- Mount 4 new hydraulic units to ATE test rig as described in ATEN. spec. shown on assembly drawing, para.5, Sheet 142.
- Adjust the test stand to provide the following test conditions during brake application without anti-skid function.
 - . Stroke master cylinder 60 to 75% of maximum possible.
 - . Provide pulsating master cylinder pressure between 0-100 bar
 - . Master cylinder pressure to rise from 0-100 bar in .5 sec.
 - . Cycle duration to be 5 seconds
 - . Electric motor duty cycle factor to be 20% (approximately 150 brake applications/hr).

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Durability

Booster/Master Cylinder

B. Life Cycle at Varying Temperature (Contd.)

1. Production Validation and I.P. Tests (Contd.)

- c. Adjust the test stand to provide the following conditions during brake application with anti-skid function.
 - Push rod force to be 3400 N maximum.
 - Pressure in hydraulic load absorbers to be 100 ± 10 bar at room temperature and above and 20 ± 10 bar at low temperature.
 - The anti-skid application duration to be 5 seconds at room temperature and above and 15 seconds at low temperature.
 - The control frequency to be 3 to 4 cps.
 - Electric motor duty cycle factor to be 20% (approximately 30 anti-skid stops/hour).
- d. Apply 3,000 brake applications with anti-skid control at room temperature.
- e. Apply 70,000 brake applications at $80^\circ \text{C} \pm 4^\circ$ including 500 applications with anti-skid control (5 anti-skid applications after every 695 brake applications).
- f. Apply 30,000 brake applications at $-40^\circ \pm 2^\circ \text{C}$ of which 1,500 with anti-skid control and 28,500 without, (15 anti-skid applications after every 285 brake applications).
- g. Perform functional and leak tests on complete hydraulic unit according to ATEN spec. shown on assembly drawing, para. 3.3 group A, Sheet 142.

2. Acceptance Requirements

- a. Must comply with acceptance requirements of tests listed above in B.1.g. except:
 - Leak rates may be twice as high as given in para. 10.2, 10.3, 10.4 and 10.6.
 - Clearance of combined piston, para. 10.1, must not be greater than 8 mm.
 - Gas pressure in accumulator may be 40 bar below the initial pressure.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Durability (Contd.)

Booster/Master Cylinder

C. Life Cycle at High Temperature

1. Product Validation and I.P. Tests

- Mount 4 new hydraulic units, less pump assembly and hoses, in service position with an external source of brake fluid pressure between 140 and 180 bar.
- The test temperature to be 114 to 126°C .
- Adjust external load cells so that a pressure of 48 ± 2 bar. is in the master cylinder secondary chamber at a push rod travel of 50 to 75% of maximum stroke.
- Apply 70,000 strokes at a rate of $1,000 \pm 100$ strokes per hour.
- After the 70,000 strokes, conduct the following functional tests: ATEN spec. shown on assembly drawing, para. 3.3 group D, Sheet 142.

2. Acceptance Requirements

- No leakage allowed at external sealing point other than wetting the casting and .5 cubic centimeters at booster bore end.
- Must comply with acceptance requirements of tests listed above in C.1.a. except leak rates may be twice as high as given in para. 10.6, 10.7, 10.8 and 10.9.

D. Vibration/Fatigue

1. Product Validation and IP-1 Tests at Room Temperature

- Mount the hydraulic unit in service position with all master cylinder and booster hoses attached.
- Fill and bleed hydraulic assembly to insure proper weight.
- Torque booster/master cylinder attaching bolts, A/S valve cover nuts and all hose attachments to maximum drawing limits for half of units to be tested and minimum torque for other half.
- Apply an input of $1.5 \pm .2$ g acceleration at the booster mounting flange in a vertical direction at 40 ± 5 cps for a total of 3,000,000 cycles. Alternate tests using maximum torque and minimum torque units.
- After the vibration/fatigue tests, the units shall be tested per ATEN spec. shown on assembly drawing, para. 3.3 group B, Sheet 142.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Cont'd.)

Durability (Cont'd.)

Booster/Master Cylinder

D. Vibration/Fatigue (Cont'd.)

2. Acceptance Requirements

- The booster/master cylinder, reservoir, pump and attaching flanges/brackets must be free of cracks.
- Torqued nuts and bolts must not be loose.
- Must comply with acceptance requirements of tests listed above in D.1.a.

E. Torque Limits

1. Production Validation Test at Room Temperature

- Torque all hydraulic fittings at 10% over maximum drawing specification.
- Mount hydraulic unit in service position on a bench fixture.
- Test the hydraulic unit per ATEN spec. shown on assembly drawing, para. 3-3 group 2, Sheet 142.
- At completion of above tests, torque all fasteners to failure and record results.

2. Acceptance Requirements

- No failures may occur in the booster, master cylinder and/or pump castings prior to step 1.d. above.
- Must conform to acceptance requirements of E.1.a. above.
- Ultimate torque failure must occur in the casting threads, the fastener, or if in the casting at 2 times the maximum specified torque.

F. Salt Spray

1. Production Validation and IP Test at Room Temperature

- Mount the hydraulic unit in service position with outlet ports A, B and C, per attached drawing, plugged and all electrical connectors protected with suitable leak proof plugs.
- Subject the unit to a minimum of 24 hours of salt spray per ASTM-B-117.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Cont'd.)

Durability (Cont'd.)

Booster/Master Cylinder

F. Salt Spray (Cont'd.)

2. Acceptance Requirements

- a. After a minimum of 24 hours of salt spray testing, the external surfaces, less machined surfaces, must be 90% minimum free of corrosion as described in Ford Specification FTM B1-3-1.



Pump/Motor/Accumulator Assembly

G. Life Cycle at Room Temperature

1. Production Validation and Tests

- a. Mount 4 new pump, motor and accumulator assemblies with high pressure hoses to a test stand in service position.
- b. Fill the system with brake fluid.
- c. Cool the electric motor so that the steady state temperature of the bearings is the same as if were continuously cycling with 9 seconds on and 36 seconds off.
- d. Adjust the test rig to run at 200 ± 20 cycles per hour. One cycle consists of building brake fluid pressure in the accumulator with the electric motor until it is switched off by the high pressure switch and then deplete the accumulator pressure until the motor starts again at the low pressure switch point.
- e. Apply 100,000 cycles to the assembly and check the nitrogen pressure in the accumulator every 50,000 cycles.

2. Acceptance Requirements

- a. No brake fluid leakage permitted except:
 - . Wetting the seating
 - . 4 cc at pump to motor interface
 - . 4 cc at pressure switch drain holes
- b. Pump must be able to reach 188 bar pressure at end of cycle test.
- c. Accumulator nitrogen pressure must be at least 50 bars at end of test.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Durability (Contd.)

Pump/Motor/Accumulator Assembly (Contd.)

H. Life Cycle at Various Temperatures (Contd.)

1. In-Process Tests

- Mount 4 new pump and motor assemblies into pump test rig in service position.
- Adjust the voltage to the motor terminals to 12-0.5 volt.
- The following cycles are to be performed in the sequence given below against a pump pressure of 160 ± 5 bar.

Test No.	Cycles	Temperature	Online	Offline
1	50,000	R.T.	15 s	60 s
2	10,000	$-30 \pm 4^{\circ}\text{C}$	15 s	60 s *
3	1,500	$-40 \pm 4^{\circ}\text{C}$	15 s	60 s ⊕
4	50,000	R.T.	15 s	60 s
5	10,000	$100 \pm 4^{\circ}\text{C}$	15 s	75 s
6	2,500	$126 \pm 6^{\circ}\text{C}$	15 s	90 s

* After each 100 cycles pause to allow the fluid to cool to $-30 \pm 4^{\circ}\text{C}$.

⊕ After each 50 cycles pause to allow the fluid to cool to $-40 \pm 4^{\circ}\text{C}$.

- After the test sequence is finished, install a new accumulator and measure the time required to charge the accumulator to 188 bar.

2. Acceptance Requirements

- Pump and motor assembly must complete test sequence.
- The pump and motor assembly must be able to charge a new accumulator to 188 bar in 60 seconds.

Fluid Level Indicator

I. Life Cycle at Room Temperature

1. Production Validation and IP Tests

- Mount the F.L.I. assembly on test fixture in service position.
- Connect a 13.5 ± 1 volt D.C. power supply and 3W/12 volt test bulb to both circuits which are fed by the clamshell. Add a 6.8 ohm resistor in series with the warning switch contact which is closed at the upper position of the float.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Durability (Contd.)



Fluid Level Indicator (Contd.)

I. Life Cycle at Room Temperature (Contd.)

1. Production Validation and JP Tests (Contd.)

- c. Mechanically cycle the float 100 times in the following way:
 - . Maintain the float for 5 seconds in the upper position where the test light for the 3 pin connector is off and the light for the 2 pin connector is on.
 - . Move the float down in the next .5 seconds and maintain in lowest position for 5 seconds where the 3 pin connector is on and the 2 pin connector off. Move float up in next .5 seconds to complete cycle.
 - . After 5, 10, 15, 20 and 100 cycles, maintain the float under electric load in lower position for 3 hours.

2. Acceptance Requirements

- a. F.L.I. assembly must conform with performance as specified on drawing.
- b. Assembly must not exhibit any visible damage or excessive wear.

Reservoir Cap

J. Latching Life

1. Production Validation and JP Tests

- a. Mount the reservoir on a test bench in car position.
- b. Wet the sealing area of the cap gasket with brake fluid.
- c. Twist the cap on and off 25 times.

2. Acceptance Requirements

- a. The torque for the first twist installation must be 4 Nm maximum.
- b. The torque for the first twist removal must be 2.5 Nm minimum.
- c. Torque values for installation and removal must not vary more than 50% from the initial values during the 25th cycle.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests

Leak Tests

Booster/Master Cylinder

K. Evacuate and Fill

1. Production Validation and IP Tests

- Mount a complete hydraulic unit that had been previously wet tested and drained on a test fixture in car position.
- Deplete accumulator and verify that the evacuate and Fill valves are open before plugging outlet ports A, B, and C per attached sketch.
- Apply 0.8 ± 0.05 bar vacuum to the reservoir opening.
- Allow 30 or more seconds for stabilization, close off vacuum source and measure vacuum in hydraulic unit after 10 seconds.
- Apply 6 ± 0.5 bar air pressure to reservoir opening allow 30 seconds or more for stabilization. Close off pressure source and measure pressure in hydraulic unit after 10 seconds.
- Deplete air from hydraulic unit and manually open the evacuate and Fill valves.

2. Acceptance Requirements

- Leakage in vacuum mode must not exceed .05 bar in 10 seconds.
- Leakage on pressure mode must not exceed .3 bar in 10 seconds.

L. Medium Pressure Hydraulic

1. Production Validation Tests

- Mount complete hydraulic unit in car position.
- Bleed the system and charge the accumulator with the electric pump to upper switch point.
- Plug outlet ports A, B and C with suitable leak-proof plugs to withstand high pressure.
- Advance the booster push rod sufficient to produce $95 \pm .5$ bar pressure in the master cylinder secondary chamber.
- Held the push rod position constant for 3 minutes with the electric pump motor disconnected to allow the pressure to stabilize.
- Measure the pressure decrease at outlet ports A, B and C during the next 2 minutes.

2. Acceptance Requirements

- Leakage from the hydraulic unit shall not exceed amount indicated by pressure drop of 5 bar in 2 minutes.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Cont'd.)

Functional Tests (Cont'd.)

Leak Tests (Cont'd.)

Booster/Master Cylinder (Cont'd.)

M. Medium Pressure Hydraulic

1. In-Process Tests - 100%

- a. Mount booster assembly in Teves test stand.
- b. Apply low pressure air test per Teves Q.C. procedure ATEN spec. shown on assembly drawing, para. 10.10 and 10.11, Sheet 142.

2. Acceptance Requirements

- a. Must comply with Teves In-process Q.C. test requirements listed in M.1.b. above.

N. High Pressure Hydraulic

1. Production Validation Tests

- a. Mount the booster/master cylinder in service position.
- b. Bleed the system and charge the accumulator with the electric pump to upper switching point.
- c. Plug outlet ports A, B and C with suitable leak-proof plugs to withstand high pressure.
- d. Advance the booster push rod sufficient to produce 100 ± 10 bar pressure in the master cylinder secondary chamber. Hold the push rod position constant and stabilize for 3 minutes.
- e. Disconnect the electric pump and measure the leakage from the hydraulic unit after an additional 2 minutes.

2. Acceptance Requirement

- a. Leakage from the hydraulic unit shall not exceed an amount indicated by a pressure drop of 9 bar in 2 minutes.

O. High Pressure Hydraulic

1. In-Process Tests - 100%

- a. Mount the booster/master cylinder in Teves test stand.
- b. Apply high hydraulic pressure to the unit per Teves Q.C. procedure ATEN spec. shown on assembly drawing para. 10.12, Sheet 142.

2. Acceptance Requirements

- a. Must comply with Teves In-process Q.C. test requirements listed in O.1.b. above.

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ENGINEERING SPECIFICATION

11. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

Leak Tests (Contd.)

Booster/Master Cylinder (Contd.)

P. High Pressure Hydraulic with Anti-Skid

1. Production Validation Tests

- Mount a booster/master cylinder assembly on test stand in any position.
- Bleed the assembly, plug outlet ports A and B with leak-proof high pressure plugs and connect a pressure gauge to outlet port C.
- Advance the master cylinder piston 10 ± 2 mm, actuate the main valve and apply 100 ± 10 bar through the high pressure hose.
- After stabilization, close off the pressure source and test for leakage per Teves procedure ATEN spec. shown on assembly drawing para. 10.9, Sheet 142.

2. Acceptance Requirements

- Leakage from the master cylinder through the main valve shall not exceed limits as described in P.1.d. above.

Q. High Pressure Hydraulic with Anti-Skid

1. In-Process Tests - 100%

- Mount the booster/master cylinder in Teves test stand.
- Apply high pressure hydraulic and measure dynamic return fraction of positioning sleeve vs speed and load per Teves Q.C. procedure ATEN spec. shown on assembly drawing para. 9.3.4, Sheet 142.

2. Acceptance Requirements

- Must comply with Teves In-process Q.C. test requirements listed in Q.1.b. above.

R. Low Pressure with Anti-Skid

1. Production Validation and IP Tests

- Mount complete hydraulic unit on Teves simulator test bench #2.11 or equivalent with load valve connected.
- Bleed the system and charge the accumulator to upper switching point of pressure switch.
- Apply a simulated anti-skid step as follows:
 - Production Validation - set friction surface at 0.1 μ and vehicle speed at 100 Km/hour.
 - In-Process - cycle the anti-skid valves at a frequency of 2 C.P.S. with a duration of 9.7 mill. seconds.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

Leak Tests (Contd.)

Booster/Master Cylinder (Contd.)

R. Low Pressure with Anti-Skid (Contd.)

1. Production Validation and IP Tests (Contd.)

- d. Immediately after the simulated stop provide 10 ± 1 bar brake fluid pressure inside the master cylinder secondary chamber and hold for 2 minutes.

2. Acceptance Requirements

- a. Pressure loss within the master cylinder must not exceed 1.5 bar in 2 minutes.

S. Burst Pressure

5. Hydraulic Unit

1. Production Validation and IP Tests

- a. Mount hydraulic unit, less accumulator, in test fixture with the following modifications.
 - . Pressure relief valve in pump blocked.
 - . Outlet ports A, B and C plugged.
 - . Main valve in master cylinder closed to reservoir.
 - . Booster spool valve actuated by push rod.
- b. Fill and bleed the system
- c. Apply hydraulic pressure through the accumulator opening until failure.

2. Acceptance Requirements

- a. The minimum burst pressure must be greater than 350 bar.

T. Reservoir

1. Production Validation and IP Tests

- a. Mount reservoir in fixture.
- b. Seal outlet ports with suitable high pressure plugs.
- c. Fill and bleed the reservoir.
- d. Apply hydraulic pressure to fill port until the reservoir bursts.

2. Acceptance Requirements

- a. The average burst pressure $\pm 3 \sigma$ standard deviations must be greater than 20 bar.

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ENGINEERING SPECIFICATION

1N. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

▽ Burst Pressure (Contd.)

U. Master Cylinder

1. Production Validation and IP Tests

- Mount master cylinder body in fixture.
- Seal outlet ports and bore end with suitable high pressure plugs.
- Fill and bleed the unit.
- Apply hydraulic pressure through valve block opening A or C until the master cylinder casting ruptures.

2. Acceptance Requirements

- The minimum burst pressure must be greater than 410 bar.

V. Accumulator

1. Production Validation and IP Tests

- Mount accumulator, less nitrogen gas pressure, in fixture.
- Apply hydraulic pressure through the accumulator inlet until it bursts.

2. Acceptance Requirements

- The average burst pressure -3σ standard deviations must be greater than 600 bar.

W. Hose

1. Production Validation and IP Tests

- Mount the high pressure hydraulic hose in test fixture.
- Block one end with suitable high pressure plug.
- Fill and bleed the hose.
- Apply hydraulic pressure until the hose ruptures.

2. Acceptance Requirements

- The average burst pressure -3σ standard deviations must be greater than 350 bar.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

• Attachment Strength

X. Hydraulic Unit to Dash

1. Production Validation and IP Tests

- a. Mount a wet hydraulic unit assembly, less pump and motors, to a rigid plate simulating a dash panel.
- b. Torque the booster adapter mounting studs to 34 Nm.
- c. Advance the push rod until the master cylinder pistons are fully stroked and then apply $10,000 \pm 200$ N compression load to the push rod.

2. Acceptance Requirements

- a. Push rod must not bend or take a permanent set.
- b. Master cylinder, booster, or adapter mounting ears must not fracture or show any permanent set in excess of 0.6 mm when measured from mounting plate to end of master cylinder.

Y. Push Rod to Booster

1. Production Validation and IP Tests

- a. Mount a booster push rod and piston assembly into a tensile test fixture.
- b. Apply an axial tension load between the eye end of the push rod and the piston until the push rod pulls out.

2. Acceptance Requirements

- a. The minimum force to separate the push rod from the piston must be greater than 2,000 N.

Z. Pump/Motor and Accumulator to Adapter

1. Production Validation Test

- a. Mount a pump/motor and accumulator assembly with a booster adapter to a simulated dash panel in-service position.
- b. Apply a vertical acceleration of $4G \pm .5$ to the total assembly at a rate of 5 to 10 Hz for 6,000 applications.

2. Acceptance Requirements

- a. Pump/motor and accumulator assembly must not disengage from the adapter housing or show any visible damage.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

• Attachment Strength (Contd.)

AA. Reservoir to Booster

1. Production Validation Tests

- a. Mount a previously wet but empty reservoir to a hydraulic unit in-service position.
- b. Apply a 45° load mid-length to the top of the reservoir from the outboard side 90° to the axial centerline of the master cylinder sufficient to separate the reservoir from the booster grommet.

2. Acceptance Requirements

- a. The load to separate the reservoir from the booster must exceed 50 N.

▽ Internal Cleanliness

BB. Hydraulic Components

1. Production Validation and IP Tests

- a. Prior to assembly, major internal components of the hydraulic unit must be measured for cleanliness.
 - Control Valve
 - Main valve Internals
 - Bleed valves
 - Valves SO Internals
 - Valves SG Internals
 - Master cylinder Internals
 - Booster Internals
 - Pump Internals
 - Hydraulic accumulator
 - Pressure hose
 - Reservoir
 - Fluid level indicator
- b. Wash the parts in alcohol previously filtered through a 5 micron filter.

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Functional Tests (Contd.)

▽ Internal Circulation

BB. Hydraulic Components (Contd.)

1. Production Validation and IP Tests

- c. Pour the wash alcohol solution through a 44 micron filter. The alcohol and residue that passes through the sieve is insignificant and is to be discarded.
- d. Subject the residue that is caught by the 44 micron filter to Tores ATEN 54380 test specification for cleanliness measurements.

2. Acceptance Requirements

- a. Total weight per the following group of components must not exceed 5 milligrams of contamination.
 - Master cylinder with reservoir, FLI, main valve and A.S. valve block assembly.
 - Booster, high pressure hose and banjo bolts.
 - Pump, pressure switch and accumulator.
- b. Particle size must not exceed:
 - 150 micron in width X 9,000 micron length
 - 150 to 300 micron in width X 4,500 micron length
 - 300 to 1400 micron in width X 3,000 micron length

CC, Total Hydraulic Assembly

1. Production Validation and IP Tests

- a. Mount total hydraulic unit into test fixture in service position with load cells connected.
- b. Fill and bleed the system.
- c. Actuate the system at least 6 times, including anti-skid functions, against a 122 ± 4 bar load.
- d. Blow out brake fluid with 4 ± 1 bar air pressure through booster reservoir opening into a clean container.
- e. Pour the brake fluid through a 44 micron filter.
- f. Measure and identify the contamination retained by the 44 micron per Texas ATEH S4380 test specification for cleanliness measurement.
- g. Disassemble the complete hydraulic unit and visually examine all areas for contamination, measure and identify type.

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III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

Internal Cleanliness (Contd.)

CC. Total Hydraulic Assembly (Contd.)

2. Acceptance Requirements

- a. Total weight per assembly must not exceed 30 milligrams.
- b. Particle size must not exceed:
 - . 150 micron in width X 9,000 micron length
 - . 150 to 300 micron in width X 4,500 micron length
 - . 300 to 1400 micron in width X 3,000 micron length

Performance

Booster/Master Cylinder, with and without Anti-Skid

DD. Pressure-Force Characteristics

1. Production Validation Tests

- a. Mount booster/master cylinder in Teves test bench.
- b. Perform Teves test procedure ATEN spec. shown on assembly drawing para. 3.1 group D, Sheet 142.

2. Acceptance Requirements

- a. Must comply with Teves requirements contained in DD.1.b. above.

Booster/Master Cylinder without Anti-Skid

EE. Pressure-Force Characteristics

1. In-Process Tests - 100%

- a. Mount the booster/master cylinder in Teves assembly fixture.
- b. Perform Teves Q.C. procedure ATEN spec. shown on assembly drawing para. 9.1.3, Sheet 142.

2. Acceptance Requirement

- a. Must comply with Teves in-process Q.C. test requirements listed in EE.1.b. above.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Cont'd.)

Functional Tests (Cont'd.)

Performance (Cont'd.)

Master Cylinder

FF. Seal Regeneration

1. Production Validation Tests

- Mount empty master cylinder in test fixture.
- Stroke master cylinder pistons 7 to 8 mm and hold and then plug ports A and C.
- Apply $1.0 \pm .1$ bar air pressure into a modified master cylinder reservoir and close off pressure source.
- Open port A and observe pressure drop in reservoir after 5 seconds.
- Replug port "A".
- Repeat step "c".
- Open port C and measure pressure drop in reservoir after 5 seconds.

2. Acceptance Requirement

- The pressure in the reservoir after 5 seconds with either outlet port open must be .35 bar or less.

GG. Seal Regeneration

1. In-Process Tests - 100%

- Mount a booster/master cylinder assembly in the Texas test fixture.
- Perform Texas Q.C. test procedure ATEN spec. shown on assembly drawing, para. 10.10, Sheet 142.

2. Acceptance Requirement

- Must comply with Texas in-process Q.C. test requirements as listed in GG.1.b. above.

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II. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

Performance (Contd.)

Master Cylinder (Contd.)

III. Travel/Displacement

1. Production Validation Tests

- a. Mount the master cylinder in a test fixture in service position with outlet ports A and C connected to zero pressure displacement gages.
- b. Fill and bleed the system with brake fluid.
- c. Completely stroke the master cylinder at a constant rate of 2.5 ± 1 mm/sec.

2. Acceptance Requirements

- a. The piston travel must be within the tolerance limits shown on the master cylinder drawing.
- b. The fluid displacement from the primary and secondary chambers must be at least the minimum values shown on the hydraulic unit drawing.

IV. Travel/Displacement

1. In-Process Tests - 100%

- a. Mount the booster/master cylinder assembly in Test fixture.
- b. Perform Test Q.C. test procedure ATEN open, shown on assembly drawing, para. 9.4.3, Sheet 142.

2. Acceptance Requirements

- a. Must comply with Test in-process Q.C. test requirements as listed in 11.1.b. above.

V. Compensation Restriction

1. Production Validation Tests

- a. Mount the master cylinder in a test fixture with a cover plate in place of the anti-skid valve block assembly.
- b. Attach a brake fluid reservoir to the master cylinder vent and fill the assembly with brake fluid.
- c. Mechanically block the secondary master cylinder piston from compressing and apply $.2 \pm .05$ bar air pressure through the valve block plate into the primary master cylinder chamber.

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Functional Tests (Contd.)

Performance (Contd.)

Master Cylinder (Contd.)

JJ. Compensation Restriction (Contd.)

1. Production Validation Tests (Contd.)

- Measure the travel of the primary piston necessary to close the compensating center valve by slowly advancing the primary piston until the air bubbles stop rising in the reservoir.
- Advance the primary piston an additional 5 mm and increase the air pressure to $2 \pm .1$ bar.
- Seal off the pressure source trapping the air pressure in the chamber.
- Measure the loss of air pressure at the valve block plate after 5 minutes.
- Repeat steps c through g except reverse the master cylinder chambers.

2. Acceptance Requirements

- The travel to close either compensating center valve must be less than 1.6 mm.
- The pressure decrease after 5 minutes in either master cylinder chamber must not exceed .03 bar/min.

KK. Compensation Restriction

1. In-Process Tests - 100%

- Mount master cylinder in Teves Q.C. fixtures.
- Perform Teves Q.C. procedure ATEN spec. shown on assembly drawing spec. 9.4.4, Sheet 142.

2. Acceptance Requirements

- Must comply with Teves in-process Q.C. test requirements listed in KK.1.b. above.

NUMBER
VES-ETSC-22215-AR

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FRAME 25 OF 28

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Performance Tests (Contd.)

Valve Body

LI. Evacuate/Fill Valves

1. Production Validation Tests

- Mount valve block assembly in test fixture.
- Connect master cylinder ports to a vacuum/pressure source using a cover plate.
- Attach vacuum/pressure gauges to outlet ports A, B and C.
- Apply $0.8 \pm .05$ bar vacuum to the cover plate.
- Allow 10 seconds to stabilize the vacuum and close off the source sealing the vacuum inside the assembly.
- Record vacuum readings at outlet ports A, B and C after an additional 10 seconds.
- Change the vacuum source to a pressure source and pressurize the assembly through the cover to 10 ± 5 bar.
- Allow 2 seconds to stabilize and close off the pressure source sealing the pressure inside the assembly.
- Record the pressure readings at outlet ports A, B and C after an additional 10 seconds.
- Repeat steps d through i 30 times except record only on the 1st and 30th cycle.

2. Acceptance Requirements

- By-pass valves must remain open during the vacuum test. No vacuum leakage greater than .05 bar in 10 seconds permitted.
- By-pass valves must close with a maximum pressure of 10 bar and must not reopen during step j). No pressure leakage greater than .5 bar in 10 seconds permitted.

Reservoir

MI. Fluid Level Regulation

1. Production Validation

- Mount a reservoir assembly in a test fixture in service position and fill to specified level with brake fluid.
- Connect a 15.5 ± 1 volt D.C. power supply and a 3W/12 volt test bulb to both wirepins fed by the connector. Add a 6.8 ohm resistor in series with the circuit which is closed when the float is in the down position.
- Tilt the reservoir down and down 17° and rotate the horizontal plane 12° to the left of the transverse centerline.
- Stroke the assembly up and down vertically with one G acceleration and ± 6 mm displacement for 500 cycles.

DET 34 3847-a2

Q P

3718 7096

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NUMBER
△ ES-ETSC-2C215-AP

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82 of 26
FRAME

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ENGINEERING SPECIFICATION

III. TEST PROCEDURES AND REQUIREMENTS (Contd.)

Performance Tests (Contd.)

Reservoir

MM. Fluid Level Indicator (Contd.)

1. Production Validation (Contd.)

- e. Change the horizontal plane to 12° to the right of the transverse centerline.
- f. Repeat step d.
- g. Drain out the necessary amount of brake fluid to activate both low fluid warning switches in the fluid level indicator.

2. Acceptance Requirements

- a. Low fluid level indication must not occur during shake test with filled reservoir.
- b. Low fluid level indication must occur after shake test for both brake and A.S. systems during step g.
- c. No fluid leakage permitted.

Motor

MM Switch Thermo Protection

1. Production Validation

- a. Mount & new pump & motor assemblies into pump test rig in service position.
- b. Adjust voltage to motor terminals to 12.0 ± 5 volts.
- c. Bypass the pressure switch so that the motor voltage is supplied continuously.
- d. Perform the test sequence given below against the pressure provided by the pressure relief valve. The duty cycle will be determined by the thermo protection switch.

Test Temperature	Load Cycles
Room Temp.	3,000
+60 $^{\circ}$ F	4,000
-30 $^{\circ}$ F	1,000

2. Acceptance Requirements

- a. Motor must complete test sequence.
- b. Motor must be capable of functioning a new pump assembly to fully charge the accumulator within 60 sec.

Doc No 3047-02

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NUMBER
MM-51232-3SL7-57

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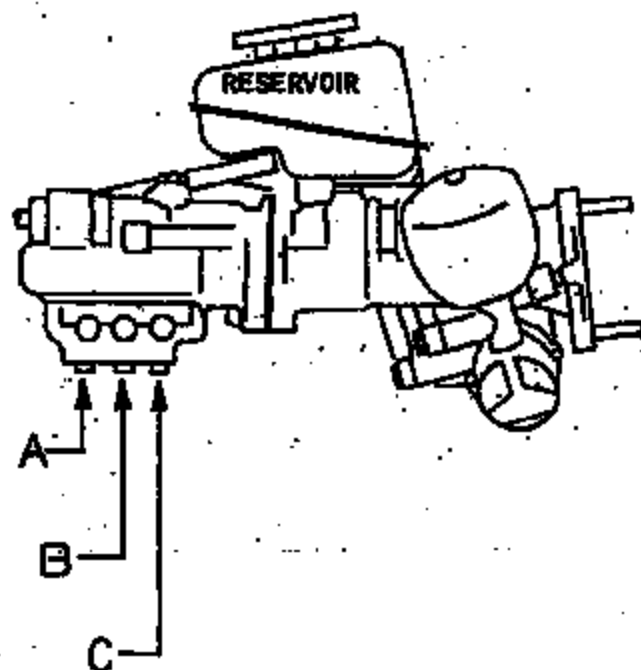
FRAME 27 OF 28

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ENGINEERING SPECIFICATION

BRAKE ANTI-SKD ASSEMBLY TEST PORT LOCATIONS



NUMBER

ES-ETSC-22215-AA

REVISION

82 28

DATE

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DET 26 2047-02

GP

3718 7098

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Engineering Specification

Part Name

SPECIFICATION - BRAKE SYSTEM RECALL PREVENTION

I. GENERAL

This specification is an extension of the released drawing and requires that all documented causes of brake system recalls and corrective actions be addressed and reported with the ISIR submission. All other requirements of the released drawing must be met in addition to demonstrating compliance to this specification. Minimum measures necessary for demonstrating compliance are listed.

II. COMPLIANCE DEMONSTRATION

- A. 1) At 1-3 months after source selection, complete an engineering design review of the potential concerns referenced in attached schematic and demonstrate that each is reflected in design and development plans. Document results in:
- Design FMEA
 - DVP&R test plans
 - Definition of significant/critical characteristics
 - Preliminary Manufacturing/assembly process flow charts
- 2) The design review shall be conducted with representatives from the supplier, Ford Product & Process Engineering, Ford SQE, and Ford Purchasing.
- 3) Ford Product Engineering to provide program timing plans at the engineering design review meeting and schedule review timing for section B and C.

FRAME 2 of 37

REVISED

NUMBER ES-Y17A-2L118-2A

MAY 1999 PD 3047-02 (Previous editions only MAY be used)

3718 7100

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Engineering Specification

Part Name

**SPECIFICATION - BRAKE SYSTEM RECALL PREVENTION-
Continued**

II. COMPLIANCE DEMONSTRATION-Continued

- B. 1) Prior to receipt of parts to support engineering prototype builds, conduct a manufacturing design review of the potential concerns referenced in attached schematics and demonstrate that each is reflected in production plans. A copy of the appropriate schematic from this specification should be attached to the Process FMEA with cross reference to FMEA sections noted. Document results in:

- Process FMEA
- Manufacturing/assembly process flow charts

- B. 2) This review shall be conducted with representatives from the supplier, Ford Product & Process Engineering, Ford WQ, and Ford Purchasing.

- C. Coincident with receipt of parts to support engineering prototype build, confirm that process control and capability is acceptable for each potential concern referenced in attached schematic based on prior prototype manufacturing experience. Quality Control plans must be finalized and reaction plans must be in place that absolutely preclude shipment of non-conforming production components. Surrogate process control and capability results are acceptable and must be appropriately identified and approved when it is not cost effective to utilize the proposed manufacturing process.

PAGE 3 of 37

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NUMBER ES-F17A-2L116-2A

SI PD 3647-62 (Previous editions may NOT be used)

3718 7101

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Engineering Specification

Part Name

SPECIFICATION - BRAKE SYSTEM RECALL PREVENTION-Continued

II. COMPLIANCE DEMONSTRATION-Continued

- D. 1) The ISIR submission provided by the manufacturing facility to Ford Product Engineering, Ford OSA, and Ford Purchasing must include the following:
- Manufacturing/assembly process flowcharts
 - Listing of significant/critical characteristics
 - Process FMEA and schematic
 - Quality Control Plan
 - Process Capability Results
- 2) Supplier Product Engineering must provide to Ford Product Engineering by the ISIR date the following:
- Completed Design FMEA
 - Completed DVP&R

III. SYSTEM SCHEMATICS

FRAME NUMBER

BRAKE BOOSTERS	5 & 6
MASTER CYLINDERS	7, 8, 9, 10 & 11
PRESSURE CONTROL VALVES	12, 13, 14 & 15
BRAKE ANTI-LOCK VALVES	16 & 17
DISC BRAKE	18, 19 & 20
DISC BRAKE ROTORS	21 & 22
DRUM BRAKES	23 & 24
BRAKE LAMP	25 & 26
BRAKE ANTI-LOCK CONTROLS	27, 28 & 29
PARKING BRAKES	30, 31 & 32
BRAKE HOSE ASSEMBLY	33
BRAKE TUBE	34
WHEEL BEARINGS	35, 36 & 37

FRAME 4 OF 37

REVISED

NUMBER ES-F17A-21118-2A

PD 3947-82 (Previous editions may NOT be used)

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3718 7102

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BRAKE BOOSTER

Engineering Specification

SOLUTIONS CONTAINING
AMMONIUM SALTS (SUCH AS
HIGH SOAP) ATTACK DELPHIN
CHECK VALVE

REINFORCING PLATE NOT
ASSEMBLED IN SHELL

VALVE BODY BREAKS

INCORRECT DIAPHRAGM
RETURN SPRING
INSTALLED

VACUUM LEAKAGE
AT GASKET

BOOSTER DAMAGED FROM
EXTENSION SYSTEM
HEAT - DIAPHRAGM

PEDAL ROD PULLS OUT

STOP LIGHT SURFACE
WELDED INCORRECTLY

INCORRECT MATERIAL
USED IN PEDAL ROD/
OUTPUT ROD

WRONG REAR SHELL

REAR SHELL THINOUT
CAUSED SEPARATION
OF BOOSTER SHELLS

SHEET 1 OF 2

PAGE 5 OF 37

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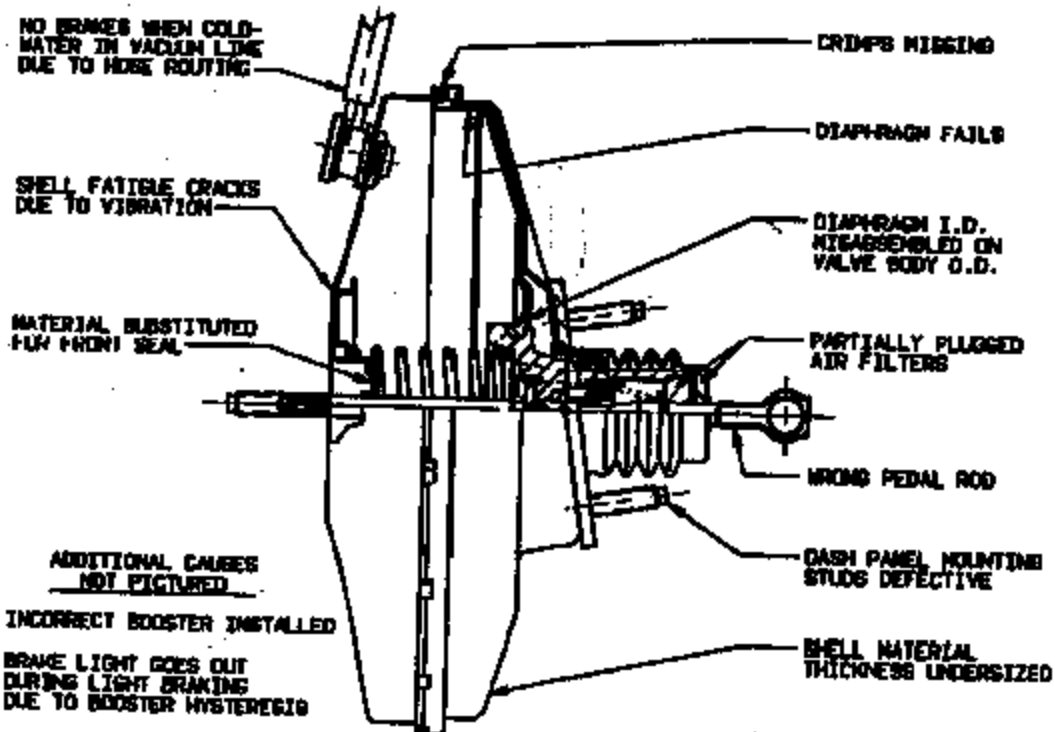
NUMBER ES-F17A-2L118-AA

REF PO 3847 - 82 previous edition (see 1st to 4th)

3718 7103

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BRAKE BOOSTER



SHEET 2 OF 2

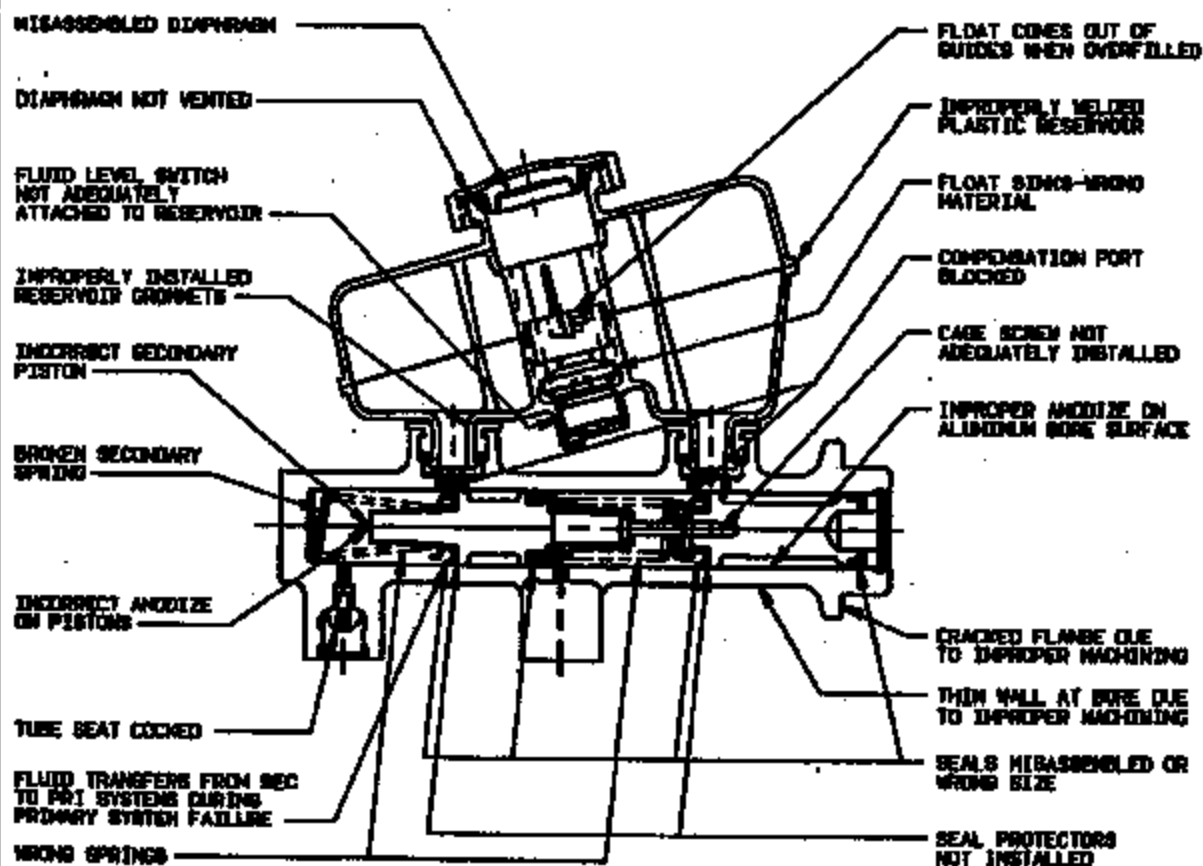
FIGURE 8 OF 37
 MAY PD 3047-02 (includes subfigure 801 and 802)

MANAGER 88-717A-21118-NA

3718 7104

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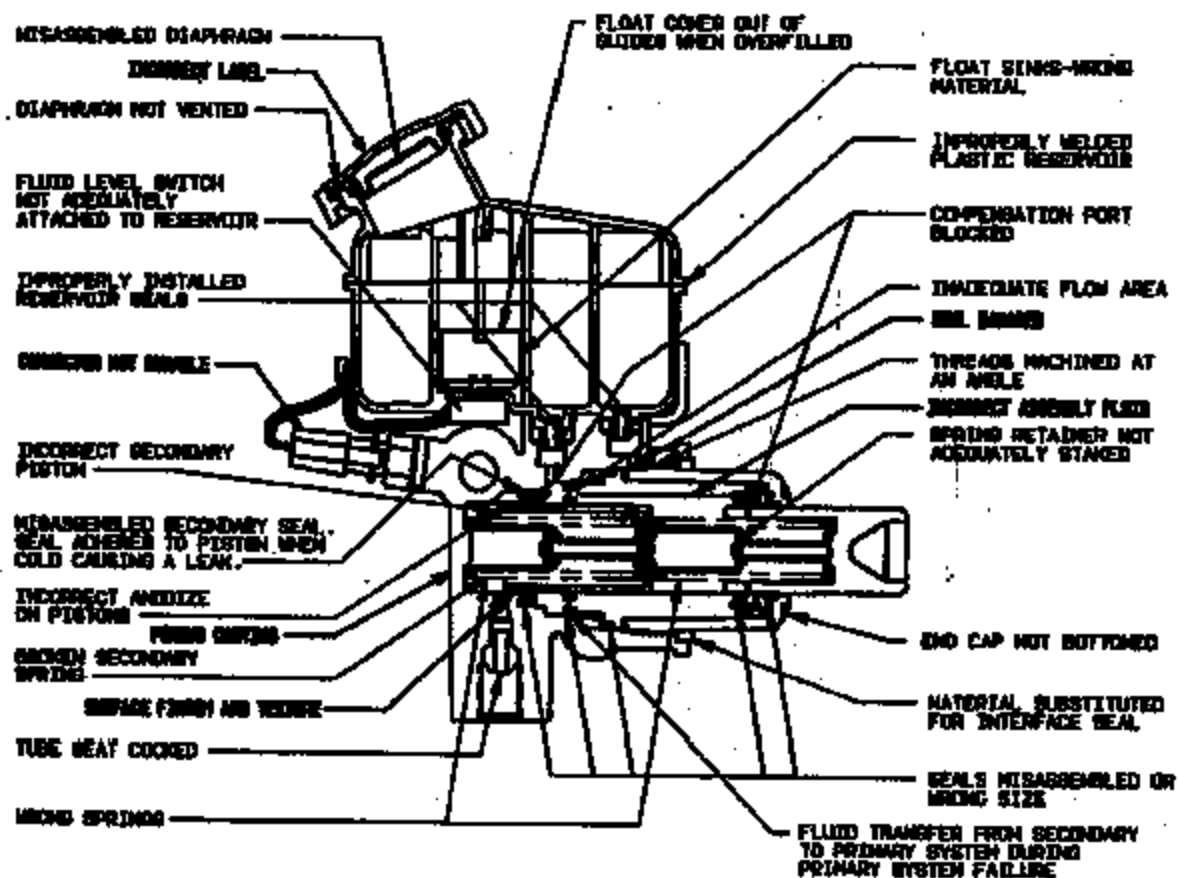
Engineering Specification



FROM	7 of 37	REVIEWED
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MEMPHIS 204-7172-2111B-2A

MASTER CYLINDER



Engineering Specification

PLATE 1

1 of 37

References

References

65-1174-21110-7A

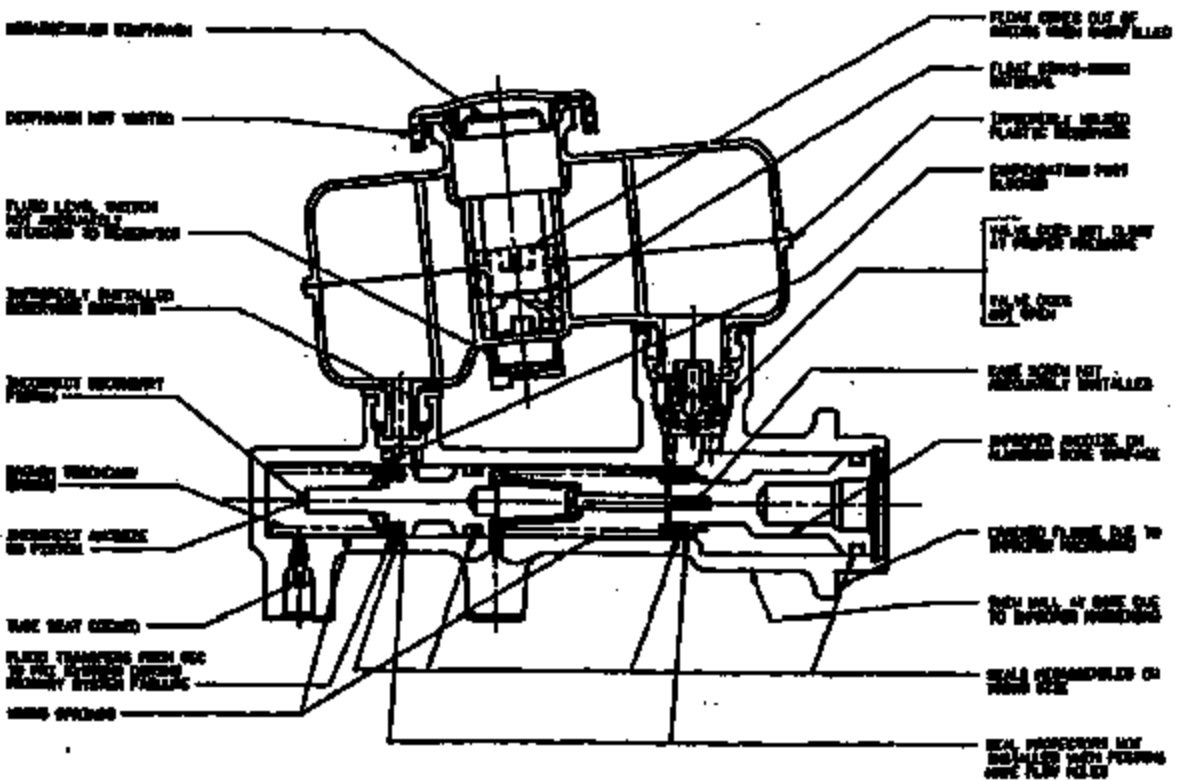
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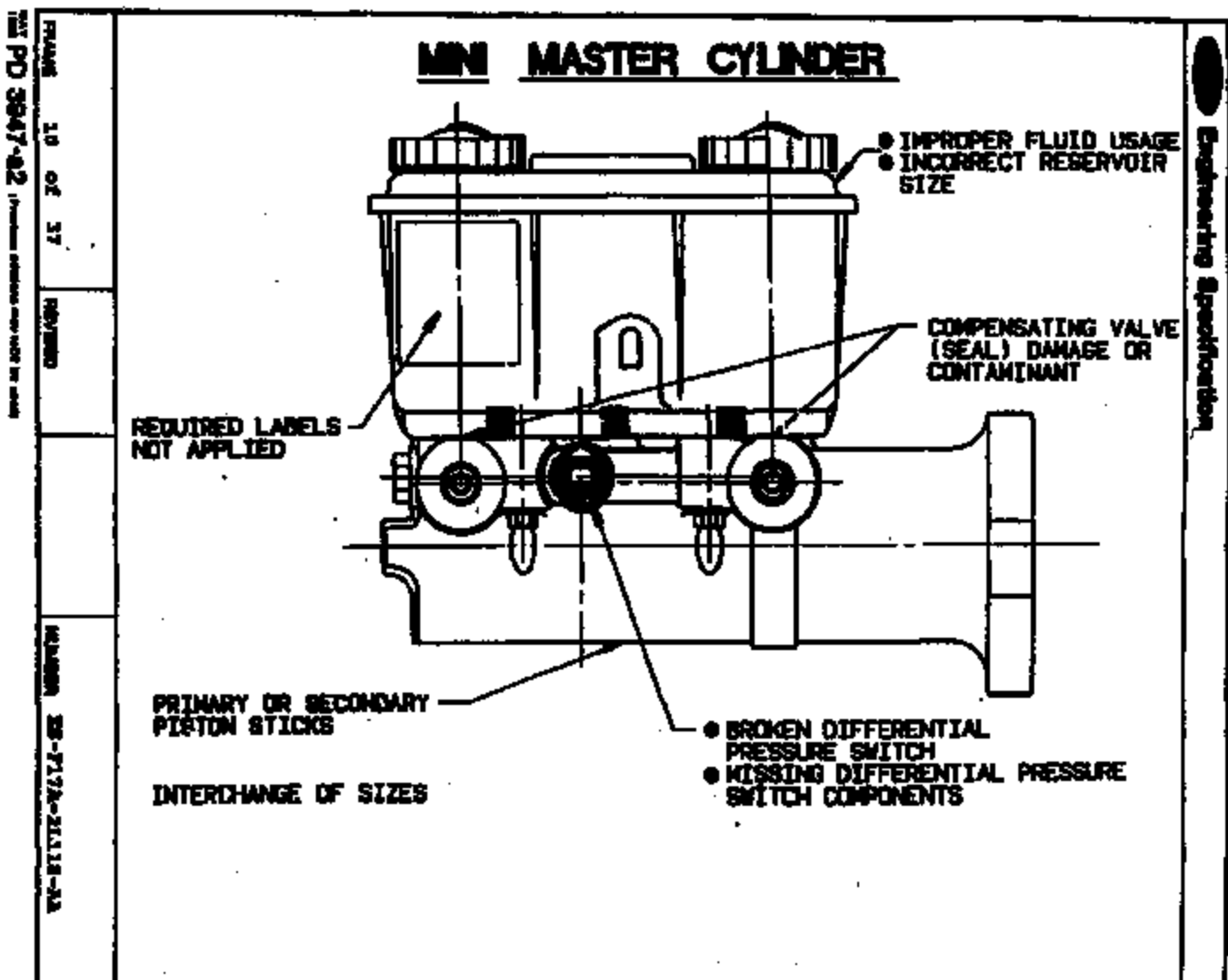
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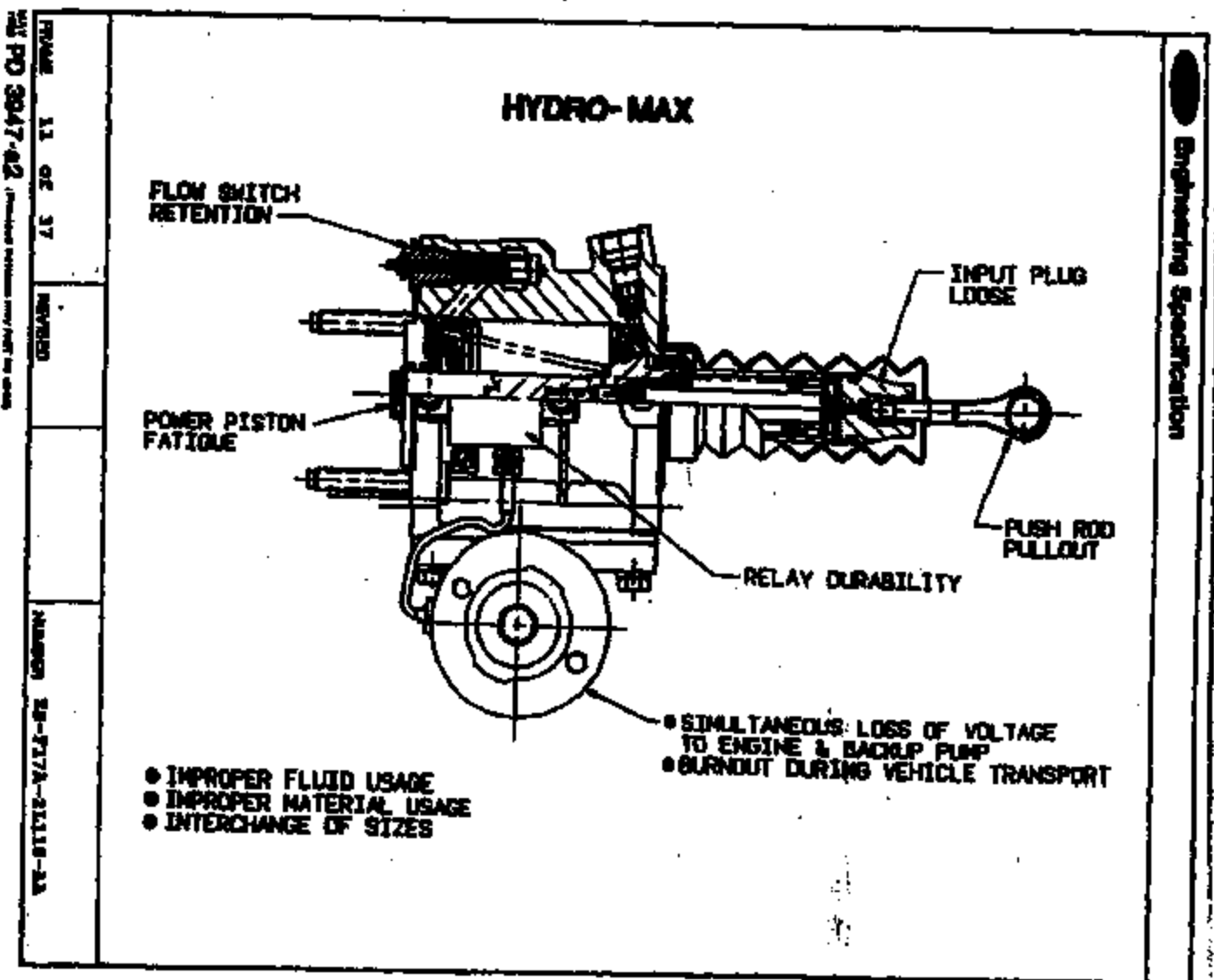
FAST FILL MASTER CYLINDER

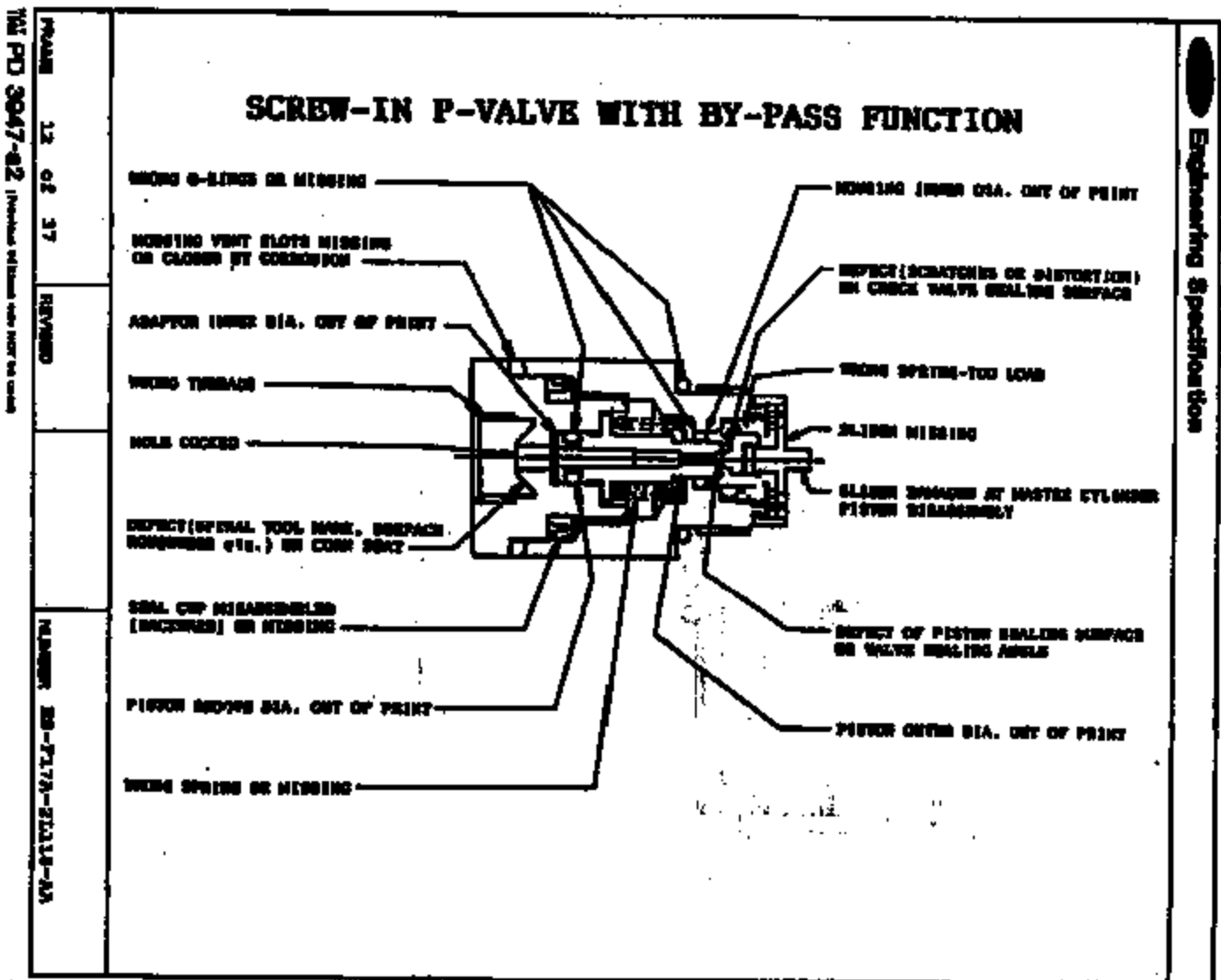


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MAX PD 3847-82 (Photos added very nice to study)

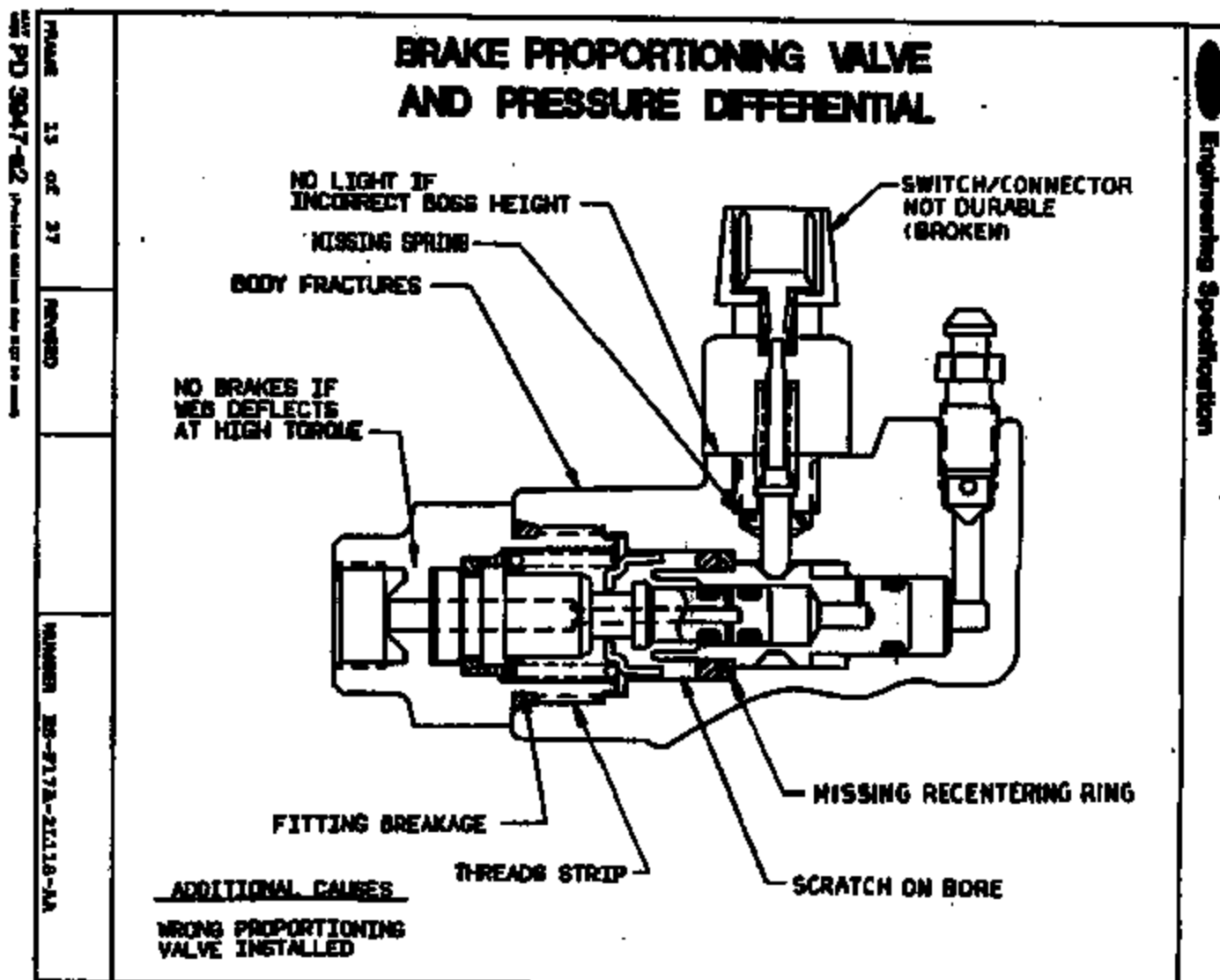






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REMOTE COMBINATION VALVE WITH PROPORTIONING, METERING, AND DIFFERENTIAL PRESSURE SWITCH.

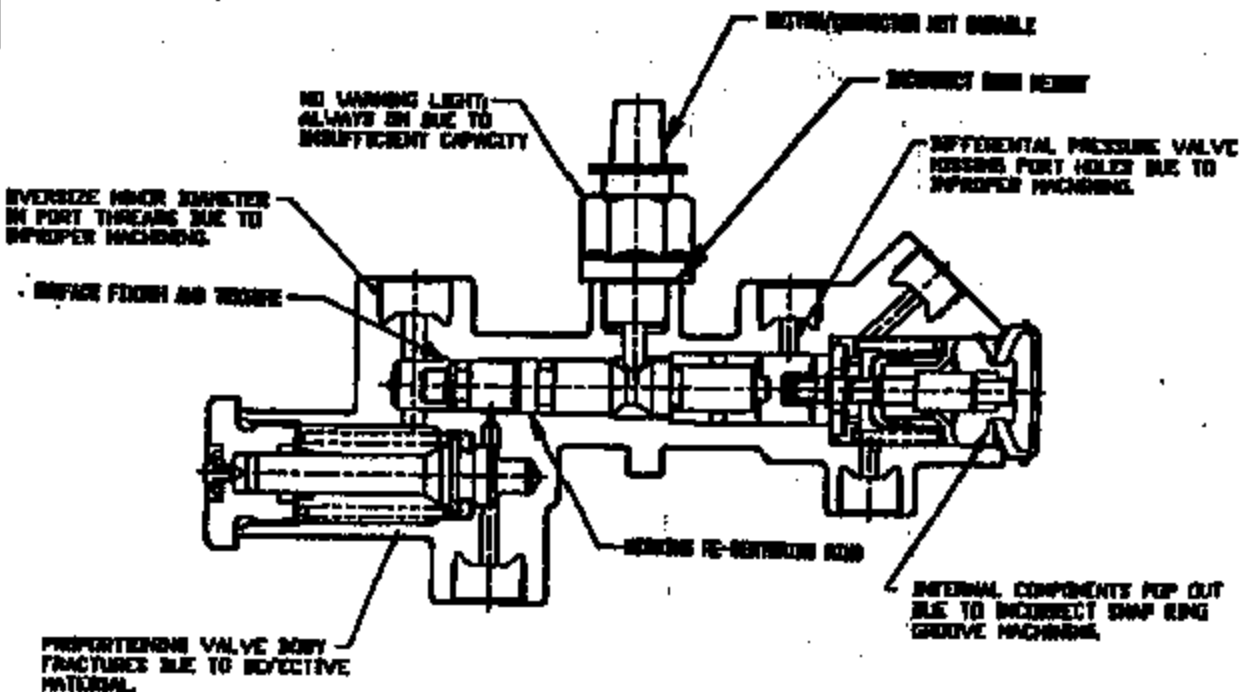
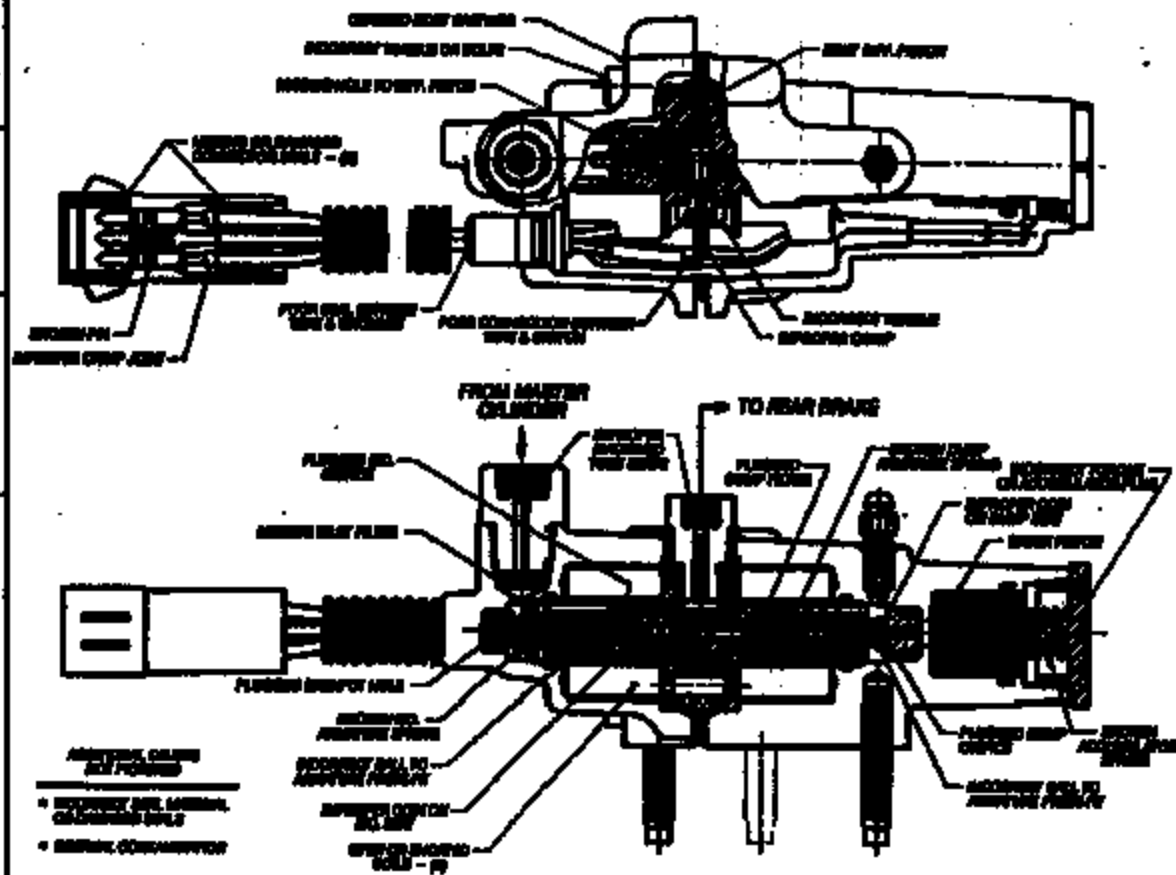


FIGURE 14 OF 17
REVISED
NUMBER 22-7112-2112-NA

Ergebnisangabe

REAR WHEEL ANTI LOCK VALVE



- * **RESEARCH AND ANALYSIS**
- * **RESEARCH CONSULTATION**

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== PD 3047-02				

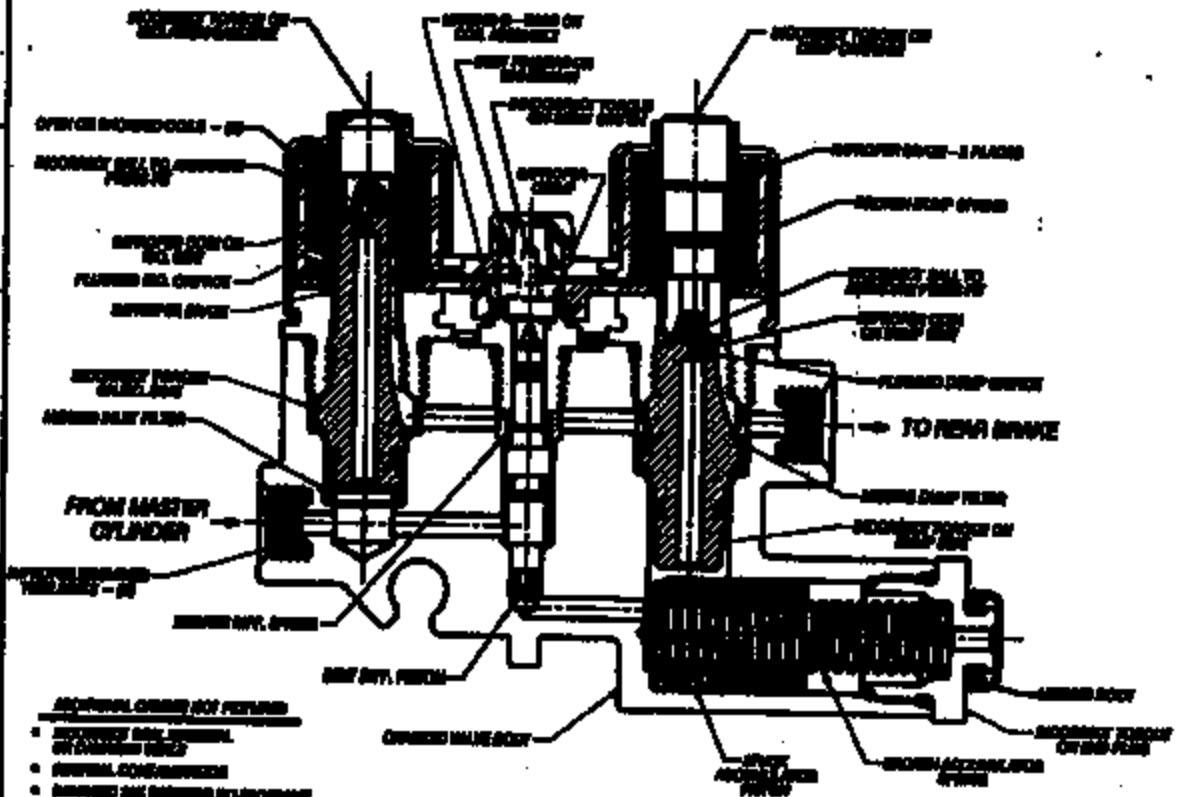
NUMBER 10-7172-21110-22

3718 7114

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Engineering Specification

REAR WHEEL ANTI LOCK VALVE

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PAGE 17 OF 37

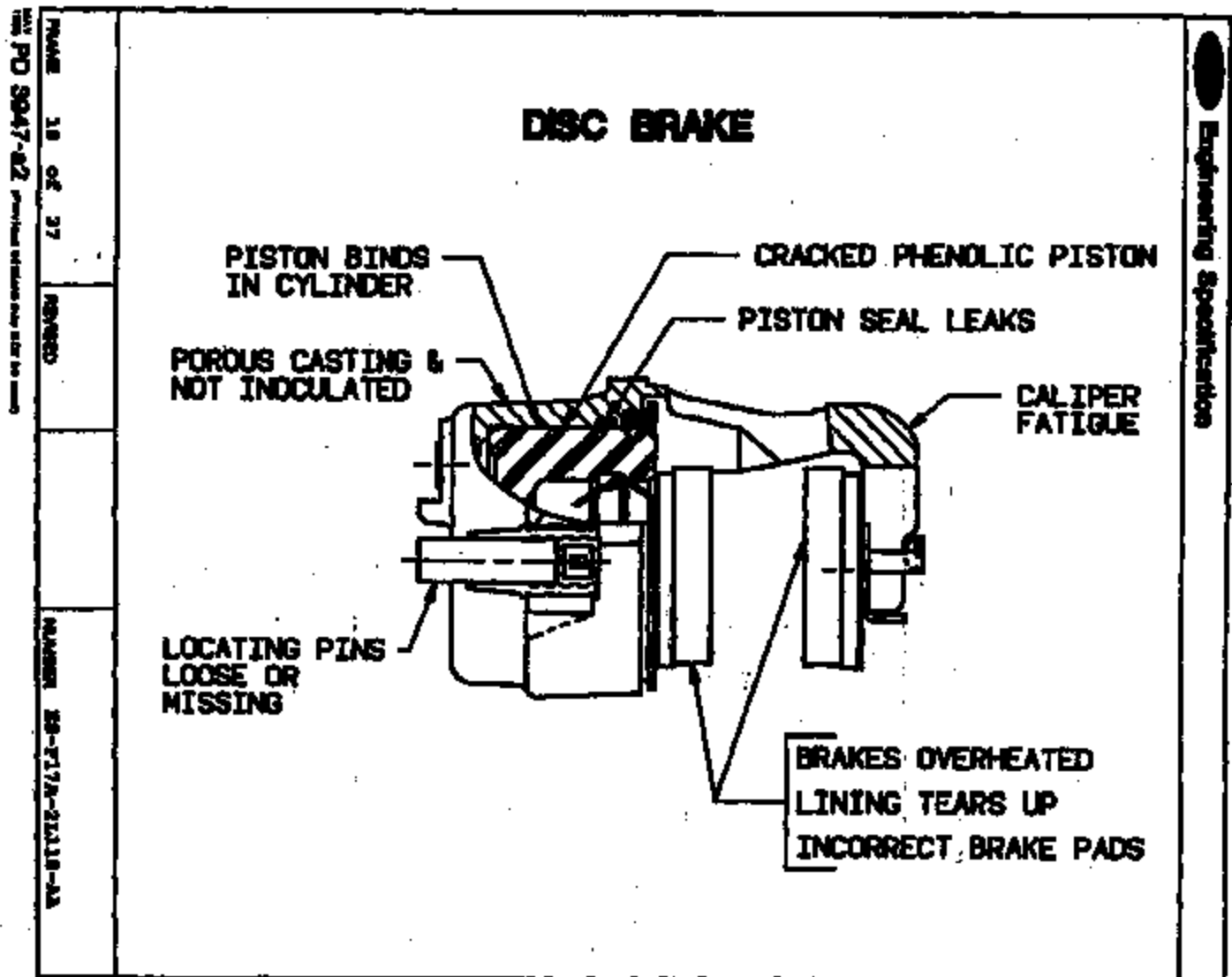
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PD 3847-#12 provides information and help to users

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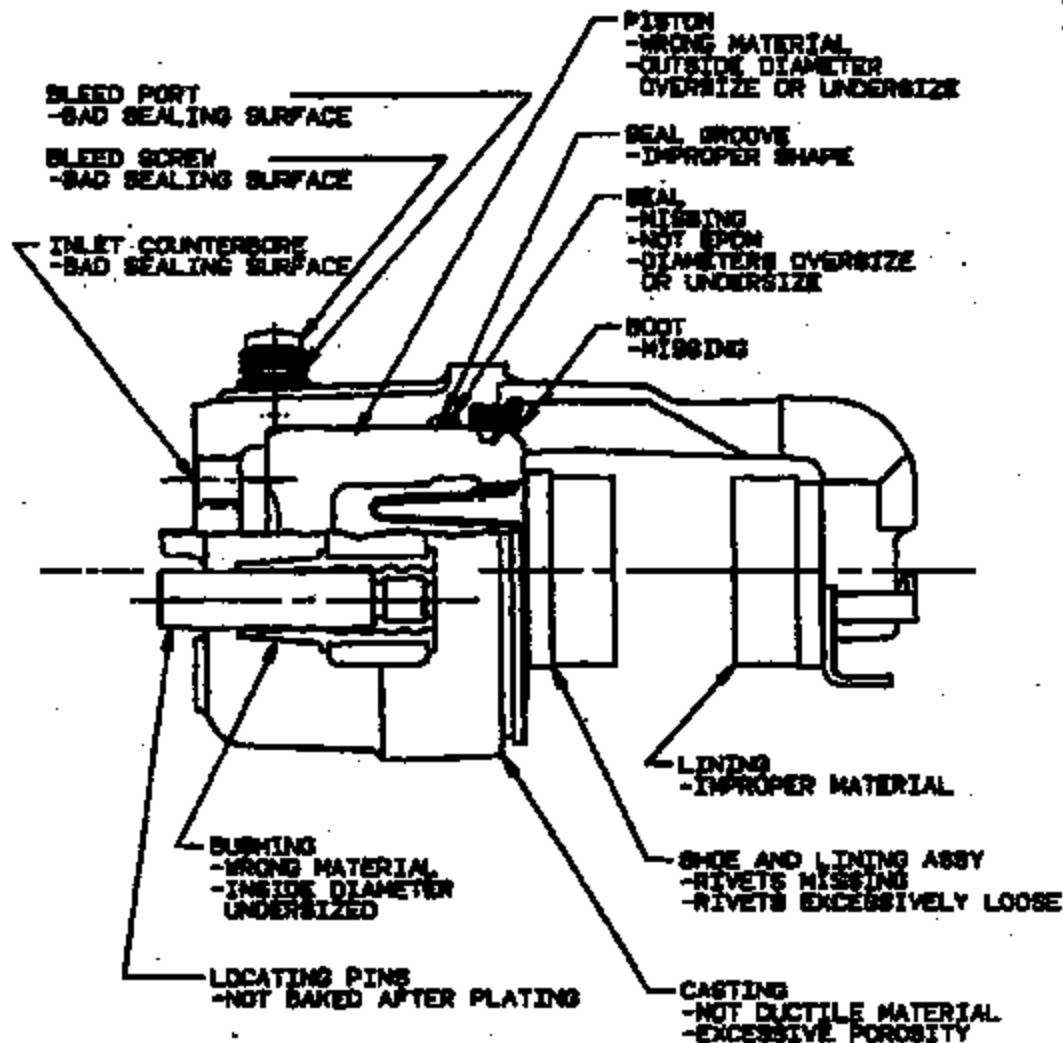
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Engineering Specification

BRAKE CALIPER



FRAME 19 of 27

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NUMBER ES-F17A-2L118-AA

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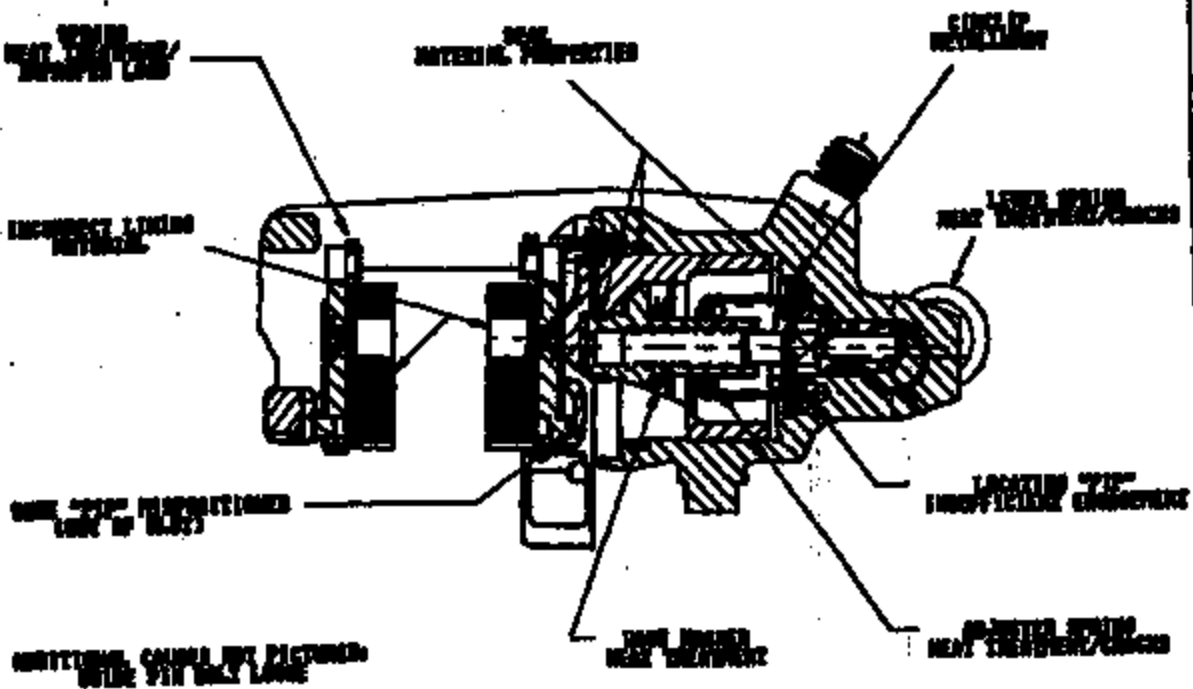
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REAR CALIPER W/INTEGRAL PARKING BRAKE

Engineering Specification



FRAGE 20 OF 37

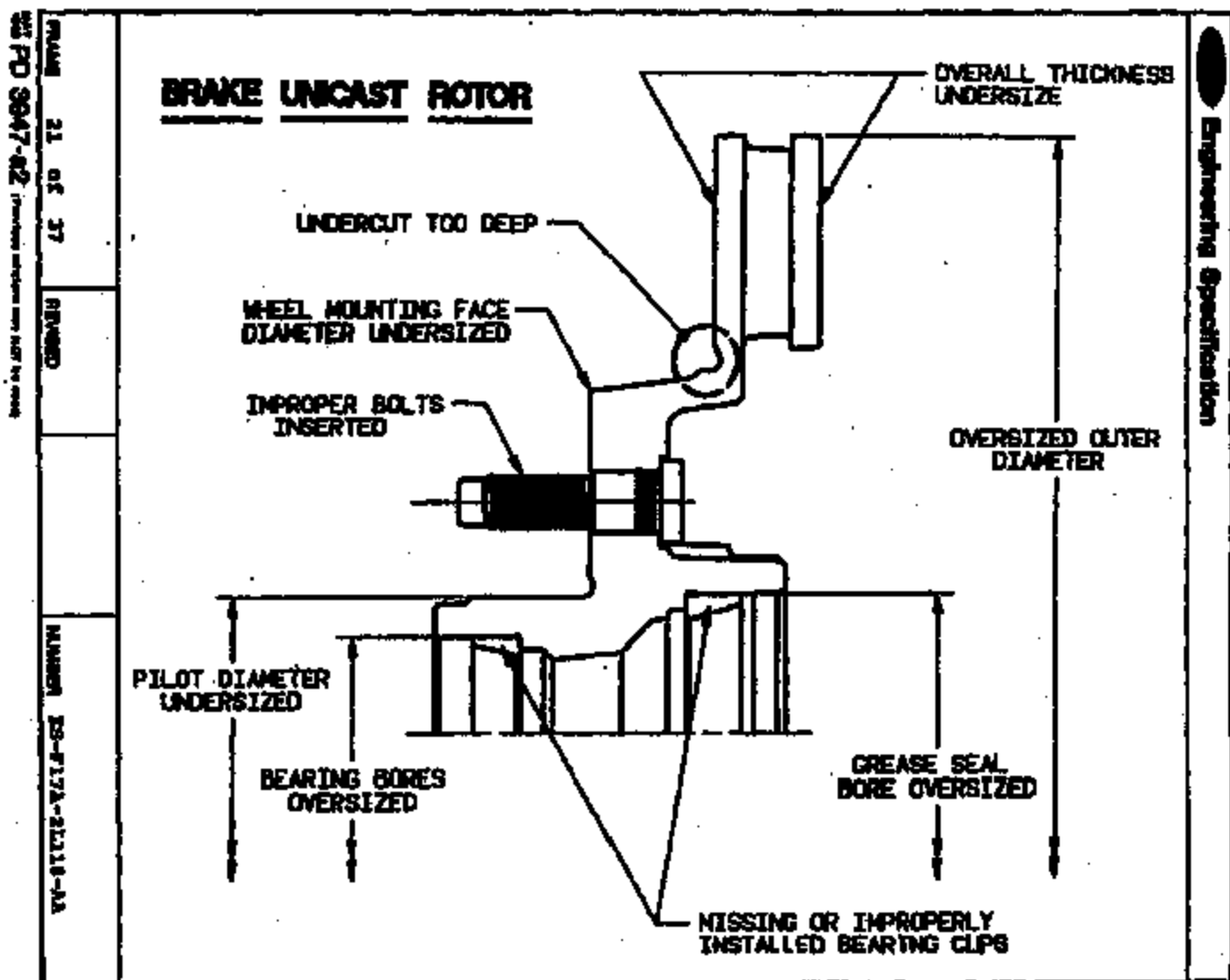
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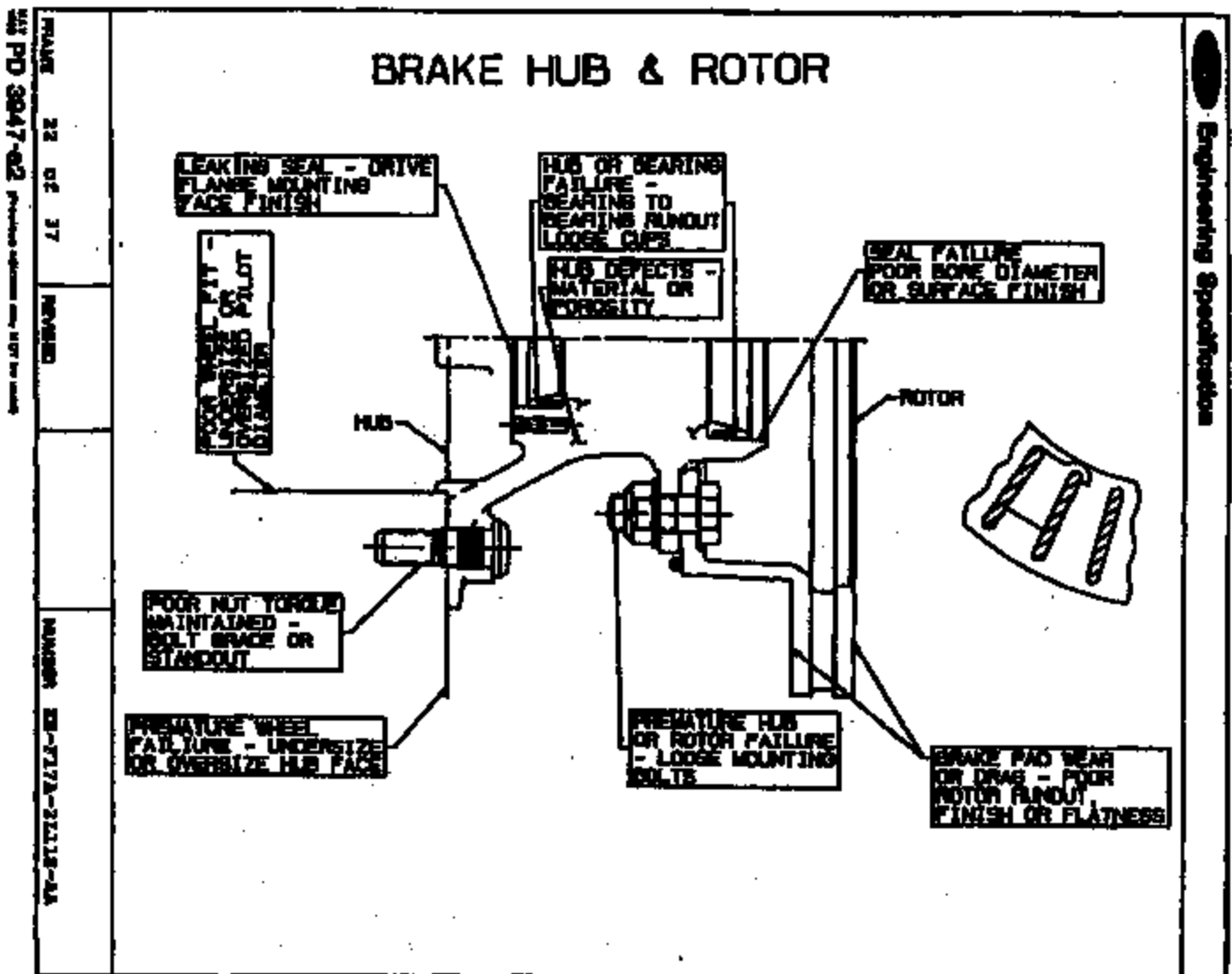
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444 PD 3847-12 From: [redacted] sent 11/17/14 to: [redacted]

3718 7118

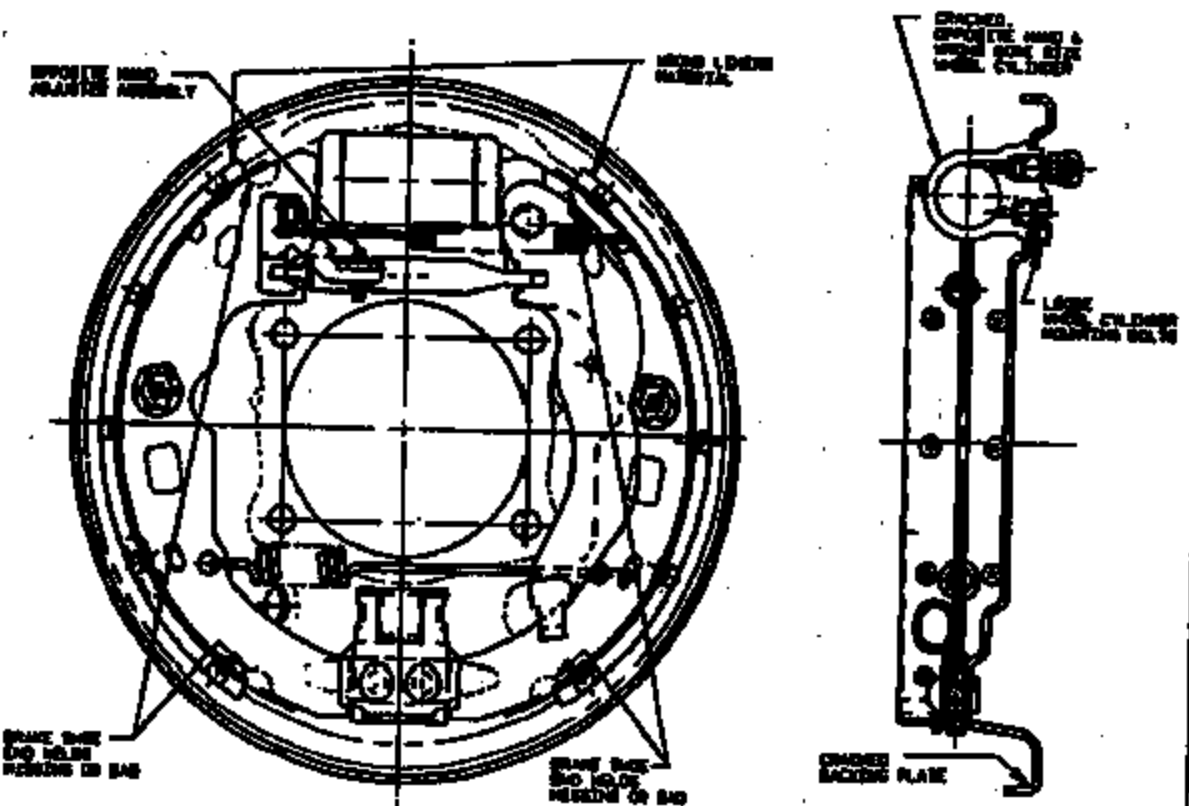
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Engineering Specifications

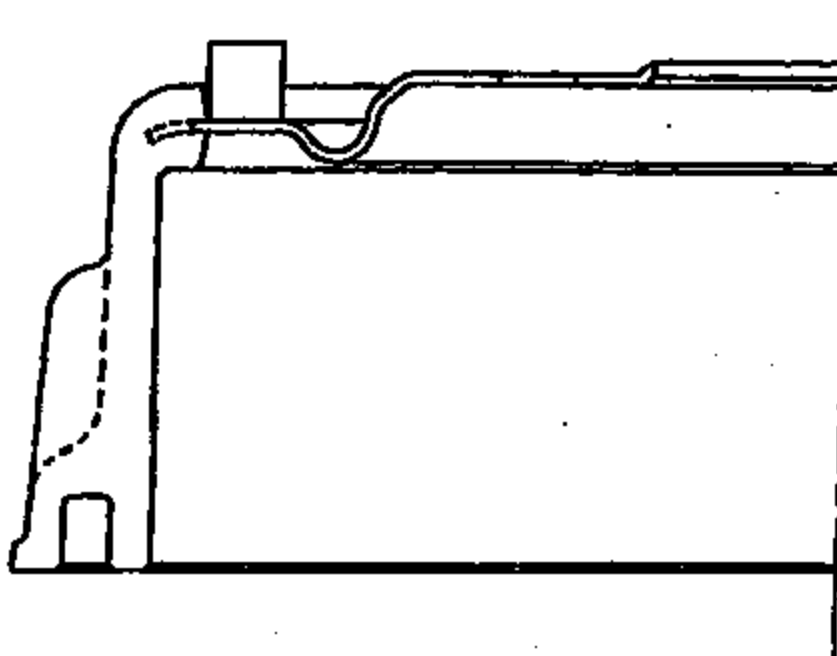
NON-SERVO DRUM BRAKES



PD 8847-02	23	02	37	REVIEWS	NUMBER	23-7274-3111-03
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Engineering Specification

BRAKE DRUM



CRACKED DRUMS :

- **SUBSURFACE POROSITY
(RESULTING IN CRACKED
BRAKE DRUM)**
- **BRAKE DRUMS TOO BRITTLE
RESULTING IN CRACKS**

FRAME 25 of 37

REVISED

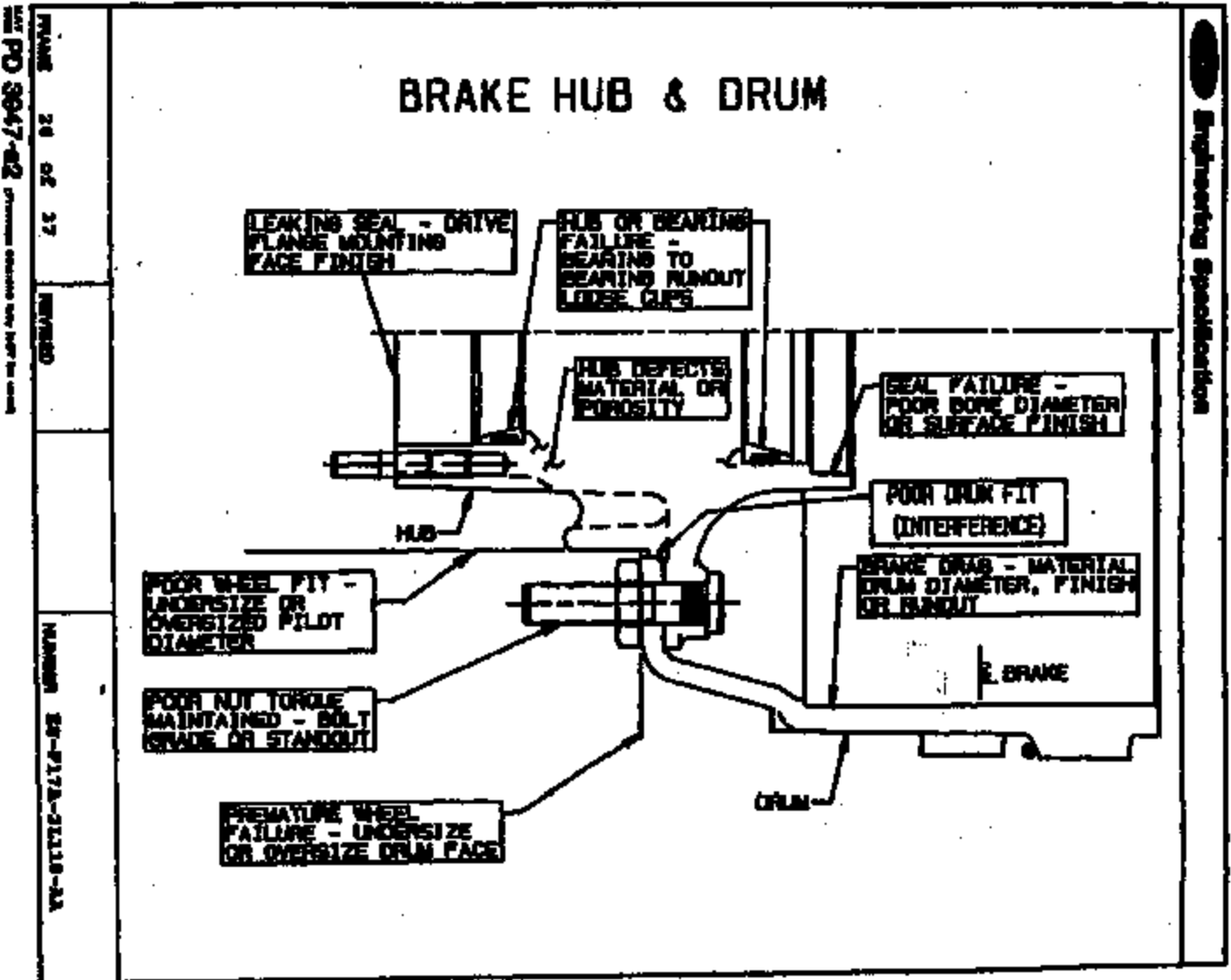
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PD 3947-02 (includes additional data NOT on sheet)

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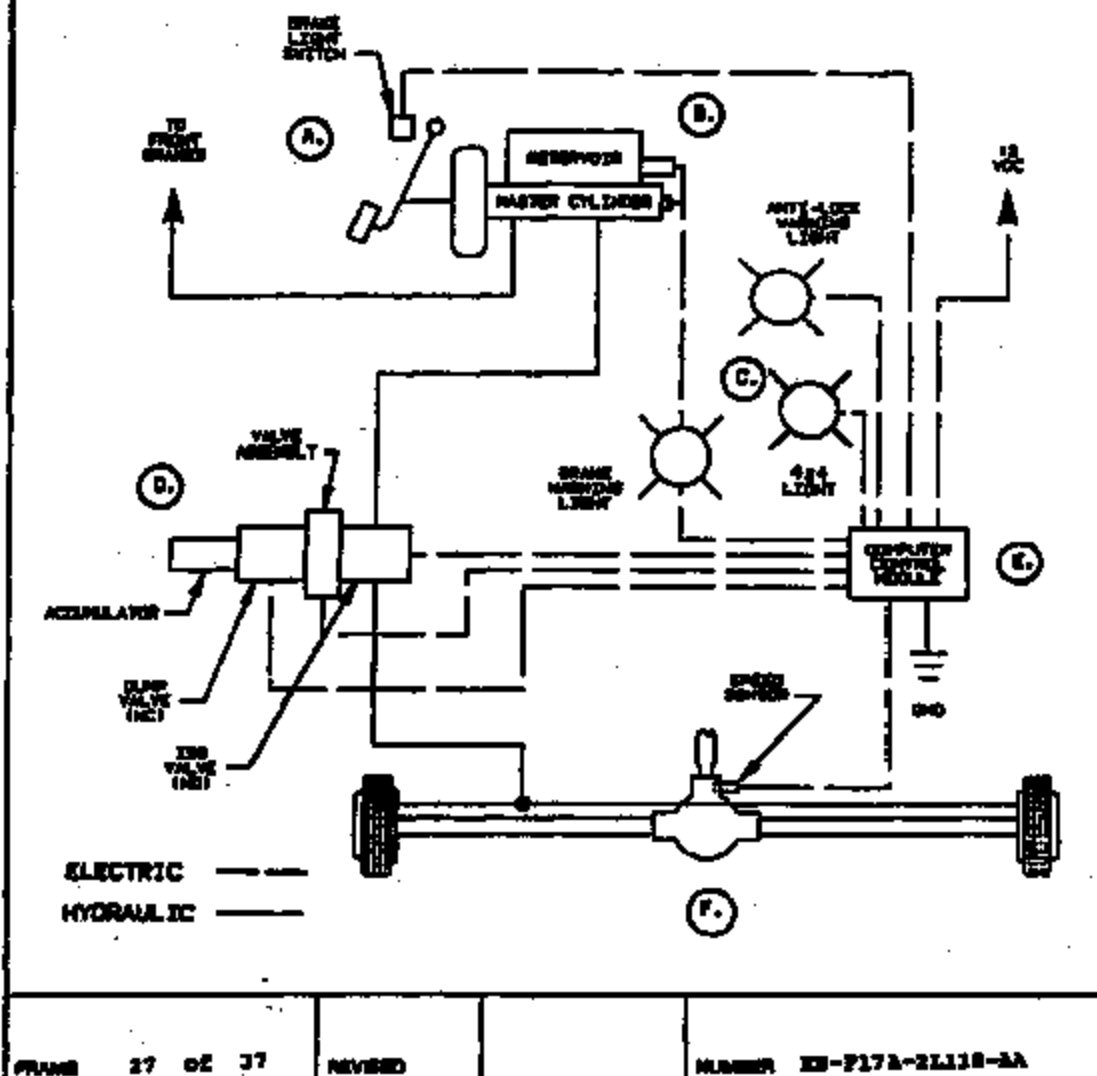
3718 7123

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Engineering Specification

**FORD REAR WHEEL
ANTI - LOCK
BRAKE SYSTEM**



MAY 1968 PD 3947-22 (Two-hour sessions) daily NOT GO AHEAD

MEMPHIS 44-1972-21110-2A

3718 7125

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Engineering Specification

POTENTIAL EABS SYSTEM PROBLEMS

-- The following are problems that the EABS system cannot detect --

- A. - Field failure of an open circuit from brake switch to module
- B. - Low fluid level ground circuit open
- Parking brake switch adjustment causing excessive drag
- C. - GND signal not seen by module (open wiring)
- D. - None (any system failure, with respect to the EABS valve, will be positively detected)
- E. - Unforeseen obstruction in module wiring (open/shorted)
- Hidden algorithm defects
- Bad quality components (short life)
- F. - Intermittent short in sensor circuit
- Metal chips in rear axle
- Exciter ring failed in field
- Sensor gap too big
- Excessive rear brake drag

NOTE: All EABS connectors and connectors associated with the EABS system indirectly (brake, fluid level etc.) are presently (and must be in the future) keyed, to prevent improper connection.

FRAME 28 of 37

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NAME: EE-F17A-21A18-AA

DATE: PD 3947-a2 (Previous editions may NOT be used)

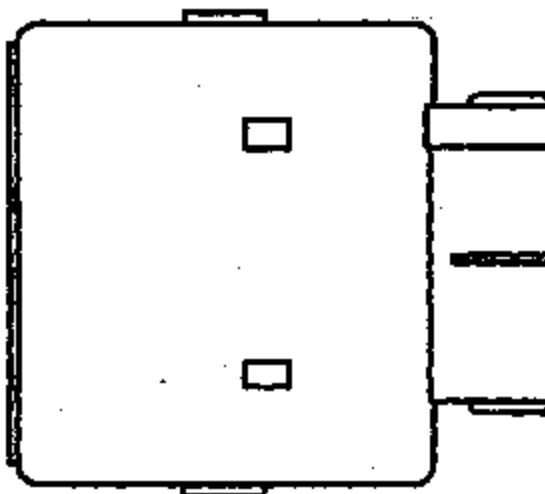
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3718 7126

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Engineering Specification

MONITOR MODULE



- ELECTROMAGNETIC INTERFERENCE
- TRACK BURNOUT

FRAME 29 OF 37

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NUMBER ES-F17A-2L118-22

UAT PD 3947-62 (previous editions may be in use)

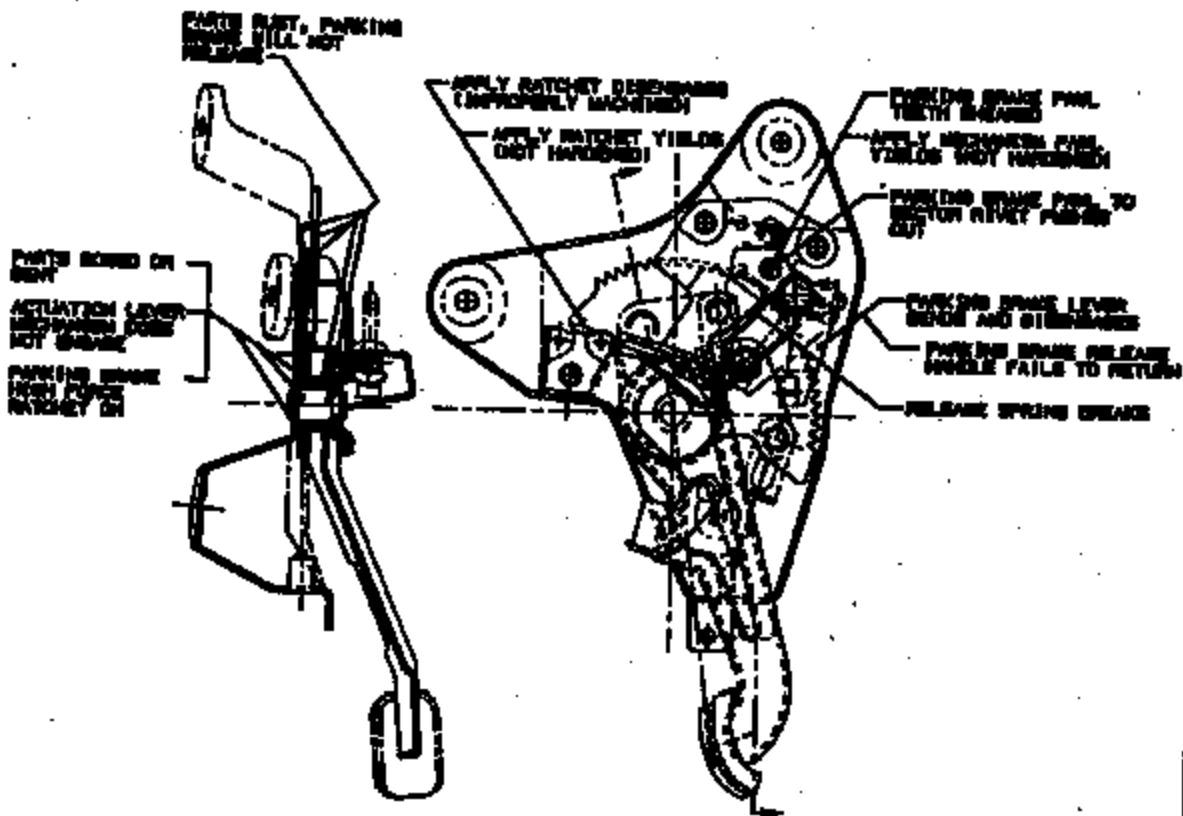
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Engineering Applications

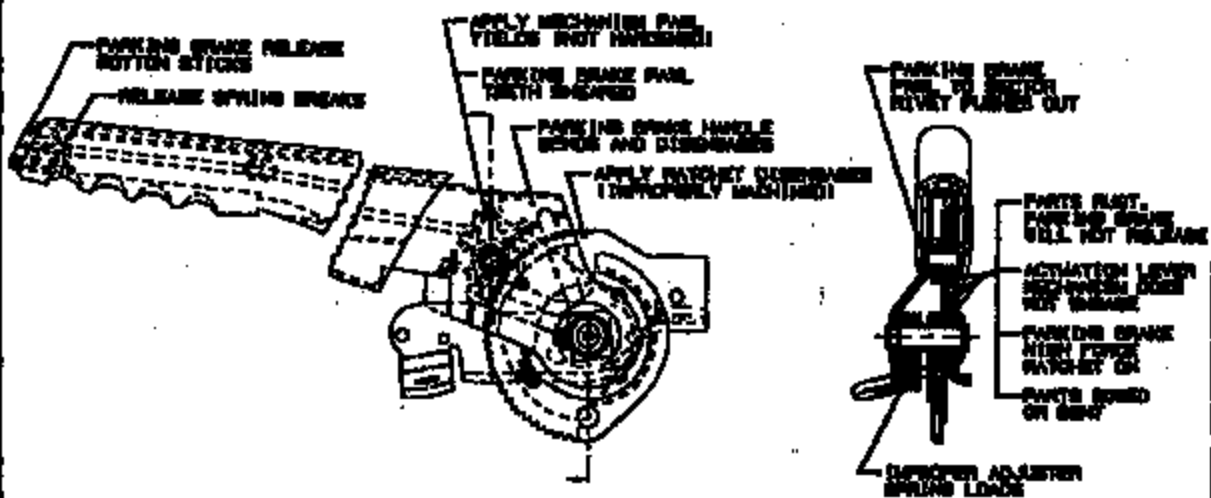
BRAKE FOOT LEVER



NAME	30 of 37	REVISED	NUMBER	22-7172-21118-1A
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WFO PD 3847-42 (classification indicates copy is not for release)

BRAKE HAND LEVER



Engineering Specification

FRAME 31 OF 37

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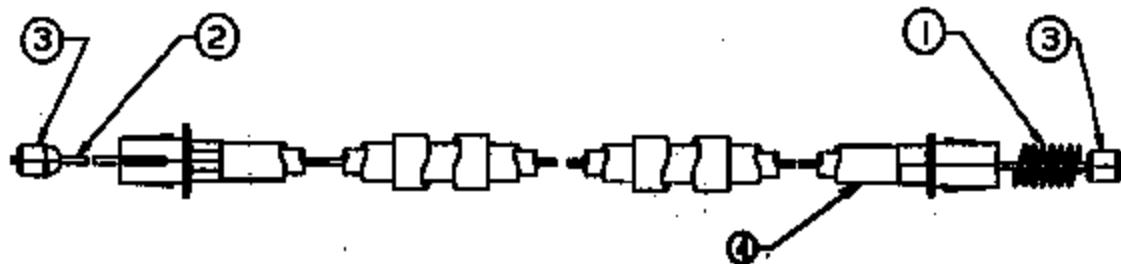
NUMBER 35-7178-21113-AA

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3718 7129

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PARKING BRAKE CABLE



1. REAR BRAKE DRAG - IMPROPER RETURN SPRING
2. LOSS OF PARKING BRAKE - CABLE STRETCH
3. LOSS OF PARKING BRAKE - END FITTING PULL-OFF
4. IMPROPER CABLE CORROSION PROTECTION - CABLE BIND/TENSILE FAILURE

REVISION 25 OF 37

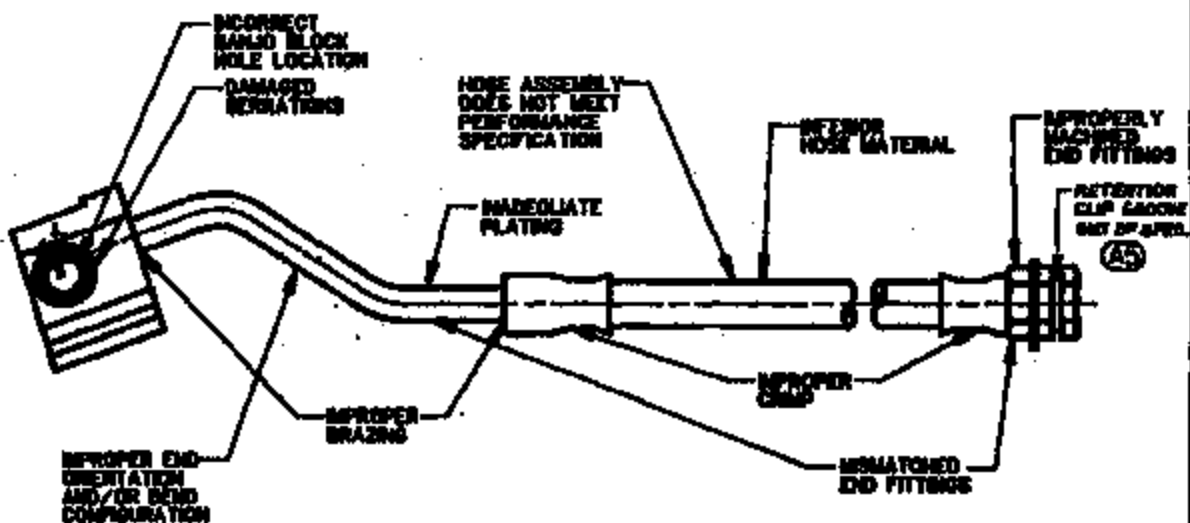
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Engineering Specification

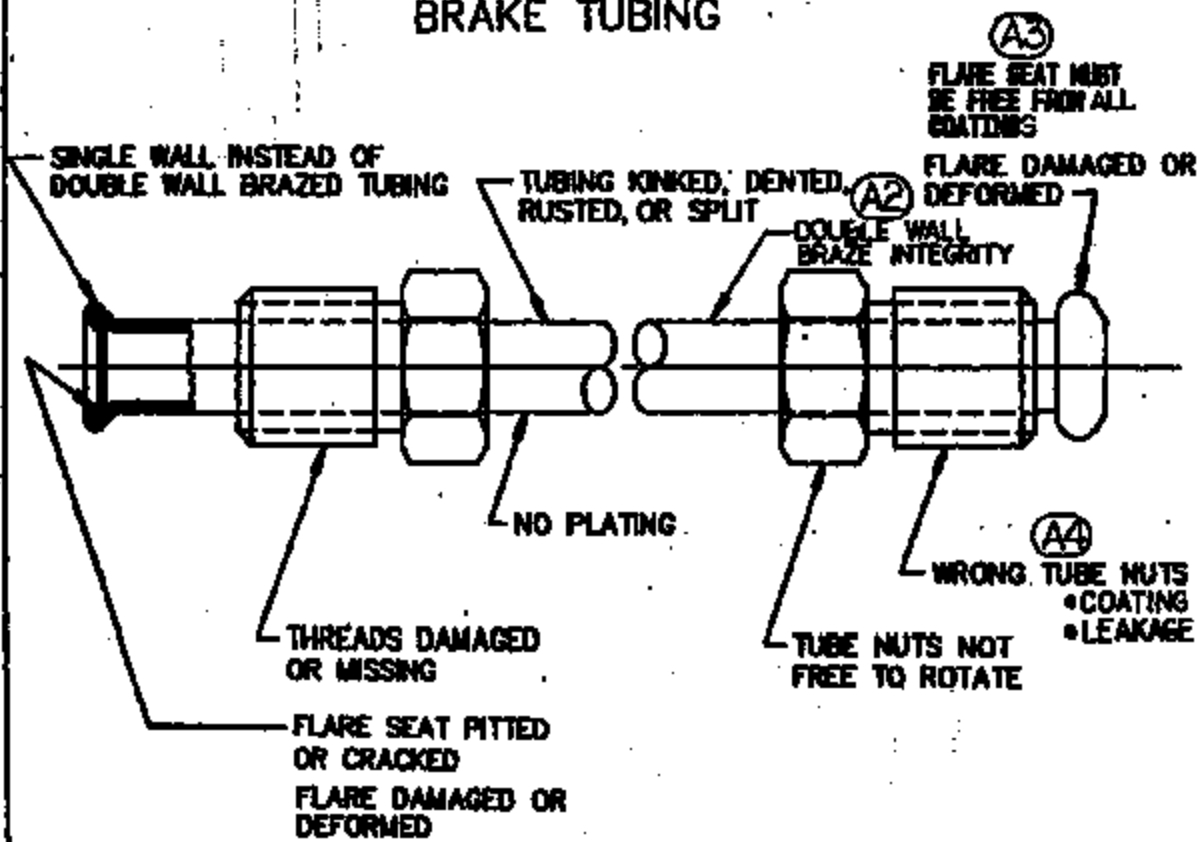
BRAKE HOSE ASSEMBLY



NAME	33 OF 37	REVISED	NUMBER	25-5775-25115-12
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25 PD 2847-22 (Previous editions may not be used)

BRAKE TUBING



Engineering Specification

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MEMPHIS 88-272-31110-2A

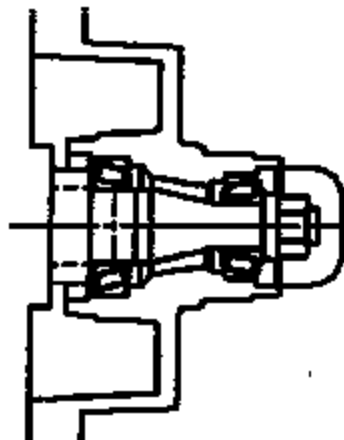
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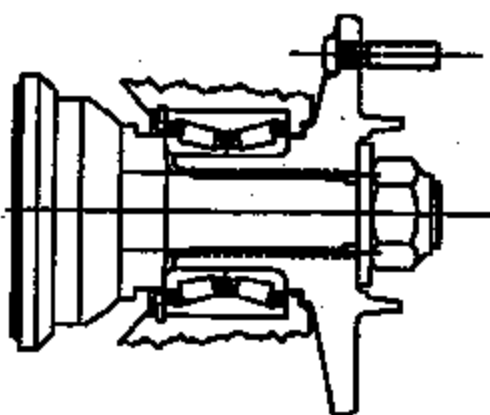
Engineering Specification

TAPERED ROLLER BEARING WHEEL SYSTEM

2-SINGLE SYSTEM



SEALED CARTRIDGE SYSTEM



1. BEARINGS

- Bearing Component Specifications
 - Selection Based on Defined Loading Condition, Operating Temperature and Speed
 - Selection Based on Statistical Fatigue Life Calculations
 - Proper Case Bore, Cup Outside Diameter and Bearing Width
 - Proper Material Selection and Manufacture
 - Proper Heat Treatment Specification and Manufacture
 - Surface Hardness -- Case Depth
 - Core Hardness -- Material Chemistry
- Lubrication
 - Selection Based on Defined Loading Condition, Operating Temperature and Speed
 - Proper Lubricant and Quantity
 - Use Verifiable Lubrication Operation
- Installation
 - Determine Bearing Setting vs Life Data
 - Use Verifiable Bearing Setting Operation

2. SPINDLE, NUT, SEAL and RELATED COMPONENTS

- Selection Based on Defined Loading Condition, Operating Temperature and Speed
- Components must properly support and align bearings
- System must provide Lubricant Retention and prevent Contaminant Ingress
- Use Verifiable Installation Operation
- Proper Fitting Practices

FRAME 35 of 37

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NUMBER ES-F17A-2L118-AA

REV PD 3047-02 (Previous editions may NOT be used)

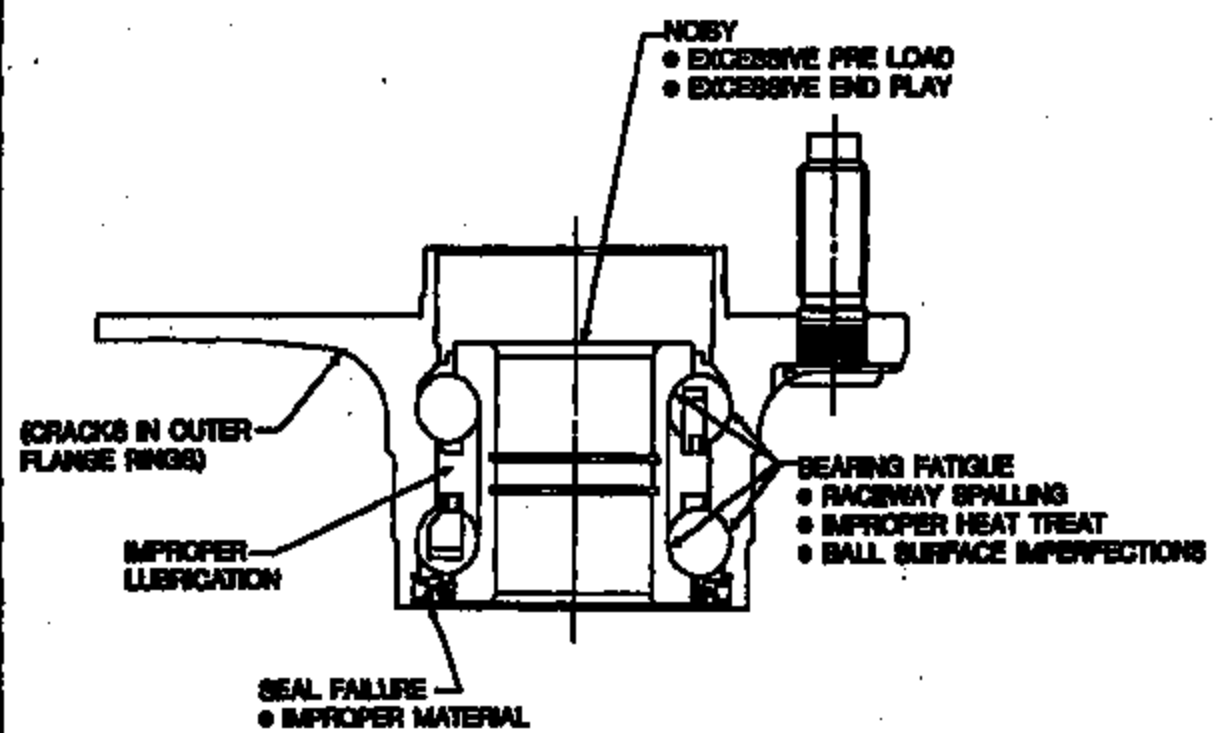
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Engineering Specification

BEARING HUB UNIT



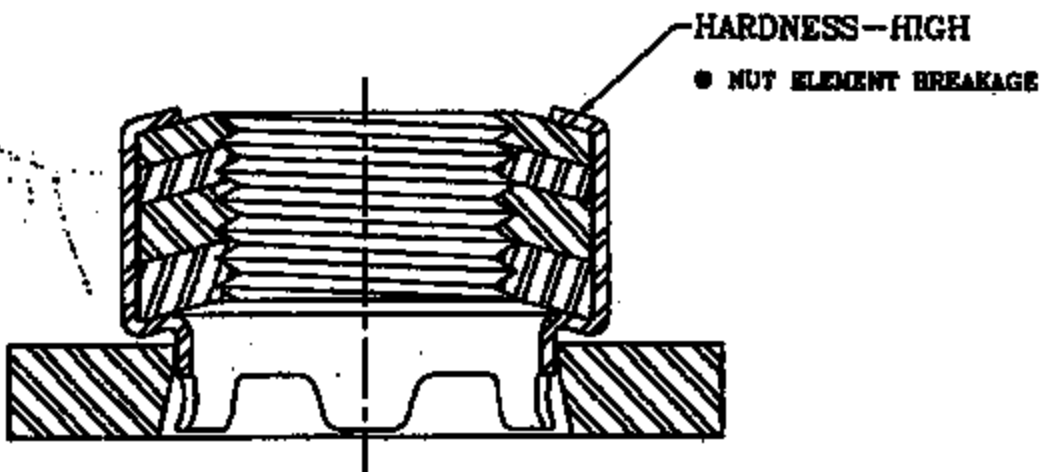
NAME 36 OF 37 REVISION NUMBER ES-717A-2118-AA

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3718 7184

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Engineering Specification



PAC-NUT™

PLANS 37 02 57

REVISED

NUMBER 22-7172-21118-01

NOT PD 3947-62 (Procedures apply only to the 1990)

3718 7135

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ENGINEERING SPECIFICATION

PART NAME SPECIFICATION - CYLINDER & PNEUMATIC CONTROL VALVE - BRAKE MASTER

PART NUMBER

ES-EBAC-2C156-AB

LEV.	FR.	LEV.	FR.	DATE	LEV.	FR.	REVISIONS	DR.	CL.	REFERENCE
				3-17-57			RELEASED CAR2-771038-C	JA	25	5-15-57
										DESIGNED/REVISED BY
										CHECKED BY
										CONFORMANCE/APPROVAL
										SIGNATURES
										PRINCIPAL DESIGN ENGINEER
										DESIGN ENGINEER ASST.
										PERMANENT ENGINEERING
										MANUFACTURING ENGINEER
										QUALITY CONTROL/ISA

Form 3847-01 (7-57) (If no other address may not be used)

3718 7136

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NUMBER
ES-EBAC-2C156-ABPrinted on 3/9/00 at 2:12 PM
PAGE 1 OF 9



ENGINEERING SPECIFICATION

▽ CONTROL ITEM - AFFECTS COMPLIANCE TO FEDERAL REGULATIONS - AREAS MARKED ARE CRITICAL CHARACTERISTICS - CHANGE IN DESIGN COMPOSITION OR PROCESSING FROM THE PART PREVIOUSLY APPROVED FOR PART PRODUCTION REQUIRES PRIOR ENGINEERING APPROVAL.

I. GENERAL

The master cylinder assembly converts input force, from a push rod, into hydraulic output pressure for brake system activation. The master cylinder also provides quick take up of the caliper and wheel cylinder clearances.

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

The engineering tests, sample size, and test frequencies contained within this engineering specification reflect the minimum requirements established to provide a regular evaluation of conformance to design intent. The engineering test program is intended as a supplement to normal material inspection, dimensional checking, and in-process controls, and should in no way adversely influence other inspection operations. QI suppliers may implement different test sample sizes and frequencies providing these changes have been included in an alternate Control Plan approved by the design responsible Product Engineering Office and concurred in by SQI.

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

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

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

In-Process Tests Phase 2 (IP-2) - IP-2 test program may be implemented only after process capability has been established. Tests must be completed with production parts on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as much as possible. In the event that any portion of these tests are not met, the reaction plan specified in Ford Q-101 Section III.E.3. "88 Test Performance Requirements" shall be invoked.

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TEST NAME	TEST NUMBER	PRODUCTION VALIDATION		IN-PROCESS IP-1		IN-PROCESS IP-2	
		MINIMUM SAMPLE SIZE	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE (AND PERFORMANCE)	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE (AND PERFORMANCE)	STATISTICAL TEST ACCEPTANCE CRITERIA
Durability Tests	KI-772						
Life Cycle	A	5	P.60-.80	6	P.60-.80		
Compensating Port Seal Damage	B	6	P.60-.80	12	P.90-.94		
Reservoir Cap Latching	C	6	P.60-.80	12	P.90-.94		
Low Temperature Cycling	D	6	P.60-.80	6	P.60-.80		
High Temperature Cycling	E	6	P.60-.80	6	P.60-.80		
Durability - Process Audit							
Life Cycle	A			3/no.*	All must pass 2/3 no.		All must pass
Compensating Port Seal Damage	B			3/no.*	All must pass 2/3 no.		All must pass
Reservoir Cap Latching	C			3/no.*	All must pass 2/3 no.		All must pass
Low Temperature Cycling	D			3/no.*	All must pass 2/3 no.		All must pass
High Temperature Cycling	E			3/no.*	All must pass 2/3 no.		All must pass
Durability - Lot Control							

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TEST NAME	TEST NUMBER	PRODUCTION VALIDATION		IN-PROCESS IP-1		IN-PROCESS IP-2	
		MINIMUM SAMPLE SIZE	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE (AND PERCENTAGE)	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE (AND PERCENTAGE)	STATISTICAL TEST ACCEPTANCE CRITERIA
Functional Tests	KI-772						
Vacuum Leakage	F	6	F.60-.88	18	F.90-.94		
Proportioning Valve Function	G	18	F.90-.99	24	F.90-.91		
Low Pressure Leakage	H	18	F.90-.99	24	F.90-.91		
Travel and Displacement	I	18	F.90-.99	24	F.90-.91		
Medium Pressure Leakage	J	18	F.90-.99	24	F.90-.91		
Seal Replenishing	K	18	F.90-.99	24	F.90-.91		
Compensating Port Restriction	L	18	F.90-.99	24	F.90-.91		
Structural	M	6	F.60-.88	18	F.90-.95		
Tube Seat Leakage	N	6	F.60-.88	12	F.90-.94		
Internal Cleanliness	O	6	F.60-.88	12	F.90-.94		
Reservoir Retention & Burst	P	6	F.60-.88	18	F.90-.99		
Fluid Level Indicator	Q	6	F.60-.88	12	F.90-.94		

IP- PRODUCTION VALIDATION AND IN-PROCESS TESTS (cont'd.)

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TEST NAME	TEST NUMBER	PRODUCTION VALIDATION		IN-PROCESS IP-1		IN-PROCESS IP-2	
		MINIMUM SAMPLE SIZE	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE (APP. REQUIREMENTS)	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE AND ACCEPTANCE CRITERIA	STATISTICAL TEST ACCEPTANCE CRITERIA
Functional Audit	KI-772						
Vacuum Leakage	F			15/no.*	All must pass	10/3 no.	All must pass
Proportioning Valve Function	G			9/no.*	All must pass	6/3 no.	All must pass
Low Pressure Leakage	H			9/no.*	All must pass	6/3 no.	All must pass
✓Travel and Displacement	I			9/no.*	All must pass	6/3 no.	All must pass
Medium Pressure Leakage	J			9/no.*	All must pass	6/3 no.	All must pass
Seal Replenishing	K			9/no.*	All must pass	6/3 no.	All must pass
Compensating Port Restriction	L			9/no.*	All must pass	6/3 no.	All must pass
✓Structural	M			3/no.*	All must pass	2/3 no.	All must pass
Tube Seal Leakage	N			3/no.*	All must pass	2/3 no.	All must pass
Internal Cleanliness	O			2/day*	All must pass	2/day	All must pass
Reservoir Retention & Burst	P			1/day*	All must pass	1/day	All must pass
✓Fluid Level Indicator	Q			3/no.*	All must pass	2/3 no.	All must pass

* Until Process Capability is demonstrated.

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS (cont'd.)

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TEST NAME	TEST NUMBER	PRODUCTION VALIDATION		IN-PROCESS IP-1		IN-PROCESS IP-2	
		MINIMUM SAMPLE SIZE	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE (AND FREQUENCY%)	STATISTICAL TEST ACCEPTANCE CRITERIA	MINIMUM SAMPLE SIZE AND FREQUENCY	STATISTICAL TEST ACCEPTANCE CRITERIA
Functional - 100%	KI-773						
Vacuum Leakage	A			---	All must pass	---	All must pass
Low Pressure Leakage	B			---	All must pass	---	All must pass
Travel & Displacement	C			---	All must pass	---	All must pass
Seal Replenishing	D			---	All must pass	---	All must pass
Compensating Port Restriction	E			---	All must pass	---	All must pass
Bypass Performance Test	F			---	All must pass	---	All must pass



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III. TEST PROCEDURES AND REQUIREMENTS

This section shall conform to the following:

Allied Rexroth Engineering Instructions

KI-772 Test Instructions - Master Cylinder with Primary Bore and Screw-In Bypass Proportioning Valve.

Section IV Test Procedures and Requirements

	Sheet
A. Life Cycle	2
B. Compensating Port Seal Damage Test	4
C. Reservoir Cap Latching Test	5
D. Low Temperature Cycling	5
E. High Temperature Cycling	7
F. Vacuum Leakage Test	8
G. Proportioning Valve Function Test	9
H. Low Pressure Leakage Test	10
I. Travel and Displacement Test	10
J. Medium Pressure Leakage Test	11
K. Seal Replenishing Test	12
L. Compensating Port Restriction Test	12
M. Master Cylinder Structural Test	13
N. Tube Seat Leak Test	13
O. Internal Cleanliness	14
P. Reservoir Retention and Burst Test	15
Q. Fluid Level Indicator Test	15
R. Drop Test	16

KI-773 Production Test Specification - Master Cylinder Assembly with Screw-In Proportioning Valve

Section III Test Procedures and Requirements

	Sheet
A. Vacuum Leakage Test	1
B. Low Pressure Leakage Test	1
C. Travel and Displacement Test	2
D. Seal Replenishing Test	2
E. Compensating Port Restriction Test	3
F. Bypass Performance Test	3

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IV. STATISTICAL ANALYSIS METHOD

Following are the methods for reducing the test data to compute the statistical values.

A. $P_{.60} = .51$, $P_{.90} = .89$, $P_{.99} = .91$

1. Test the number of samples specified in Section II per the requirements in Section III.
2. If a failure occurs stop the test; part fails to meet the statistical acceptance criterion.
3. If no failures occur the statistical acceptance criterion is met.

B. 3 Sigma

1. Test the number of samples specified in Section II and compute the three sigma values.
2. Compare the resultant Sigma values with the requirements of the appropriate test procedure given in Section III.

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V. REVALIDATION REQUIREMENTS

No change to processing, material, or supplier may be allowed without prior engineering approval.

The following revalidation is required for a change in process material, supplier (material source), or subsequent year's production.

RUNNING CHAMBER REVALIDATION

Element	Specific Process Change	EE Test Run's A-E	Material Change	New Supplier
Body	Bore(s) Machining Compensating Holes	IV.A,D, & E IV.E	IV.A,D,S & M	IV.A,B,D,MM
Caps & Seals - Fri. & Sec.	Any	IV.A,B,C,D,GM	IV.A,B,C,D,GM	IV.A,B,C,D,GM
Pistons - Fri. & Sec.	O.D., Sealing Surfaces, or Replacishing Holes	IV.A,D, & E	IV.A,D, & E	IV.A,D, & E
Reservoir	Any	IV.C,F, & Q	IV.C, F, & Q	IV.C,F, & Q
Cap-Reservoir	Any	IV.C.	IV.C.	IV.C.
Seals-Reservoir	Any	IV.A,D, & E	IV.A,B, & E	IV.A,B, & E
Spring, Spring Retainers, Cage Screw	Finish	IV.D, & E	IV.A.	IV.A.

SUBSEQUENT YEAR REVALIDATION

Carryover Design IV.A, B, C, D, E, & Q

VI. LOT DEFINITION

A lot is defined as one shift's production.

VII. RECORD RETENTION

Recording and record retention shall conform to Ford Q-101.

VIII. INSTRUCTIONS & NOTES - none.

IX. COMPILED OF REFERENCE DOCUMENTS

- ES-DAAA-1287-AA Reliability Analysis
- Continuing Process Control and Process Capability Improvement
- 1985 - Ford Motor Company
- Allied-Signal Engineering Instructions:
 - (XI-772) - Test Instructions Master Cylinder w/Primary Rods and Screw-in Bypass Proportioning Valve - latest issue
 - (XI-773) - Production Test Specification - Master Cylinder Assembly w/Screw-in Bypass Proportioning Valve - latest issue

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CIRCUIT OPERATION 7-6

SECTION 23 (cont'd)

The Profile Ignition Pickup (PIP) signal is produced by a Hall Effect device in the distributor. It sends RPM and Crankshaft position information to the PCM. This information is used by the PCM to determine shift scheduling and EPC.

The Mass Air Flow (MAF) Sensor measures the amount of air flowing into the engine and outputs a voltage to the PCM. The PCM uses this input to help calculate fuel delivery. For transmission strategies this sensor is used for

EPC pressure control, shift and converter clutch scheduling.

Electronic Pressure Control (EPC) Solenoid

The Electronic Pressure Control (EPC) Solenoid is a variable force type solenoid (VFS). The VFS is an electro-hydraulic actuator combining a solenoid and a regulating valve. It supplies Electronic Pressure Control (EPC) which regulates transmission line pressure.

Shift Solenoid (SS1, SS2)

The Shift Solenoids provide gear selection of first through fourth gears by controlling the pressure to the shift valves.

Torque Converter Clutch (TCC)

The Torque Converter Clutch (TCC) Solenoid provides the torque converter clutch control. By shifting the converter clutch control valve to apply or release the torque converter clutch.

For diagnostic information, refer to Powertrain Control/Emissions Diagnostic Manual, Section 77 of the Service Manual or Transmission Reference Manual.

SECTION 31

SPEED CONTROL

HOW THE CIRCUIT WORKS

The Speed Control System consists of a Servo Assembly, Actuator Cable, Horn Relay, Steering Wheel Switches, Brake On/Off (BOO) Switch, and Brake Pressure Switch. The Servo Assembly is made up of a Stepper Motor with integrated electronics, eliminating the need for any electronic modules in the vehicle. The system operates independent of engine vacuum, therefore no vacuum lines are required. The servo is mounted in the engine compartment near the Brake Booster, and is connected to the Throttle Linkage with an Actuator Cable.

When activated, the Speed Control System maintains a driver selected vehicle road speed. Using input information from the Ve-

hicle Speed Sensor (VSS), servo motor position is varied, which, in turn, moves the engine throttle linkage to speed up or slow down the vehicle.

Brake Pressure and Brake On/Off (BOO) Switches

The Brake Pressure Switch is a normally closed switch and replaces the Vacuum Dump Valve as a redundant safety feature in the system. Normally when the brake pedal is depressed, voltage is applied to the Servo Amplifier from the stop lamps through circuit 511, which disengages the system. Under increased brake pedal efforts (5-10 lbs, engine running), the Switch will open and remove power from the Servo Clutch (circuit 838), releasing the throttle independent of amplifier control. The Brake Pressure Switch is located

at the Rear Brake Proportioning Valve or Junction Block below the Brake Booster.

Vehicle Speed Sensor

The Vehicle Speed Sensor (VSS) is a permanent magnet generator mounted to the transmission. Sensor output is proportional to vehicle road speed. With sensor output indicating that vehicle road speed is above 30 MPH, the Speed Control System can be engaged. The speed sensor signal is then used to maintain vehicle speed while the system is operating.

Speed Control Switch Assembly

Voltage is present at the Speed Control Switch Assembly ON contact at all times through Fuse L, the Horn Relay coil, and the Clockspring Assembly. The Switch Assembly

7-7 CIRCUIT OPERATION

SECTION 31 (cont'd)

signals the Speed Control Amplifier to turn the system on or off, to set and hold vehicle speed, and to accelerate or coast. When the On switch is pressed, voltage is applied to the Amplifier through circuit 151 (LB/BK). In OFF,

circuit 151 is grounded. With the switch held in SET/ACCEL, a 880 ohm resistor is placed in the ground circuit. In RESUME, a 2200 ohm resistor is placed in the circuit. In COAST, a 120 ohm resistor is used.

Speed Control Indicator

The Instrument Cluster will display "SPEED CONTROL" in the center bezel when the system is engaged. The Speed Control Amplifier grounds circuit 203 to activate the indicator.

For diagnostic information, refer to Section 10-03 of the Service Manual.

SECTION 37

SHIFT LOCK

HOW THE CIRCUIT WORKS

The Shift Lock Actuator prevents the driver from shifting the automatic transmission out of

PARK unless the Ignition Switch is in RUN and the brake pedal is depressed. Battery voltage is applied to the Shift Lock Actuator from Fuse 6 when the Ignition Switch is in RUN. When the brake pedal is depressed, battery voltage is

applied to the Shift Lock Actuator from Fuse 12 via the Brake On/Off (BOO) Switch. The Shift Lock Actuator is then de-activated, allowing the transmission gear selector to be moved from the PARK position.

For diagnostic information, refer to Section 04-05 of the Service Manual.

SECTION 41

AIR SUSPENSION

HOW THE CIRCUIT WORKS

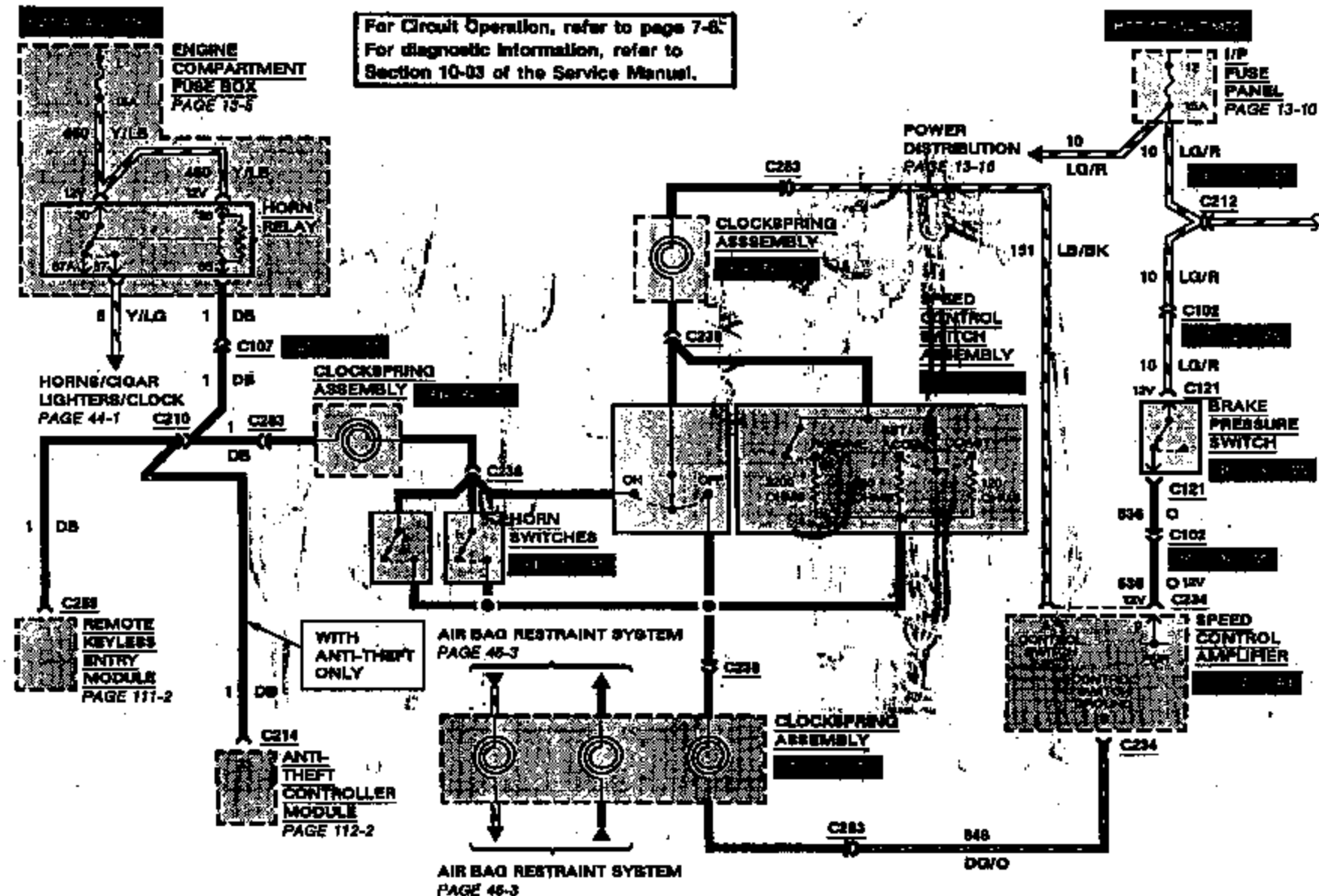
The Air Suspension/EVO Steering Module continuously receives inputs from the Vehicle Speed Sensor (VSS), the Door Courtesy Lamp Switches and the Linear Height Sensor and maintains vehicle height by controlling two Air Spring Solenoids, one Vent Solenoid and one Compressor Relay.

To raise the vehicle, the module turns on the Compressor through the Compressor Relay. After a one second delay, the desired Air Spring Solenoids are also turned on. The condition is maintained until the module determines, through the Linear Height Sensor, that the vehicle has reached the desired (trim) level. The Compressor Relay and Air Spring Solenoid then turn off.

The vehicle is lowered in much the same way, except the Vent Solenoid is turned on in place of the Compressor Relay, ignoring the one second delay.

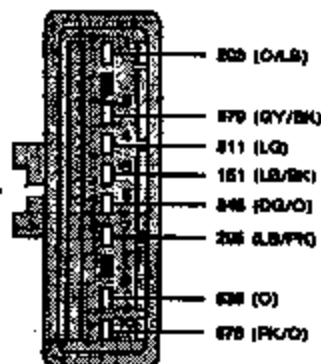
The door courtesy lamp switch input is used to indicate whether or not a door is open. The system will not lower the vehicle if a door is open.

31-1 SPEED CONTROL



31-3 SPEED CONTROL

1035 0W7 CAN



C234

SPEED CONTROL AMPLIFIER

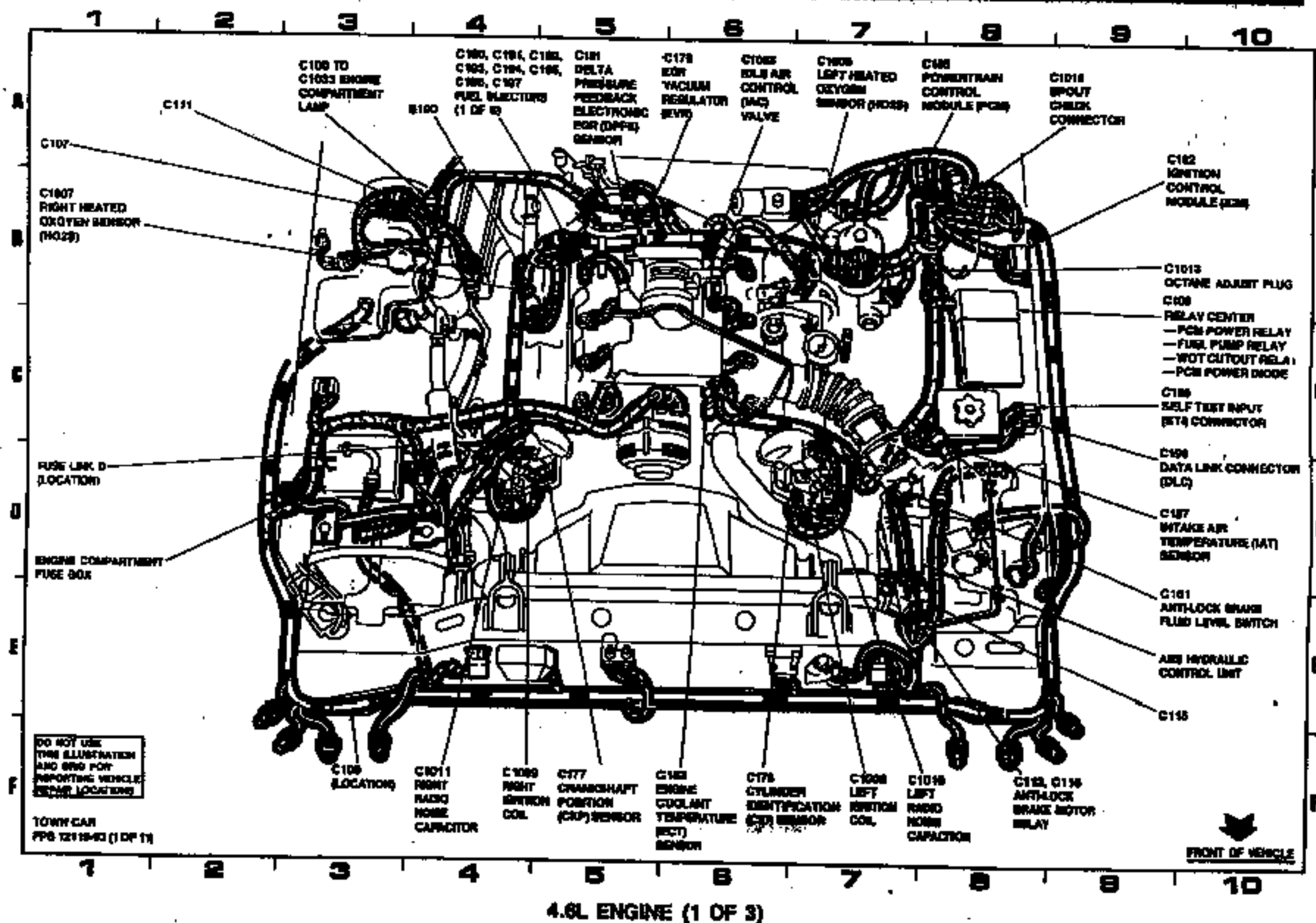
CONNECTOR REFERENCE LIST

CONNECTOR	SECTION
C214	112
C255	63
C259	111

PIN NUMBER	CIRCUIT	CIRCUIT FUNCTION
1	203 (O/LB)	Speed Control Indicator Lamp Output
2	—	NOT USED
3	679 (GY/BK)	Vehicle Speed Signal Input
4	511 (LG)	Brake On/Off (BOO) Switch Output
5	151 (LB/BK)	Speed Control Switch Input
6	848 (DG/O)	Speed Control Switch Ground
7	295 (LB/PK)	Hot in RUN
8	—	NOT USED
9	836 (O)	Brake Pressure Switch Output
10	876 (PK/O)	Ground

151-1 COMPONENT LOCATION VIEWS

1990 TOWN CAR

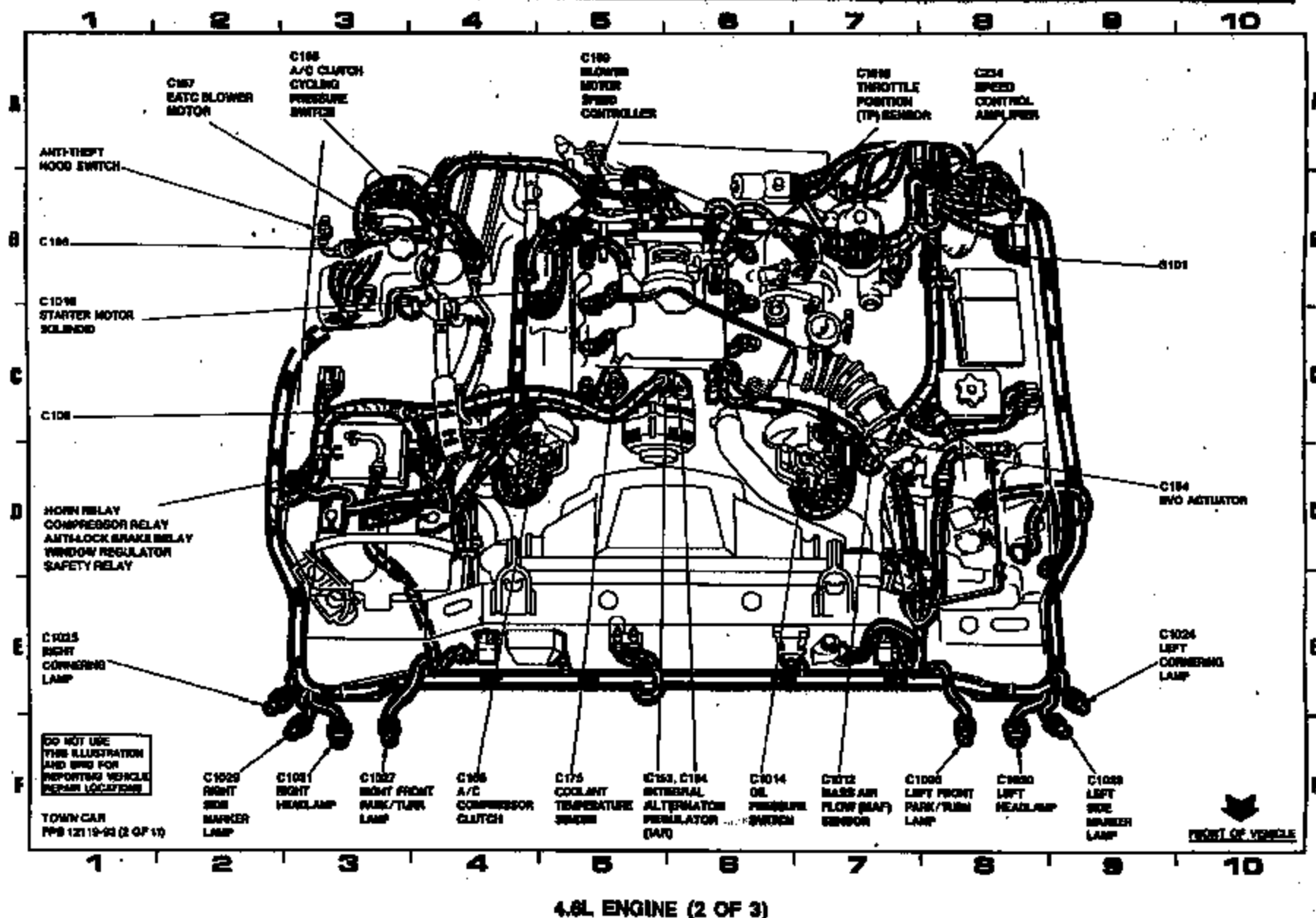


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COMPONENT LOCATION VIEWS 151-2

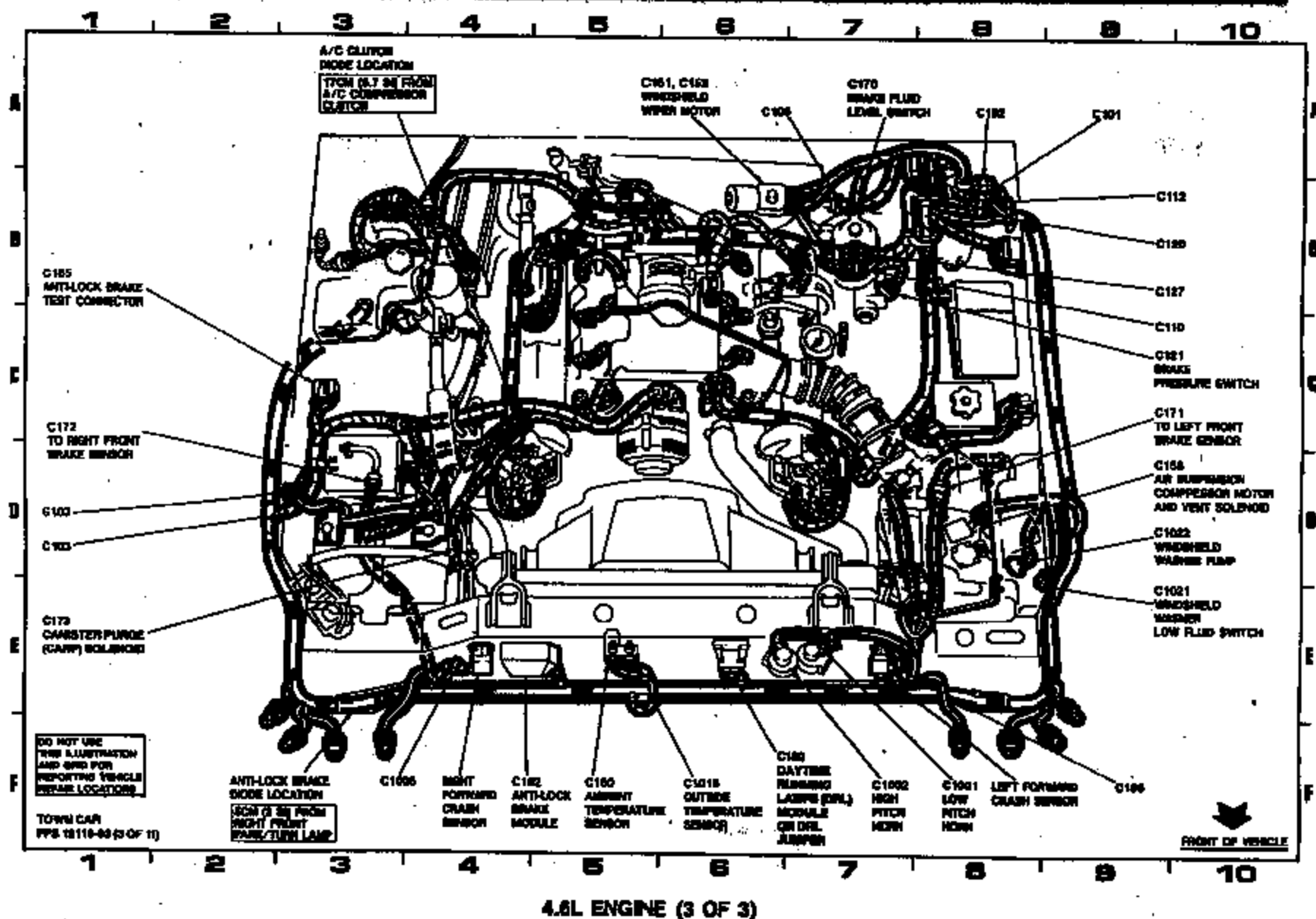
TOWN CAR



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151-3 COMPONENT LOCATION VIEWS



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- 6 FUNCTIONAL TEST LOAD PROFILE
- 7 MONITORED DURABILITY TEST BLOCK DIAGRAM
- 8 MONITORED CLIMATIC ENVIRONMENT TEST CYCLE
- 8a MONITORED CLIMATIC ENVIRONMENT TEST CYCLE
- 9 HUMIDITY-TEMPERATURE ENVIRONMENT TEST CYCLE
- 9a HUMIDITY-TEMPERATURE ENVIRONMENT TEST CYCLE
- 10 EMC SCREEN ROOM SETUP
- 11 SPEED CONTROL INITIALIZATION/SET-UP FOR EMC TESTS
- 12 ACCELERATED LIFE TEST DIAGRAM
- 13 ACCELERATED LIFE TEST PARAMETERS
- 14 VIBRATION AXIS
- 15 SERVO FUNCTIONAL TEST DOWNLOAD CODE
- 16 SERVO MONITORED DURABILITY TEST DOWNLOAD CODE
- 17 SERVO ACCELERATED LIFE TEST DOWNLOAD CODE
- 18 MONITORED DURABILITY I/O DEFINITION
- 19 SOFTWARE VERSION TABLES
- 20 CHANGE VALIDATION MATRIX - MQSC SERVO ASSEMBLY

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1 GENERAL

This specification governs the speed control electronic actuator assembly. It is a subassembly to an electronic Speed Control system which regulates vehicle speed. The electronic actuator subassembly is comprised of an electronic amplifier module and a mechanical servo assembly which contains a motor, gears and clutch.

Four amplifier "families" are regulated by this specification. The first is referred to as the "base" amplifier and is denoted by a character of "C", "Y", or "G" as the second character of the amplifier identification barcode that is inscribed on the side of the module. The second family is referred to as the "Diagnostic" amplifier, which features self-diagnostic capability that may be used by B&B and servicing dealerships to assist in assembly and repair. The family designation is "D" for the diagnostic modules. The third family is referred to as the "Honda" amplifier, which is similar to the base with 2 additional input circuits, and has the family designation of "H". The fourth is the "SCP" amplifier which has the ability to communicate with a vehicle through the SCP network, and has the family designation of "S".

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

The Engineering Specification is intended to evaluate specific characteristics as a supplement to normal material inspections dimensional checking, and in-process controls, and should in no way adversely influence other inspection operations.

Preparation and submission of an acceptable Control Plan are the responsibility of the manufacturing source. Control Plan approval by the Product Engineering Office and by other activities according to Q-101 is a prerequisite for initial sample review and approval. The manufacturing source will retain the original of the approved Control Plan and any later revisions per Q-101 and provide a copy to the design responsible PED.

2 SUMMARY OF PRODUCTION VALIDATION AND IN PROCESS TESTS

Production Validation (PV) tests are used to obtain an initial estimate of the process potential to produce parts that conform the engineering requirements, and to identify causal or predictive relationships between significant design and process characteristics (to be used for process control). These tests must be completed satisfactorily using initial parts from production tooling and processes before Production Sample Warrant (PSW) approval and authorization of production parts can be issued. Sampling plans for PV testing must be included in the Control Plan.

Complete PV testing MUST be run on at least one version of a module family type; results of a PV cannot be used between family types. Modified ("mini") PVs may be run within a family as long as at least one version from a family has completed a full PV.

In-Process (IP) tests are used to further understand the relationship between significant design and process characteristics and to establish a basis for continuing improvement. Tests must be completed with production parts on an ongoing basis. The sample size from each family type undergoing IP testing must be proportional to the production ratio of "base" versus "diagnostic" families at the time of the sampling. Sampling plans for both IP testing and evaluation of the significant process characteristics must be included in the Control Plan. When the process is found to be out of control or the test acceptance criteria are not met, the reaction plan approved in the Control Plan shall be invoked.

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2 SUMMARY OF PRODUCTION VALIDATION AND IN-PROCESS TESTS (cont'd)

Figure 1 lists the Tests required for Production Validation (PV) and In-Process (IP) testing. Refer to section 3.3 for descriptions of each test.

It is recommended that ES test sample sizes and frequencies be developed by the manufacturer, with concurrence by ACD-GEMO, and documented in the Control Plan.

Some Audit Tests (see Figures 1, 2) must be conducted yearly for each of the following family groupings:

- Families C, F, or G
- Family D
- Family M
- Family S

The remaining Audit Tests (see Figures 1, 2) may be conducted once yearly for any one of the family groupings.

Figures 3 & 3a list the PV flow plan per WDM 00.005A-D07 classification for this assembly. Three temperature Functional Testing, as defined by section 3.3.1 meets the intent of Performance/Functional Evaluations as defined by the WDM. Modules subjected the Temperature/Time profile per Figures 3 and 3a while performing the Monitored Durability Test Cycle outlined in section 3.3.5.4 meet the intent of the following PV test sequences:

- 3.4.5.1 Low Temperature Exposure
- 3.4.5.2 Low Temperature Operation
- 3.4.5.3 High Temperature Exposure
- 3.4.5.4 High Temperature Operation
- 3.4.5.5 Powered Thermal Cycle

Modules subjected the Temperature/Time/Humidity profile per Figures 9 and 9a while performing the Monitored Durability Test Cycle outlined in section 3.3.5.4 meet the intent of the following PV tests:

- 3.4.5.8 Humidity-Temperature Thermal Cycle

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FIGURE 1 - PRODUCTION VALIDATION AND IN-PROCESS TESTS

TEST NUMBER	TEST NAME	TEST USE	TEST LIMITS (FIG. 5)	MINIMUM CONFORMANCE TO TOLERANCE	SUGGESTED FREQUENCY/SAMPLE SIZE 1/
3.3.1,2,3	LOT CHECK Functional Evaluation Tests				24/lot
3.3.1	Quiescent Current	FV/IP		Cpk > 1.33	
3.3.2	Software Version	FV/IP		1/	
3.3.3	Internal RAM/ROM Tests	FV/IP		1/	
3.3.4	On/Off Switch Test	FV/IP		1/	
3.3.5	2nd Command Switch Test	FV/IP		1/	
3.3.6	Deactivator Switch	FV/IP		1/ 2/	
3.3.7	System Voltage	FV/IP		1/ 2/	
3.3.8	Command Decode	FV/IP		Cpk > 1.33	
3.3.9	Over-Voltage Detector	FV/IP		Cpk > 1.33	
3.3.10	Resonator Test	FV/IP		Cpk > 1.33	
3.3.11	Set Indicator	FV/IP		Cpk > 1.33	
3.3.12	Full-Load Deactivate	FV/IP		Cpk > 1.33	
3.3.13	Loaded Pull Test	FV/IP		Cpk > 1.33	
3.3.14	No-Load Release and Watchdog Timeout	FV/IP		Cpk > 1.33	
3.3.5	Reliability Accelerated Life Test	FV/IP		1/	3/lot
3.3.4	100% CHECK End-of-Line Test	FV/IP	Same as 3.3.1,2,3		100%
3.3.6	ADMIT Extended Ann. Life Test	FV/IP		1/	3/Day
3.4.2	Radiated Immunity	FV		1/	2/Group/Year
3.4.3	Conducted Immunity	FV		1/	2/Group/Year
3.4.4	Endurance	FV		1/	2/Group/Year
3.4.5.1	Low Temp. Exposure	FV/IP		1/	18/Group/Yr.
3.4.5.2	Low Temp. Operation	FV/IP		1/	18/Group/Yr.
3.4.5.3	High Temp. Exposure	FV/IP		1/	18/Group/Yr.
3.4.5.4	High Temp. Operation	FV/IP		1/	18/Group/Yr.
3.4.5.5	Powered Thermal Cycle	FV/IP		1/	18/Group/Yr.
3.4.5.6	Thermal Shock Resistance	FV/IP		1/	18/Group/Yr.
3.4.5.8	Humidity-Temp. Cycle	FV/IP		1/	12/Year
3.4.5.9.2	Carwash Spray	FV/IP		1/	12/Year
3.4.5.9.3	Heavy Splash/Shower	FV/IP		1/	12/Year
3.4.5.10	Dust	FV/IP		1/	6/Year
3.4.6.1.1	Endurance Vib. Method B	FV/IP		1/	18/Group/Yr.
3.4.6.2	Acoustic Noise	FV/IP		1/	18/Group/Yr.
3.4.6.3	Seach Drop	FV/IP		1/	18/Group/Yr.
3.4.7.1	Salt Mist Atmosphere	FV/IP		1/	3/Year
3.4.7.2	Chemical Resistance	FV/IP		1/	3/Year

1/ GO / NO-GO Test - All Must Pass

2/ Digital resolution of module restricts statistical significance - all must pass.
 Modules may be mixed generically within Groupings for lot testing; use control plan. Subsequent family groupings must be run in subsequent quarters. It is strongly recommended that test sample sizes be developed by the manufacturer, with concurrence by FRO.



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FIGURE 2- PRODUCTION VALIDATION ASSET TESTS / SEQUENCE

TEST		TESTING SEQUENCE WITHIN THE SUBGROUP				SUGGESTED FREQUENCY
Ref. No. 1/	Title	SUB-GROUP A/B	SUB-GROUP C	SUB-GROUP D	SUB-GROUP E	
SAMPLE SIZE		NINETEEN			TWELVE	
4.1.1.1/ 4.1.1.4	Performance/Functional Evaluations	1,7, 12,16	1,7, 12,13	1,7, 12,13		Yearly
4.1.1.6	Inspections	17	16	16		Yearly
4.3.1	Low Temperature Exposure		2			Yearly*
4.3.2	Low Temperature Operation		3			Yearly*
4.3.3	High Temperature Exposure		4			Yearly*
4.3.4	High Temperature Operation		5			Yearly*
4.3.5	Powered Thermal Cycle		6			Yearly*
4.6.1	Vibration					
4.6.1.1	Vibration Endurance (B)		8			Yearly*
4.6.1.2	Vibration Operation (B)		-			-
4.6.2	Audible Noise		9			Yearly*
4.6.3	Mechanical Shock/Drop					
4.6.3.3	Bench Drop		10			Yearly*
4.5.6	Thermal Shock Resistance		11			Yearly*
SAMPLE SIZE		TWELVE	SIX			
4.5.8	Humidity-Temperature Cycle	13				Yearly
4.5.9	Water/Fluids Ingress					
4.5.9.2	Carwash Spray	14				Yearly
4.5.9.3	Heavy Splash/Shower	15				Yearly
4.5.10	Dust		13			Yearly
SAMPLE SIZE			THREE	THREE		
4.7.1	Salt Mist Atmosphere		14			Yearly
4.7.2	Chemical Resistance			14		Yearly
4.5.7	Thermal Shock Endurance 2/					
4.8.1	High Temp. Endurance 2/					
4.8.3	Mech. Wearout (Life Test)				1	

* Each of these tests to be run once yearly per Family Group: (C,F,D) (D) (M) (S)
 1/ Reference WDE 00.00KA-007 - ELECTRICAL REQUIREMENTS - Electrical/Electronic Components
 2/ For -9DB44- Assembly only; see EE-PZVF-9DB44-AA

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FIGURE 2a PROTECTION VALIDATION AUDIT TEST - EMI

SUBGROUP F - 2 Samples / Family Group

TEST 1/		TITLE	DOT I/O	PERFORM CLASS
4.1.1.1/ 4.1.1.4		Performance/Functional Evaluations		
4.2		Radiated Immunity		
4.2.1.1	RI01-1	Stripline	ALL	I
4.2.2	RI02	Parallel Wire Ignition Noise	ALL	I
4.2.3	RI03	Parallel Wire Misc. Noise	ALL	I
4.3		Conducted Immunity		
4.3.1	CI01-1A	Sinusoidal Noise Normal Operation	7,9	I
4.3.2	CI01-1B	Sinusoidal Noise Abnormal Operation	7,9	II
4.3.3	CI02-1A	Inductive Switching - Severe	7,9	II
4.3.4	CI02-1B	Inductive Switching - Typical	7,9	I
4.3.5	CI02-2	Inductive Switching - VBat Disconnected	7,9	II
4.3.6	CI02-3A	Mechanical Switch Arcing Noise - Negative	7,9	I
4.3.7	CI02-3B	Mechanical Switch Arcing Noise - Positive	7,9	I
4.3.8	CI02-4	Power Line Variation and Cycling	7,9	II
4.3.9	CI02-5	Alternator Load Dump	7,9	II
4.3.10	CI02-6	Groundshift	7,9	I
4.3.11	CI03-1	Reverse Battery Voltage	7,9	III
4.3.12	CI03-2	Overvoltage - Failed Regulator	7,9	II
4.3.13	CI03-3	Overvoltage - Dual Battery Jump Start	7,9	II
4.3.14	CI04-1	Electrostatic Discharge - Unpowered	ALL	III
4.3.15	CI04-2	Electrostatic Discharge - Operating	MODULE	II
4.3.16	CI05	Ignition Spark Arc-over	MODULE	III
4.4		Emissions		
4.4.1	RE01	Radiated Emissions (Electric Field)	ALL	I
4.4.2	CE02	Conducted Emissions (Frequency Domain)	ALL	I

- 1/ Reference WDR 00.008A-007 - Section 4.1 - Electrical Environment Protection and
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3 TEST PROCEDURES AND REQUIREMENTS

3.1 General

Every Speed Control Module assembly or subassembly shall be capable of passing the Functional, Production Validation, In-process and End of Line Tests specified. Factory ambient tests shall be conducted at 25°C +/- 5°C.

The following operating conditions and environmental test classifications apply to this module, per the System Design Specification / Product Verification Specification. For definitions of each refer to the WDM 00.00EA-007.

3.1.1 OPERATING CONDITIONS

3.1.1.1 Environmental Test Classifications

Functional Importance Class (EMG)B-1
EMC Performance Classification(see Fig. 2a)
Temperature ClassV
Water/Fluid Ingress ClassIV
Salt Class IV
Dust Class II
Chemical ClassI
Vibration ClassII
Mechanical Shock/Drop ClassII

3.1.1.2 Temperature

Exposure TestT5(min) = -40°C T5(max) = 150°C *
Operation TestT1(min) = -40°C T2(max) = 115°C
Performance TestT3(min) = -40°C T4(max) = 125°C
Functional TestT1(min) = -40°C T7(max) = 125°C

* Prolonged storage above 100°C is not recommended. No short term damage will be apparent, however heat aging will accumulate.

3.1.1.3 Voltage

Normal V1 = 11 volts V2 = 16 volts
V3 = 11 volts V4 = 16 volts

Short Term (survive) 16 to 18 volts
Mandatory (1 second) 18 to 24 volts
Abnormal Low (survive) 0 to 11 volts

3.1.1.4 Load

Pounds 0 to 25
Newtons 0 to 110

3.1.1.5 Operational Life and Duty Cycle Ratings

Hours 8800
Miles 130,000

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.2 Test Setup / Test Conditions

Reference Figure 3 for electrical test circuit. For Families C, F, G, (Base) reference Figure 4 for test circuit stimulus and Figure 5 for test limits. For Family B (Diagnostic), reference Figure 4a for test circuit stimulus and Figure 5a for test limits. For Family M (Menda), reference Figure 4b for test circuit stimulus and Figure 5b for test limits. For Family S (SCF), reference Figure 4c for test circuit stimulus and Figure 5c for test limits. Not all tests are used on all families: see Figures 4, 4a, 4b, 4c, 5, 5a, 5b and 5c for details.

Modules must meet this specification in the temperature range of -40°C to 125°C. Sample testing must be performed at -40°C, 25°C, and 125°C ambient. Unless the procedure itemized below is used, the environmental chamber soak time when performing functional tests at temperature extremes shall be 2 hours. This allows the servo to stabilize at the final test temperature for most chamber capacities and loading. The limiting factor being the chamber cooling capacity when fully loaded.

The soak time in the QC audit area may be reduced for three temperature functional testing if the time required to reach the temperature extremes, both hot and cold, is determined using a thermocouple type thermometer and a thermocoupled sample module. Procedure:

- Prepare a test sample module by drilling and tapping a #6-32 thread in an area of the module casting having the thickest cross section next to the motor. (This test sample should be saved for future use.)
- Using a #6-32 screw and washer, clamp a thermocouple under the washer firm against the module. (Alternate methods for attachment are not permitted).
- Load the chamber with the necessary fixtures, the maximum number of modules to be tested including the temperature verification module having the threaded hole in the casting and the thermocouple clamped using a screw and washer. Be sure the module containing the thermocouple is mounted at the station closest to the door.
- Record the time required for the verification module to stabilize within 2 degrees of final value.
- Take the stabilization times for hot and cold and adjust by multiplying each by 1.1 to account for unknown factors that will occur during normal testing.
- Use the adjusted time as the soak requirement. Post the soak time and date of validation and date of next revalidation on the front of the test equipment. Submit the adjusted soak times to PEO.

The chamber soak time must be revalidated as follows:

- Every 6 months
- If any chamber service is done to correct a chamber problem,
- If the thermal loading of the chamber is increased (more things added to chamber since the last time Validated),
- If a different chamber is used.

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests

3.3.1 Three Temperature Functional (-40°C, 25°C, 125°C) - FAMILINE C.D.F.G

The test sequence is in a time saving order. If speed is important, avoid interrupting module power, time will be lost for microcomputer boot. The tests have two categories, monitor mode tests and RAM program execution tests.

Note: On reset, the module requires about 1 second to perform internal self tests on RAM, ROM and A/D. After completion, for a period of 3 seconds, the module will permit wake up of the monitor. The monitor will stay awake if monitor commands are received at least every 3 seconds. If there are any syntax errors, the monitor aborts and speed control mode is entered. To save time after power-up, perform test 3.3.1.1 while the microcomputer is executing self tests, then start the monitor at test 3.3.1.2

3.3.1.1 Module Quiescent Current

With all external loads removed, measure current draw of the module.

3.3.1.2 Software Version

Wake up the monitor, record the software version number.

3.3.1.3 Internal RAM, ROM, and A/D Converter Self Tests.

Record a pass or fail for these internal self tests.

3.3.1.4 Deactivator Switch Threshold Voltages

- 1) Open DEACTIVATOR input and record the DEACTIVATOR input via the monitor.
- 2) Set DEACTIVATOR input to Vignition and record the DEACTIVATOR input via the monitor.

3.3.1.5 System Voltage test

Record SYSTEM VOLTAGE via the monitor.

3.3.1.6 Driver Command Decode test

- 3.3.1.6.1 With the DRIVER COMMAND input open circuit, read the DRIVER COMMAND conversion and record. Verify the balance of the DRIVER COMMAND conversion to the SYSTEM VOLTAGE conversion of test "3.3.1.5" by recording the difference between the two measurements.

Recorded	SYSTEM VOLTAGE	Open Circuit
Test Result -	Conversion	DRIVER COMMAND
	(3.3.1.5)	Conversion
		(3.3.1.6.1)

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.1 Thrust Temperature Func. (-40°C, 25°C, 125°C) - FAMILIES C, D, F, G (cont'd)

3.3.1.6 Driver Command Decode test (cont'd)

3.3.1.6.2 Present a "SET" Command to the DRIVER COMMAND input. Read the conversion and subtract the open circuit conversion from test "3.3.1.5".

Recorded "SET" Command Open Circuit
Test Result - Conversion - DRIVER COMMAND
(3.3.1.6.2) Conversion
(3.3.1.6.1)

3.3.1.7 Over Voltage Detector Test (N/A for D FAMILY)

Record OVERVOLTAGE DETECTOR via the monitor.

3.3.1.8 Resonator Test (N/A for D FAMILY)

Apply a speed signal at the SPEED SENSOR input. Fetch a two byte speed value from RAM via the monitor, and convert from hex to decimal. Calculate and record the resonator frequency using the equation below.

Resonator
Frequency = (RAM value) X (speed signal frequency) X 8

3.3.1.9 Set Indicator Test

3.3.1.9.1 Measure the open circuit voltage at the SET INDICATOR output.

3.3.1.9.2 Turn SET INDICATOR "on" via the monitor and record saturation voltage.

The remaining tests are performed while executing a program loaded into the module RAM. The module brake input is used to cycle through the remaining functional tests and completes verification of the module brake circuit. The download programs for Families C, F, G (Base), and Family D (Diagnostic) are unique; reference Figure 15.

3.3.1.10 Full Load / Partial Stroke / Deactivate Test

3.3.1.10.1 With Full Power enabled to the module Deactivator Switch input, initialize speed input to energize clutch and boot module RAM with the test program via the monitor. For object file see Figure 15.

3.3.1.10.2 Execute RAM program and measure the position of the loaded, partially stroked servo.

3.3.1.10.3 To verify the clutch full-load release, supply Deactivator Switch power through the current limiting resistor, dwell 250 ms, measure and record the servo position.

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.1 Three Temperatures Pops. (-40°C, 23°C, 125°C) - PASTILKE C.B.E.G (cont'd)

5.3.1.11 Pull Load / Pull Stroke Test

With the RAN program still executing and using the spring lead profile in Figure 6:

3.3.1.12.1 No-apply full Demutivator switch power and drill 100ms to allow the clutch to engage.

3.3.1.21.3 Initiate a move from the idle position to the fully
stroked position by grounding the brake input,
receiving the Monitor interface, then presenting the
module brake input with an open circuit for > 7ms.

3.3.1.11.3 Ground the module brake input causing the servo to stop at the full stroke position. Measure and record the servo position.

3.4.1.12 No Load Release and Hatchdog Timout Test

1.3.1.12.1 With the HAM program still executing, remove all mechanical loads from the servo.

3.3.1.12.2 To verify the clutch no load release and watchdog reset, momentarily open circuit the module brake input for 100ms. The module RAM program will stop throwing the watchdog a bone causing a reset to the module and a release of the clutch. Check for a return of the servo from the fully stroked position to the idle position within 750ms. Measure and record the idle position of the servo.

9.1.2 Three Temperature Functional (-40°C, 25°C, 125°C) - FAMILY M (HAXDA)

The test sequence is in a time saving order. If speed is important, avoid interrupting module power, time will be lost for microcomputer boot. The tests have two categories, monitor mode tests and RAM program execution tests.

Note: On reset, the module requires about 1 second to perform internal self tests on RAM, ROM and A/D. After completion, for a period of 3 seconds, the module will permit wake up of the monitor. The monitor will stay awake if monitor commands are received at least every 3 seconds. If there are any system errors, the monitor aborts and speed control mode is entered. To save time after power-up, perform test letter 3.3.2.1 while the microcomputer is executing self tests, then start the monitor at test 3.3.8.2.



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1 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.2 Three Temperature Functional (-40°C, 25°C, 125°C) - FAMILY M (cont'd)

3.3.2.1 Module Quiescent Current

With all external loads removed, measure current draw of the module.

3.3.2.2 Software Version

Wake up the monitor, record the software version number.

3.3.2.3 Internal RAM, ROM, and A/D Converter Self Tests

Record a pass or fail for these internal self tests.

3.3.2.4 ON/OFF Switch Input Test

- 1) Open ON/OFF input and record the ON/OFF input via the monitor.
- 2) Set ON/OFF input to Vignition and record the ON/OFF input via the monitor.

3.3.2.5 Second Command Switch Input Test

- 1) Open SECOND COMMAND SWITCH input and record the SECOND COMMAND SWITCH input via the monitor.
- 2) Set SECOND COMMAND SWITCH input to ground and record the SECOND COMMAND SWITCH input via the monitor.

3.3.2.6 Deactivator Switch Threshold Voltage

- 1) Open DEACTIVATOR input and record the DEACTIVATOR input via the monitor.
- 2) Set DEACTIVATOR input to Vignition and record the DEACTIVATOR input via the monitor.

3.3.2.7 System Voltage Test

Record SYSTEM VOLTAGE via the monitor.

3.3.2.8 Driver Command Decode Test

- 3.3.2.8.1 With the DRIVER COMMAND input open circuit, read the DRIVER COMMAND conversion and record.
- 3.3.2.8.2 Present a "SET" Command to the DRIVER COMMAND input. Read the A/D conversion and record.

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.2 Three Temperature Functional (-40°C, 25°C, 125°C) - FAMILY M (cont'd)

3.3.2.9 Over Voltage Detector Test

Record OVERVOLTAGE DETECTOR via the monitor.

3.3.2.10 Resonator Test

Apply a speed signal at the SPEED SENSOR input. Fetch a two byte speed value from RAM via the monitor, and convert from hex to decimal. Calculate and record the resonator frequency using the equation below.

Resonator
Frequency = (RAM value) X (speed signal frequency) X 8

3.3.2.11 Set Indicator Test

3.3.2.11.1 Measure the open circuit voltage at the SET INDICATOR output.

3.3.2.11.2 Turn SET INDICATOR "on" via the monitor and record saturation voltage.

The remaining tests are performed while executing a program loaded into the module RAM. The module brake input is used to cycle through the remaining functional tests and completes verification of the module brake circuit. The download programs for Family M (Menda) is unique; reference Figure 15.

3.3.2.12 Full Load / Partial Stroke / Deactivator Test

3.3.2.12.1 With Full Power enabled to the module Deactivator Switch input, initialize Speed input to energize clutch and boot module RAM with the test program via the monitor. For object file see Figure 15.

3.3.2.12.2 Execute RAM program and measure the position of the loaded, partially stroked servo.

3.3.2.12.3 To verify the clutch full-load release, supply Deactivator Switch power through the current limiting resistor, dwell 250 ms, measure and record the servo position.

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ENGINEERING SPECIFICATION

PART NUMBER

ES-F2VF-SC733-AA

REV

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.1 Three Temperature Functional (-40°C, 25°C, 125°C) - Family H (cont'd)

3.3.2.13 Full Load / Full Stroke Test

With the RAM program still executing and using the spring load profile in Figure 6:

3.3.2.13.1 Re-apply full deactivator switch power and dwell 100ms to allow the clutch to engage.

3.3.2.13.2 Initiate a move from the idle position to the fully stroked position by grounding the brake input, removing the Monitor interface, then presenting the module brake input with an open circuit for > 7 ms.

3.3.2.13.3 Ground the module brake input causing the servo to stop at the full stroke position. Measure and record the servo position.

3.3.2.14 No Load Release and Watchdog Timeout Test

3.3.2.14.1 With the RAM program still executing, remove all mechanical loads from the servo.

3.3.2.14.2 To verify the clutch no load release and watchdog reset, momentarily open circuit the module brake input for 100 ms. The module RAM program will stop throwing the watchdog a bone causing a reset to the module and a release of the clutch. Check for a return of the servo from the fully stroked position to the idle position within 750 ms. Measure and record the idle position of the servo.

3.3.3 Three Temperature Functional (-40°C, 25°C, 125°C) - FAMILY S (SCF)

Note: On reset, the module requires 200 milliseconds before it can receive SCF network traffic. Internal self tests on RAM, ROM and A/D are done in the diagnostic mode and the format is specified in the Part II Diagnostic Specification for the RMC-SCF. The tester must send a Tester Present Message per F710-12X329-GA at least every 5 seconds in order for the module to stay in the diagnostic state.

3.3.3.1 Module Quiescent Current

With all external loads removed, measure current draw of the module.

3.3.3.2 Software Version

Via the SCF network, record the software version number.

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.3 Three Temperature Functional (-40°C, 25°C, 125°C) - Family B (cont'd)

3.3.3.3 Internal RAM, ROM, and A/D Converter Self Tests.

Via the SCP network, record a pass or fail for these internal self tests.

3.3.3.4 Deactivator Switch Threshold Voltage

- 1) Open DEACTIVATOR input and record the DEACTIVATOR input via the SCP network.
- 2) Set DEACTIVATOR input to Vignition and record the DEACTIVATOR input via the SCP network.

3.3.3.5 System Voltage Test

Record SYSTEM VOLTAGE via the SCP network.

3.3.3.6 Driver Command Decode Test

- 3.3.3.6.1 With the DRIVER COMMAND input open circuit, read the DRIVER COMMAND conversion via the SCP network. Verify the balance of the DRIVER COMMAND conversion to the SYSTEM VOLTAGE conversion of test "3.3.3.5" by recording the difference between the two measurements of tests "3.3.3.5" and "3.3.3.6.1"

Recorded	SYSTEM VOLTAGE	Open Circuit
Test Result -	Conversion	DRIVER COMMAND
	(3.3.3.5)	Conversion
		(3.3.3.6.1)

- 3.3.3.6.2 Present a "SET" Command to the DRIVER COMMAND input. Read the conversion and subtract the open circuit conversion from test "3.3.3.6.1".

Recorded	"SET" Command	Open Circuit
Test Result -	Conversion	DRIVER COMMAND
	(3.3.3.6.2)	Conversion
		(3.3.3.6.1)

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3 TEST PROCEDURES AND REQUIREMENTS (cont'd)**3.3 Functional Tests (cont'd)****3.3.3 Three Temperature Functional (-40°C, 25°C, 125°C) FAMILY 5 (cont'd)**

The remaining tests are performed while executing a program loaded into the module RAM. This program is unique to Family 5 (SGF) modules. The module brake input is used to cycle through the remaining functional tests and completes verification of the module brake circuit.

3.3.3.7 Full Load / Partial Stroke / Deactivate Test

Using the spring load profile in Figure 4:

3.3.3.7.1 With full power enabled to the module Deactivator Switch input, initialize Speed input to energize clutch and boot module RAM with test program via monitor. For RAM test program listing see Figure 15.

3.3.3.7.2 Execute RAM program and measure the position of the loaded, partially stroked module.

3.3.3.7.3 To verify the clutch full load release, supply Deactivator Switch power through the current limiting resistor, dwell 250 ms, measure and record the servo position.

3.3.3.8 Full Load / Full Stroke Test

With the RAM program still executing and using the spring load profile in Figure 5:

3.3.3.8.1 Re-apply full Deactivator switch power and dwell 100 ms to allow the clutch to engage.

3.3.3.8.2 Initiate a move from the idle position to the fully stroked position by grounding the brake input, removing the Monitor interface, then presenting the module brake input with an open circuit for > 7 ms.

3.3.3.8.3 Ground the module brake input causing the module to stop at the full stroke position. Measure and record the position.

3.3.3.9 No Load Release and Watchdog Timeout Test.

3.3.3.9.1 With the RAM program still executing, remove all mechanical loads from the servo.

3.3.3.9.2 To verify the clutch no load release, and watchdog reset, momentarily open circuit the module brake input for 100 ms. The module RAM program will stop throwing the watchdog a bone causing a reset to the module and a release of the clutch. Check for a return of the servo from the fully stroked position to the idle position within 750 ms. Measure and record the idle position of the servo.

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FRAME 2.2

3 TEST PROCEDURES AND REQUIREMENTS (cont'd)

3.3 Functional Tests (cont'd)

3.3.4 End of Line Test (ALL FAMILIES)

Same as 3.3.1, 2, 3 except:

- The test is performed at factory ambient temperature.
- The Full Load Deactivate Test (step 3) has the dwell time reduced from 250ms to 100ms.
- The No-load Release and Watchdog Timeout Test (step 2) has the servo return time reduced from 750ms to 300ms and the current limiting resistor (Fig 3) is to be reduced from 2.2K to 910 ohms.

3.3.5 6 Hour Accelerated Life Test

The purpose of the test is to identify any supplier/process defects before shipment of a lot. Use the accelerated test fixture shown in Figure 12. The load applied to the Speed control module assembly is depicted in Figure 5. Test Cycle Description.

- a. Use the computer controller to select the test stations to be cycled, power up the modules, main power and clutch power.
- b1. Wake up the module monitor and boot the amplifier RAM with the test cycle. (Ref. Figure 17).
 - OR FOR FAMILY "6" .
- b2. Via the SCP monitor, enter SCP diagnostics and BOOT the amplifier RAM with the test cycle. (Ref. Figure 17).
- c. Jump to the test routine now residing in the module RAM.
- d. Open the DEACT line in order to remove power from this signal.
- e. Remove the monitor or SCP interface from the module.
- f. Check that all the test stations are in the idle position according to the limit switches.
- g. Close the DEACT line restoring power to the signal.
- h. Check for all the selected test stations to stroke to the full stroke position using the limit switches.
- i. Momentarily open circuit the brake digital I/O line to the module brake input for 100ms causing the module to:
 - 1) Stroke to a partial stroke position.
 - 2) Stop, and release the clutch causing a hard return of the air spring to the hard stop position.
- j. Repeat steps f through i continuing at the fastest possible rate for 6 hours duration.

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