SSME EA/CIL
REDUNDANCY SCREEN

Component Group:	Actuators
CIL Item:	E150-01
Part Number:	RES1008-7XXX
Component:	Chamber Coolant Valve Actuator
FMEA Item:	E150
Failure Mode:	Fails to respond to position commands.

Prepared:	S. Heater
Approved:	T. Nguyen
Approval Date:	6/9/00
Change #:	1
Directive #:	CCBD ME3-01-5624
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Phase	Failure / Effect Description	Criticality Hazard Reference
M 4.2	Following channel A failure, controller switches to channel B (servovalve No. 2); if failure continues, controller initiates hydraulic lockup. Mission abort may result when hydraulic lockup occurs during Max Q throttling. Redundancy Screens: ACTUATOR SYSTEM - CONTROLLER SYSTEM: UNLIKE REDUNDANCY A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Pass - Loss of a redundant hardware items is detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event.	1R ME-B2M
M 4.3	Failure to respond may result in controller initiated shutdown due to engine limit exceeded. Mission abort. Redundancy Screens: ACTUATOR SYSTEM - SENSOR SYSTEM: UNLIKE REDUNDANCY A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Pass - Loss of a redundant hardware items is detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event.	1R ME-B2M

SSME FMEA/CIL DESIGN

Component Group:	Actuators	Prepared:	S. Heater
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Design / Document Reference

FAILURE CAUSE: **A: Actuator: Shaft, crank, crank pin, or pushrod failure.**

THE ACTUATOR SHAFT (1) MATERIAL IS A-286 CRES. THE MATERIAL WAS SELECTED FOR ITS STRENGTH, ELASTIC MODULUS, THERMAL CHARACTERISTICS AND STRESS CORROSION RESISTANCE (3). THE SHAFT IS HEAT TREATED TO DEVELOP MATERIAL STRENGTH. THE SHAFT IS ALSO PASSIVATED TO DEVELOP ADDITIONAL CORROSION RESISTANCE. THE ACTUATOR CRANK (2) MATERIAL IS 18Ni MARAGING STEEL BAR. THE MATERIAL WAS SELECTED FOR ITS MECHANICAL STRENGTH (3). THE CRANK IS PROTECTED FROM CORROSION BY THE HYDRAULIC FLUID ENVIRONMENT. THE CRANK IS HEAT TREATED FOR MAXIMUM STRENGTH AND SHOT PEENED FOR ADDITIONAL STRESS CORROSION RESISTANCE (1) AND FATIGUE STRENGTH. THE CRANK PIN (4) MATERIAL IS VASCO MATRIX II CVM STEEL. THE CRANK PIN IS HEAT TREATED AFTER ROUGH MACHINING, AND STRESS RELIEVED AFTER FINAL MACHINING. THE MATERIAL WAS SELECTED FOR STRENGTH AND HARDNESS (3). THE CRANK PINS ARE LUBRICATED WITH DICRONITE NO. 25504 TO MINIMIZE FRICTION. THE PUSHRODS (5) ARE HEAT TREATED CUSTOM 455 CRES. THE MATERIAL WAS SELECTED FOR ITS STRENGTH AND HARDNESS (3). MONOBALL ROD END BEARINGS (6) WITH 440C BALLS AND 17-4PH OUTER RACES ARE USED AT THE CRANK END OF THE PUSHRODS. THE BALLS AND RACES ARE DICRONITE COATED FOR REDUCED FRICTION. THE MONOBALL BEARING COMPENSATES FOR PISTON AND CRANK MISALIGNMENT AND ENSURES UNIFORM LOADING ON THE CRANK PIN. THE PUSHROD BALL END IS TUFFTRIDE SURFACE HARDENED TO PROVIDE RESISTANCE TO WEAR AND GALLING. THE END ALSO PROVIDES A PATH FOR HYDRAULIC FLUID LUBRICATION (5).

(1) 41004606; (2) 41004591; (3) RSS-8582; (4) 41003902; (5) 34000373; (6) 84000378

FAILURE CAUSE: **B: Actuator: Bearing failure.**

BALL BEARINGS ARE USED IN THE SHAFT BEARINGS (1) FOR THEIR FRICTION AND LOAD CAPACITY CHARACTERISTICS. THE BEARINGS ARE MS27642 CONFIGURATION WITH MINOR MODIFICATIONS. THE NICKEL PLATE IS ELIMINATED FROM THE OUTER SURFACES OF THE RACES AND THE SEALS AND SEAL RETAINERS ARE ELIMINATED (1). THE BALLS AND RACES ARE 52100 ALLOY STEEL WHICH IS HEAT TREATED FOR BEARING STRENGTH AND HARDNESS (2). CORROSION PROTECTION AND LUBRICATION ARE PROVIDED BY THE HYDRAULIC OIL IN THE ACTUATOR RETURN CAVITY (3). THE NORMAL OPERATION OF THE ACTUATOR DURING ENGINE OPERATION PRECLUDES BEARING FAILURES CAUSED BY HEAT GENERATION, WEAR, OR SPALLING.

(1) 84000369; (2) RSS-8582; (3) 41003740

FAILURE CAUSE: **C: Actuator: Hydraulic piston seizure.**

THE HYDRAULIC PISTONS ARE FABRICATED FROM AISI E 9310 (1). THE MATERIAL WAS SELECTED FOR ITS HARDNESS AND WEAR RESISTANCE (2). THE PISTONS ARE GAS CARBURIZED FOR ADDITIONAL SURFACE HARDNESS AND WEAR RESISTANCE. THE HOUSING IS FABRICATED FROM 7175-T736, HEAT TREATED AFTER ROUGH MACHINING (3). THE HOUSING BORES ARE HARD ANODIZED FOR WEAR AND CORROSION RESISTANCE. THE PISTONS ARE PROTECTED FROM CORROSION BY THE HYDRAULIC FLUID ENVIRONMENT. A L/D OF ONE, CHAMFERS ON THE PISTON ENDS, AND CLOSE DIAMETRICAL CLEARANCES PREVENT SEIZURE CAUSED BY COCKING. ALL DETAIL PARTS ARE CLEANED FOR HYDRAULIC SERVICE PRIOR TO ASSEMBLY. ASSEMBLY IS ACCOMPLISHED IN A CONTAMINATION CONTROLLED AREA (4). THE PARTS ARE LUBRICATED WITH HYDRAULIC FLUID DURING ASSEMBLY. THE HYDRAULIC FLUID SUPPLY IS FILTERED THROUGH A 25-MICRON FILTER (5).

(1) 34000309; (2) RSS-8582; (3) 34000694; (4) RC1008, RL10012; (5) RES1008-3003

FAILURE CAUSE: **D: Servovalve: Nozzle or orifice restricted.**

HYDRAULIC LINES AND ACTUATOR DETAILS ARE CLEANED PRIOR TO ACTUATOR ASSEMBLY (1). THE HYDRAULIC FLUID USED FOR ASSEMBLY AND TEST IS EITHER IN ACCORDANCE WITH JSC SPECIFICATION REQUIREMENTS OR PER AN MSFC APPROVED WAIVER (2). THE HYDRAULIC FLUID CLEANLINESS IS CONTROLLED. THE SERVOVALVE AND ACTUATOR ASSEMBLY IS PERFORMED IN A CONTAMINATION CONTROLLED AREA (1). HYDRAULIC FLUID CLEANLINESS IS CONTROLLED IN COMPONENT TEST FACILITIES BOTH PRIOR TO INSTALLING ACTUATORS AND PRIOR TO REMOVING THEM AFTER COMPONENT LEVEL TESTS BY MAKING A PARTICLE COUNT (2). A 25-MICRON GLASS BEAD RATED FILTER (3) IS INSTALLED BETWEEN THE HYDRAULIC SUPPLY AND THE ACTUATOR. FILTER RATING IS VERIFIED ON EACH UNIT BY BUBBLE POINT TEST. IN ADDITION, THE SERVOVALVE (4) INCORPORATES A FILTER (5) TO PROTECT THE ORIFICES AND THE NOZZLES. THE ORIFICE FILTER IS DESIGNED TO CONTAIN ALL PARTICLES WHOSE TWO SMALLEST DIMENSIONS ARE 50-MICRONS OR LARGER. THE FILTER MUST ALSO RETAIN 95% OF ALL PARTICLES WHOSE TWO SMALLEST DIMENSIONS ARE 25-MICRONS (5).

(1) RL10012; (2) RC1008; (3) RES1008-3003; (4) 84000168; (5) 28003065

Design / Document Reference

FAILURE CAUSE: E: Servovalve: Filter O-ring leakage.

THE FILTER O-RING IS BUNA-N (1). THE MATERIAL WAS SELECTED FOR ITS ELASTIC CHARACTERISTICS, RESISTANCE TO PERMANENT SET, AND ITS COMPATIBILITY WITH HYDRAULIC FLUID, THE CONTACTING METAL COMPONENTS, AND THE OPERATING TEMPERATURES (2). THE ASSEMBLY DESIGN PERMITS VISUAL INSPECTION OF THE O-RING AFTER INSTALLATION (3).

(1) 82005510; (2) RSS-8582; (3) 84000168

FAILURE CAUSE: F: Servovalve: Torque motor contamination, open or short circuit.

THE TORQUE MOTOR PARTS ARE CLEANED PRIOR TO ASSEMBLY. THE TORQUE MOTOR DAMPING FLUID CLEANLINESS IS CONTROLLED (1). THE SERVOVALVE IS ASSEMBLED IN A LAMINAR FLOW BENCH AREA TO PREVENT CONTAMINATION ENTRY (1). THE ELECTRICAL HARNESS WIRE AND THE SERVOVALVE COIL WIRE (1) ARE PROCURED TO GOVERNMENT SPECIFICATIONS. THE ELECTRICAL CONNECTORS ARE MADE TO ROCKETDYNE APPROVED SPECIFICATIONS (2). THE COILS ARE WOUND IN LAMINAR FLOW STATIONS TO REDUCE CONTAMINATION POTENTIAL. THE COIL IS WOUND TO ENSURE THAT COIL WIRES CANNOT CROSS THE LEADWIRE FROM THE OTHER END OF THE COIL (1) (3). ALL HARNESS WIRES ARE INSTALLED IN PROTECTIVE WIREWAYS. THE INTERFACE FASTENERS ARE LOCKWIRED AND THE WIREWAYS ARE SUPPORTED WITH CLAMPS. WIREWAYS ARE FILLED WITH PLASTIC POTTING COMPOUND. COIL AND LEADWIRE TERMINATIONS ARE ENCAPSULATED (4). TEFLON WIRE GUIDES, AND COIL AND WIRE POTTING MINIMIZES THE POSSIBILITY OF MECHANICAL DAMAGE TO THE INSULATION AND WIRE, AND VIBRATION INDUCED ELECTRICAL DISCONTINUITIES. ELECTRICAL CONTINUITY AT LEADWIRE-TO-CONNECTOR AND COIL-TO-LEADWIRE CONNECTIONS IS ENSURED BY SOLDERED JOINTS (4).

(1) RC1008; (2) RES1229; (3) 28006768, 28006769; (4) 41003740

FAILURE CAUSE: G: Servovalve: Broken flapper, torque tube, or feedback wire.

THE FLAPPER (1) AND TORQUE TUBE (2) ARE MADE FROM BERYLLIUM COPPER. THIS MATERIAL WAS SELECTED FOR ITS DUCTILITY, MODULUS OF ELASTICITY, AND YIELD STRENGTH (3). THE FLAPPER AND TORQUE TUBE ARE DEFLECTION LIMITED. THIS IN COMBINATION WITH THE MATERIAL PROPERTIES REDUCES THE POSSIBILITY OF LOW AND HIGH CYCLE FATIGUE. THE FEEDBACK WIRE (4) IS 17-7PH. 17-7PH IS USED FOR ITS SHEAR STRENGTH AND WEAR RESISTANCE (3). THE FEEDBACK WIRE BALL IS RESISTANCE WELDED TO THE FEEDBACK WIRE (5) FOR STRUCTURAL INTEGRITY.

(1) 28003053; (2) 28003056; (3) RSS-8582; (4) 28003058; (5) 28003057

FAILURE CAUSE: H: Servovalve: Spool seizure.

THE SERVOVALVE SPOOL (1), AND SLEEVE (2) ARE 440C CRES. THE SPOOL AND SLEEVE ARE HEAT TREATED AND COLD STABILIZED (1) (2). THE MATERIAL WAS SELECTED FOR ITS HARDNESS AND WEAR RESISTANCE (3). 440C CRES IS CORROSION RESISTANT. THE SHARP EDGES OF THE SPOOL AND THE LAP FIT OF THE SPOOL AND SLEEVE REDUCE THE POSSIBILITY OF SEIZURE DUE TO CONTAMINANT PARTICLES. THE L/D GREATER THAN 8 AND CLOSE DIAMETRICAL CLEARANCES PREVENT SEIZURE CAUSED BY COCKING. THE SPOOL OPERATES IN HYDRAULIC FLUID, WHICH PROVIDES ADDITIONAL CORROSION PROTECTION AND LUBRICATION. THE ACTUATOR DETAIL PARTS ARE CLEANED FOR HYDRAULIC SERVICE (4), AND THE HYDRAULIC FLUID IS FILTERED THROUGH A 25-MICRON FILTER (5) WHICH IS UPSTREAM OF THE ACTUATOR. THE SERVOVALVE AND ACTUATOR ARE ASSEMBLED IN A CONTAMINATION CONTROLLED AREA (4). HYDRAULIC OIL CLEANLINESS IS VERIFIED BEFORE THE ACTUATOR IS INSTALLED IN A TEST FACILITY AND BEFORE THE UNIT IS REMOVED FROM THE SYSTEM (6). THE SERVOVALVE IS OPERATED PERIODICALLY DURING PROPELLANT CONDITIONING TO PREVENT SEIZURE CAUSED BY SILTING (7).

(1) 28003759; (2) 28003076; (3) RSS-8582; (4) RL10012; (5) RES1008-3003; (6) RC1008; (7) CP406R0002 PT 1 3.2.3:6.1.6

FAILURE CAUSE: I: Servovalve: Loss of damping fluid.

THE DAMPING FLUID IS CONTAINED BETWEEN THE TORQUE MOTOR COVER (1) AND THE SERVO-COMPONENT HOUSING (2). THE COVER-TO-HOUSING JOINT IS SEALED IN WITH AN O-RING SEAL. THE DAMPING FLUID IS SEALED FROM THE HYDRAULIC CIRCUIT BY AN O-RING BETWEEN THE HOUSING AND THE TORQUE MOTOR FRAME (3). THE TORQUE MOTOR CAVITY IS FILLED BY INJECTING A MEASURED AMOUNT OF FLUID. THE O-RING SEALS ARE MADE FROM BUNA-N. BUNA-N WAS SELECTED FOR ITS COMPATIBILITY WITH THE OPERATING ENVIRONMENT AND RESISTANCE TO PERMANENT SET (4). THE O-RINGS ARE LIFE LIMITED BY MAJOR WAIVER (5). THE TORQUE MOTOR WILL OPERATE SATISFACTORILY WITHOUT DAMPING FLUID. HOWEVER, DAMPING FLUID LOSS MAY REDUCE THE HIGH CYCLE FATIGUE LIFE OF THE TORQUE MOTOR ASSEMBLY.

(1) 28003031; (2) 28003079; (3) 28003045; (4) RSS-8582; (5) DAR 2988

Component Group:	Actuators	Prepared:	S. Heater
CIL Item:	E150-01	Approved:	T. Nguyen
Part Number:	RES1008-7XXX	Approval Date:	6/9/00
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FAILURE CAUSE: ALL CAUSES

THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE ACTUATOR MEET CEI REQUIREMENTS (1). THE MINIMUM FACTORS OF SAFETY FOR THE ACTUATOR MEET CEI REQUIREMENTS (2). THE ACTUATOR HAS BEEN CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (3). THE ACTUATOR HAS COMPLETED DESIGN VERIFICATION TESTING (4). DVS TEST RESULTS ARE DOCUMENTED (5). THE OPOVA FROM ENGINE 2010 (WHICH IS ESSENTIALLY THE SAME AS THE CCVA) WAS DISASSEMBLED AND EXAMINED. THE ACTUATOR SHOWED NO DETRIMENTAL WEAR OR DEFECTS AFTER 28 STARTS AND 10,332 SECONDS HOT FIRE TIME, INCLUDING 6,651 SECONDS AT FPL (6). A FAILURE TO RESPOND TO POSITION COMMANDS WILL BE DETECTED BY A SERVOACTUATOR ERROR INDICATION INTERRUPT (SEII) OR CONTROLLER SELF TEST (7). DURING MAINSTAGE, THE FAILURE WILL RESULT IN CONTROLLER INITIATED HYDRAULIC LOCKUP IF THE FAILURE CONTINUES IN CHANNEL B (8). THE SYSTEM IS COMPRISED OF REDUNDANT ACTUATOR POSITION SENSOR ELECTRONICS, REDUNDANT HARNESSES, AND REDUNDANT CONTROLLER CHANNELS. DURING STORAGE, RESIDUAL HYDRAULIC FLUID IS LEFT IN THE ACTUATOR AND THE ACTUATOR OPENINGS ARE SEALED TO PREVENT CONTAMINATION ENTRY. THE HYDRAULIC FLUID FILM LEFT ON THE PARTS, AND THE SEALED ENVIRONMENT, PROVIDE CORROSION PROTECTION.

(1) RL00532, CP320R0003B; (2) RSS-8546, CP320R0003B; (3) NASA TASK 117; (4) DVS-SSME-512; (5) RSS-512; (6) SSME-82-2316; (7) CP406R0002 PT 1 3.2.3:6.1.3, 3.2.3:3.2.3; (8) CP406R0002 PT 1 3.2.3:1.7.2

SSME F 'CIL
INSPECTION AND TEST

Component Group: Actuators
CIL Item: E150-01
Part Number: RES1008-7XXX
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FMEA Item: E150
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	SHAFT		41004606
	CRANK		41004591
	CRANK PIN		41003902
	PUSH ROD		34000373
	MONOBALL		84000378
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	41004606 41004591 41003902 34000373 84000378
		HEAT TREATMENTS OF SHAFT, CRANK, CRANK PIN, MONOBALL, AND PUSHROD ARE VERIFIED TO MEET DRAWING REQUIREMENTS.	41004606 41004591 41003902 34000373 84000378
		THE CRANK, CRANK PIN, AND PUSHROD ARE MAGNETIC PARTICLE INSPECTED.	41004591 41003902 34000373
		THE SHAFT IS PENETRANT INSPECTED PER DRAWING REQUIREMENTS.	41004606
		TUFFTRIDE SURFACE HARDENING OF THE PUSHROD BALL END IS VERIFIED PER DRAWING REQUIREMENTS.	34000373
		SHOT PEENING OF THE CRANK IS VERIFIED PER DRAWING REQUIREMENTS.	41004591
	LUBRICATION	DICRONITE COATING OF THE CRANK PIN AND MONOBALL ARE VERIFIED.	41003902 84000378
	ASSEMBLY INTEGRITY	ACCEPTANCE TESTING OF ACTUATOR VERIFIES PART INTEGRITY.	RC1008
B	BEARING		84000369
	BEARING INTEGRITY	BEARINGS ARE VERIFIED PER MIL STANDARDS AND DRAWING REQUIREMENTS INCLUDING RADIAL ECCENTRICITY.	84000369
C	HOUSING FORGING		34000219
	PISTON		34000309
	HOUSING - FORMED		34000657
	HOUSING ASSEMBLY		34000694
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	34000219 34000309 34000657
		GAS CARBURIZING OF THE PISTON IS INSPECTED PER DRAWING.	34000309

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
C	MATERIAL INTEGRITY	THE PISTON IS MAGNETIC PARTICLE INSPECTED.	34000309
		THE HOUSING FORGING IS ULTRASONICALLY INSPECTED.	34000219
		THE HOUSING HEAT TREAT AFTER ROUGH MACHINING IS VERIFIED PER DRAWING REQUIREMENTS.	34000657
		THE HOUSING IS ETCHED AND PENETRANT INSPECTED AFTER HEAT TREATING.	34000657
		THE HOUSING CYLINDER BORE HARD ANODIZE IS VERIFIED.	RC1008
		PISTON AND BORE SURFACE FINISHES ARE INSPECTED PER DRAWING REQUIREMENTS.	34000309 34000694
	ASSEMBLY CLEANLINESS	THE HOUSING ASSEMBLY CLEANLINESS IS VERIFIED.	RC1008, RL10012
		THE ASSEMBLY IN CONTAMINATION CONTROLLED AREA IS VERIFIED.	RC1008, RL10012
		HYDRAULIC FILTER IS INSPECTED FOR MICRON RATING AND CLEANLINESS.	RC1008
	FUNCTIONAL INTEGRITY	FUNCTIONAL ACCEPTANCE TESTING VERIFIES PROPER PISTON OPERATION.	RC1008
D	NOZZLE ORIFICE/FILTER ASSEMBLY FILTER SERVOVALVE		28003074 28006493 28003065 84000168
	COMPONENT AND FLUID CLEANLINESS	FACILITY TEST FLUIDS ARE INSPECTED FOR PARTICULATES PRIOR TO AND AFTER ACTUATOR FUNCTIONAL TESTING.	RC1008
		THE ACTUATOR AND SERVOVALVE COMPONENTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RC1008, RL10012
		CONTAMINATION CONTROL OF THE ACTUATOR AND SERVOVALVE ASSEMBLY AREA IS VERIFIED.	RC1008, RL10012
	FILTER INTEGRITY	THE SERVOVALVE FILTER IS VERIFIED TO MEET THE PARTICULATE FILTRATION REQUIREMENTS PER DRAWING.	28003065
		SERVOVALVE NOZZLE IS EXAMINED FOR BURRS, RADIAL SCRATCHES, AND NICKS.	28003074
	FUNCTIONAL INTEGRITY	SERVOVALVE AND ACTUATOR FUNCTIONAL TESTING VERIFIES NOZZLE AND ORIFICE ARE NOT RESTRICTED.	RC1008 84000168
E	SERVOVALVE SEAL		84000168 82005510-005
	SEAL INTEGRITY	THE FILTER O-RINGS ARE LOT SAMPLE INSPECTED PER MIL-STD-105 FOR VISUAL SURFACE QUALITY, PHYSICAL QUALITY, FLUID COMPATIBILITY, STRETCH, AND COMPRESSION.	29000020, HRQP 5.150
	ASSEMBLY INTEGRITY	THE FILTER O-RING INSTALLATION AND SEALING IS VERIFIED BY NULL SHIFT TESTING OF THE SERVOVALVE.	RC1008
F	COIL COIL SERVOVALVE		28006768 28006769

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
F	ELECTRICAL INTEGRITY	THE COIL WINDING IS INSPECTED TO ASSURE COIL WIRE ENDS DO NOT CROSS EACH OTHER OR THE OPPOSITE END LEADWIRE.	28006768 28006769
		SOLDERING OF ELECTRICAL CONNECTIONS IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RC1008, RL10009
		ELECTRIC COIL INSULATION, WIRE RESISTANCE, AND DIELECTRIC STRENGTH ARE TESTED.	RC1008
		COIL LEADWIRE TERMINATION ENCAPSULATION IS INSPECTED.	RC1008 RL10008
		VIBRATION, THERMAL, AND INDUCTION KICK TESTS ARE PERFORMED TO DETECT INCIPIENT SHORTS.	RC1008
		ELECTRICAL RESPONSE TESTING VERIFIES ELECTRICAL INTEGRITY.	RC1008
	CLEANLINESS	COMPONENTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RC1008, RL10012
		TORQUE MOTOR AREA IS VERIFIED TO BE CLEAN PRIOR TO CLOSEOUT OF THE CAVITY.	84000168
G	FEEDBACK WIRE BALL ASSEMBLY		28003057
	ARMATURE ASSEMBLY		
	FLAPPER		28003049
	TORQUE TUBE		28003053
	FEEDBACK WIRE		28003056
	ARMATURE-CAP ASSEMBLY		28003058
	ARMATURE-CAP/TUBE		28003050
	SPACER ASSEMBLY		28003037
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	28003053 28003056 28003058
		HEAT TREAT OF FLAPPER, TORQUE TUBE, AND FEEDBACK WIRE IS VERIFIED PER DRAWING REQUIREMENTS.	28003053 28003056 28003058
		RESISTANCE WELDING OF THE FEEDBACK WIRE TO BALL IS VERIFIED PER DRAWING REQUIREMENTS.	28003057
		PULL TESTS OF THE FEEDBACK WIRE TO BALL RESISTANCE WELD VERIFY WELD INTEGRITY.	28003057
		SILVER SOLDER BRAZING OF THE FLAPPER AND THE FEEDBACK WIRE TO THE TORQUE TUBE IS VERIFIED PER DRAWING REQUIREMENTS.	28003049 28003037 28003050
		ARMATURE ASSEMBLY BRAZE JOINTS ARE LEAK CHECKED.	28003049
	FUNCTIONAL INTEGRITY	FUNCTIONAL TESTING OF ACTUATOR VERIFIES SERVOVALVE INTEGRITY.	RC1008
H	SPOOL		
	SLEEVE		28003759
	SERVOVALVE		28003076 84000168

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H	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	28003759 28003076
		HEAT TREAT OF SPOOL AND SLEEVE IS VERIFIED PER DRAWING REQUIREMENTS.	28003759 28003076
		THE SPOOL METERING EDGES ARE REQUIRED TO BE SHARP, WITH NO BURRS OR FEATHER EDGES.	28003759
		THE SLEEVE METERING SLOTS ARE REQUIRED TO BE FREE OF NICKS AND BURRS AT I.D. EDGE.	28003076
	SPOOL - SLEEVE FIT	PROPER CLEARANCE BETWEEN THE SERVOVALVE SPOOL AND SLEEVE IS VERIFIED.	84000168
	COMPONENT CLEANLINESS	ACTUATOR COMPONENTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RC1008
		ASSEMBLY AND TESTING IS VERIFIED TO BE PERFORMED IN A CONTAMINATION CONTROLLED AREA.	RC1008 RL10012
		SERVOVALVE FILTER IS VERIFIED TO MEET FILTRATION REQUIREMENTS, INCLUDING PARTICULATE FILTRATION AND CLEANLINESS.	28006493
	ASSEMBLY INTEGRITY	FUNCTIONAL TESTING, INCLUDING NULL SHIFT TESTING, VERIFIES SATISFACTORY SPOOL DIMENSIONS AND OPERATION.	RC1008
I	SERVOVALVE		84000168
	TORQUE MOTOR DAMPING	PROPER FILLING OF TORQUE MOTOR CAVITY WITH DAMPING FLUID IS VERIFIED.	84000168
		SSME COMPONENTS EXTERNAL INSPECTION VERIFIES THERE IS NO EVIDENCE OF FLUID LEAKAGE PRIOR TO EACH FLIGHT.	OMRSD V41BU0.030
ALL CAUSES	COMPONENT CLEANLINESS	ALL ACTUATOR DETAILS ARE VERIFIED TO BE CLEAN PRIOR TO INSTALLATION.	RC1008, RL10012
	FUNCTIONAL INTEGRITY	HOTFIRE TESTING AND SECOND E & M INSPECTIONS VERIFY SATISFACTORY OPERATION.	RL00050-04 RL00056-06 RL00056-07
		ACTUATOR OPERATION IS VERIFIED PRIOR TO EACH FLIGHT DURING HYDRAULIC SYSTEM CONDITIONING.	OMRSD S00FA0.211
		ACTUATOR OPERATION IS VERIFIED DURING FLIGHT READINESS CHECKOUT PRIOR TO EACH FLIGHT.	OMRSD V41AS0.030
		ACTUATOR OPERATION IS VERIFIED DURING THE ACTUATOR CHECKOUT MODULE PRIOR TO EACH FLIGHT.	OMRSD V41AS0.010
		ACTUATOR POSITION SHIFT BETWEEN PURGE SEQUENCE 3 AND PURGE SEQUENCE 4 IS VERIFIED AS PART OF LAUNCH COMMIT CRITERIA. (LAST TEST)	JSC 16007

Compone	ıup: Actuators	Prepared:	S. Heat
CIL Item:	E150-01	Approved:	T. Nguy.
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)
Reference: NASA letter SA21/88/308 and Rocketdyne letter 88RC09761.

Operational Use: FAILURE MODE CAN BE DETECTED IN REALTIME BY THE FLIGHT CONTROL TEAM WHO WILL EVALUATE EFFECTS UPON VEHICLE PERFORMANCE AND ABORT CAPABILITY. BASED ON THIS EVALUATION THE APPROPRIATE ABORT MODE OR SYSTEM CONFIGURATION WILL BE SELECTED. FAILURE DETECTION CUES AND ASSOCIATED SSME PERFORMANCE DATA HAVE BEEN COORDINATED BETWEEN THE ENGINEERING AND FLIGHT OPERATIONS ORGANIZATIONS WITH THE RESPONSES DOCUMENTED IN MISSION FLIGHT RULES.