

SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: Actuators
 CIL Item: E140-07
 Part Number: RES1008-6XXX
 Component: Oxidizer Preburner Oxidizer Valve Actuator
 FMEA Item: E140
 Failure Mode: Fails to switch to servovalve No. 2.

Prepared: S. Heater
 Approved: T. Nguyen
 Approval Date: 6/9/00
 Change #: 1
 Directive #: CCBD ME3-01-5624

Page: 1 of 1

Phase	Failure / Effect Description	Criticality Hazard Reference
M 4.1	<p>Error continues; failsafe servoswitch de-energized; all actuators go into hydraulic lockup. Mission abort may result when hydraulic lockup occurs during Max Q throttling.</p> <p>Redundancy Screens: ACTUATOR SYSTEM - CONTROLLER SYSTEM: UNLIKE REDUNDANCY</p> <p>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.</p>	1R ME-G4M
M 4.2	<p>Error continues, or when detected by controller self test the controller initiates pneumatic engine shutdown Oxidizer cannot be dumped through this engine. Mission abort.</p> <p>Redundancy Screens: ACTUATOR SYSTEM - CONTROLLER SYSTEM: UNLIKE REDUNDANCY</p> <p>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.</p>	1R ME-G4M

E - 235

SSM/ IEA/CIL
DESIGN

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Page: 1 of 3

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FAILURE CAUSE: A: Fail-operate servoswitch: 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 SERVO SWITCH AND ACTUATOR ASSEMBLY ARE 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 SERVO SWITCH (4) INCORPORATES A FILTER (5) TO PROTECT THE ORIFICES AND ALSO INCORPORATES 50-MICRON FILTERS IMMEDIATELY UPSTREAM OF THE NOZZLES FOR FILTERING THE FIRST STAGE FLUID SUPPLY. THE ORIFICE FILTER IS DESIGNED TO CONTAIN ALL PARTICLES WHOSE 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) 84000259; (5) 28003065

FAILURE CAUSE: B: Fail-operate servoswitch: 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 SERVO SWITCH IS ASSEMBLED IN A LAMINAR FLOW BENCH AREA TO PREVENT CONTAMINATION ENTRY (1). THE ELECTRICAL HARNESS WIRE AND THE SERVO SWITCH 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) 41003720

FAILURE CAUSE: C: Fail-operate servoswitch: 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) 84000259

FAILURE CAUSE: D: Fail-operate servoswitch: Broken flapper or torque tube.

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 PREVENTS LOW AND HIGH CYCLE FATIGUE FAILURE.

(1) 28003504; (2) 28003056; (3) RSS-8582

Component Group: Actuators
CIL Item: E140-07
Part Number: RES1008-6XXX
Component: Oxidizer Preburner Oxidizer Valve Actuator
FMEA Item: E140
Failure Mode: Falls to switch to servovalve No. 2.

Prepared: S. Heater
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Page: 2 of 3

Design / Document Reference

FAILURE CAUSE: E: Fail-operate servoswitch: Spool seizure.

THE SERVOSWITCH 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 SERVOSWITCH 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 SERVOSWITCH IS OPERATED PERIODICALLY DURING PROPELLANT CONDITIONING TO PREVENT SEIZURE CAUSED BY SILTING (7).

(1) 28003503; (2) 28003076; (3) RSS-8582; (4) RL10012; (5) RES1008-3003; (6) RC1008; (7) CP406R0002 PT 1 3.2.3:6.1.6

FAILURE CAUSE: F: Fail-operate servoswitch: 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

FAILURE CAUSE: G: Fail-operate servoswitch: Armature to stop Interference.

THE ARMATURE STOP (1) IS MADE OF BERYLLIUM COPPER ALLOY 172. THIS MATERIAL WAS SELECTED FOR ITS NON-MAGNETIC CHARACTERISTICS AND HIGH STRENGTH (2). THE ARMATURE ASSEMBLY (3) IS A BRAZED ASSEMBLY WHICH IS MADE UP OF THE FLAPPER AND STUD ASSEMBLY (4), ARMATURE TUBE, SPACER, AND CAP (5). THE STUD (6) IS THE CONTACTING SURFACE BETWEEN THE ARMATURE ASSEMBLY AND THE STOP. THE STUD IS MADE OF 17-4PH CRES. THE MATERIAL WAS SELECTED FOR ITS WEAR RESISTANCE, STRENGTH, AND CORROSION RESISTANCE (2). THE STUD IS HEAT TREATED AND TEMPERED FOR STRENGTH (6). THE ARMATURE STOP AND STUD ARE CHAMFERED REDUCING PARTICLE GENERATION OR GALLING DURING ASSEMBLY AND OPERATION. THE SERVOSWITCH TORQUE MOTOR IS FILLED WITH SILICONE DAMPING FLUID PROVIDING LUBRICATION AND ADDITIONAL CORROSION PROTECTION (7).

(1) 28003060; (2) RSS-8582; (3) 28003508; (4) 28003513; (5) 28003037; (6) 28003512; (7) 20101160

FAILURE CAUSE: H: Shuttle valve: Piston or spool seizure.

THE SHUTTLE VALVE PISTON (1) IS 440C CRES, THE SHUTTLE VALVE SPOOL (2), AND SLEEVE (3) ARE CRES 440C MICRO-MELT. THE SPOOL AND SLEEVE ARE HEAT TREATED AND COLD STABILIZED (2) (3). THE MATERIAL WAS SELECTED FOR ITS HARDNESS AND WEAR RESISTANCE (4). CRES 440C AND 440C CRES MICRO-MELT ARE CORROSION RESISTANT. THE PISTON AND SPOOL OPERATE IN HYDRAULIC FLUID WHICH PROVIDES ADDITIONAL CORROSION PROTECTION AND LUBRICATION. THE ACTUATOR DETAIL PARTS ARE CLEANED FOR HYDRAULIC SERVICE AND THE HYDRAULIC FLUID IS FILTERED THROUGH AN ENGINE MOUNTED 25-MICRON FILTER (5). THE ACTUATOR IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA. 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 SHARP EDGES OF THE SPOOL, THE L/D GREATER THAN 10, AND THE LAP FIT OF THE SPOOL AND SLEEVE REDUCE THE POSSIBILITY OF SEIZURE DUE TO CONTAMINANT PARTICLES (7). THE PISTON L/D GREATER THAN 1.5 AND THE CLOSE PISTON TO HOUSING CLEARANCE PREVENT SEIZURE CAUSED BY COCKING. THE PISTON IN A DEAD END CAVITY. BECAUSE THERE IS NO THROUGH FLUID CIRCULATION, THE EXPOSURE TO CONTAMINATION IS NOT ACCUMULATIVE AND THE POSSIBILITY OF SEIZING IS CAUSED BY CONTAMINATION IS MINIMIZED. THE SPOOL IS KEYED TO THE SLEEVE TO PREVENT INDEXING THEREFORE REDUCING THE GENERATION OF CONTAMINATION PARTICLES (2) (3) (8).

(1) 34000142; (2) 41009428; (3) 41009429; (4) RSS-8582; (5) RES1008-3003; (6) RC1008, RL10012; (7) 41009431; (8) 41009499

E - 237

Component: Actuators
CIL Item: E140-07
Part Number: RES1008-6XXX
Component: Oxidizer Preburner Oxidizer Valve Actuator
FMEA Item: E140
Failure Mode: Fails to switch to servovalve No. 2.

Prepared: S. Heat
Approved: T. Nguy.
Approval Date: 6/9/00
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Page: 3 of 3

Design / Document Reference

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 WAS 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 WAS DISASSEMBLED AND EXAMINED. THE ACTUATOR SHOWED NO DETRIMENTAL DEFECTS OR WEAR. THIS ACTUATOR HAD 28 STARTS AND 10,332 SECONDS HOT FIRE TIME, INCLUDING 6,651 SECONDS AT FPL (6). A FAILURE TO SWITCH TO SERVOVALVE NO. 2 IS DETECTED BY SEII OR CONTROLLER SELF TEST (7). IF THE ERROR CONTINUES, THE FAILSAFE SERVOSWITCH IS DE-ENERGIZED AND ALL ACTUATORS GO INTO HYDRAULIC LOCKUP (8). THE SYSTEM IS COMPRISED OF REDUNDANT ACTUATOR POSITION SENSOR ELECTRONICS, REDUNDANT HARNESSSES, AND REDUNDANT CONTROLLER CHANNELS.

(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 FMEA/CIL INSPECTION AND TEST

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Page: 1 of 4

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference	
A	NOZZLE		28003074	
	ORIFICE/FILTER ASSEMBLY		28006493	
	FILTER		28003065	
	SERVOSWITCH		84000259	
	COMPONENT AND FLUID CLEANLINESS	FACILITY TEST FLUIDS ARE INSPECTED FOR PARTICULATES PRIOR TO AND AFTER ACTUATOR FUNCTIONAL TESTING.		RC1008
		THE ACTUATOR AND SERVOSWITCH COMPONENTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.		RC1008, RL10012
		CONTAMINATION CONTROL OF THE ACTUATOR AND SERVOSWITCH ASSEMBLY AREAS IS VERIFIED.		RC1008, RL10012
	FILTER INTEGRITY	SERVOSWITCH FILTER IS VERIFIED TO MEET THE PARTICULATE FILTRATION REQUIREMENTS PER DRAWING.	28003065 28006493	
		SERVOSWITCH NOZZLE IS EXAMINED FOR BURRS, RADIAL SCRATCHES, AND NICKS.	28003074	
	FUNCTIONAL INTEGRITY	SERVOSWITCH AND ACTUATOR FUNCTIONAL TESTING VERIFIES NOZZLE AND ORIFICE ARE NOT RESTRICTED.	RC1008 84000259	
B	COIL		28006769	
	COIL		28006768	
	SERVOSWITCH		84000259	
	ELECTRICAL INTEGRITY	THE COIL WINDING IS INSPECTED TO ASSURE COIL WIRE ENDS DO NOT CROSS EACH OTHER OR THE OPPOSITE END LEADWIRE.	28006769 28006768	
		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		
	THE TORQUE MOTOR AREA IS VERIFIED TO BE CLEAN PRIOR TO CLOSEOUT OF THE CAVITY.	84000259		
C	SERVOSWITCH SEAL		84000259 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	FILTER O-RING INSTALLATION AND SEALING ARE VERIFIED BY SERVOSWITCH "PULL IN" AND "DROPOUT" TESTS.	RC1008 84000259	

E - 239

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Page: 2 of 4

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D	FLAPPER		28003504
	TORQUE TUBE		28003056
	ARMATURE ASSEMBLY		28003508
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	28003504
		HEAT TREAT OF THE FLAPPER AND TORQUE TUBE IS VERIFIED PER DRAWING REQUIREMENTS.	28003056
	BRAZE INTEGRITY	BRAZING OF THE FLAPPER AND TORQUE TUBE IS INSPECTED PER DRAWING REQUIREMENTS.	28003508
		BRAZE INTEGRITY IS VERIFIED BY LEAK TEST PER DRAWING REQUIREMENTS.	28003508
ASSEMBLY TESTING	FLAPPER AND TORQUE TUBE INTEGRITY IS VERIFIED BY SERVOSWITCH AND ACTUATOR ACCEPTANCE TESTING.	RC1008	
E	SPOOL		28003503
	SLEEVE		28003076
	SERVOSWITCH		84000259
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	28003503
		HEAT TREAT OF SPOOL AND SLEEVE IS VERIFIED PER DRAWING REQUIREMENTS.	28003076
			28003503
	SURFACE FINISH	INSPECTION VERIFIES THAT METERING EDGES ARE SHARP, WITH NO BURRS, NICKS, OR FEATHER EDGES PER DRAWING REQUIREMENTS.	28003076
	SPOOL - SLEEVE FIT	PROPER CLEARANCE BETWEEN THE SERVOSWITCH SPOOL AND SLEEVE IS VERIFIED.	84000259
	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.	RL10012
	SERVOSWITCH FILTER IS VERIFIED TO MEET FILTRATION REQUIREMENTS INCLUDING PARTICULATE FILTRATION, PRESSURE DIFFERENTIAL, AND CLEANLINESS.	RC1008	
FUNCTIONAL INTEGRITY	FUNCTIONAL TESTING VERIFIES SATISFACTORY SPOOL OPERATION.	RL10012	
		28003065	
F	SERVOSWITCH		RC1008
	TORQUE MOTOR DAMPING	PROPER FILLING OF TORQUE MOTOR CAVITY WITH DAMPING FLUID IS VERIFIED.	84000259
		SSME COMPONENTS EXTERNAL INSPECTION VERIFIES THERE IS NO EVIDENCE OF FLUID LEAKAGE PRIOR TO EACH FLIGHT.	84000259
		OMRSD V41BU.030	
G	STUD		28003512
	ARMATURE STOP		28003060
	SERVOSWITCH		20101160

E - 240

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Page: 3 of 4

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference		
G	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	28003512 28003060		
		HEAT TREAT OF THE STUD IS VERIFIED PER DRAWING REQUIREMENTS.	28003512		
	SURFACE FINISH	THE STUD AND ARMATURE STOP ARE VERIFIED TO HAVE PROPER FINISH AND EDGE GEOMETRY, WITH NO BURRS, NICKS, OR SCRATCHES.	28003512 28003060		
		THE ARMATURE STOP IS INSPECTED WITH 20X MAGNIFICATION TO VERIFY ABSENCE OF BURRS.	28003060		
	COMPOUND CLEANLINESS	THE ACTUATOR PARTS ARE VERIFIED CLEANED PRIOR TO ASSEMBLY.	RC1008		
	FUNCTIONAL INTEGRITY	SERVOSWITCH RESPONSE TEST VERIFIES CORRECT TORQUE MOTOR STOP INSTALLATION PER ASSEMBLY TEST AND INSPECTION RECORD.	20101160		
	H	SHUTTLE VALVE SPOOL/SLEEVE ASSY. SPOOL SLEEVE PISTON		41009431 41009428 41009429 34000142	
			MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	41009428 41009429 34000142
				THE PISTON, SLEEVE, AND SPOOL HEAT TREAT HARDNESS IS VERIFIED PER DRAWING REQUIREMENTS.	41009428 41009429 34000142
				PISTON, SLEEVE, AND SPOOL COLD STABILIZATION IS VERIFIED PER DRAWING REQUIREMENTS.	41009428 41009429 34000142
THE PISTON, SLEEVE, AND SPOOL ARE MAGNETIC PARTICLE INSPECTED PER DRAWING REQUIREMENTS.				41009428 41009429 34000142	
THE PISTON SURFACE FINISH IS VERIFIED TO DRAWING REQUIREMENTS.		34000142			
COMPONENT CLEANLINESS		THE SPOOL AND SLEEVE ARE VERIFIED BY BORESCOPE TO HAVE PROPER FINISHES AND EDGE GEOMETRY, WITH NO DETRIMENTAL BURRS OR SURFACE DEFECTS.	41009431 41009428 41009429		
		THE SPOOL TO SLEEVE LAP FIT CLEARANCE IS VERIFIED.	41009431		
		THE SPOOL/SLEEVE ASSEMBLY IS INSPECTED TO ASSURE 100% CLEANUP ON THE SLEEVE DIAMETER.	41009431		
		THE SPOOL AND SLEEVE ARE VERIFIED TO BE MAINTAINED AS A MATCHED SET.	41009431		
		THE ACTUATOR PARTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RC1008		
		ACTUATOR ASSEMBLY IS VERIFIED TO BE IN A CONTAMINATION CONTROLLED AREA.	RC1008		
		HYDRAULIC OIL SAMPLING PRIOR TO AND AFTER FUNCTIONAL TESTING, AND RETURN CAVITY FLUSHING AFTER TESTING VERIFY ACTUATOR CLEANLINESS	RC1008		

E - 241

Compose up: Actuators
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Page: 4 of 4

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H	FUNCTIONAL INTEGRITY	FUNCTIONAL TESTING OF VALVE ASSURES PROPER SPOOL AND PISTON OPERATION.	RC1008
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 THE ACTUATOR CHECKOUT MODULE PRIOR TO EACH FLIGHT.	OMRSD V41AS0.010
		ACTUATOR OPERATION IS VERIFIED DURING FLIGHT READINESS CHECKOUT PRIOR TO EACH FLIGHT. (LAST TEST)	OMRSD V41AS0.030

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.