

SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: Actuators
 CIL Item: E110-12
 Part Number: RES1008-8XXX
 Component: Main Fuel Valve Actuator
 FMEA Item: E110
 Failure Mode: Structural failure.

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
P 4.1	Major pneumatic leak into aft compartment; loss of MFVA/MFV closing control pressure. Fuel leakage results in fire, open air detonation, and overpressure condition. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A.	1 ME-A1P, ME-A2P, ME-B4S, ME-B6S
C 4.1	If in pneumatic shutdown, major pneumatic leak preventing proper pneumatic shutdown sequence. Overpressurization aft compartment. Loss of vehicle. Redundancy Screens: PNEUMATIC SYSTEM - ACTUATOR SYSTEM: UNLIKE REDUNDANCY A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Fail - Loss of a redundant hardware items is not detectable during flight. C: Fail - Loss of redundant hardware items could result from a single credible event.	1R ME-A1A, ME-G10C,D

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DESIGN

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Design / Document Reference

FAILURE CAUSE: A: Structural failure of housing or end caps.

THE ACTUATOR HOUSING IS MACHINED FROM A FORGED 7175 ALUMINUM BILLET, HEAT TREATED TO CONDITION T736 (1). THIS ALLOY WAS SELECTED FOR ITS TENSILE STRENGTH AND FATIGUE STRENGTH. THE EXTERIOR OF THE HOUSING IS SHOT-PEENED TO ENHANCE THE STRESS CORROSION RESISTANCE (1) (2). THE HOUSING IS ANODIZED FOR CORROSION PROTECTION AND THE CYLINDER BORES ARE HARD ANODIZED FOR WEAR RESISTANCE (3). STANDARD LEE PLUGS ARE USED TO CLOSE OFF DRILLED PASSAGE ACCESS HOLES WHERE SECONDARY RETENTION IS AVAILABLE (SUCH AS BOLTING ANOTHER PART OVER THE PLUG). OTHERWISE A "PIN PLUG" IS USED WHICH IS A LEE PLUG WITH THREADS ON THE IN-HOLE END FOR SECONDARY RETENTION (1). LEE PLUGS AND PIN PLUGS ARE ALUMINUM TO PREVENT GALVANIC CORROSION. THE BYPASS VALVE END CAP (4) IS MADE FROM 7075-T73 ALUMINUM ALLOY. THE MATERIAL IS ANODIZED FOR GENERAL CORROSION PROTECTION. 7075-T73 ALLOY IS USED FOR ITS STRENGTH AND RESISTANCE TO STRESS CORROSION CRACKING (2). THE MATERIAL IS COMPATIBLE WITH ITS OPERATING ENVIRONMENT AND HAS THERMAL PROPERTIES SIMILAR TO THE ACTUATOR HOUSING. THE PNEUMATIC CAP (5) IS MADE FROM 2024-T6 ALUMINUM ALLOY. THE MATERIAL WAS SELECTED FOR ITS STRENGTH, STRESS CORROSION RESISTANCE, AND SIMILARITY TO THE HOUSINGS THERMAL CHARACTERISTICS (2). THE CAP ANODIZING PROVIDES CORROSION PROTECTION. THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE ACTUATOR MEET CEI REQUIREMENTS (6). THE MINIMUM FACTORS OF SAFETY FOR THE ACTUATOR MEET CEI REQUIREMENTS (7). THE ACTUATOR WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (8). THE ACTUATOR HAS COMPLETED DESIGN VERIFICATION TESTING (9). DVS TEST RESULTS ARE DOCUMENTED (10). THE MFVA FROM ENGINE 2010 WAS DISASSEMBLED AND EXAMINED. THE ACTUATOR SHOWED NO DETRIMENTAL DEFECTS OR WEAR. THIS ACTUATOR HAD 10,332 SECONDS OF HOT FIRE TIME WITH 28 STARTS, INCLUDING 6,651 SECONDS AT FPL (11).

(1) 34000658; (2) RSS-8576; (3) 34000695; (4) 34000149; (5) 41004165; (6) RL00532, CP320R0003B; (7) RSS-8546, CP320R0003B; (8) NASA TASK 117; (9) DVS-SSME-512; (10) RSS-512; (11) SSME-82-2316

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INSPECTION AND TEST

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	HOUSING FORGING		34000228
	HOUSING, ACTUATOR		34000658
	HOUSING ASSY.		34000695
	END CAP, BYPASS VALVE		34000149
	CAP, PNEUMATIC		41004165
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	34000658
			34000149
			41004165
		HOUSING FORGING IS ULTRASONIC INSPECTED PER DRAWING REQUIREMENTS.	34000228
	HEAT TREAT	HEAT TREAT OF HOUSING IS VERIFIED TO MEET DRAWING REQUIREMENTS.	34000658
		SHOT PEENING OF HOUSING EXTERIOR IS VERIFIED TO DRAWING REQUIREMENTS.	34000658
		HOUSING AND END CAPS ARE PENETRANT INSPECTED AFTER MACHINING.	34000658
			34000149
			41004165
	ANODIZE OF HOUSING AND END CAPS IS VERIFIED PER DRAWING REQUIREMENTS.	34000695	
		34000149	
		41004165	
	PROOF PRESSURE TESTING VERIFIES THE STRUCTURAL INTEGRITY OF THE HOUSING AND END CAPS.	RC1008	
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: Not Applicable.

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