

SSME IEA/CIL
REDUNDANCY SCREEN

Component Group: Actuators
 CIL Item: E130-10
 Part Number: RES1008-6XXX
 Component: Fuel Preburner Oxidizer Valve Actuator
 FMEA Item: E130
 Failure Mode: Structural failure.

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
SMC 4.1	Major hydraulic fluid leak into aft compartment; loss of hydraulic pressure; loss of FPOVA/FPOV control; actuator fails to move, the MOVA/MOV, MFVA/MFV and CCVA/CCV also remain open; engine fails to shutdown until vehicle pre valve closure, propellant depletion shutdown. Loss of vehicle.	1 ME-E1P,S,M,A,C,D
Redundancy Screens: SINGLE POINT FAILURE: N/A.		

SSME FMEA/CIL
DESIGN

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Page: 1 of 1

Design / Document Reference

FAILURE CAUSE: A: Structural failure of housings, cover, 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) AND FATIGUE STRENGTH (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 (3). LEE PLUGS AND PIN PLUGS ARE ALUMINUM TO PREVENT GALVANIC CORROSION. EACH NEW ACTUATOR ASSEMBLY IS SUBJECTED TO A PROOF PRESSURE TEST (4). THE HOUSING COVER PLATE (5) MATERIAL MAY BE EITHER 2024-T651 OR 2024-T6511, ANODIZED TO PREVENT CORROSION (5). THE MATERIAL IS USED FOR ITS STRENGTH AND SIMILARITY IN THERMAL PROPERTIES TO THE HOUSING (2). TWO CYLINDER END CAPS ARE REQUIRED (6). THE HYDRAULIC AND PNEUMATIC CYLINDER END CAPS ARE MACHINED FROM 2024-T6 ALUMINUM ALLOY (7)(8). THE MATERIAL WAS SELECTED FOR ITS STRENGTH, STRESS CORROSION RESISTANCE, AND SIMILARITY TO THE HOUSING THERMAL CHARACTERISTICS (2). THE CAPS ARE ANODIZED FOR CORROSION PROTECTION. THE PNEUMATIC CYLINDER (18) IS MADE FROM 6061-T651 ALUMINUM ALLOY. THE CYLINDER IS SHOT PEENED TO ENHANCE STRESS CORROSION RESISTANCE AND FATIGUE STRENGTH. THE CYLINDER IS ANODIZED FOR ADDITIONAL CORROSION PROTECTION. THE MATERIAL WAS SELECTED FOR ITS STRENGTH, CORROSION RESISTANCE, AND RESISTANCE TO STRESS CORROSION CRACKING (2). THE SHUTTLE VALVE END CAP (9) 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 HYDRAULIC FLUID AND HAS THERMAL PROPERTIES SIMILAR TO THE ACTUATOR HOUSING. THE SERVOVALVE AND SERVOSWITCH HOUSING (10) AND END PLATES (11) ARE MADE FROM 17-4 PH CRES COND H1025. THE MATERIAL IS USED FOR ITS STRENGTH, CORROSION RESISTANCE, AND RESISTANCE TO STRESS CORROSION CRACKING (2). THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE ACTUATOR MEET CEI REQUIREMENTS (12). THE MINIMUM FACTORS OF SAFETY FOR THE ACTUATOR MEET CEI REQUIREMENTS (13). THE ACTUATOR WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (14). THE ACTUATOR HAS COMPLETED DESIGN VERIFICATION TESTING (15). DVS TEST RESULTS ARE DOCUMENTED (16). AN OPOVA (WHICH IS ESSENTIALLY THE SAME AS THE FPOVA) 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 (17).

(1) 34000657; (2) RSS-8582; (3) 34000694; (4) RC1008; (5) 34000306; (6) 41003720; (7) 34000312; (8) 34001925; (9) 34000149; (10) 28003079; (11) 28003183, 28003062; (12) RL00532, CP320R0003B; (13) RSS-8546, CP320R0003B; (14) NASA TASK 117; (15) DVS-SSME-512; (16) RSS-512; (17) SSME-82-2316; (18) 34001927

E-176

SSME FI /CIL
INSPECTION AND TEST

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Page: 1 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference	
A	SV & SSW END PLATE		28003183	
	SV & SSW END PLATE		28003062	
	HOUSING, SV & SSW		28003080	
	HOUSING, ACTUATOR		34000657	
	HOUSING, ASSY.		34000694	
	HOUSING COVER		34000306	
	CAP, HYDRAULIC		34000312	
	PNEUMATIC CYLINDER		34001927	
	END CAP, SHUTTLE VALVE		34000149	
	HOUSING FORGING		34000219	
	CAP, PNEUMATIC		34001925	
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.		28003183
				28003062
				28003080
				34000657
			34000306	
			34000312	
			34001927	
			34000149	
			34001925	
		HOUSING FORGING IS ULTRASONIC INSPECTED PER DRAWING REQUIREMENTS.	34000219	
HEAT TREAT	HEAT TREAT OF HOUSINGS, COVER, AND END PLATES IS VERIFIED TO MEET DRAWING REQUIREMENTS.		28003183	
			28003062	
			28003080	
			34000657	
			34000306	
			34000312	
			34001925	
			34001927	
		ANODIZE IS VERIFIED PER DRAWING REQUIREMENTS.	34000694	
			34000306	
			34000312	
			34001927	
			34000149	
			34001925	
		SERVOVALVE AND SERVOSWITCH HOUSING AND END PLATES PASSIVATION IS INSPECTED PER DRAWING REQUIREMENTS.	28003080	
			28003062	
			28003183	
		SHOT PEENING OF HOUSING AND PNEUMATIC CYLINDER EXTERIOR IS VERIFIED PER DRAWING REQUIREMENTS.	34000657	
			34001927	

E - 177

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Page: 2 of 2

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A	HEAT TREAT	THE HOUSING AND THE SHUTTLE VALVE END CAP ARE PENETRANT INSPECTED AFTER MACHINING.	34000149 34000694
		THE SERVOVALVE/SERVOSWITCH HOUSING IS MAGNETIC PARTICLE AND X-RAY INSPECTED PER DRAWING REQUIREMENTS.	28003080
	PROOF TEST FUNCTIONAL INTEGRITY	PROOF PRESSURE TESTING VERIFIES INTEGRITY OF HOUSING, COVER, AND END CAPS.	RC1008
		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	

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.

E-178