

**SSMF EA/CIL
REDUNDANCY SCREEN**

Component Group: Actuators
 CIL Item: E140-10
 Part Number: RES1008-6XXX
 Component: Oxidizer Preburner Oxidizer Valve Actuator
 FMEA Item: E140
 Failure Mode: Structural failure.

Prepared: S. Heater
 Approved: T. Nguyen
 Approval Date: 6/9/00
 Change #: 1
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Phase	Failure / Effect Description	Criticality
		Hazard Reference
SMC 4.1	Major hydraulic fluid leak into aft compartment; loss of hydraulic pressure; loss of OPOVA/OPOV control; actuator fails to move, the other propellant valves also remain open; engine fails to shutdown until vehicle pre valve closure, propellant depletion shutdown. Loss of vehicle.	1 ME-E1P,S,A,M,C,D
	Redundancy Screens: SINGLE POINT FAILURE: N/A	

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SSME FMEA/CIL
DESIGN

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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 17-4PH 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). 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 (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

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SSME FI /CIL
INSPECTION AND TEST

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

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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	PROOF PRESSURE TESTING VERIFIES INTEGRITY OF HOUSING, COVER, AND END CAPS.	RC1008
		FUNCTIONAL INTEGRITY	HOTFIRE TESTING AND SECOND E & M INSPECTIONS VERIFY SATISFACTORY OPERATION.
		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.

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