SSME EA/CIL
REDUNDANCY SCREEN

Component Group:	Actuators
CIL Item:	E140-11
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
Directive #:	CCBD ME3-01-5624
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Phase	Failure / Effect Description	Criticality Hazard Reference
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-B4A,C, ME-C1A,C, ME-D1A,C, ME-G10C,D

SSME FMEA/CIL
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 IS MADE FROM 7075-T73 ALUMINUM ALLOY (4). 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) AND SEQUENCE VALVE CAP (6) ARE MADE FROM 2024-T6 ALUMINUM ALLOY. THE MATERIAL WAS SELECTED FOR ITS STRENGTH, STRESS CORROSION RESISTANCE, AND SIMILARITY TO THE HOUSING'S THERMAL CHARACTERISTICS (2). THE CAP ANODIZING PROVIDES CORROSION PROTECTION. THE PNEUMATIC CYLINDER (7) IS MADE FROM 6061-T651 ALUMINUM. 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 HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE ACTUATOR MEET CEI REQUIREMENTS (8). THE MINIMUM FACTORS OF SAFETY FOR THE ACTUATOR MEET CEI REQUIREMENTS (9). THE ACTUATOR WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (10). THE ACTUATOR HAS COMPLETED DESIGN VERIFICATION TESTING (11). DVS TEST RESULTS ARE DOCUMENTED (12). 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 (13).

(1) 34000657; (2) RSS-8582; (3) 34000694; (4) 34000149; (5) 34001925; (6) 34000319; (7) 34001927; (8) RL00532, CP320R0003B; (9) RSS-8546, CP320R0003B; (10) NASA TASK 117; (11) DVS-SSME-512; (12) RSS-512; (13) SSME-82-2316

SSME FI /CIL
INSPECTION AND TEST

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	HOUSING FORGING PVA HOUSING ASSY. PVA HOUSING FORMED END CAP, BYPASS VALVE CAP, PNEUMATIC CYLINDER, PNEUMATIC END CAP, SEQUENCE VALVE		34000219 34000694 34000657 34000149 34001925 34001927 34000319
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	34000219 34000694 34000657 34000149 34001925 34001927 34000319
		THE HOUSING FORGING IS ULTRASONIC INSPECTED PER DRAWING REQUIREMENTS.	34000219
	HEAT TREAT	HEAT TREAT OF HOUSING IS VERIFIED TO MEET DRAWING REQUIREMENTS.	34000657
		SHOT PEENED HOUSING AND PNEUMATIC CYLINDER EXTERIORS ARE VERIFIED TO MEET DRAWING REQUIREMENTS.	34000657 34001927
		THE HOUSING AND END CAPS ARE PENETRANT INSPECTED AFTER MACHINING.	34000149 34001925 34000319 34000657 34000694 34001927
		ANODIZE OF HOUSING, PNEUMATIC CYLINDER, AND END CAPS IS VERIFIED PER DRAWING REQUIREMENTS.	34000149 34001925 34000319 34000657 34000694 34001927
		PROOF PRESSURE TESTING VERIFIES THE STRUCTURAL INTEGRITY OF THE END CAPS AND HOUSING.	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

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FUNCTIONAL INTEGRITY	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.