SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group:	**Actuators**	**Prepared:**	**S. Heater**
CIL Item:	**E150-11**	**Approved:**	**T. Nguyen**
Part Number:	**RES1008-7XXX**	**Approval Date:**	**6/9/00**
Component:	**Chamber Coolant Valve Actuator**	**Change #:**	**1**
FMEA Item:	**E150**	**Directive #:**	**CCBD ME3-01-5624**
Failure Mode:	**Structural failure.**	**Page:**	**1 of 1**

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.	1R ME-G10C,D
	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.	

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 CAP IS SHOT PEENED TO ENHANCE STRESS CORROSION RESISTANCE AND FATIGUE STRENGTH. 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 (7). THE MINIMUM FACTORS OF SAFETY FOR THE ACTUATOR MEET CEI REQUIREMENTS (8). THE ACTUATOR WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (9). THE ACTUATOR HAS COMPLETED DESIGN VERIFICATION TESTING (10). DVS TEST RESULTS ARE DOCUMENTED (11). THE OPOVA FROM ENGINE 2010 (WHICH IS ESSENTIALLY THE SAME AS THE CCVA) WAS DISASSEMBLED AND EXAMINED. THE ACTUATOR SHOWED NO DETRIMENTAL WEAR OR DEFECTS AFTER 28 STARTS AND 10,332 SECONDS HOT FIRE TIME, INCLUDING 6,651 SECONDS AT FPL (12).

(1) 34000657; (2) RSS-8582; (3) 34000694; (4) 34000149; (5) 34000344; (6) 34000319; (7) RL00532, CP320R0003B; (8) RSS-8546, CP320R0003B; (9) NASA TASK 117; (10) DVS-SSME-512; (11) RSS-512; (12) SSME-82-2316

SSME FMEA/CIL
INSPECTION AND TEST

Component Group: Actuators
CIL Item: E150-11
Part Number: RES1008-7XXX
Component: Chamber Coolant Valve Actuator
FMEA Item: E150
Failure Mode: Structural failure.

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

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	HOUSING FORGING HOUSING ASSY. HOUSING, FORMED END CAP, BYPASS VALVE CAP, PNEUMATIC END CAP, SEQUENCE VALVE		34000219 34000694 34000657 34000149 34000344 34000319
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	34000219 34000694 34000657 34000149 34000344 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 PEENING OF HOUSING AND PNEUMATIC CAP EXTERIOR IS VERIFIED TO DRAWING REQUIREMENTS.	34000657 34000344
		THE HOUSING AND END CAPS ARE PENETRANT INSPECTED AFTER MACHINING.	34000149 34000344 34000319 34000657 34000694
		ANODIZE OF HOUSING AND END CAPS IS VERIFIED PER DRAWING REQUIREMENTS.	34000149 34000344 34000319 34000657 34000694
		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
		ACTUATOR OPERATION IS VERIFIED DURING FLIGHT READINESS CHECKOUT PRIOR TO EACH FLIGHT. (LAST TEST)	OMRSD V41AS0.030

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