SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group:	Actuators	Prepared:	S. Heater
CIL Item:	E130-13	Approved:	T. Nguyen
Part Number:	RES1008-6XXX	Approval Date:	6/9/00
Component:	Fuel Preburner Oxidizer Valve Actuator	Change #:	1
FMEA Item:	E130	Directive #:	CCBD ME3-01-5624
Failure Mode:	Sequence valve fails to pass pneumatic pressure to downstream components.	Page:	1 of 1

Phase	Failure / Effect Description	Criticality Hazard Reference
C 4.2	MFVA/MFV and CCVA/CCV fail to close; fuel flow continues until vehicle prevalve closure; overspeed of HPFTP. Open air detonation and overpressure condition when pneumatic shutdown occurs on launch pad. 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-A1P, ME-A1A

SSME FMEA/CIL Design

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Design / Document Reference

FAILURE CAUSE: **A: Seizure of sequence valve piston.**

THE SEQUENCE VALVE PISTON (1) IS MADE FROM CUSTOM 455 CRES MATERIAL. THE MATERIAL IS HEAT TREATED AND AGED. CUSTOM 455 CRES IS USED FOR ITS STRENGTH, HARDNESS, AND STIFFNESS (2). THE PISTON SLEEVE (3) MATERIAL IS 2024-T6 ALUMINUM. 2024-T6 ALUMINUM IS USED FOR ITS STRENGTH AND SIMILARITY OF THERMAL PROPERTIES TO THE 7175 ALUMINUM HOUSING (2). THE SLEEVE IS ANODIZED FOR GENERAL CORROSION RESISTANCE (2). DIFFERENTIAL HARDNESS, 2.5 L/D, AND SMALL CLEARANCES BETWEEN THE PISTON AND SLEEVE AND CORNER CHAMFER MINIMIZE SEIZURE POTENTIAL. SEQUENCE VALVE PARTS ARE CLEANED BEFORE ASSEMBLY. THE ACTUATOR AND SEQUENCE VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA. CLEANLINESS OF THE HYDRAULICS AND PNEUMATICS TO THE VALVE ARE CONTROLLED TO PREVENT CONTAMINATION DAMAGE (2).

(1) 34000316; (2) RSS-8582; (3) 34000319

FAILURE CAUSE: **B: Blockage of pneumatic passages.**

THE ACTUATOR DETAILS ARE CLEANED PRIOR TO ASSEMBLY (1). THE ACTUATORS ARE ASSEMBLED IN A CONTAMINATION CONTROLLED AREA (2). THE PNEUMATIC BENCH SUPPLY IS FILTERED BY TWO FILTERS IN SERIES. THE FIRST IS A 3-MICRON FILTER. THE DOWNSTREAM IS A 0.3-MICRON FILTER. THE PNEUMATIC SUPPLY TO THE ACTUATOR DURING OPERATION IS FILTERED TO 15-MICRONS BY THE PCA FILTERS. THE CONNECTING LINES ARE CLEANED PRIOR TO INSTALLATION.

(1) RL10012; (2) RC1008

FAILURE CAUSE: **ALL CAUSES**

THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE ACTUATOR MEET CEI REQUIREMENTS (1). THE MINIMUM FACTORS OF SAFETY FOR THE ACTUATOR MEET CEI REQUIREMENTS (2). THE ACTUATOR WAS CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (3). THE ACTUATOR HAS COMPLETED DESIGN VERIFICATION TESTING (4). DVS TEST RESULTS ARE DOCUMENTED (5). 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 (6).

(1) RL00532, CP320R0003B; (2) RSS-8546, CP320R0003B; (3) NASA TASK 117; (4) DVS-SSME-512; (5) RSS-512; (6) SSME-82-2316

SSME FMEA/CIL
INSPECTION AND TEST

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	PISTON SLEEVE		34000318 34000319
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	34000318 34000319
		THE PISTON HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS.	34000318
		THE SLEEVE IS PENETRANT INSPECTED AFTER MACHINING.	34000319
		SLEEVE ANODIZE IS INSPECTED PER DRAWING REQUIREMENTS.	34000319
		THE PISTON & SLEEVE SURFACE FINISHES ARE VERIFIED PER DRAWING REQUIREMENTS.	34000318 34000319
		THE PISTON IS MAGNETIC PARTICLE INSPECTED PER DRAWING REQUIREMENTS.	34000318
	COMPONENT CLEANLINESS	COMPONENTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RC1008 RL10012
		COMPONENT ASSEMBLY IS VERIFIED TO BE IN A CONTAMINATION CONTROLLED AREA.	RC1008 RL10012
	FUNCTIONAL INTEGRITY	SEQUENCE VALVE AND ACTUATOR FUNCTIONAL TESTS, INCLUDING PNEUMATIC SHUTDOWN SLEW RATE TESTS, VERIFY SEQUENCE VALVE OPERATION.	RC1008
B	ACTUATOR		RES1008
	COMPONENT CLEANLINESS	THE ACTUATOR DETAILS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RC1008 RL10012
		ACTUATOR ASSEMBLY IS VERIFIED TO BE IN A CONTAMINATION CONTROLLED AREA.	RC1008 RL10012
	FUNCTIONAL TESTING	ASSEMBLY AND FUNCTIONAL TESTING VERFIES PROPER FLOW THROUGH PNEUMATIC PASSAGES.	RC1008
ALL CAUSES	COMPONENT CLEANLINESS	ALL ACTUATOR DETAILS ARE VERIFIED TO BE CLEAN PRIOR TO INSTALLATION.	RC1008, RL10012
	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

Compone·	·up:	Actuators	
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FMEA Item:		E130	
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Approved:	T. Nguy.
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
Failure History:	Comprehensive failure history data is maintained in the Rroblem Reporting database (PRAMS/PRACA) Reference: NASA letter SA21/88/308 and Rocketdyne letter 88RC09761.		
Operational Use:	Not Applicable.		

SSME FMEA/CIL
FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

Component Group: Actuators
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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. E130-01, E130-04, E130-07 SHUTTLE AND BYPASS VALVE OPERATIONS ARE VERIFIED PER SPECIFICATION REQUIREMENTS (RC1008).	SOME ACTUATORS ARE USING THE NON-ANTI-ROTATION SHUTTLE AND BYPASS VALVE DESIGN.	THE NON-ANTI-ROTATION SHUTTLE AND BYPASS VALVE DESIGN IS MORE SUSCEPTIBLE TO GALLING. THE NEW DESIGN ADDED THE ANTI-ROTATION FEATURE, PRESSURE BALANCE AND USES CRES 440C MICRO-MELT (VERSUS 440C) TO MANUFACTURE THE SPOOLS AND SLEEVES. THIS DESIGN MINIMIZES THE POSSIBILITY OF SHUTTLE OR BYPASS VALVE GALLING. USE AS IS RATIONALE: 1. RISK ASSESSMENT OF THE NON-ANTI-ROTATION SHUTTLE AND BYPASS VALVE INDICATE THAT THE LIKELIHOOD OF A CRITICALITY 1 FAILURE DUE TO A GALLED BYPASS VALVE (WORST CASE) IS EXTREMELY LOW AND THEREFORE THERE ARE NO CURRENT AND FUTURE USAGE LIMITATIONS.	P/N 34000137 -102 P/N 34000134 -009, -010