

**SSME / EA/CIL
REDUNDANCY SCREEN**

Component Group: Pneumatic Controls
 CIL Item: C200-12
 Component: Pneumatic Control Assembly
 Part Number: R0019450
 Failure Mode: Purge sequence valve fails to supply helium pressurant.

Prepared: P. Lowrimore
 Approved: T. Nguyen
 Approval Date: 6/2/99
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Phase	Failure / Effect Description	Criticality Hazard Reference
C 4.1	<p>Failure to supply HPV control pressurant prevents backdoor actuation of HPV for Pogo shutdown charge. Loss of Pogo shutdown charge during MECO, at zero G condition and minimum NPSP will result in cavitation/overspeed of HPOTP and/or LPOTP. Failure to supply preburner shutdown purge results in a temperature spike during the cutoff transient causing internal engine damage. Loss of vehicle.</p> <p>Redundancy Screens. HYDRAULIC SYSTEM - PNEUMATIC SYSTEM: UNLIKE REDUNDANCY</p> <p>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: Pass - Loss of redundant hardware items could not result from a single credible event</p>	1R ME-C1C

C-43

SSME FMEA/CIL
DESIGN

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Design / Document Reference

FAILURE CAUSE: A: Purge sequence PAV failure: Broken spring.

THE VALVE SPRING (1) IS MANUFACTURED FROM ELGILOY WIRE. STRENGTH AND ELASTIC LIMIT, TOGETHER WITH ELASTIC MODULUS, ARE THE PRIMARY REASONS FOR USING ELGILOY. THE MATERIAL IS CORROSION RESISTANT AND EXHIBITS RESISTANCE TO STRESS CORROSION CRACKING (2) FOR THIS APPLICATION. THE SPRING IS STRAIN RELIEVED AND INCORPORATES CLOSED AND DEBURRED ENDS REDUCING STRESS CONCENTRATIONS THAT MAY CAUSE BREAKAGE.

(1) R0019404; (2) MSFC-SPEC-522, RSS-8582-6

FAILURE CAUSE: B: Purge sequence PAV failure: Pushrod jammed.
C: Purge sequence PAV failure: Piston jammed.
D: Purge sequence PAV failure: Flow passage blocked.
E: Purge sequence PAV failure: Damaged guide (contamination jammed between guides, piston, and body).
F: Purge sequence PAV failure: Vent port poppet/seal leakage due to: Contamination.

DETAIL PARTS AND TEST FIXTURES ARE CLEANED (1) PRIOR TO ASSEMBLY (2). ASSEMBLY AND TEST ARE PERFORMED IN A CLEAN ROOM (3). LUBRICANTS ARE NOT ALLOWED FOR ASSEMBLY OR TEST (2). COMPONENT LEVEL TEST FLUIDS ARE NITROGEN AND HELIUM WHICH MEET THE HARDWARE CLEANLINESS REQUIREMENTS (1). THE COMPONENT PARTS AND SUBASSEMBLY ARE FREE OF VISIBLE FOREIGN PARTICLES AT THE TIME OF ASSEMBLY (2). AT THE ENGINE LEVEL, A 15-MICRON FILTER IN THE PNEUMATIC CONTROL ASSEMBLY (4) AND 15-MICRON FILTERS AT THE INLET AND OUTLET OF THE SOLENOID VALVE (5) ENSURE THAT CONTAMINANTS LARGER THAN 15-MICRONS WILL BE REMOVED. THESE DESIGN FEATURES PREVENT GENERATION OF METALLIC PARTICLES WHICH COULD JAM THE SOLENOID ASSEMBLY ARMATURE, PUSHROD, OR STEM ASSEMBLY, AND THE PAV PISTON OR SHAFT. THE PISTON-POPPET LD RATIO PREVENTS COCKING. THE PAV PISTON ASSEMBLY AND SHAFT ARE HELD IN ALIGNMENT AT EACH END (6). IN THE EVENT THAT METALLIC PARTICLES FROM ANOTHER SOURCE GET INTO THESE AREAS, THE PARTICLES BECOME IMBEDDED IN THE TEFLON SLEEVE. THIS PREVENTS GALLING AND JAMMING

(1) RL10001 (2) RL00278, RLJ0312 (3) RQ0711-600; (4) R0019450; (5) R0010725; (6) R0019401

FAILURE CAUSE: G: Purge sequence PAV failure: Vent port poppet/seal leakage due to: Damaged/defective sealing surface.

TUNGSTEN CARBIDE IS USED TO MANUFACTURE THE PURGE SEQUENCE PAV POPPET (1). TUNGSTEN CARBIDE WAS SELECTED FOR ITS RESISTANCE TO WEAR AND ITS VIRTUALLY POROSITY-FREE STRUCTURE. THE MATERIAL IS CORROSION RESISTANT AND, WHERE USED, IS NOT SUBJECT TO STRESS CORROSION CRACKING (2). THE SEAL (3) IS MANUFACTURED FROM 440C CRES BAR. HARDNESS AND WEAR RESISTANCE ARE THE PRIMARY REASONS FOR USING 440C CRES. THE MATERIAL ALSO EXHIBITS CORROSION RESISTANCE (2).

(1) R0019409 (2) MSFC-SPEC-522, RSS-8582-6 (3) R0019410

FAILURE CAUSE: ALL CAUSES

HIGH CYCLE AND LOW CYCLE FATIGUE LIFE, AS WELL AS THE MINIMUM FACTORS OF SAFETY FOR THE PCA (1), MEET CEI REQUIREMENTS (2). THE PCA WAS CLEARED FOR FRACTURE MECHANICS INDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (3). THE PNEUMATIC CONTROL ASSEMBLY HAS COMPLETED DESIGN VERIFICATION TESTING (4), INCLUDING PRESSURE TESTING (5), PRESSURE CYCLING (6), AND VIBRATION TESTING (7). THE PURGE SEQUENCE PAV DESIGN FEATURES AND MATERIALS WERE FURTHER VERIFIED BY TEARDOWN OF THE PCA FROM ENGINE 0107 AFTER 58 STARTS AND OVER 19,000 SECONDS (8). DISASSEMBLY SHOWED NO DEGRADATION OR WEAR OF THE DETAIL PARTS.

(1) R0019450; (2) RL00532, GP320R0003R, RSS-8548; (3) NASA TASK 117; (4) DVS-SSME-510; (5) RSS-510-48; (6) RSS-510-51; (7) RSS-510-50; (8) SSME-63-0230

**SSME FM CIL
INSPECTION AND TEST**

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	SPRING		R0019404
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	
		AFTER MACHINING, SPRING CHARACTERISTICS ARE INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS.	R0019404 RAD102-012
		LOAD RANGE OF THE DEPRESSED SPRING IS TESTED PER DRAWING REQUIREMENTS.	R0019404
B, C, D, E, F	PNEUMATIC CONTROL ASSEMBLY PNEUMATIC CONTROL SOLENOID PURGE SEQUENCE PRESSURE ACTIVATED VALVE ASSEMBLY FILTER FILTER		R0019450 R0010725 R0019401 RES1090 RES1107
	CLEANLINESS OF COMPONENTS	THE PNEUMATIC CONTROL ASSEMBLY, THE PRESSURE ACTUATED VALVES, AND THE SOLENOID VALVES ARE CLEAN TO OXYGEN/FUEL SERVICE PER SPECIFICATION AND DRAWING REQUIREMENTS.	RL10501 R0010450 R0010725 R0019401
		DURING MANUFACTURE AND ACCEPTANCE TEST OF THE SOLENOID VALVE, THE FILTER INSTALLATION, VALVE CLEANING, AND CLEAN FLUSH PARTICAL COUNT IS INSPECTED PER SPECIFICATION.	RL00278

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 CR Item: C100-12
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
B, C, D, E, F	CLEANLINESS OF COMPONENTS	DURING ASSEMBLY OF THE PRESSURE ACTUATED VALVE, THE ACTUATION AND DEACTUATION OPERATION AND SEALING ARE VERIFIED. OPERATION OF THE VALVE VERIFIES NO CONTAMINATION BLOCKAGE IN MOVING PARTS.	RL00312
	FILTER INTEGRITY	FILTERS ARE INSPECTED TO MEET FLOW AND FILTRATION REQUIREMENTS PER SPECIFICATION	RC1060 RC1107
G	SEAT PAV POPPET		R0019410 R0019409
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS. HEAT TREAT OF PAV SEAT IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	R0019410 RA1111-C02
C - 46	SEALING SURFACES	SEALING SURFACES ARE INSPECTED PER DRAWING REQUIREMENTS. DURING ASSEMBLY AND ACCEPTANCE TEST, THE VALVE ACTUATION AND DEACTUATION OPERATION AND SEALING FUNCTIONS ARE VERIFIED.	R0019410 R0019409 RL00312
ALL CAUSES	PNEUMATIC CONTROL ASSEMBLY		R0019450
	ASSEMBLY INTEGRITY	THE FOLLOWING TESTS ARE PERFORMED DURING ASSEMBLY AND FUNCTIONAL TESTING OF THE PNEUMATIC CONTROL ASSEMBLY: - SEAT LEAKAGE IS VERIFIED TO BE WITHIN SPECIFICATION FOR BOTH ENERGIZED AND DE-ENERGIZED OPERATION. - ASSEMBLY OPERATION IS VERIFIED BY TESTING EACH FUNCTION OF THE PNEUMATIC CONTROL ASSEMBLY. - FILTER OPERATION IS VERIFIED BEFORE AND AFTER INSTALLATION.	RL00344 RL00344 RL00344
	HOT-FIRE ACCEPTANCE TESTING (GREEN RUN)	PNEUMATIC CONTROL ASSEMBLY OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING.	RL00465
	PRE-FLIGHT CHECKOUT	EMERGENCY PNEUMATIC SHUTDOWN OPERATION IS VERIFIED DURING SSME ELECTRICAL CHECKOUT PRIOR TO FLIGHT OR AFTER ANY REPLACEMENT OF RELATED COMPONENTS BY PERFORMING THE FOLLOWING OMRSD REQUIREMENTS:	

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
ALL CAUSES	PRE-FLIGHT CHECKOUT	- FLIGHT READINESS TEST INCLUDING PNEUMATIC SHUTDOWN. - FLIGHT READINESS TESTS AND VALVE CYCLE VERIFICATION. (LAST TEST)	OMRSD V41A.S0.030 OMRSD S00FAC 211

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)
 Reference: NASA letter SA21/88/308 and Rockwell letter 68RC09761.

Operational Use: Not Applicable.