

**SSMF 1EA/CIL  
REDUNDANCY SCREEN**

Component Group: Orifices  
 CIL Item: N719-01  
 Part Number: RS009546  
 Component: FPB ASI Fuel Orifice (F21)  
 FMEA Item: N719  
 Failure Mode: Orifice restricted or blocked.

Prepared: D. Early  
 Approved: T. Nguyen  
 Approval Date: 7/25/00  
 Change #: 1  
 Directive #: CCBD ME3-01-5638

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Phase	Failure / Effect Description	Criticality Hazard Reference
S 4.1	<p>The preburner gases do not ignite due to lack of fuel, causing fuel pump speed to be below redline values. Mission scrub. Loss of vehicle due to LOX-rich operation may result if failure to establish fuel preburner ignition is not detected.</p> <p>Redundancy Screens: ORIFICE SYSTEM, SENSOR SYSTEM: UNLIKE REDUNDANCY</p> <p>A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround.            B: Pass - Loss of a redundant hardware items is detectable during flight.            C: Pass - Loss of redundant hardware items could not result from a single credible event.</p>	1R ME-B2S
SMC 4.1	<p>Loss of fuel to ASI causes high mixture ratio erosion of the ASI combustion chamber walls, injector burnout, loss of turbine and engine failure. Loss of vehicle.</p> <p>Redundancy Screens: SINGLE POINT FAILURE: N/A.</p>	1 ME-B2S, ME-B2M, ME-B2A,C, ME-B6S

**SSME FMEA/CIL  
DESIGN**

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Design / Document Reference

**FAILURE CAUSE: A: Contamination.**

FUEL SYSTEM IS PURGED WITH GASEOUS HELIUM DURING PROPELLANT CONDITIONING PRIOR TO PROPELLANT DROP ENSURING EVACUATION OF GASEOUS NITROGEN. GASEOUS HELIUM PARTICULATES ARE CONTROLLED BY THE INTERFACE CONTROL DOCUMENT (1). CLEANLINESS REQUIREMENTS ARE ESTABLISHED TO REDUCE THE POSSIBILITY OF ORIFICE BLOCKAGE (2). ENGINE SYSTEMS ARE CLEANED TO APPLICABLE MEDIA CLEANLINESS REQUIREMENTS (2). HELIUM PURGE IS FILTERED BY PNEUMATIC CONTROL ASSEMBLY (PCA) HELIUM INLET FILTER, WHICH REMOVES PARTICLES LARGER THAN 15-MICRONS (3). THE PCA DETAIL PARTS AND TEST FIXTURES ARE CLEANED (2) PRIOR TO ASSEMBLY (4). ASSEMBLY AND TEST ARE PERFORMED IN A CLEAN ROOM (5). LUBRICANTS ARE NOT ALLOWED FOR ASSEMBLY OR TEST (4). COMPONENT LEVEL TEST FLUIDS ARE NITROGEN AND HELIUM, WHICH MEET THE HARDWARE CLEANLINESS REQUIREMENTS (2). THE COMPONENT PARTS AND SUBASSEMBLY ARE FREE OF VISIBLE FOREIGN PARTICLES AT THE TIME OF ASSEMBLY (4). THE ORIFICE SIZE IS LARGER THAN ACCEPTABLE PARTICULATES.

(1) ICD13M15000; (2) RL10001; (3) R0019450; (4) RL00226, RL00347; (5) RQ0711-600

**FAILURE CAUSE: B: Structural failure of fuel ASI filter.**

THE FUEL IS FILTERED TO 400-MICRONS AT THE EXTERNAL TANK INTERFACE (1). THE FUEL ASI DELIVERY SYSTEM IS DESIGNED TO REMOVE ANY PARTICLES THAT MAY CAUSE CUTOFF OR PARTIAL BLOCKAGE OF THE PASSAGES. A FILTER IS LOCATED AT THE HEAD OF THE DELIVERY SYSTEM REMOVING PARTICLES 2/3 THE SIZE OF THE SMALLEST ASI PASSAGE (2). THE FILTER IS DESIGNED TO STOP THE PARTICLES IN THE FUEL AND ALLOW THEM TO SETTLE OFF THE FILTER FACE (3). THIS ALLOWS FOR PARTICLE REMOVAL WITHOUT FILTER FLOW REDUCTION. SHOULD GROSS CONTAMINATION OCCUR, THE FILTER CAN WITHSTAND PLUGGING OF OVER HALF ITS SURFACE AREA PRIOR TO A REDUCTION IN ASI CHAMBER FUEL DELIVERY. THE ASI FUEL FILTER IS FABRICATED FROM INCONEL 625 ALLOY WHICH WAS SELECTED BECAUSE OF ITS BRAZABILITY, MACHINABILITY, AND MATERIAL PROPERTIES (4). INCONEL 625 CAN BE BRAZED WITHOUT PLATING IN A CONTROLLED ATMOSPHERE. THE FUEL FILTER IS BRAZED IN EITHER HYDROGEN, ARGON AND HELIUM, HELIUM, OR VACUUM (5). THE ASI FUEL FILTER HAS BEEN ANALYZED FOR FLOW INDUCED LOADS, DYNAMIC LOADS, AND PRESSURE LOADS AND MEETS THE HIGH AND LOW CYCLE FATIGUE LIFE CEI REQUIREMENTS (6). THE MINIMUM FACTORS OF SAFETY FOR THE ASI FUEL FILTER MEET CEI REQUIREMENTS (7). DESIGN TESTING OF THE FILTER WITH INDUCED CONTAMINATION SHOWED THE FLOW WASHES THE FILTER. THE ASI SYSTEM HAS BEEN DESIGN VERIFICATION TESTED FOR LOW PRESSURE IGNITION AND HIGH MIXTURE RATIOS (8).

(1) ICD13M15000; (2) RS007004; (3) R0018225; (4) RSS-8572; (5) RA0107-010; (6) RL00532, CP320R0003B; (7) RSS-8546, CP320R0003B; (8) RSS-305-19

**SSME FM CIL**  
**INSPECTION AND TEST**

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	PNEUMATIC CONTROL ASSEMBLY (PCA)		R0019450
	PCA HELIUM INLET FILTER		RES1090
	ASI FUEL FILTER		R0018225
	FUEL PREBURNER LINE		R0010752
	CLEANLINESS OF PCA	THE PNEUMATIC CONTROL ASSEMBLY IS CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
	PCA HELIUM FILTER INTEGRITY	FILTERS ARE INSPECTED TO MEET FLOW AND FILTRATION REQUIREMENTS PER SPECIFICATION REQUIREMENTS.	RC1090
PCA ASSEMBLY TESTING	THE ASSEMBLY FUNCTION IS VERIFIED BY INSPECTION OF THE FLOW RATE AND PRESSURE DURING FLOW CHECK.		RL00344
	DURING THE PROPELLANT CONDITIONING, THE FUEL SYSTEM PURGE IS VERIFIED PER SPECIFICATION REQUIREMENTS.		OMRSD S00FB0.310 OMRSD S00FB0.320
B	ASI FUEL FILTER		R0018225
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	R0018225
	CLEANLINESS OF FILTER	THE FILTER IS CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
	FILTER INTEGRITY	THE FILTER BRAZE JOINTS ARE INSPECTED TO VERIFY COMPLETED COVERAGE.	R0018225
ALL CAUSES	FUEL PREBURNER LINE		R0010752
	CLEANLINESS OF COMPONENTS	THE ASSEMBLY AND UPSTREAM COMPONENTS ARE CLEANED PER SPECIFICATION REQUIREMENTS.	RL10001
		AFTER WELDING, THE PASSAGE PORTS ORIFICES ARE INSPECTED FOR BLOCKAGE DUE TO WELD MATERIAL.	RL10011
		THE SSME PROPELLANT SYSTEM IS DRIED AND VERIFIED DRY PRIOR TO EACH FLIGHT.	OMRSD V41CB0.080 OMRSD V41CB0.081
	ASSEMBLY INTEGRITY	THE HOT FIRE TESTING AND 2ND E & M INSPECTION VERIFY ASI INTEGRITY.	RL00050-04 RL00056-06 RL00056-07
PRE-FLIGHT CHECKOUT	INSPECTION OF INJECTOR ASI CHAMBER AFTER EACH FLIGHT VERIFIES NO BLOCKAGE HAS OCCURRED DURING PREVIOUS OPERATION. (LAST TEST)	OMRSD V41BU0.040	

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.