

SSME    EA/CIL  
**REDUNDANCY SCREEN**

Component Group: Combustion Devices  
 CIL Item: A206-D1  
 Part Number: R5009122  
 Component: Baffleless Main Injector (Phase II+)  
 FMEA Item: A205  
 Failure Mode: ASI fails to Ignite

Prepared: A. Kay  
 Approved: T. Nguyen  
 Approval Date: 9/9/99  
 Change #: 2  
 Directive #: CCBD ME3-01-5238

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Phase	Failure / Effect Description	Criticality Hazard Reference
S 4.1	The main combustion chamber gases do not ignite. Low main chamber pressure results in failure to satisfy grain confirmed limits and controller initiated shutdown. Mission scrub. Loss of vehicle due to LOX duct rupture may result if failure to establish MCC ignition is not detected.	1R ME-FCSS
<p>Redundancy Screens: MAIN INJECTOR 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>		

**DESIGN**

Component Group: Combustion Devices  
 CIL Item: A205-01  
 Part Number: RS009122  
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Design / Document Reference

**FAILURE CAUSE: A: Contamination blocking the ASI fuel orifices or passages.**

THE FUEL IS FILTERED TO 400-MICRONS AT THE EXTERNAL TANK (1). THE FUEL ASI DELIVERY SYSTEM IS DESIGNED TO REMOVE ANY FUEL PARTICLES THAT MAY CAUSE CUTOFF OR PARTIAL BLOCKAGE OF THE PASSAGES. A FILTER LOCATED AT THE HEAD OF THE DELIVERY SYSTEM REMOVES PARTICLES FROM THE FUEL THAT MAY BE LARGE ENOUGH TO CAUSE A REDUCTION IN FUEL FLOW (2). THE FILTER IS DESIGNED TO STOP 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 OF ITS SURFACE AREA BEFORE RESULTING IN FUEL DELIVERY REDUCTION TO THE ASI CHAMBER. A PRE-START HELIUM PURGE MINIMIZES THE POSSIBILITY OF ASI ICE BLOCKAGE. THE ASI FUEL FILTER IS FABRICATED FROM INCONEL 625 ALLOY WHICH WAS SELECTED ON THE BASIS OF ITS BRAZEABILITY, WELDABILITY, 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, OR A VACUUM (5). THE ASI FUEL FILTER HAS BEEN ANALYZED FOR FLOW INDUCED LOADS, DYNAMIC LOADS, AND PRESSURE LOADS. THE ASI FUEL FILTER STRUCTURAL ANALYSIS MEETS THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE CEI REQUIREMENTS (6). THE MINIMUM FACTORS OF SAFETY FOR THE ASI FUEL FILTER MEET CEI REQUIREMENTS (7). THE ASI SYSTEM HAS BEEN DESIGN VERIFICATION TESTED FOR LOW PRESSURE IGNITION AND LOW MIXTURE RATIOS. THE FLEET LEADER ASI FUEL FILTER HAS BEEN REMOVED FOR MICROSCOPIC AND PENETRANT INSPECTION ON TWO OCCASIONS WITHOUT DETECTING ANY ANOMALIES (8). DESIGN TESTING OF THE FILTER WITH INDUCED CONTAMINATION SHOWED THE FLOW WASHES THE FILTER. THE ASI SYSTEM HAS BEEN DESIGN VERIFICATION TESTING FOR LOW PRESSURE IGNITION AND HIGH MIXTURE RATIOS (9).

(1) ICD 12M15000 (2) RS007034; (3) R0018725 (4) RSS-8572-10; (5) R00107-010; (6) RLC0532 CP320R0003B; (7) RSS-8545, CP320R0003B; (8) MPR-85-0859 MPR-85-0309 (9) RSS-305-19

**FAILURE CAUSE: B: Contamination which blocks oxidizer orifices or passages.**

THE OXIDIZER SUPPLY IS FILTERED TO 800-MICRONS AT THE EXTERNAL TANK (1). THE OXIDIZER ASI DELIVERY SYSTEM IS DESIGNED TO REMOVE ANY PARTICLES THAT MAY CAUSE CUTOFF OR PARTIAL BLOCKAGE OF THE PASSAGES. THE ASI SYSTEM HAS BEEN DESIGN VERIFICATION TESTED FOR LOW PRESSURE IGNITION AND LOW MIXTURE RATIOS (2).

(1) ICD 12M15000 (2) RSS-305-19

**FAILURE CAUSE: ALL CAUSES**

THE ASI CAN OPERATE OVER A WIDE MIXTURE RATIO RANGE. PARTIAL BLOCKAGE CAN STILL ALLOW TIMELY PROPELLANT IGNITION (1)

(1) RSS-305-19

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**SSME FM 2IL  
INSPECTION AND TEST**

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 FMEA Item: A205  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FI_LTER		R0018225
	FUEL FILTER INTEGRITY	FILTER BRAZE JOINTS ARE INSPECTED TO VERIFY COMPLETE BRAZE FLOW AT SCREEN INTERSECTIONS PER DRAWING AND SPECIFICATION REQUIREMENTS.	R0018225 RA0107-010
	ASI SYSTEM CLEANLINESS	ASI SUBASSEMBLIES ARE CLEANED DURING MANUFACTURING AND PRIOR TO FINAL ASSEMBLY	RL10001 RA1610-005
		AFTER BRAZING, THE PASSAGE PORTS AND ORIFICES ARE INSPECTED FOR BLOCKAGE DUE TO BRAZING MATERIAL	RA1607-009
		DURING PROPELLANT CONDITIONING, THE FUEL SYSTEM IS PURGED TO MAINTAIN IT FREE OF MOISTURE AND ICE.	OMRSD S00FB0.310 OMRSD S00FB0.320
B	ORIFICES		RS009036
	ASI SYSTEM CLEANLINESS	ASI SUBASSEMBLIES AND THE MOV ARE CLEANED DURING MANUFACTURING TO OXYGEN SERVICE REQUIREMENTS	RL10001
		AFTER BRAZING, THE PASSAGE PORTS AND ORIFICES ARE INSPECTED FOR BLOCKAGE DUE TO BRAZING MATERIAL.	RA1607-009
		DURING THE PROPELLANT CONDITIONING, THE OXIDIZER ASI SYSTEM IS PURGED TO MAINTAIN IT FREE OF MOISTURE AND ICE.	OMRSD S00FB0.300
ALL CAUSES	PROPELLANT SYSTEM CLEANLINESS	SSME PROPELLANT SYSTEMS ARE DRIED AND VERIFIED DRY PRIOR TO EACH FLIGHT	OMRSD V41C80.052 OMRSD V41C80.053
	ASSEMBLY INTEGRITY	HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY CORRECT OPERATION.	RL00050-04 RL00056-06 RL00056-07
		ASI CHAMBERS ARE INSPECTED FOR DAMAGE PRIOR TO EACH LAUNCH (LAST TEST).	OMRSD V41BU0.029

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Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)  
 Reference: NASA letter SA21/88/308 and Rocketdynamics letter 88RC09761.  
 Operational Use: Not Applicable.

**SSME I A/CIL  
WELD JOINTS**

Component Group: Combustion Devices  
 CIL Item: A205  
 Component: RS009122  
 Part Number: Baffleless Main Injector (Phase II+)  
 A205

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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable		Comments
						HCF	LCF	
MAIN INJECTOR ASI LINE	RS009061	3	GTAW	I		X	X	
MAIN INJECTOR ASI LINE	RS009061	5	GTAW	I		X	X	
MAIN INJECTOR	RS009126	1	EBW	I				
MAIN INJECTOR	RS009126	6-7,52-53	GTAW	I	X	X	X	
MAIN INJECTOR	RS009126	9	EBW	I				
MAIN INJECTOR	RS009126	3	CBW	I	X			
MAIN INJECTOR	RS009126	10	EBW	II	X	X	X	
MAIN INJECTOR	RS009126	12-13	GTAW	I	X			
MAIN INJECTOR BODY	RS009126	14-15	GTAW	I	X	X	X	
MAIN INJECTOR BODY	RS009126	16	GTAW	I	X	X	X	
MAIN INJECTOR BODY	RS009126	17	GTAW	I	X	X	X	
MAIN INJECTOR	RS009126	20	GTAW	I	X			
MAIN INJECTOR	RS009126	21	GTAW	I	X			
MAIN INJECTOR	RS009126	22	GTAW	I	X			
MAIN INJECTOR	RS009126	23-29,54	GTAW	I	X			
MAIN INJECTOR	RS009126	44-45	EBW	I	X	X	X	
MAIN INJECTOR	RS009126	50-51	CBW	Ia	X	X	X	
MAIN INJECTOR	RS009126	59	EBW	I,II	X			
MAIN INJECTOR	RS009126	60-61	GTAW	II	X			
MAIN INJECTOR BODY	RS009237	600 FLCS	FRW	I		X	X	
MAIN INJECTOR LOX SUPPLY LINE	RC018C15	1	GTAW	I	X	X		

**FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE**

Component Group: Combustion Devices  
 Item Name: Baffleless Main Injector (Phase II+)  
 Item Number: A205  
 Part Number: RS009122

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Base Line Rationale	Variance	Change Rationale	Variant Case Number
1. NO RATIONALE EFFECTED	REWORKED BAFFLE POSTS EXIST ON 2 DASH NUMBERS.	INLINE REWORK OF COMPLETED BAFFLE MAIN INJECTOR IS AN ALLOWABLE ALTERNATE TO THE BAFFLELESS MAIN INJECTOR	RS009122-1571, RS009122-1581
2. NO RATIONALE EFFECTED.	BLOCK I Isp IMPROVEMENTS DO NOT EXIST ON 2 POWERHEADS	BLOCK I FLIGHT ENGINES MEET CEI REQUIREMENTS FOR Isp. HOWEVER, CERTAIN FLIGHT MANIFESTS REQUIRE AN INCREASE IN Isp FROM THE BLOCK I FLIGHT ENGINES. THE MAIN INJECTOR PRIMARY AND SECONDARY FACEPLATES WERE MODIFIED TO ENHANCE THE COMBUSTION PROCESS.	RS009122-1671
3. A205-12 AND A205-13, BLOCK III Isp IMPROVEMENTS.	THE BLOCK I FLIGHT ENGINES DO NOT HAVE THE MODIFIED MAIN INJECTOR PRIMARY AND SECONDARY FACEPLATES, ROW 13, FUEL SLEEVES AND NEW V-SEAL	BLOCK I FLIGHT ENGINES MEET CEI REQUIREMENTS FOR Isp	RS009122-1681

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