

**SSME EA/CIL  
REDUNDANCY SCREEN**

Component Group: Combustion Devices  
 CIL Item: A200-02  
 Part Number: RS009121  
 Component: Main Injector  
 FMEA Item: A200  
 Failure Mode: Loss of fuel to ASI.

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
SMC 4.	Partial or complete loss of fuel to ASI causes high mixture ratio erosion of the ASI combustion chamber walls, manifold inversion, injector burnout, and LOX-rich operation. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE: N/A	J ME-B4S, ME-B4A C, MF-B4M

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SSME FMEA/CIL  
DESIGN

Component Group: Combustion Devices  
CIL Item: A200-02  
Part Number: RS009122  
Component: Main Injector  
FMEA Item: A200  
Failure Mode: Loss of fuel to ASI.

Prepared: A. Kay  
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Approval Date: 8/9/99  
Change #: 2  
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Design / Document Reference

FAILURE CAUSE: A: Contamination of the ASI fuel orifice or passageways.

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 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 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 CYCLE AND LOW CYCLE FATIGUE LIFE CEI REQUIREMENTS (6). THE MINIMUM FACTORS OF SAFETY FOR THE ASI FUEL FILTER MEET CEI REQUIREMENTS (7). 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 TESTED FOR LOW PRESSURE IGNITION AND HIGH MIXTURE RATIOS (9).

(1) CD 13M-5000; (2) RS007004; (3) R2318225; (4) RSS-8572-9; (5) RAC107-010; (6) RL00332, CP320R0003B; (7) RSS-8546, CP320R0003B; (8) MPR-85 0309, MPR-85-0859; (9) RSS-305-15

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**SSME FMECA  
INSPECTION AND TEST**

Component Group: Combustion Devices  
 CIL Item: A200-02  
 Part Number: RS009122  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FILTER		RL00050
	FILTER INTEGRITY	FILTER BRAZE JOINTS ARE INSPECTED TO VERIFY COMPLETE BRAZE FLOW AT SCREEN INTERSECTIONS.	
	ASI SYSTEM CLEANLINESS	ASI SUBASSEMBLIES ARE CLEANED DURING MANUFACTURING AND PRIOR TO FINAL ASSEMBLY.	RL10001 RA161C-025
		AFTER BRAZING, THE PASSAGE PORTS AND ORIFICES ARE INSPECTED FOR BLOCKAGE DUE TO BRAZING MATERIAL.	RA1607-029
		DURING PROPELLANT CONDITIONING THE FUEL ASI SYSTEM IS PURGED TO MAINTAIN IT FREE OF MOISTURE AND ICE.	OMRSD S00FB0.310 OMRSD S00FB0.320
	PROPELLANT SYSTEM CLEANLINESS	SSME PROPELLANT SYSTEM IS DRIED AND VERIFIED DRY PRIOR TO EACH FLIGHT.	OMRSD V41CB0.080 OMRSD V41CB0.081
		DURING PROPELLANT CONDITIONING THE SSME PROPELLANT SYSTEM IS PURGED TO MAINTAIN IT FREE OF MOISTURE AND ICE	OMRSD S00I-80.300
	ASSEMBLY INTEGRITY	THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY FILTER INTEGRITY.	RL00050-04 RL00056-06 RL00056-07
		THE ASI IS INSPECTED FOR CONTAMINATION AND DAMAGE PRIOR TO EACH LAUNCH. (LAST TEST)	OMRSD V41BL0.029

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Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)

Reference: NASA letter S421/88/308 and Rocketdyne letter 88RC09751.

Operational Use: Not Applicable.

SSME / A/CIL  
WELD JOINTS

Component Group: Combustion Devices  
 CIL Item: A200  
 Component: RS009122  
 Part Number: Main Injector  
 A200

Prepared: A. Kay  
 Approved: T. Nguyen  
 Approval Date: 9/9/99  
 Change #: 1  
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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial		Comments
						Flaw Size Not	Detectable	
						HCF	LCF	
MAIN INJECTOR ASI	RSC09061	3	GTAW	I		X	X	
MAIN INJECTOR ASI	RSC09061	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	8	EBW	I		X		
MAIN INJECTOR	RS009126	9	EBW	I	X			
MAIN INJECTOR	RS009126	10	EBW	II	X	X	X	
MAIN INJECTOR	RS009126	12,13	GTAW	I	X			
MAIN INJECTOR	RS009126	14,15	GTAW	I	X	X	X	
MAIN INJECTOR	RS009126	16,17	GTAW	I		X	X	
MAIN INJECTOR	RS009126	20	GTAW	I	X			
MAIN INJECTOR	RS009126	21	GTAW	II	X			
MAIN INJECTOR	RS009126	22	GTAW	I	X			
MAIN INJECTOR	RS009126	23-25,54	GTAW	I	X			
MAIN INJECTOR	RS009126	44,45	GTAW	I		X	X	
MAIN INJECTOR	RS009126	50,51	EBW	Ia	X	X	X	
MAIN INJECTOR	RS009126	59	EBW	I,b	X			
MAIN INJECTOR	RS009126	60,61	GTAW	II	X	X		
INLET SHELL	RSD05235	1 LFT	EBW	I				
INLET SHELL	RSC09235	1 RHT	EBW	I		X	X	
INLET SHELL	RSC05237	600 FLCS	FRW	I	X			

**SSME FMEA/CIL  
FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE**

Component Group: Combustion Devices  
Item Name: Main Injector  
Item Number: A200  
Part Number: R5009122

Prepared: A. Kay  
Approved: I. Nguyen  
Approval Date: 9/8/99  
Change #: 1  
Directive #: CCDD ME3-01-5238

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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. A200-07 LOX ASI SLEEVE BRAZE IS X-RAYED AND BORESCOPEO (ECP 697)	NO BORESCOPE INSPECTION.	VISUAL VERIFICATION GAVE ADDITIONAL CONFIDENCE THAT BRAZING HAS NOT CREATED LIQUID METAL EMBRITTLEMENT. USE AS IS RATIONALE: 1. ALL SLEEVES ARE X-RAYED, WHICH SPECIFICALLY INSPECTS FOR LIQUID METAL EMBRITTLEMENT CRACKING; 2. JOINT SUSCEPTIBILITY IS LOW (NO STRAIN ON TUBE DURING WELDING, BRAZE MUST FLOW ONLY TO WITNESS HOLE).	-741, -751, -771, -761, -791, -801.
2. A200-06 WALL THICKNESS OF SECONDARY FACEPLATE RETAINERS INCREASED ON OUTER THREE ROWS. (ECP 634)	PREVIOUS CONFIGURATION HAD A THINNER WALL.	THICKER WALLS GAVE ADDITIONAL LOX POST SUPPORT IN THE HIGH FLOW AREAS. USE AS IS RATIONALE: 1. HIGH FLOW AREA POSTS WERE PLUGGED AND RODDED FOR ADDITIONAL SUPPORT; 2. LIFE LIMIT ON THE MAIN INJECTOR LOX POSTS PREVENTS DAMAGE LEVELS FROM EXCEEDING ALLOWABLE LIMITS. (DAR 1373)	-771
3. A200-06 EDDY CURRENT INSPECTION ON ALL LOX POST INERTIA WELDS. (ECP 342)	NO EDDY CURRENT INSPECTION OF INERTIA WELDS.	EDDY CURRENT INSPECTION PROVIDE ADDITIONAL CONFIDENCE IN INTERNAL WELD INTEGRITY. USE AS IS RATIONALE: 1. INERTIA WELDS ARE CONTROLLED BY SPECIFICATION; 2. NO FAILURE HISTORY WITH HAYNES 188 POSTS; 3. SURFACE FINISH IS CONTROLLED TO REDUCE STRESS CONCENTRATIONS; 4. ROW 13 POSTS ARE DYE PENETRANT INSPECTED ON O.D	-791, -751, -771, -781, -791, -801, -811, -851.
4. A200-07 ELIMINATION OF BRAZE JOINTS OF ASI INLET TUBE TO BIFID TIRES	BRAZED PREVIOUS CONFIGURATION	ELIMINATION OF BRAZE JOINT ELIMINATES THE POSSIBILITY OF LIQUID METAL EMBRITTLEMENT. USE AS IS RATIONALE: 1. BRAZE JOINTS ARE DONE WITHOUT INDUCED LOADS 2. NO RESIDUAL STRESSES IN TUBES. 3. SECTIONED HARDWARE SHOWS NO PROBLEMS	-741, -771, -781.
5. A200-07 SPLITTER VANE GEOMETRY IS VERIFIED PER CURRENT DRAWING REQUIREMENTS. (ECP 989R1)	SPLITTER VANE GEOMETRY DOES NOT MEET CURRENT DRAWING REQUIREMENTS.	RE-DESIGN OF THE SPLITTER VANE ALTERED THE STRUCTURAL RESPONSE OF THE VANES TO FLOW, ELIMINATING FLOW INDUCED CRACKING. USE AS IS RATIONALE: 1. ENGINES NOT MEETING CURRENT SPLITTER VANE DRAWING REQUIREMENTS ARE SCREENED AT GREEN RUN TO IDENTIFY THOSE EXHIBITING THE 4 KHz RESPONSE. THESE ENGINES ARE REWORKED TO CURRENT DRAWING REQUIREMENTS. RE-PRESSURE TESTED AND RE-IDENTIFIED.	-1021, -1141, -1161, -1171, -1201, -1301, -1311, -1321, -1361, -1441

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