

**SSME FA/CIL  
REDUNDANCY SCREEN**

Component Group: Combustion Devices  
 CIL Item: A600-06  
 Part Number: RS009020  
 Component: Fuel Preburner  
 FMEA Item: A600  
 Failure Mode: Oxidizer post cracks.

Prepared: A. Ray  
 Approved: T. Nguyen  
 Approval Date: 9/9/99  
 Change #: 1  
 Directive #: CCRD ME3-01.5738

Page: 1 of 1

Phase	Failure / Effect Description	Criticality Hazard Reference
SMC 4.1	A crack allows fuel to flow into the oxidizer post passage resulting in post internal erosion and possible loss of post section into turbine flow stream and subsequent turbine trace failure. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE N/A	ME-B2S, ME-S2A,C, ME-S2M

**SSME FMEA/CIL  
DESIGN**

Component Group: Combustion Devices  
CIL Item: A600-06  
Part Number: RS009020  
Component: Fuel Preburner  
FMEA Item: A600  
Failure Mode: Oxidizer post cracks.

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Page: 1 of 1

Design / Document Reference

**FAILURE CAUSE: A: Loss of support pin.**

THE FUEL PREBURNER INJECTOR ELEMENT SUPPORT IS FABRICATED FROM 304 CRES NEEDLE TUBING (1). THE TUBE DESIGN GIVES THE PINS A SPRING CHARACTERISTIC. THREE PINS ARE INSTALLED IN THE FUEL ANNULUS OF THE FUEL PREBURNER INJECTION ELEMENT (2) EQUALLY SPACED 120 DEGREES APART FROM EACH OTHER, TO DAMPEN VIBRATION CAUSED BY MECHANICAL MOVEMENT AND FLOW. THE PINS ARE HELD IN PLACE BY FRICTION. HIGH CYCLE FATIGUE AND LOW CYCLE FATIGUE LIFE MEET CEI REQUIREMENTS (3). THE MINIMUM FACTORS OF SAFETY MEET CEI REQUIREMENTS (4). RANDOM LOSS OF PINS OCCURS DURING HOT FIRE TESTING AND IN THE CASE WHERE A PIN IS LOST AN EDDY CURRENT INSPECTION OF THE POST MUST BE PERFORMED (5). IF THE EDDY CURRENT VALUE IS GREATER THAN OR EQUAL TO SPECIFICATION MINIMUM THE POST IS PLUGGED. THE METHOD OF PLUGGING PREBURNER INJECTION ELEMENTS IS TO INSERT A SOLID 316SS ROD INTO THE ID OF THE 304L POST. THE TIP OF THE LOX POST IS SLIGHTLY SWAGED AND FUSION WELDED TO SEAL THE POST AND RETAINS THE PLUGGING PIN. THE PLUGGING OPERATION IS DONE BY WELDERS CERTIFIED FOR THE SPECIFIC ACTIVITY. ANALYSIS INDICATES INFINITE LIFE AND NO NOTED FAILURES OR CRACKS IN THE WELD IN THE HISTORY OF 55 SUCH OPERATIONS. IF ONE OR TWO PINS ARE LOST THE REMAINING PIN(S) WILL STILL DAMPEN OUT VIBRATION SATISFACTORILY ONLY IN THE CASE WHERE ALL THREE PINS ARE LOST FROM THE SAME ELEMENT IS DAMPING ELIMINATED AND THIS HAS NEVER HAPPENED THROUGHOUT THE TEST HISTORY OF THE SSME.

(1) R0015767; (2) RS009020; (3) RL00532, CP320R0003B; (4) RSS-8546, CP320R0003B; (5) RL00649

**FAILURE CAUSE: B: Parent material failure.**

THE PREBURNER INJECTION ELEMENT IS FABRICATED FROM 304 CRES MATERIAL (1) THIS MATERIAL WAS SELECTED FOR ITS BRAZABILITY RESISTANCE TO HYDROGEN EMBRITTLEMENT, OXYGEN FLAMEABILITY, AND STRENGTH (2). ALL MATERIALS ARE PROCURED PER SPECIFICATION (3). THE ELEMENTS ARE FORMED BY BRAZING A FUEL SLEEVE TO THE LOX POST WITH A PORTION OF THE LOX POST EXTENDING THROUGH THE CENTER OF THE SLEEVE (4). THIS FORMS THE COAXIAL INJECTION ELEMENT. LOX POST SUPPORT PINS ARE INSTALLED BETWEEN THE FUEL SLEEVE AND LOX POST (4) TO DAMPEN OUT VIBRATION OF THE LOX POST. THESE PINS ARE HELD IN PLACE BY FRICTION AND REQUIRE PERIODIC INSPECTION. IF PINS HAVE BEEN LOST, AN EDDY CURRENT INSPECTION MUST BE PERFORMED (5). IF THE READING IS EQUAL TO OR GREATER THAN SPECIFICATION MINIMUM THEN THE POST IS DEACTIVATED. HIGH CYCLE FATIGUE AND LOW CYCLE FATIGUE LIFE MEET CEI REQUIREMENTS (6). THE MINIMUM FACTORS OF SAFETY MEET CEI REQUIREMENTS (7). THE PREBURNER ELEMENTS PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/NDE FLAW GROWTH SINCE THEY CONTAIN NO FRACTURE CRITICAL PARTS (8). PREBURNER INJECTION ELEMENTS FROM ENGINE 2010'S FUEL PREBURNER WERE DESTRUCTIVELY EVALUATED BY ME & T, AND THEY FOUND NO ANOMALIES CONDITION, THOUGH THE AMOUNT OF MARTENSITIC TRANSFORMATION OBSERVED ALONG THE LENGTH OF THE LOX POST WAS NOT PREDICTED (9). THE PREBURNER WAS DVS TESTED (10).

(1) RS009020; (2) RSS-8571-8; (3) QQ-S-783; (4) RS009020; (5) RL00649; (6) RL00532, CP320R0003B; (7) RSS-8546, CP320R0003B; (8) NASA TASK #17; (9) IL CDSB-1010; (10) DVS-305

A - 208

**SSME FMI  
INSPECTION AND TEST**

Component Group: Combustion Devices  
 CIL Item: A600-06  
 Part Number: RS009020  
 Component: Fuel Preburner  
 FMEA Item: A600  
 Failure Mode: Oxidizer post cracks.

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Page: 1 of 1

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FIN ELEMENT		RS0016767 RS003025
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	R0016767
	PROPER PIN INSTALLATION	PIN INSTALLATION DEPTH AND RADIAL LOCATION IS VERIFIED PER DRAWING REQUIREMENTS.	RS009020
B	LOX POST MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS	RS009025
		ALL PARTS ARE PROCURED ONLY FROM APPROVED SOURCES WHICH HAVE PROVEN CAPABILITY TO MANUFACTURE ACCEPTABLE PARTS.	
	LOX POST BRAZE INTEGRITY	THE LOX POST TO FUEL SLEEVE FURNACE BRAZING IS INSPECTED FOR BRAZE FLOW AND DEFECTS PER SPECIFICATION REQUIREMENTS.  THE LOX POST TO INTERPROPELLANT PLATE BRAZING IS INSPECTED PER SPECIFICATION REQUIREMENTS FOR BRAZE FLOW AND DEFECTS	RA1607-004 RA1607-007
ALL CAUSES	ASSEMBLY INTEGRITY	THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY LOX POST INTEGRITY.  SUPPORT PINS ARE INSPECTED EACH TIME THE HPFTP IS REMOVED OR PER TIME CYCLE REQUIREMENTS.  THE PREBURNER IS INSPECTED PRIOR TO EACH FLIGHT FOR DAMAGE. (LAST TEST)  ANY ELEMENT FOUND WITH MISSING LOX POST PINS IS EDDY CURRENT INSPECTED TO DETERMINE IF POST SHOWS EXCESSIVE WORK HARDENING.	RL00358-04 RL00358-06 RL00358-07  OMRSD V41BUD.0410 OMRSD C008A0.015  OMRSD V41BUD.040  OMRSD V41BUD.039

A - 209

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA).  
 Reference: NASA letter SA21/88/208 and Rocketdyne letter 88RC05751.  
 Operational Use: Not Applicable

**SSME F A/CIL  
WELD JOINTS**

Component Group: Combustion Devices  
 CIL Item: A600  
 Component: RS009020  
 Part Number: Fuel Preburner  
 A600

Prepared: A. Kay  
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 Page: 1 of 1

A - 227

Component	Basic Part Number	Weld Number	Weld Type	Class	Access	Critical Initial Flaw Size Not		Comments
						Root Side Not	Detectable	
FPB CHAMBER	RS009019	1,2	GTAW	I	X	X	X	
FPB INJECTOR	RS009020	1	EBW	II	X	X	X	
FPB INJECTOR	RS009020	2	EBW	II	X			
FPB INJECTOR	RS009020	3	GTAW	I	X	X	X	
FPB INJECTOR	RS009020	9	EBW	II	X			
FPB INJECTOR	RS009020	38	EBW	II	X			
FPB INJECTOR	RS009020	39	EBW	II	X			
FPB BODY	RS009023	1 (OPT)	GTAW	I	X			(AC50)
FPB BODY	RS009023	5	EBW	I	X			(AC50)
FPB FUEL MANIFOLD	RS009029	7 (OPT), 8 (OPT)	GTAW	I		X	X	(AC50)
FPB FUEL MANIFOLD	RS009029	11 (OPT)	GTAW	I		X		(AC50)
FPB FUEL MANIFOLD	RS009029	13 (OPT)	GTAW	I		X		(AC50)
FPB OXID INLET	RS009030	1	GTAW	I		X		
FPB OXID INLET	RS009030	2	GTAW	I	X	X	X	
FPB OXID INLET	RS009030	4	GTAW	I				
PREBURNER EXPANSION JOINT	RS009032	1	GTAW	I				
PREBURNER EXPANSION JOINT	RS009032	2,3	GTAW	II	X			
FPB ASH FUEL LINE	RS009026	1 PLC	GTAW	I	X			
FPB CHAMBER	RS009019	3 (OPT), 4 (OPT)	GTAW	I		X	X	(AC50)
FPB CHAMBER	RS009019	5 (OPT)	GTAW	I		X		(AC50)
FPB CHAMBER	RS009019	6 (OPT)	GTAW	I		X		(AC50)

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

Component Group: Combustion Devices  
 Item Name: Fuel Preburner  
 Item Number: A603  
 Part Number: RS009920

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Page: 1 of 1

Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. A603- NO RATIONALE EFFECTED.	MDLY LINER IS INSTALLED IN VARIOUS PREBURNER ASSEMBLIES.	LINER MAY BECOME DAMAGED. USE AS IS RATIONALE; DEBONDED LINER HAS BEEN DETERMINED TO BE A CRITICALITY THREE.	RS007051-1441 RS007051-1457

A-228