

SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: Combustion Devices
 CIL Item: A600-09
 Part Number: RS009020
 Component: Fuel Preburner
 FMEA Item: A600
 Failure Mode: Interpropellant plate or element-to-plate braze joint leakage.

Prepared: A. Kay
 Approved: T. Nguyen
 Approval Date: 9/9/99
 Change #: 1
 Directive #: CCBD MP3-01-5238

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Phase
 SMC
 4.f

Failure / Effect Description

Ignition of the mixed propellants at the leakage point causes erosion and/or ice production within the manifold having the lowest pressure. Contamination by ice or injector face erosion causes propellant maldistribution and burnout of turbines and other components within or downstream of the combustion chamber. Loss of vehicle

Redundancy Screens: SINGLE POINT FAILURE: N/A

Criticality
 Hazard Reference
 1
 ME-B2S,
 ME-S2A,C,
 ME-B2M

SSME F A/CIL
DESIGN

Component Group: Combustion Devices
CEL Item: A600-09
Part Number: RS009020
Component: Fuel Preburner
FMEA Item: A600
Failure Mode: Interpropellant plate or element-to-plate braze joint leakage.

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Approved: T. Ngli-yen
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Design / Document Reference

FAILURE CAUSE: A: Braze joint or Interpropellant plate failure.

THE ELEMENTS ARE MADE OF 304L CRES WHICH IS RESISTANT TO HYDROGEN EMBRITTLEMENT AND OXYGEN FLAMEABILITY (1). IT HAS GOOD BRAZABILITY CREATING BONDS WITH HIGH INTEGRITY. THE INTERPROPELLANT PLATE IS MADE OF INCONEL 625. INCONEL 625 WAS SELECTED FOR ITS BRAZABILITY AND MACHINABILITY. INCONEL 625 IS DUCTILE AT CRYOGENIC TEMPERATURES, AND IS COMPATIBLE WITH LOX. AN INCOLOY 903 OVERLAY WELD IS ADDED TO THE OUTER DIAMETER SURFACE AS A PROTECTION AGAINST HYDROGEN ENVIRONMENT EMBRITTLEMENT FOR THE SUBSEQUENT EBW DURING INSTALLATION INTO THE POWERHEAD (2). THE FACEPLATE RETAINS GOOD DUCTILITY AND EXHIBITS MINOR STRAINS, MAKING IT STABLE IN HYDROGEN ENVIRONMENTS (1). SUPPORT PINS ARE INSERTED IN THE INJECTOR ANNULUS TO GIVE ADDITIONAL SUPPORT TO THE INJECTOR ELEMENTS, HELPING TO MINIMIZE THE POSSIBILITY OF SUPPORT CRACK PROPAGATION (3). TIGHT TOLERANCES ON THE ELEMENTS AND FACEPLATE PROVIDE FOR GOOD BRAZE BONDING (3) (4). THE BRAZING OPERATION IS CONTROLLED BY SPECIFICATION REQUIREMENTS (5). PREBURNERS ARE SCREENED FOR FABRICATION FACEPLATE DEFORMATION BY VERIFYING FACEPLATE FLATNESS IN ACCORDANCE WITH SPECIFICATION REQUIREMENTS (12). PRIMARY STRESS FACTORS OF SAFETY MEET CEI REQUIREMENTS (6). HIGH CYCLE FATIGUE LIFE AND LOW CYCLE FATIGUE LIFE MEET CEI REQUIREMENTS (7). THE INTERPROPELLANT PLATE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (8). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH BY THE WELD ASSESSMENT (9). TABLE A600 LISTS ALL FMEA/CIL WELDS AND IDENTIFIES THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE AND THOSE WELDS IN WHICH THE ROOT SIDE IS NOT ACCESSIBLE FOR INSPECTION. THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE ARE ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (9). DURING THE TEARDOWN OF ENGINE 2010, SHRINKAGE CRACKS WERE OBSERVED EMANATING FROM THE ELECTRON BEAM WELD BETWEEN THE INJECTOR AND BODY IN THE AREA OF THE INCOLOY 903 OVERLAY ON THE INTERPROPELLANT PLATE. ME & T ANALYSIS OF THIS CRACK SHOWED THAT THERE WAS NO FATIGUE PROPAGATION OF THE CRACK. STRUCTURAL ANALYSIS OF THE AREA SHOWS THE DEFECT TO BE ACCEPTABLE EVEN IF THE WORST CASES ARE ASSUMED (10). THE PREBURNER WAS DVS TESTED (11).

(1) RSS 8571-8; (2) RS003024; (3) RS009020; (4) RS009025; (5) RA1607 007; (6) RSS-9548, CP32DR0003B; (7) RL00532, CP32GR0003B; (8) NASA TASK 117; (9) RSS-8736; (10) MPM 25-0884; (11) DVS 305; (12) RL00525

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**SSME FMEA/CIL
INSPECTION AND TEST**

Component Group: Combustion Devices
 CIL Item: A830-09
 Part Number: RS009020
 Component: Fuel Preburner
 FMEA Item: A600
 Failure Mode: Interpropellant plate or element-to-plate braze joint leakage.

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference	
A	PIN, BAFFLE ELEMENT INTERPROPELLANT PLATE PIN	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS	RS009025 RS009024 R0015767
			THE PLATE IS PENETRANT INSPECTED BEFORE MACHINING AND AFTER MACHINING PER SPECIFICATION REQUIREMENTS.	RS009025 RS009024
			PLATE IS ULTRASONICALLY INSPECTED BEFORE MACHINING PER SPECIFICATION REQUIREMENTS.	RA0115-116
		BRAZE OPERATION IS INSPECTED TO SPECIFICATION REQUIREMENTS, AND THE ALLOY IS TRACEABLE TO CERTIFICATIONS.	RA0115-012	
		ASSEMBLY JOINTS ARE LEAK CHECKED, PENETRANT INSPECTED, AND INSPECTED VISUALLY TO INSURE 360 DEGREES OF ALLOY FILLET.	RA1607-007 RD0170-150	
		AFTER BRAZING THE BAFFLES ARE FLOW CHECKED.	RS009020 RA0115-116 RA1607-007	
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL0056B	
			RL10011 RAC007-094 RAC115-116 RAC115-006 RA0115-127 RA115-001	
	ASSEMBLY INTEGRITY	THE INJECTOR ASSEMBLY IS PRESSURE TESTED AFTER BRAZING, WELDING, AND INSTALLATION	RL00241 RL00287	
		PREBURNER INJECTOR FACEPLATE FLATNESS IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00526	
	THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY ASSEMBLY INTEGRITY. (LAST TEST)	RL00050-04 RL00056-06 RL00056-07		

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)
 Reference: NASA letter SA21/88/308 and Rocketdyne letter 85RC09761.
 Operational Use: Not Applicable.

**SSME F A/CIL
WELD JOINTS**

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

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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

Prepared: A. Kay
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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

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