

SSME CA/CIL  
REDUNDANCY SCREEN

Component Group: Combustion Devices  
 CIL Item: A700-09  
 Part Number: RS009004  
 Component: Oxidizer Preburner  
 FMEA Item: A700  
 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 ME3 01 6238

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Phase	Failure / Effect Description	Criticality	Hazard Reference
SMC 4.1	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.	1	ME-D65 ME-B6A.C, ME-B5M
	Redundancy Screens: SINGLE POINT FAILURE: N/A		

**SSME FMEA/CIL  
DESIGN**

Component Group: Combustion Devices  
CIL Item: A700-09  
Part Number: RS009004  
Component: Oxidizer Preburner  
FMEA Item: A700  
Failure Mode: Interpropellant plate or element-to-plate braze joint leakage.

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Approval Date: 9/2/99  
Change #: 1  
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Design / Document Reference

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

THE ELEMENTS ARE MADE OF 304L GRES WHICH IS RESISTANT TO HYDROGEN EMBRITTEMENT AND OXYGEN FLAMMABILITY (1). IT HAS GOOD BRAZEABILITY, CREATING BONDS WITH HIGH INTEGRITY. THE INTERPROPELLANT PLATE IS MADE OF INCONEL 625. INCONEL 625 WAS SELECTED FOR ITS BRAZEABILITY AND MACHINABILITY. INCONEL 625 IS DUCTILE AT CRYOGENIC TEMPERATURES, AND COMPATIBLE WITH LOX. AN INCOLOY 903 OVERLAY WELD IS APPLIED TO THE OUTER DIAMETER SURFACE FOR PROTECTION AGAINST HYDROGEN ENVIRONMENT EMBRITTEMENT OF THE SUBSEQUENT ELECTRON BEAM WELD (2). THE FACEPLATE RETAINS GOOD DUCTILITY AND EXHIBITS MINOR STRAINS, MAKING IT STABLE IN HYDROGEN ENVIRONMENTS (1). TIGHT TOLERANCES ON THE ELEMENTS AND FACEPLATE PROVIDE FOR GOOD BRAZE BONDING (2) (3). THE BRAZING OPERATION IS CONTROLLED BY SPECIFICATION REQUIREMENTS (4). PREBURNERS ARE SCREENED FOR BOTH FABRICATION AND CUTOFF POP RELATED FACEPLATE DEFORMATION BY VERIFYING FACEPLATE FLATNESS IN ACCORDANCE WITH SPECIFICATION REQUIREMENTS (11). PRIMARY STRESS FACTORS OF SAFETY MEET CEI REQUIREMENTS (5). HIGH CYCLE FATIGUE AND LOW CYCLE FATIGUE LIFE MEET CEI REQUIREMENTS (5). THE INTERPROPELLANT PLATE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (7). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH BY THE WELD ASSESSMENT (8). TABLE A700 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 (8). 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 FUEL PREBURNER INTERPROPELLANT PLATE. ME & T ANALYSIS OF THIS CRACK SHOWED THAT THERE WAS NO FATIGUE PROPAGATION OF THE CRACK. STRUCTURAL ANALYSIS OF THE ARCA SHOWS THE DEFECT TO BE ACCEPTABLE EVEN IF THE WORST CASES ARE ASSUMED (NOTE THE FUEL PREBURNER AND OXIDIZER PREBURNER ARE THE SAME IN THIS AREA)(9). THE PREBURNER WAS DVS TESTED (10).

(1) RSS-3571-9; (2) RS009003; (3) RS009002; (4) RA\*507-007; (5) RSS-8546, CP320RC003B; (6) RL00532, CP320R0003B; (7) NASA TASK 117; (8) RSS-3756; (9) MPR-55-0684; (10) DVS-305; (11) RL00350-04, RL003526

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**SSME FM CIL  
INSPECTION AND TEST**

Component Group: Combustion Devices  
 CIL Item: A700-09  
 Part Number: R5009004  
 Component: Oxidizer Preburner  
 FMEA Item: A700  
 Failure Mode: Interpropellant plate or element-to-plate braze joint leakage.

Prepared: A. Kay  
 Approved: T. Nguyen  
 Approval Date: 3/9/99  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	ELEMENT INTERPROPELLANT PLATE		RSD09008 RS009008
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RS009008 RS009008
		PLATE IS ULTRASONICALLY INSPECTED PRIOR TO MACHINING PER SPECIFICATION REQUIREMENTS	RA0115-012
		PLATE IS PENETRANT INSPECTED PRIOR TO MACHINING AND AFTER MACHINING PER SPECIFICATION REQUIREMENTS.	RA0115-116
	BRAZE INTEGRITY	BRAZE OPERATION IS CONTROLLED BY SPECIFICATION REQUIREMENTS AND THE ALLOY IS TRACEABLE TO CERTIFICATIONS	RA1607-027 RBD170-120
		ASSEMBLY JOINTS ARE IFAI CHECKED, PENETRANT INSPECTED AND INSPECTED VISUALLY AFTER BRAZING TO INSURE 360 DEGREES OF ALLOY FILLET	RSC09004 RA1607-037 RA0115-116
		AFTER BRAZING THE GAFFLES ARE FLOW CHECKED.	RL00568
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS INSPECTIONS INCLUDING: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL AS APPLICABLE	RL10011 RA0007-094 RA0115-116 RA0115-005 RA0115-127 RA1115-001
	ASSEMBLY INTEGRITY	THE INJECTOR ASSEMBLY IS PRESSURE TESTED AFTER BRAZING, WELDING, AND INSTALLATION (LAST TEST)	RL000241 RL00587
		PREBURNER INJECTOR FACEPLATE FLATNESS IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RL00528
		THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY ASSEMBLY INTEGRITY	RL00360-04 RL00366-06 RL00366-07
		ENGINES EXHIBITING HIGH MAGNITUDE CUTOFF POPS DURING HOT FIRE ARE SUBJECT TO PREBURNER FACEPLATE FLATNESS INSPECTION PER SPECIFICATION REQUIREMENTS.	MSTC FLN 1228

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

Reference: NASA letter SA21/28/3C8 and Rocketdyne letter 86RC09761.

Operational Use: Not Applicable.

**SSME FMEA/CIL  
WELD JOINTS**

Component Group: Combustion Devices  
 CIL Item: A700  
 Component: RS009004  
 Part Number: Oxidizer Preburner  
 A700

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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	
OPB CHAMBER	RS009003	1,2	GTAW	I	X	X	X	(A050)
OPB CHAMBER	RS009003	1(60DEG)	GTAW	II	X	X	X	(A050)
OPB INJECTOR	RS009004	1	EBW	II	X	X	X	
OPB INJECTOR	RS009004	2	EBW	I	X			
OPB INJECTOR	RS009004	3	GTAW	I	X			
OPB INJECTOR	RS009004	9	EBW	II	X			
OPB INJECTOR	RS009004	28	FBW	II	X			
OPB INJECTOR	RS009004	29	EBW	II	X			
OPB BODY	RS009007	1	GTAW	II	X			(A050)
OPB BODY	RS009007	2	EBW	II	X			(A050)
OPB BODY	RS009007	3	EBW	I				(A050)
OPB BODY	RS009007	4 (OPT)	GTAW	I	X			(A050)
OPB BODY	RS009007	10,11	GTAW	I	X	X	X	(A050)
OPB BODY	RS009007	12	GTAW	I	X		X	(A050)
OPB BODY	RS009007	13	GTAW	I	X	X	X	(A050)
OPB BODY	RS009007	14	GTAW	I	X	X	X	(A050)
OPB BODY	R0018067	1	GTAW	II	X	X	X	
OPB BODY	R0018067	2	EBW	I	X			
OPB BODY	R0018067	6	GTAW	I	X			
OPB BODY	R0018067	7	GTAW	I	X			
OPB FUEL MANIFOLD	RS009013	9(OPT)10 (OPT)	GTAW	I		X	X	(A050)
OPB FUEL MANIFOLD	RS009013	11 (OPT)	GTAW	I		X	X	(A050)
OPB FUEL MANIFOLD	RS009013	13 (OPT)	GTAW	I	X			(A050)
OPB OXID INLET	RS009014	6-8	GTAW	I		X		
OPB LINER	RS009015	2-17	GTAW	II	X			(A050)
OPB ASI FUEL LINE	RS009024	1	GTAW	I	X	X	X	(A050)
OPB CHAMBER	RS009003	3 (OPT) 4 (OPT)	GTAW	I		X	X	(A050)
OPB CHAMBER	RS009003	5 (OPT)	GTAW	I		X	X	(A050)
OPB CHAMBER	RS009003	6 (OPT)	GTAW	I	X			