

**SSME FMEA/CIL  
REDUNDANCY SCREEN**

Component Group: Combustion Devices  
CIL Item: A335-04  
Part Number: RD46300  
Component: Large Throat Main Combustion Chamber  
FMEA Item: A335  
Failure Mode: External rupture.

Prepared: A. El-Ahmad  
Approved: T. Nguyen  
Approval Date: 9/9/99  
Change #: 3  
Directive #: CCBD ME3-01-5238

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Phase	Failure / Effect Description	Critical by Hazard Reference
SMC 4.1	Leakage into the aft compartment will cause overpressurization. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE N/A	1 MF-R55 ME-B5M ME-B5A C

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SSMEL A/CIL  
DESIGN

Component Group: Combustion Devices  
CIL Item: A335-04  
Part Number: R046300  
Component: Large Throat Main Combustion Chamber  
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Design / Document Reference

**FAILURE CAUSE:** A: Weld or parent material failure.

THE MCC INLET AND OUTLET MANIFOLD COMPONENTS ARE INVESTMENT CAST FROM JBK-75 MATERIAL AND SOLUTION TREATED (ANNEALED) PER SPECIFICATION (1) (2) (3). JBK-75 WAS SELECTED FOR ITS CASTABILITY AND RESISTANCE TO HYDROGEN EMBRITTLEMENT (4). THE CAST PROCESS AND QUALITY REQUIREMENTS ARE CONTROLLED PER SPECIFICATION (5). EACH CASTING IS HOT ISOSTATIC PRESSED (HIP) (6) AND AGE HARDENED (3) AND PRESSURE TESTED PER SPECIFICATION AND DRAWING REQUIREMENTS (1) (2). THE STRUCTURAL JACKET IS DESIGNED TO RESTRAIN THE LINER FROM EXPANSION DUE TO CHAMBER PRESSURE. THE JACKET STRUCTURE IS REINFORCED BY THE JACKET THROAT SHELL. THE STRUCTURAL JACKET AND SHELL ARE FABRICATED FROM INCONEL 718 FORGINGS AND HEAT TREATED PRIOR TO ASSEMBLY. INCONEL 718 WAS SELECTED DUE TO ITS STRENGTH AFTER HEAT TREAT (4). ELECTRON BEAM (E.B.) WELDS ARE USED TO JOIN THE JACKET SECTIONS ALONG THE LONGITUDINAL WELDS AND AT THE THROAT (7). THE E.B. WELD PROCESS IS CONTROLLED BY SPECIFICATION (8). THE WELD JOINT CONFIGURATION IS SPECIFIED BY DRAWING (9)(7). THE LONGITUDINAL JACKET WELDS ARE TIG OVERLAYED WITH ADDITIONAL INCONEL 718 TO INCREASE THE WELD THICKNESS (7). THE JACKET SHELLS ARE JOINED WITH A E.B. WELD WITH A BACKUP STRIP, THIS PROCESS IS CONTROLLED BY SPECIFICATION (8). THE INSIDE DIAMETER OF THE JACKET IS MACHINED PER NUMERICAL CONTROL TAPE TO MATCH THE CONTOUR OF THE LINER O.D. FOR MINIMAL LINER EXPANSION DURING HOT FIRE (10). THE FORWARD END OF THE JACKET AT THE MANIFOLD WELD JOINT IS PROTECTED FROM HYDROGEN EMBRITTLEMENT BY AN INCOLOY 903 OVERLAY (4). AN E.B. WELD JOINS THE FORWARD CLOSEOUT RING TO THE FORWARD MANIFOLD AND IS PRESSURE LEAK TESTED PER DRAWING (7). HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE MANIFOLDS MEET CEI REQUIREMENTS (11). THE LTMCC PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH SINCE THERE ARE NO FRACTURE CRITICAL PARTS BASED ON SIMILARITY TO THE STMCC CONFIGURATION, EXCEPT FOR THE STRUCTURAL JACKET WHICH WAS CLEARED BY RISK ASSESSMENT (12). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH BY THE WFI D ASSESSMENT (12). TABLE A335 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. PRIMARY STRESS FACTORS OF SAFETY MEET CEI REQUIREMENTS FOR THE LTMCC (14).

(1) R046290; (2) R046291; (3) RB0150-C80; (4) 572K; (5) RA1814-C01; (6) RL00368; (7) R046300; (8) RA1607-071 (9) R046297 (10) CMR046297; (11) RLD0532, CP320R00033; (12) NASA TASK 117; (13) RSS-8756 (14) CP320R00033B

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**SSME FMEA/CIL  
INSPECTION AND TEST**

Component Group: Combustion Devices  
 CIL Item: A335-04  
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 Component: Large Throat Main Combustion Chamber  
 FMEA Item: A335  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	INLET MANIFOLD OUTLET MANIFOLD		R046290 R046281
	MATERIAL INTEGRITY	INTEGRALLY CAST TEST SPECIMENS ARE EVALUATED PER SPECIFICATION REQUIREMENTS.  PENETRANT INSPECTION OF THE I.D. AND O.D. CAST MANIFOLD SURFACES INCLUDING WINDOW WELD ARE PERFORMED PER DRAWING REQUIREMENTS.	RSC100-180 RA0115-116 R046261 R046290
	HEAT TREAT	RADIOGRAPHIC INSPECTION OF CAST MANIFOLD MATERIAL INCLUDING WINDOW WELDS IS PERFORMED PER DRAWING REQUIREMENTS.  HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.  HOT ISOSTATIC PRESSING IS APPLIED PER SPECIFICATION REQUIREMENTS.  PROCESS CONTROL IS DEFINED PER SPECIFICATION REQUIREMENTS.  THE CAST MANIFOLDS ARE PROOF PRESSURE TESTED AND PENETRANT INSPECTED AFTER PROOF PER DRAWING REQUIREMENTS.	RA0115-006 RBO160-020 R100368 RA1614-001 R046290 R046261 RA0115-110
	JACKET	A PROOF PRESSURE AND LEAK TEST IS PERFORMED ON BOTH INLET AND OUTLET MANIFOLDS AND COMPLETED ASSEMBLY	RL00784 R046261 R046290
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.  FORGINGS ARE PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	R046257 RB0170-153 RA0115-116
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS	RA0311-020
	MAIN COMBUSTION CHAMBER ASSEMBLY		RD46300
	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.	RL10011 RAC1607-071 RAC115-115 RA0115-006 RA0115-127 RA1115-001
	ASSEMBLY INTEGRITY	THE HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY MCC INTEGRITY.  A HELIUM SIGNATURE LEAK TEST VERIFIES NO EXTERNAL LEAKAGE PRIOR TO EACH LAUNCH (LAST TEST).	RL00050-04 RL00055-06 RL00056-07 OMRSD: 500000.950

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
Failure History	Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA) Reference: NASA letter SA21/88/303 and Rocketdyne letter RBRC09761.		
Operational Use:	Not Applicable		

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**SSME :A/CIL  
WELD JOINTS**

Component Group: Combustion Devices  
 CIL Item: A335  
 Component: R046300  
 Part Number: Large Throat Main Combustion Chamber  
 A335

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Component	Basic Part Number	Weld Number	Weld Type	Class	Access	Critical Initial		Comments
						Root Side Not	Flaw Size Not Detectable	
						HCF	LCF	
MAIN COMBUSTION CHAMBER	R046300	5	EBW	Ia	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	6,7	EBW	Ib	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	58,59	GTAW	II	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	10	GTAW	II	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	11,12	GTAW	II	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	13,14	GTAW	II	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	15	GTAW	II	X	X	X	
MAIN COMBUSTION CHAMBER	RC46300	16	FBW	II	X	X	X	
MAIN COMBUSTION CHAMBER	R046300	18	EBW	I	X			
MAIN COMBUSTION CHAMBER	R046300	22,23	EBW	I, Ia	X			
MAIN COMBUSTION CHAMBER	R046300	39,40	EBW	I	X			
MAIN COMBUSTION CHAMBER	R046300	63	GTAW	II	X	X	X	
MAIN COMBUSTION CHAMBER	RC46300	69,70	GTAW	II	X	X	X	

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