

SSME FIREARMS
REDUNDANCY SCREEN

Component Group: Combustion Devices
CIL Item: A205-08
Part Number: RS009122
Component: Baffleless Main Injector (Phase IH)
FMEA Item: A205
Failure Mode: External rupture.

Prepared: A. Kay
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 2
Directive #: CCGO ME3-01-5239

Page: 1 of 1

Phase	Failure / Effect Description	Criticality Hazard Reference
SMC 4.1	Fuel and hot gas leakage into the aft compartment causes overpressurization and fire. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-FB4G, ME-FB4M, ME-FB4A,C

A-127

**SSME FUEL
DESIGN**

Component Group: Combustion Devices
CIL Item: A205-08
Part Number: RS009122
Component: Baffleless Main Injector (Phase II+)
FMEA Item: 4205
Failure Mode: External rupture.

Prepared: A. Kay
Approved: T. Nguyen
Approval Date: 9/9/99
Change #: 2
Directive #: CCBD ME3-01-5238

Page: 1 of 1

Design / Document Reference

FAILURE CAUSE: A: Weld or parent material failure.

THE ASI LINE IS SUPPORTED AT THE FLANGE TO REDUCE LINE LOADING AND DAMPEN VIBRATION (1). THE ASI ASSEMBLY IS FABRICATED FROM INCONEL 625. INCONEL WAS CHOSEN FOR ITS BRAZABILITY AND WELDABILITY. THE COMPONENT DESIGN OPERATES WELL BELOW THE CRITICAL TEMPERATURES FOR HYDROGEN EMBRITTLEMENT (2). A STRUCTURAL ANALYSIS WAS PERFORMED TO VERIFY THE STRUCTURAL INTEGRITY OF THE BAFFLELESS MAIN INJECTOR DESIGN CHANGES. THE ANALYSIS SUBSTANTIATED THE STRUCTURAL CAPABILITY TO MEET THE STRUCTURAL DESIGN REQUIREMENTS. THIS ANALYSIS WAS BASED ON AN ASSESSMENT OF THE MOST CRITICAL ENGINE OPERATING CONDITIONS TO ESTABLISH THE LIMIT DESIGN PRESSURE AND THE MAXIMUM EXPECTED OPERATING LOADS. THE ANALYSIS FOR THE BAFFLELESS MAIN INJECTOR MEETS CEI REQUIREMENTS FOR HIGH CYCLE FATIGUE AND LOW CYCLE FATIGUE (3) (4). THE PRIMARY STRESS FACTOR OF SAFETY MEET CEI REQUIREMENTS (4). THE ASI FUEL LINE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (5). THE FMEACIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH BY THE WELD ASSESSMENT (6). TABLE A205 LISTS ALL FMEACIL 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 (6). A GAP BETWEEN THE WALL AND THE ASI LINE REDUCES THE CHANCE OF CRACK INITIATION FROM IMPACTING OR RUBBING ON THE DOME. THE BAFFLELESS MAIN INJECTOR HAS COMPLETED DVR TESTING (7).

(1) RS007004; (2) RSS-8572-10; (3) RI 00532, CP320R0003B; (4) RSS-8560, CP320R0003B; (5) NASA TASK 117; (6) RSS-8756; (7) RSS-8879-1

FAILURE CAUSE: B: Liquid metal embrittlement at braze areas.

THE BRAZE JOINTS ARE ACCOMPLISHED IN A TEMPERATURE CONTROLLED FURNACE (1). THIS REDUCES THE POTENTIAL FOR LIQUID METAL EMBRITTLEMENT OR BRAZE DEFECTS. PREVIOUS PROBLEM AREAS AT THE THRUST CONE WITH LIQUID METAL EMBRITTLEMENT HAVE BEEN RE-DESIGNED TO ELIMINATE THE BRAZING AND SLEEVE (2). THE OTHER BRAZE JOINTS ARE NOW BEING WELDED WITH THE EXCEPTION OF THE FUEL INLET TO BODY, WHICH REMAINS A BRAZE JOINT (3). THIS JOINT IS BRAZED TOGETHER WITH NO INDUCED LOADS.

(1) RA1607 009; (2) RS009125; (3) RS009061

A - 128

**3301E FIREARMS
INSPECTION AND TEST**

Component Group: Combustion Devices
 CIL Item: A206-08
 Part Number: RS009122
 Component: Baffleless Main Injector (Phase II+)
 FMEA Item: A206
 Failure Mode: External rupture.

Prepared: A. Kay
 Approved: T. Nguyen
 Approval Date: 9/9/99
 Change #: 2
 Directive #: CCBD ME3-01-5238

Page: 1 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	INJECTOR BODY ASI TUBF ASI ASSEMBLY		RS009126 RS009126 RS009091
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION AND DRAWING REQUIREMENTS TUBING WALL THICKNESS IS INSPECTED WHEN RAW STOCK IS RECEIVED ASI LINE IS ULTRASONICALLY AND PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RS0170-210 RB0170-213 RA0115-012 RA0115-018
	TUBE CLEARANCE	TUBE-TO-THRUST CONE CLEARANCE IS VERIFIED AFTER WELDING PER DRAWING REQUIREMENT.	RS009125
	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.	RL10311 RA1607-071 RA0115-115 RA0115-026 RA0115-127 RA1115-001 RF0001-120
B	BRAZE WELD INTEGRITY	ALL BRAZE WELDS ARE VISUALLY INSPECTED TO VERIFY BRAZE INTEGRITY. ASI WELDS ARE PENETRANT INSPECTED AFTER PROOF TEST PER SPECIFICATION REQUIREMENTS.	RSC09061 RA1607-009 RA0115-116
	ALL CAUSLS	ASI ASSEMBLY IS PROOFED AND LEAK TESTED PER DRAWING AND SPECIFICATION REQUIREMENTS HOT FIRE TESTING AND 2ND E & M INSPECTIONS VERIFY ASSEMBLY INTEGRITY. TUBE-TO-THRUST CONE CLEARANCE IS INSPECTED PRIOR TO EVERY FLIGHT. EXTERIOR OF ASI LINES ARE VISUALLY INSPECTED PRIOR TO LAUNCH. THE HELIUM SIGNATURE LEAK TEST VERIFIES NO EXTERNAL LEAKAGE PRIOR TO EACH LAUNCH (LAST TEST)	RS009126 RL00127 RLC0060-04 RLC0066-06 RLC0066-07 OMRSD V418U0.030 OMRSD V418U0.029 OMRSD V00001.950

A - 129

Component Group: Combustion Devices
 CIL Item: A205-05
 Part Number: RS009122
 Component: Baffleless Main Injector (Phase II+)
 FMEA Item: A205
 Failure Mode: External rupture.

Prepared: [blank]
 Approved: T. Nguyen
 Approval Date: 9/8/99
 Change #: 2
 Directive #: CCBD ME3-01-5238

Page: 2 of 2

Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
Failure History:	Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRAQA) Reference: NASA letter SA21/88/308 and Rockwell's letter B8RC03761		
Operational Use	Not Applicable.		

A - 130

**SSME I A/CIL
WELD JOINTS**

Component Group: Combustion Devices
 CIL Item: A205
 Component: RS009122
 Part Number: Baffleless Main Injector (Phase II+)
 A205

Prepared: A. Kay
 Approved: T. Nguyen
 Approval Date: 9/9/99
 Change #: 2
 Directive #: CCB0 ME3-01 5238
 Page: 1 of 1

A - 135

Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable		Comments
						HCF	LCF	
MAIN INJECTOR ASI LINE	RS009061	3	GTAW	I		X	X	
MAIN INJECTOR ASI LINE	RS009061	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	9	EBW	I				
MAIN INJECTOR	RS009126	3	CBW	I	X			
MAIN INJECTOR	RS009126	10	EBW	II	X	X	X	
MAIN INJECTOR	RS009126	12-13	GTAW	I	X			
MAIN INJECTOR BODY	RS009126	14-15	GTAW	I	X	X	X	
MAIN INJECTOR BODY	RS009126	16	GTAW	I	X	X	X	
MAIN INJECTOR BODY	RS009126	17	GTAW	I	X	X	X	
MAIN INJECTOR	RS009126	20	GTAW	I	X			
MAIN INJECTOR	RS009126	21	GTAW	I	X			
MAIN INJECTOR	RS009126	22	GTAW	I	X			
MAIN INJECTOR	RS009126	23-29,54	GTAW	I	X			
MAIN INJECTOR	RS009126	44-45	EBW	I	X	X	X	
MAIN INJECTOR	RS009126	50-51	CBW	Ia	X	X	X	
MAIN INJECTOR	RS009126	59	EBW	I,II	X			
MAIN INJECTOR	RS009126	60-61	GTAW	II	X			
MAIN INJECTOR BODY	RS009237	600 FLCS	FRW	I		X	X	
MAIN INJECTOR LOX SUPPLY LINE	RC018C15	1	GTAW	I	X	X		

SSWIE FIVEA/CIL

FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

Component Group: Combustion Devices
 Item Name: Baffleless Main Injector (Phase II+)
 Item Number: A205
 Part Number: RS009122

Prepared: A. Kay
 Approved: T. Nguyen
 Approval Date: 9/9/99
 Change #: 2
 Directive #: CCBD ME3-01 5238

Page: 1 of 1

Base Line Rationale	Variance	Change Rationale	Variant Case Number
1. NO RATIONALE EFFECTED	REWORKED BAFFLE POSTS EXIST ON 2 DASH NUMBERS.	INLINE REWORK OF COMPLETED BAFFLE MAIN INJECTOR IS AN ALLOWABLE ALTERNATE TO THE BAFFLELESS MAIN INJECTOR	RS009122-1571, RS009122-1581
2. NO RATIONALE EFFECTED.	BLOCK I Isp IMPROVEMENTS DO NOT EXIST ON 2 POWERHEADS	BLOCK I FLIGHT ENGINES MEET CEI REQUIREMENTS FOR Isp. HOWEVER, CERTAIN FLIGHT MANIFESTS REQUIRE AN INCREASE IN Isp FROM THE BLOCK I FLIGHT ENGINES. THE MAIN INJECTOR PRIMARY AND SECONDARY FACEPLATES WERE MODIFIED TO ENHANCE THE COMBUSTION PROCESS.	RS009122-1671
3. A205-12 AND A205-13, BLOCK III Isp IMPROVEMENTS.	THE BLOCK I FLIGHT ENGINES DO NOT HAVE THE MODIFIED MAIN INJECTOR PRIMARY AND SECONDARY FACEPLATES, ROW 13, FUEL SLEEVES AND NEW V-SEAL	BLOCK I FLIGHT ENGINES MEET CEI REQUIREMENTS FOR Isp	RS009122-1681

A - 136