

**SSME FMEA/CIL**  
**REDUNDANCY SCREEN**

Component Group: Propellant Valves  
 CIL Item: D130-05  
 Component: Fuel Preburner Oxidizer Valve  
 Part Number: RS008257  
 Failure Mode: Piece part structural failure.

Prepared: P. Low/more  
 Approved: T. Nguyen  
 Approval Date: 6/30/99  
 Change #: 1  
 Directive #: CCBD ME3-01-8225  
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Phase	Failure / Effect Description	Criticality Hazard Reference
PSMCD 4.1	Fire from LOX impact or rubbing. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE: N/A.	1 ME-C3P,D ME-C3S, ME-C3M, ME-C3A,C

SSME / FA/CIL  
DESIGN

Component Group: Propellant Valves  
CIL Item: D130-05  
Component: Fuel Preburner Oxidizer Valve  
Part Number: RS008257  
Failure Mode: Piece part structural failure.

Prepared: P. Lowrimore  
Approved: T. Nguyen  
Approval Date: 6/30/99  
Change #: 1  
Directive #: CGBD ME3-01-5228  
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Design / Document Reference

**FAILURE CAUSE:** A: Internal structural failure of: Ball seal, Shaft seal, Shaft, Bellows, Cam follower, Inlet sleeve, Outlet sleeve, Shaft bearing retainer, Cam bearing, Shaft bearing, Fasteners and cupwashers.

FPOV INTERNAL STRUCTURAL PARTS ARE THE SHAFT (1), BELLOW (2), CAM FOLLOWER (3), INLET SLEEVE (4), OUTLET SLEEVE (5), SHAFT BEARING RETAINERS (6), CAM BEARINGS (7), SHAFT BEARINGS (8), THRUST BEARING (9), BALL SEAL (10), SHAFT SEALS (11), INLET SLEEVE FASTENERS (12), AND CUPWASHERS (13), AND THE OUTLET SLEEVE FASTENERS (14) AND CUPWASHERS (15). HEAT TREATED INCONEL 718 IS USED FOR THE SHAFT, BELLOW, CAM FOLLOWER, THE INLET AND OUTLET SLEEVES (1), (2), (3), (4), (5). INCONEL 718 WAS SELECTED FOR ITS CRYOGENIC STRENGTH AND DUCTILITY AND FOR ITS WELDABILITY (16). THE INLET AND OUTLET SLEEVES ARE INSTALLED WITH 6 HEAT TREATED A-286 SCREWS. THE CUPWASHERS ON THE INLET SLEEVE ARE STAKED INTO THE SCREWHEAD AND THE SLEEVE FLANGE TO PREVENT LOSS OF SCREW TORQUE. THE OUTLET FLANGE SCREWS ARE LOCKED BY A FLAT ON THE CUP AND BY STAKING THE CUP INTO THE SCREWHEAD. THE CAM BEARINGS, SHAFT BEARINGS, AND THRUST BEARINGS HAVE HEAT TREATED 440C CRES ROLLERS AND RACES (7), (8), (17). THE MATERIAL IS USED FOR ITS HARDNESS AND WEAR RESISTANCE (18). THE SHAFT BEARINGS AND THRUST BEARINGS HAVE BE-CU RETAINERS WHICH SEPERATE THE ROLLERS AND PREVENT ROLLER SKEWING. BE-CU WAS CHOSEN FOR ITS WEAR RESISTANCE. THE SHAFT BEARING RETAINER RING IS 304 CRES (6). THE MATERIAL IS USED IN THIS APPLICATION FOR ITS DUCTILITY (16). THE BALL SEAL MATERIAL IS KEL-F (10). KEL-F IS USED FOR ITS CRYOGENIC STRENGTH, DUCTILITY, AND WEAR RESISTANCE (16). THE BALL SEAL O.D. IS A CLOSE FIT WITH THE BELLOW. WHEN FPOV INLET PRESSURE IS APPLIED, THE SEAL DEFLECTION IS LIMITED AND THE HOOP LOAD IS PICKED UP BY THE BELLOW. THIS LIMITS THE HOOP STRESS IN THE SEAL, AND PREVENTS STRUCTURAL FAILURE (18). THE BALL SEALS ARE LIMITED TO 27 STARTS (26). THE SHAFT SEAL MATERIAL IS GRAPHITE-FILLED POLYIMIDE (11). THE MATERIAL WAS SELECTED FOR ITS STRENGTH, CREEP RESISTANCE, AND WEAR RESISTANCE (16). THE INLET AND OUTLET FASTENERS AND CUPWASHERS ARE PREVENTED FROM ENTERING THE LOX FLOW AREAS BY THE ATTACHING DUCT FLANGES. THE INLET CUPWASHERS ARE MADE FROM ANEALD 302 CRES. THE OUTLET CUPWASHERS ARE MADE FROM ANEALD 321 CRES. BOTH MATERIALS ARE USED FOR THEIR DUCTILITY CORROSION RESISTANCE AND STRENGTH. ALL OF THE INTERNAL STRUCTURAL PARTS MEET THE STANDARD LOX COMPATIBILITY REQUIREMENTS WITH THE EXCEPTION OF THE SHAFT AND BALL SEALS. THE SHAFT AND BALL SEALS HAVE BEEN VERIFIED TO BE LOX COMPATIBLE IN THEIR OPERATING ENVIRONMENT AND APPROVED FOR USE (19). HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE FPOV COMPONENTS MEET CEI REQUIREMENTS (20). THE MINIMUM FACTORS OF SAFETY FOR THE FPOV MEET CEI REQUIREMENTS (21). THE FPOV COMPONENTS WERE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH, SINCE THEY ARE NOT FRACTURE CRITICAL PARTS (22). TABLE D130 LISTS ALL THE 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. THESE WELDS HAVE BEEN ASSESSED AS ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (23). THE FPOV SUCCESSFULLY PASSED THE DESIGN VERIFICATION TESTING REQUIREMENTS (24), INCLUDING VIBRATION AND ENDURANCE TESTS (25).

(1) RS008262; (2) RS008230; (3) RS008310; (4) RS008311; (5) RS010353; (6) RS008305; (7) RES1095; (8) RES1027 (9) RES1032; (10) RS008309; (11) RES1147; (12) R0011948; (13) RD153-3003/ RD153-3006; (14) RS010355; (15) RS010360; (16) RSS-8582; (17) RES1096; (18) RS008257; (19) RL10017; (20) RL00532, CP320R0003B; (21) RSS-8548, CP320R0003B; (22) NASA TASK 117; (23) RSS-8756; (24) DVS-SSME-515; (25) RSS-515-24A, RSS-515-17; (26) DAR 2761

D-52



Component Group: Propellant Valves  
 CIL Item: D130-05  
 Component: Fuel Preburner Oxidizer Valve  
 Part Number: RSD08257  
 Failure Mode: Piece part structural failure.

Prepared: P. Lowrim  
 Approved: T. Nguyen  
 Approval Date: 6/30/99  
 Change #: 1  
 Directive #: CCBD ME3-01-5226  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference	
A	MATERIAL INTEGRITY	HEAT TREAT OF FOLLOWER IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020	
		THE INLET SLEEVE IS PENETRANT INSPECTED AFTER MACHINING.	RA0115-116	
		DRY-FILM LUBE OF THE INLET SLEEVE IS VERIFIED PER DRAWING REQUIREMENTS.	RS009311	
		THE BELLOWS HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1611-002	
		DRY-FILM LUBRICANT OF THE BELLOWS IS INSPECTED PER DRAWING REQUIREMENTS.	RS008230	
		BELLOWS SPRING RATE/LOAD AND ELASTIC RETURN ARE TESTED PER DRAWING REQUIREMENTS.		
		ONE OF EVERY 25 DELIVERABLE BELLOWS IS SECTIONED AFTER ACCEPTANCE TESTING AND INSPECTED	RS008230 RL00273/ RL01122	
		THE BELLOWS ASSEMBLY IS PROOF PRESSURE TESTED AND LEAK CHECKED.		
		SHAFT HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020	
		SHAFT DETAILS ARE PENETRANT INSPECTED.	RA0115-116	
		DRY-FILM LUBE OF THE SHAFT BEARING RETAINERS IS VERIFIED PER DRAWING REQUIREMENTS.	RES1027	
		BEARING HEAT TREATMENT IS VERIFIED PER DRAWING REQUIREMENTS.	RES1095 RES1027 RES1032	
		BELLOWS ASSEMBLY SHAFT ASSEMBLY		RS008230 RS008262
		SHAFT AND BELLOWS 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 RA0607-094 RA0115-116 RA0115-008 RA0115-127 RA1115-001
ASSEMBLY INTEGRITY	TORQUE AND STAKING OF INLET AND OUTLET FASTENERS ARE INSPECTED.	RL00472		
HOT-FIRE ACCEPTANCE TESTING (GREEN RUN)	THE ASSEMBLED VALVE IS OPERATION/FUNCTION TESTED DURING MANUFACTURING.			
	VALVE OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING.	RL00461		
	VALVE ACTUATION IS VERIFIED DURING PRE-LAUNCH CHECKOUT.	OMRSD V41AS0.010 OMRSD V41AS0.030 OMRSD S00FA0.211		
	THE BALL SEAL IS LEAK TESTED PRIOR TO EACH LAUNCH. (LAST TEST)	OMRSD V41BQ0.120 OMRSD S00FA0.214		

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Component Group: Propellant Valves  
CIL Item: D130-06  
Component: Fuel Preburner Oxidizer Valve  
Part Number: RS008257  
Failure Mode: Piece part structural failure.

Prepared: P. Lowrimore  
Approved: T. Nguyen  
Approval Date: 6/30/99  
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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 SA21/88/308 and Rocketdyne letter 88RC09761.		
Operational Use:	Not Applicable.		

SSME F FA/CIL  
WELD JOINTS

Component Group: Propellant Valves  
 CIL Item: D130  
 Component: Fuel Preburner Oxidizer Valve  
 Part Number: RS008257

Prepared: P. Lowrmore  
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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	
BELLOWS	RS008230	3,4	GTAW	II	X	X		
BELLOWS	RS008230	5-7	GTAW	I				
SHAFT	RS008252	1,2	EBW	II	X	X		