

**SSME FMEA/CIL  
REDUNDANCY SCREEN**

Component Group: Propellant Valves  
 CIL Item: D120-03  
 Component: Main Oxidizer Valve  
 Part Number: RS098255  
 Failure Mode: Shaft seal leakage.

Prepared: P. Lowrimore  
 Approved: T. Nguyen  
 Approval Date: 5/30/99  
 Change #: 1  
 Directive #: CCBD ME3-01-5226  
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Phase	Failure / Effect Description	Criticality Hazard Reference
PSMCD 4.1	Primary seal leakage vents into the oxidizer drain. Leakage past both the primary and secondary seals results in burst diaphragm rupture. If hydraulic fluid leakage from the actuator primary and secondary seals exist concurrently, commingling of oxidizer and hydraulic fluid will result in fire. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE. N/A	1 ME-C3S, ME-C3M, ME-C3P,D, ME-C3A,C

SSME FA/CIL  
DESIGN

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Design / Document Reference

**FAILURE CAUSE:** A: Contamination generated from coupling.

THE SHAFT (1), UPPER COUPLING (2), AND LOWER COUPLING (3) ARE HEAT TREATED INCONEL 718. IT WAS CHOSEN FOR ITS CRYOGENIC STRENGTH, DUCTILITY, AND CORROSION RESISTANCE (4). THE INTERMEDIATE COUPLING (5) IS HEAT TREATED NITRIDING STEEL. THIS PROVIDES CORE STRENGTH AND DUCTILITY TO TRANSMIT TORQUE AND SURFACE HARDNESS TO RESIST WEAR (4). THE INTERMEDIATE COUPLING IS DRY-FILM LUBRICATED TO REDUCE FRICTION AND WEAR (5). THE INTERMEDIATE COUPLING IS NOT CORROSION RESISTANT, HOWEVER IT IS INSTALLED IN A SEALED CAVITY BETWEEN THE VALVE AND ACTUATOR. THIS PROTECTS THE COUPLING FROM MOISTURE AND MINIMIZES CORROSION. THE MIXING OF OXIDIZER AND HYDRAULIC FLUID REQUIRES THE FOLLOWING FAILURES: THE PRIMARY SHAFT SEAL ON THE VALVE MUST LEAK SUFFICIENTLY TO PRESSURIZE THE VENTED CAVITY BETWEEN THE PRIMARY AND SECONDARY SEALS, THE SECONDARY SHAFT SEAL ON THE VALVE MUST LEAK, THE PRIMARY SHAFT SEAL ON THE ACTUATOR MUST LEAK SUFFICIENTLY TO PRESSURIZE THE VENTED CAVITY BETWEEN THE ACTUATOR PRIMARY AND SECONDARY SHAFT SEALS, AND THE ACTUATOR SECONDARY SHAFT SEALS MUST LEAK TO CREATE A CRITICAL FAILURE, ALL THESE THINGS MUST OCCUR PLUS SUFFICIENT HEAT ENERGY MUST BE GENERATED IN THE COUPLING CAVITY TO PROVIDE IGNITION. THE LOW ROTATIONAL VELOCITY WITH LESS THAN 90 DEGREES TRAVEL AND ONE OPEN/CLOSE CYCLE PER FLIGHT MINIMIZES HEAT GENERATION POTENTIAL IN THE COUPLING CAVITY. DURING LAUNCH, THE ALTITUDE PRESSURE CHANGES CREATE A POSITIVE PRESSURE IN THE SEALED COUPLING CAVITY. THIS REDUCES POTENTIAL LEAKAGE ACROSS THE SECONDARY SEAL. THE CONTAMINATION HAS TO ENTER THE SEAL AGAINST LEAKAGE FLOW. THE SHAFT RADIAL MOTION WILL NOT PULL CONTAMINANTS INTO THE SEALING AREAS. THE VALVE SHAFT SEALS (6) ARE MADE FROM GRAPHITE AND TEFLON-FILLED POLYIMIDE. THIS MATERIAL WAS SELECTED FOR ITS HIGH MODULUS, RESISTANCE TO DEFORMATION UNDER PRESSURE, AND FRICTION AND WEAR CHARACTERISTICS AT TEMPERATURES FROM -320F TO +300F (4). THE ACTUATOR SHAFT SEALS (7) INCORPORATE A BUNA-N O-RING WITH A TEFLON SEALING RING BETWEEN THE O-RING AND THE SHAFT. THE BUNA-N O-RING PROVIDES PRESSURE ACTUATION OF THE SEAL, AND THE TEFLON SEAL PROVIDES LOW FRICTION WEAR RESISTANT CONTACT WITH THE SHAFT (4). THE VALVE COMPONENTS ARE CLEANED PRIOR TO ASSEMBLY (8). THE VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA (9). HIGH CYCLE AND LOW CYCLE FATIGUE AS WELL AS MINIMUM FACTORS OF SAFETY FOR THE MAIN OXIDIZER VALVE MEET CEI REQUIREMENTS (10). THE MOV WAS CLEARED FOR FRACTURE MECHANICS/IDE FLAW GROWTH, SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (11). THE MAIN OXIDIZER VALVE SUCCESSFULLY COMPLETED DVS TEST REQUIREMENTS (12), INCLUDING ENDURANCE (13), AND VIBRATION (14).

(1) RS008271, (2) RS000004, (3) RS008083, (4) RSS-8576, (5) RS008180, (6) RES1149, (7) RES1008, (8) RL10001, (9) R00711-600, (10) RLD0532 CP32DR0003B, RSS-8546, (11) NASA TASK 117, (12) DVS-SSME-515, (13) RSS-515-17, (14) RSS-515-24

**SSME FMEA/CIL**  
**INSPECTION AND TEST**

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	SEAL		RES1149
	SEAL INTEGRITY	THE VALVE SHAFT SEALS ARE INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS INCLUDING SURFACE FINISH, TENSILE STRENGTH, FLEXURAL STRENGTH, AND LOX COMPATIBILITY.	RES1149 RB0130-090 RL10017
	COMPONENT CLEANLINESS	VALVE COMPONENTS ARE VERIFIED TO BE CLEAN PRIOR TO ASSEMBLY.	RL10001
	HOT-FIRE ACCEPTANCE TESTING (GREEN RUN)	VALVE OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING.	RL00461
	ASSEMBLY INTEGRITY	MOV SHAFT PRIMARY SEAL LEAKAGE IS TESTED EVERY FLIGHT TO ASSURE NO EXCESSIVE LEAKAGE EXISTS. (LAST TEST)	OMRSD V41BQ0.036

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

Reference: NASA letter SA21/88/308 and Rockeidyne letter 88RC09761.

Operational Use: Not Applicable.

SSME / FA/CIL  
WELD JOINTS

Component Group: Propellant Valves  
 CIL Kent: D120  
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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	RS008211	3,4	EBW	II	X	X	X	
BELLOWS	RS008211	5-8	GTAW	I				
SHAFT	RS008271	1,2	EBW	II	X	X		