

**SSME FMEA/CIL
REDUNDANCY SCREEN**

Component Group: Propellant Valves
 CIL Item: D130-02
 Component: Fuel Preburner Oxidizer Valve
 Part Number: RS008257
 Failure Mode: Fails to move or moves slowly.

Prepared: P. Lowrmore
 Approved: T. Nguyen
 Approval Date: 8/30/99
 Change #: 2
 Directive #: CCBDM3-01-5228
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Phase	Failure / Effect Description	Criticality Hazard Reference
S 4.2	When not detectable by SEII, FPOV failure results in failure to establish FPB ignition or in excessive preburner temperatures. Mission scrub. Loss of vehicle due to turbine overtemperature or LOX-rich operation may result if failure not detected. Redundancy Screens: VALVE SYSTEM - SENSOR SYSTEM: UNLIKE REDUNDANCY. A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Pass - Loss of a redundant hardware items is detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event.	1R ME-B2S
M 4.1	When detected by SEII, out-of-limit valve position results in controller switch to channel B; continuation of failure mode results in hydraulic lockup of all actuators. Mission abort may result when hydraulic lockup occurs during Max Q throttling. Redundancy Screens: VALVE SYSTEM - SENSOR SYSTEM: UNLIKE REDUNDANCY A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Pass - Loss of a redundant hardware items is detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event	1R ME-B2M, ME-B6M
M 4.2	When not detectable by SEII, FPOV failure causes engine shutdown due to exceeding turbine discharge temperature. Mission abort. Redundancy Screens: VALVE SYSTEM - SENSOR SYSTEM: UNLIKE REDUNDANCY. A: Pass - Redundant hardware items are capable of checkout during normal ground turnaround. B: Pass - Loss of a redundant hardware items is detectable during flight. C: Pass - Loss of redundant hardware items could not result from a single credible event.	1R ME-B2M, ME-B6M
C 4.1	Out-of-limits valve position results in controller switch to channel B, continuation of failure mode results in pneumatic shutdown; HPFTP overspeed. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A.	1 ME-D'A C

SSME / A/CIL
DESIGN

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Design / Document Reference

FAILURE CAUSE: A: Seizure of FPOV shaft/bearings.

THE FPOV (1), THRUST (2), AND SHAFT BEARINGS (3) ARE ROLLER BEARINGS. THEY ARE USED FOR THEIR FRICTION AND LOAD CAPACITY CHARACTERISTICS. THE ROLLERS AND RACES ARE 440C (2) (3), WHICH WAS SELECTED FOR ITS HARDNESS, STRENGTH, AND CORROSION RESISTANCE (4). THE ROLLERS ARE SEPARATED BY A BE-CU RETAINER (2) (3). THE SHAFT BEARING RETAINERS ARE DRY-FILM LUBRICATED (4) TO REDUCE ROLLER-TO-RETAINER FRICTION (3). THE RETAINER PREVENTS ROLLER-TO-ROLLER CONTACT AND MINIMIZES THE ROLLER RUBBING VELOCITY. THE RETAINER PREVENTS SEIZURE CAUSED BY ROLLER SKEWING. THE LOW ROTATIONAL VELOCITY WITH LESS THAN 90 DEGREES TRAVEL PRECLUDES SEIZURE CAUSED BY WEAR OR SPALLING. THE VALVE COMPONENTS ARE CLEANED PRIOR TO ASSEMBLY (5). THE VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA (6). THE OXIDIZER SUPPLY TO THE ENGINE IS FILTERED TO 800-MICRONS (7). BINDING OR SEIZURE OF THE FPOV WILL BE DETECTED BY THE ACTUATOR RVDT CONTROLLER MONITOR AND RESULT IN A VEHICLE COMMANDED SHUTDOWN (8). THE MONITOR SYSTEM IS COMPRISED OF REDUNDANT SENSOR ELECTRONICS, REDUNDANT HARNESS, AND REDUNDANT CONTROLLER CHANNELS.

(1) RS008257; (2) RES1032; (3) RES1027; (4) RSS-8582; (5) RL10001; (6) RQ0711-600; (7) ICD 13M15000; (8) CP406R0002 PT 1.3.2.3.6.1

FAILURE CAUSE: B: Broken shaft or coupling.

THE 3 PIECE COUPLING TRANSFERS TORQUE FROM THE ACTUATOR TO THE FPOV SHAFT (1) (2). THE COUPLING PREVENTS SIDE LOADS CAUSED BY ACTUATOR/VALVE CENTERLINE MISALIGNMENT. THE SHAFT, UPPER, AND LOWER COUPLINGS (3) ARE INCONEL 718 WHICH 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).

(1) RS008257; (2) RS008262; (3) RS008318; (4) RSS-8582 (5) RS008320

FAILURE CAUSE: ALL CAUSES

HIGH CYCLE AND LOW CYCLE FATIGUE AS WELL AS MINIMUM FACTORS OF SAFETY FOR THE FUEL PREBURNER OXIDIZER VALVE MEET CEI REQUIREMENTS (1). THE FPOV WAS CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH. SINCE IT CONTAINS NO FRACTURE CRITICAL PARTS (2). THE FUEL PREBURNER OXIDIZER VALVE SUCCESSFULLY COMPLETED DVS TEST REQUIREMENTS (3), INCLUDING ENDURANCE (4), AND VIBRATION (5).

(1) RLD0532, CP320R0003B RSS-8546; (2) NASA TASK 117; (3) DVS-SSME-515; (4) RSS-515-17; (5) RSS-515-24

SSME FINEA/CIL
INSPECTION AND TEST

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	FPB OXIDIZER VALVE SHAFT SHAFT BEARING THRUST BEARING		RS008257 RS008262 RES1027 RES1032
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008262 RES1027 RES1032
		HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS	
	LUBRICATION	DRY-FILM COATING OF SHAFT BEARINGS IS VERIFIED PER DRAWING REQUIREMENTS.	RES1027
	ASSEMBLY INTEGRITY	DURING ASSEMBLY AND FUNCTIONAL TEST OF THE FPB OXIDIZER VALVE TORQUE ACTUATION IS VERIFIED.	RL00472
		VALVE IS ACTUATED AND RESPONSE TIME IS VERIFIED DURING CONTROLLER FLIGHT READINESS CHECKOUT AND DURING ACTUATOR CHECKOUT. VALVE IS ACTUATED 10 TIMES DURING HYDRAULIC CONDITIONING. (LAST TEST)	OMRSD V41AS0.030 OMRSD V41AS0.010 OMRSD S00FA0.211
B	SHAFT COUPLING SLIDER		RS008262 RS008318 RS008320
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS. HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS MACHINED PARTS ARE PENETRANT INSPECTED PER DRAWING REQUIREMENTS.	RS008262 RS008320 RS008320
	LUBRICATION	DRY-FILM LUBRICATION IS VERIFIED PER DRAWING REQUIREMENTS.	
	ALL CAUSES	FPB OXIDIZER VALVE ASSEMBLY INTEGRITY	FINISHED PARTS ARE VERIFIED CLEAN PER SPECIFICATION REQUIREMENTS. VALVE IS ASSEMBLED IN A CONTAMINATION CONTROLLED AREA. VALVE IS ASSEMBLED AND FUNCTIONALLY TESTED PER SPECIFICATION.
	HOT-FIRE ACCEPTANCE TESTING (GREEN RUN)	VALVE OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING VALVE IS RE-TESTED WHENEVER VALVE OR ACTUATOR IS CHANGED OR FPOV OUTLET FLANGE FASTENERS ARE LOOSENED	RL00461 OMRSD V41BQ0.181

D-41

Component Group: Propellant Valves
 GIL Item: D130-02
 Component: Fuel Preburner Oxidizer Valve
 Part Number: RS00B257
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 Approved: T. Nguyen
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 Directive #: CGBD ME3-01-5226
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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 Rockelodyne letter 88RC09761.		
Operational Use	FAILURE MODE CAN BE DETECTED IN REALTIME BY THE FLIGHT CONTROL TEAM WHO WILL EVALUATE EFFECTS UPON VEHICLE PERFORMANCE AND ABORT CAPABILITY. BASED ON THIS EVALUATION THE APPROPRIATE ABORT MODE OR SYSTEM CONFIGURATION WILL BE SELECTED. FAILURE DETECTION CUES AND ASSOCIATED SSME PERFORMANCE DATA HAVE BEEN COORDINATED BETWEEN THE ENGINEERING AND FLIGHT OPERATIONS ORGANIZATIONS WITH THE RESPONSES DOCUMENTED IN MISSION FLIGHT RULES.		

SSME F FA/CIL
WELD JOINTS

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