

**SSME / FACIL**  
**REDUNDANCY SCREEN**

Component Group: Propellant Valves  
CIL Item: D130-06  
Component: Fuel Preburner Oxidizer Valve  
Part Number: RS008257  
Failure Mode: Fretting of internal parts.

Prepared: P. Lowmore  
Approved: T. Nguyen  
Approval Date: 6/30/99  
Change #: 1  
Directive #: CCBD ME3-01-5226  
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Phase	Failure / Effect Description	Criticality Hazard Reference
SMC 4.1	Fire from ignition of internal parts. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE: N/A.	? ME-C3S, ME-C3M, ME-C3A,C

SSME FMEA/CIL  
DESIGN

Component Group: Propellant Valves  
CIL Item: D13B-06  
Component: Fuel Preburner Oxidizer Valve  
Part Number: RS008267  
Failure Mode: Fretting of internal parts.

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Design / Document Reference

FAILURE CAUSE: A: Relative motion of: Bellows/Housing, Inlet sleeve/Bellows/Shim, Cam follower/Guide/Housing, Bellows/Guide/Cam follower, Shaft bearings/Retainer, Retainer/Shaft, Retainer/Wavewashers/Cap, Outlet sleeve/Housing/Shim.

THE BELLOWS (1) AND HOUSING (2) ARE FABRICATED FROM INCONEL 718. THE PILOT DIAMETER ON THE BELLOWS IS DRY-FILM LUBRICATED TO REDUCE FRICTION AND THE POTENTIAL OF FRETTING. THE BELLOWS IS INSTALLED WITH 6 SCREWS INTO LOCKING INSERTS IN THE HOUSING, SCREW RUNNING AND FINAL TORQUE ARE SPECIFIED (3). THE MATING DUCT FLANGE TRAPS THE SCREWS AND PROVIDES ADDITIONAL FLANGE LOADING TO PREVENT BELLOWS/HOUSING FRETTING. THE SLEEVE (4) IS INSTALLED IN THE BELLOWS (1) WITH A SHIM (5) BETWEEN THE TWO FLANGES. THE PILOT DIAMETER OF THE SLEEVE AND THE SHIM ARE DRY-FILM LUBRICATED TO REDUCE FRICTION AND THE POTENTIAL OF FRETTING. THE INLET SLEEVE IS INSTALLED WITH 6 SCREWS WHICH ARE LOCKED WITH DRY-LUBED CONICAL WASHERS (3). THE SLEEVE IS INCONEL 718, THE SCREWS ARE A-286 CRES, THE CONICAL WASHERS ARE 302 CRES, AND THE SHIM IS INCONEL 718. THE CAM FOLLOWER (6) CONTAINS A BE-CU GUIDE (7) WHICH OPERATES ON THE HOUSING (3). BE-CU WAS SELECTED FOR ITS WEAR RESISTANCE AND FRICTION CHARACTERISTICS (8). DRY-FILM LUBRICANT ON THE GUIDE REDUCES FRICTION, IMPROVES WEAR RESISTANCE, AND REDUCES THE POTENTIAL OF FRETTING. THE BELLOWS (1) CONTAINS A BE-CU GUIDE (9) WHICH OPERATES ON THE CAM FOLLOWER (6). THE GUIDE IS DRY-FILM LUBRICATED TO REDUCE FRICTION, IMPROVE WEAR RESISTANCE, AND TO REDUCE THE POTENTIAL OF FRETTING. THE INCONEL 718 RETAINER (10) IS SPRING-LOADED AGAINST THE 440C CRES SHAFT BEARING RACE (11) BY ELGILOY WAVEWASHERS (12). THE SPRING LOAD AND THE DIFFERENTIAL HARDNESS OF THE TWO MATERIALS PREVENTS WEAR AND FRETTING. THE RETAINER IS LUBRICATED WITH DRY-FILM LUBRICANT (9) FOR ADDITIONAL PROTECTION. THE RETAINER (9) IS INSTALLED ON THE INCONEL 718 SHAFT (13). THE DIFFERENT MATERIALS, DIFFERENTIAL HARDNESS, AND DRY-FILM LUBRICANT PROVIDE PROTECTION AGAINST FRETTING BETWEEN THESE PARTS. THE WAVEWASHERS (12) LOAD AGAINST THE HEAT TREATED INCONEL 718 CAP (14) AND THE HEAT TREATED A-286 WASHER (15). THE SPRING LOAD AND THE DIFFERENTIAL HARDNESS OF THE MATERIALS PROVIDES PROTECTION AGAINST FRETTING MOTION AND FRETTING. THE INCONEL 718 OUTLET SLEEVE (16) AND ANNEALED INCONEL 718 SHIM (5) ARE INSTALLED WITH 6 SCREWS WITH CUPWASHERS (3) FOR LOCKING. THE SHIM, CUPWASHERS, AND THE SLEEVE PILOT DIAMETER ARE DRY-FILM LUBRICATED TO PREVENT FRETTING. DRY-FILM LUBRICANT, INCONEL 718, ARMCO 21-6-9 CRES, A-286 CRES, 302 CRES, BE-CU, 440C CRES, AND ELGILOY ALL MEET THE STANDARD 10KG-M LOX COMPATIBILITY REQUIREMENTS (3). THE FUEL PREBURNER OXIDIZER VALVE SUCCESSFULLY COMPLETED DVS TEST REQUIREMENTS (17) INCLUDING ENDURANCE (18) AND VIBRATION (19).

(1) RS008230; (2) RS008236; (3) RS008257; (4) RS008311; (5) RS010354; (6) RS008310; (7) RS008232; (8) RSS-8582; (9) RS008231; (10) RS008268; (11) RES1027 (12) RS008172; (13) RS008262; (14) RS008266; (15) RS008173; (16) RS010353; (17) DVS-SSME-515; (18) RSS-515-17; (19) RSS-515-24

**SSME FMI 7IL  
INSPECTION AND TEST**

Component Group: Propellant Valves  
 CIL Item: 0130-06  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	BELLOWS	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	RS008230
	HOUSING		RS008236
	FPOV		RS008257
	SLEEVE, INLET		RS008311
	SHIM, INLET SLEEVE		RS010354
	CAM FOLLOWER		RS008310
	GUIDE, CAM FOLLOWER		RS008232
	GUIDE, BELLOWS		RS008231
	RETAINER, BEARING		RS008268
	BEARING ASSEMBLY		RES1027
	WAVEWASHER		RS008172
	SHAFT		RS008262
	CAP		RS008266
	RETAINER		RS008173
	SLEEVE		RS010353
MATERIAL INTEGRITY		RS008230	
		RS008236	
		RS008311	
		RS010354	
		RS008310	
		RS008232	
		RS008231	
		RS008268	
		RES1027	
		RS008172	
		RS008262	
		RS008266	
		RS008173	
		RS010353	
HEAT TREAT	HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS.	RS008230	
		RS008236	
		RS008310	
		RES1027	
		RS008172	
		RS008262	
	PARTS ARE PENETRANT INSPECTED PER DRAWING REQUIREMENTS.	RS008236	
		RS008311	
		RS008256	

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	HEAT TREAT	DRY-FILM LUBRICANT IS INSPECTED PER DRAWING REQUIREMENTS.	RS008231 RS008232 RS010353 RS008310 RS008311 RS008268 RS010354
	ASSEMBLY INTEGRITY	FASTENER RUNNING AND FINAL TORQUES ARE VERIFIED PER DRAWING REQUIREMENTS.	RS008257
	HOT-FIRE ACCEPTANCE TESTING (GREEN RUN)	VALVE OPERATION IS VERIFIED THROUGH HOT-FIRE ACCEPTANCE TESTING (LAST TEST)	RL00461

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA)  
 Reference: NASA letter SA21/B8/308 and Rocketdyne letter B8RC09761.

Operational Use: Not Applicable

SSME F FA/CIL  
WELD JOINTS

Component Group: Propellant Valves  
 CIL Item: D130  
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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		