

**SSME - EACIL  
REDUNDANCY SCREEN**

Component Group: Oxidizer Turbopumps  
 CIL Item: BB00-07  
 Component: Low Pressure Oxidizer Turbopump  
 Part Number: RS007801  
 Failure Mode: Structural failure (rupture).

Prepared: C. Abesamis  
 Approved: T. Nguyen  
 Approval Date: 8/7/99  
 Change #: 2  
 Directive #: CCBD ME3-01-5214  
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Phase	Failure / Effect Description	Criticality Hazard Reference
PSMCD 4.1	Reduced pump output pressure and flow to HPOTP due to LPOTP rupture. Possible internal fire or explosion from rubbing at critical clearances. Aft compartment overpressurization. Loss of vehicle.  Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-C2S,A,M,C, ME-C3P,D

SSME FMEA/CIL  
DESIGN

Component Group: Oxidizer Turbopumps  
CIL Item: B000-07  
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Design / Document Reference

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**FAILURE CAUSE:** A: Failure of housing parent metal.

THE HOUSING (1) IS DESIGNED TO SUPPORT ALL INTERNAL HYDRODYNAMIC, ROTORDYNAMIC, AND ALIGNMENT FUNCTIONS OF THE TURBOPUMP WHILE MAINTAINING STRUCTURAL DESIGN MARGINS. THE HOUSING IS CAST UTILIZING TENS-50 ALUMINUM AND IS SOLUTION HEAT TREATED AND AGE-HARDENED (1). IT IS SUBJECTED TO THE HOT ISOSTATIC PRESSING PROCESS FOR IMPROVED MECHANICAL PROPERTIES AND DENSIFICATION (1). THE ALLOY IS RESISTANT TO STRESS CORROSION CRACKING AND IS LOX COMPATIBLE (2). FOR IMPROVED CORROSION RESISTANCE, THE ENTIRE HOUSING IS CHROMIC ACID ANODIZED (1). THERE ARE NO WELDS ON THE HOUSING (1). SUCCESSFUL PRESSURE INTEGRITY WAS DEMONSTRATED BY ONE HOUSING, WHICH WAS SUBJECTED TO 240 CRYOGENIC OPERATIONAL PRESSURE CYCLES AND ONE CRYOGENIC PROOF CYCLE WITH NO STRUCTURAL FAILURE (3). THE HOUSING ASSEMBLY PARENT MATERIAL WAS CLEARED FOR FRACTURE MECHANICS/NOE FLAW GROWTH BY RISK ASSESSMENT (4). THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF THE HOUSING MEETS CEI REQUIREMENTS (5). THE HOUSING MINIMUM FACTORS OF SAFETY MEET CEI REQUIREMENTS (6). THE HOUSING HAS COMPLETED DESIGN VERIFICATION TESTING FOR PROOF PRESSURE-STRESS DISTRIBUTION (7) AND PRESSURE BURST TEST (8). REUSE OF PARTS DURING OVERHAUL ARE CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (9).

(1) RS007802; (2) RSS-8579-9; (3) SSME-83-1028; (4) NASA TASK 117; (5) RL00632, CP32DR0003B; (6) RSS-8546-16, CP32DR0003B; (7) RSS-401-30; (8) RSS-401-24; (9) RL01219

**SSME FM OIL  
INSPECTION AND TEST**

Component Group: Oxidizer Turbopumps  
 Ctl. Item: B800-07  
 Component: Low Pressure Oxidizer Turbopump  
 Part Number: RS007801  
 Failure Mode: Structural failure (rupture).

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	HOUSING		RS007802
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS. HOUSING IS PROOF PRESSURE TESTED PER DRAWING REQUIREMENTS. HOUSING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS. HOUSING IS RADIOGRAPHIC INSPECTED PER SPECIFICATION REQUIREMENTS. HOUSING HOT ISOSTATIC PRESS IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RB0170-099 RS007802 RA0115-116 RL10003 RS007802 RL00372
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020
	SURFACE FINISH	HOUSING ANODIZING IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007802 RA1609-003
	ASSEMBLY INTEGRITY	HOUSING IS INSPECTED PRIOR TO AND AFTER PROOF TESTING PER DRAWING AND SPECIFICATION REQUIREMENTS. CASTING SURFACE FINISH IS INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS CASTING CORNERS AND FILLET RADII ARE INSPECTED PER DRAWING REQUIREMENTS. HOUSING VANE SURFACES ARE INSPECTED PER DRAWING REQUIREMENTS. HOUSING WALL THICKNESS IS INSPECTED PER DRAWING REQUIREMENTS.	RS007802 RL00314 RS007802 RA0115-007 RS007802
	LPOTP		RS007801
	ASSEMBLY INTEGRITY	THE PUMP SUBASSEMBLIES ARE INSPECTED DURING OVERHAUL PER SPECIFICATION REQUIREMENTS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, AND REPLACEMENT OF USAGE ITEMS AS APPLICABLE, PER OVERHAUL SPECIFICATION. OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT FIRE TESTING AND 2ND E & M TESTS ON INSPECTIONS.	RL01219 RA0115-116 RL00050-04 RL00056-08 RL00055-07 RL00461
		TORQUE CHECKS ARE PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BS0.030
		SHAFT TRAVEL IS PERFORMED PRIOR TO EACH FLIGHT (PHASE II AND BLOCK I).	OMRSD V41BS0.032
		SHAFT TRAVEL IS PERFORMED PRIOR TO AND AFTER ACCEPTANCE TESTING AND EVERY 10 STARTS THEREAFTER (BLOCK II AND IIA).	OMRSD V41BS0.033
		AN EXTERNAL VISUAL INSPECTION IS PERFORMED PRIOR TO EACH FLIGHT.	OMRSD V41BU0.030
		AFT CLOSURE INSPECTION IS PERFORMED PRIOR TO EACH FLIGHT	OMRSD V41RI0.070

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Component Group: Oxidizer Turbopumps  
CIL Item: B800-07  
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Part Number: RS007801  
Failure Mode: Structural failure (rupture).

Prepared: C. Abesamis  
Approved: T. Nguyen  
Approval Date: 8/7/89  
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	ASSEMBLY INTEGRITY	DATA FROM THE PREVIOUS FLIGHT OR HOT FIRE IS REVIEWED FOR PROPER TURBOPUMP OPERATION/PERFORMANCE. (LAST TEST)	MSFC PLN 1228

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 TA/CIL  
WELD JOINTS**

Component Group: Oxidizer Turbopumps  
 CIL Item: B800  
 Component: Low Pressure Oxidizer Turbopump  
 Part Number: RS007801

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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	
ROTOR	RS007805	1PLC(OPT)	GTAW	I				
ROTOR	RS007805	1PLC(OPT)	EBW	I				
NOZZLE	RS007810	1PLC	EBW	I				

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**SSME FMEA/CIL  
FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE**

Component Group: Oxidizer Turbopumps  
Item Name: Low Pressure Oxidizer Turbopump  
Item Number: B800  
Part Number: RS007801

Prepared: C. Abesamis  
Approved: T. Nguyen  
Approval Date: 6/7/99  
Change #: 1  
Directive #: CCBD ME3-01-5214

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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. B800-06, B800-08 BEARINGS ARE PROCESSED AND INSPECTED PER SPECIFICATION REQUIREMENTS (RL00918). (ECP 909)	BEARINGS ARE PROCESSED AND INSPECTED PER SPECIFICATION REQUIREMENTS (RL00558).	LONG TERM FATIGUE LIFE OF BEARINGS IS EXTENDED BY REDUCING THE ALLOWABLE SIZE AND QUANTITY OF ALLOWABLE DEFECTS. USE AS IS RATIONALE: 1. THE HIGH CYCLE AND LOW CYCLE FATIGUE LIFE OF BEARINGS PROCESSED PER RL00558 MEET CEI REQUIREMENTS. 2. THE MINIMUM FACTORS OF SAFETY FOR BEARINGS PROCESSED PER RL00558 MEET CEI REQUIREMENTS (RSS-8546-16).	-011, -121, -051, -071, -081, -091, -101, -111, -141, -151, -161, -181
2. B800-01 - CAUSE C / B800-09 CAUSE E THE SUPPORT IS PILOTED BY THE DEFLECTOR, WHICH IN TURN IS PILOTED BY THE NOZZLE.	THE SEAL IS PILOTED BY THE SUPPORT THE SUPPORT IS PILOTED BY THE NOZZLE.	THE PHASE II SILVER SEAL IS DESIGNED TO BE PILOTED BY THE ONE PIECE BEARING SUPPORT. THE PHASE II DESIGN ADEQUATELY CONTROLS THE STACK-UP OF THE STATIONARY HARDWARE TO PREVENT MOTION BETWEEN MATING PARTS.	RS007810-021 RS007801-191, -201
3. B800-04 CAUSE A THE INDUCER IS REDESIGNED FOR USE WITH THE LARGE THROAT MCC. THE NEW DESIGN DEMONSTRATED INCREASED PUMP CAPABILITIES AT HIGHER FLOW/SPEED WITH ACCEPTABLE INCREASE IN HEAD OUTPUT.	THE INDUCER IS DESIGNED FOR PHASE IV BLOCK I OPERATING CONDITIONS	THE PHASE II INDUCER WAS DESIGNED FOR OPERATION WITH THE STANDARD THROAT ENGINE.	RS007812-005 RS007801-201 -191
4. B800-06 - CAUSE D, H THE BEARING OUTER RACE IS SECURED BY A TWO PIECE BEARING SUPPORT. THE SUPPORT FEATURES A STIFF INTEGRAL THRUST SHOULDER DESIGNED TO REACT TO BEARING THRUST LOADS.	THE OUTER RACE NUT SECURES THE PUMP END BEARING OUTER RACE TO THE SUPPORT. PRELOAD SUPPLIED BY THE OUTER RACE NUT REDUCES POTENTIAL FOR FRETTING OR GALLING	THE PHASE II DESIGN USING A NUT TO RETAIN THE OUTER RACE PROVIDES ADEQUATE CLAMPING AND ALIGNMENT	RS007814-015 RS007825-007 RS007826-003 RS007801-201 191
5. B800-06 - CAUSE B / B800-08 - CAUSE I BALLS ARE MADE FROM SILICON NITRIDE, WHICH WILL ELIMINATE WEAR.	THE BALLS AND RACES OF THE BEARINGS ARE MANUFACTURED UTILIZING 440C CRES	THE 440C BALLS IN THE PHASE II DESIGN ARE CONTROLLED FOR WEAR AND SPALLING BY OMRSD AND DAR 2880	RS007831-091, -181 RS007801-201 -191

Component: Oxidizer Turbopumps  
 Item Name: Low Pressure Oxidizer Turbopump  
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 Part Number: RS007801

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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
6. B800-01 - CAUSE A&B, B800-02, CAUSE A-D, B800-08 CAUSE D LPOTP NOZZLES ARE LIFE LIMITED PER DEVIATION DAR 2956	LPOTP NOZZLES ARE LIFE LIMITED PER DEVIATION DAR 2742	PHASE II LPOTP NOZZLES ARE LIFE LIMITED PER DEVIATION DAR 2742	RS007810-021
7. B800-06 - CAUSE M THE SHIM AND SPRING ARE MANUFACTURED UTILIZING INCOLOY 903, WHICH WAS SELECTED FOR CRYOGENIC MECHANICAL PROPERTIES.	B800-08 - CAUSE K THE SHIMS WERE MANUFACTURED UTILIZING NICKEL 200.	THE PHASE II DESIGN SHIM MATERIAL, NICKEL 200, PROVIDES ADEQUATE PROPERTIES FOR ITS FUNCTION.	RS007817 RS007801-201 -191
THE PUMP END BEARING OUTER RACE IS PILOTTED BY THE SUPPORT AND IS RETAINED, TIGHT AGAINST THE SUPPORT SHOULDER ALONG WITH SHIMS AND SPRING, AND IS SECURED IN PLACE BY THE DEFLECTOR.	B800-09 - CAUSE D THE PUMP END BEARING OUTER RACE IS PILOTTED BY THE SUPPORT AND IS RETAINED, ALONG WITH A SHIM, BY THE OUTER RACE NUT.	THE PHASE II DESIGN USING A NUT TO RETAIN THE OUTER RACE PROVIDES ADEQUATE CLAMPING AND ALIGNMENT.	
8. B800-01 THROUGH B800-09 THE PUMP SUBASSEMBLIES ARE INSPECTED DURING OVERHAUL PER SPECIFICATION REQUIREMENTS RL01219	THE PUMP SUBASSEMBLIES ARE INSPECTED DURING OVERHAUL PER SPECIFICATION REQUIREMENTS RL00473	THE RL00473 WAS SPECIFICALLY WRITTEN FOR THE PHASE II DESIGN	RS007801-191,-201
9. B800-02 THROUGH B800-04 AND B800-06 THROUGH B800-09 ASSEMBLY INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS RL01323	ASSEMBLY INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS RL00006.	THE RL00006 WAS SPECIFICALLY WRITTEN FOR THE PHASE II DESIGN	RS007801-191,-201
10. B800-04 FAILURE CAUSE A AND B NET POSITIVE SUCTION PRESSURE REQUIREMENTS WERE SATISFIED OVER THE ENTIRE OPERATING RANGE BY DESIGN VERIFICATION TESTING VRS 0553	NET POSITIVE SUCTION PRESSURE REQUIREMENTS WERE SATISFIED OVER THE ENTIRE OPERATING RANGE BY DESIGN VERIFICATION TESTING DVS-SSME-401B	THE DVS SSME 401B WAS SPECIFICALLY WRITTEN FOR THE PHASE II DESIGN	RS007801-191,-201

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Component Group: Oxidizer Turbopumps  
 Item Name: Low Pressure Oxidizer Turbopump  
 Item Number: B800  
 Part Number: RS007801

Prepared: C. Abesamis  
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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
11. B800-01 - CAUSE C VENT HOLES DESIGNED INTO THE SEAL RING STRUCTURE PREVENT PRESSURE BUILDUP AND DISTORTION OF THE SEAL RING ONTO THE LABYRINTH SEAL.	VENT HOLES DESIGNED INTO THE SUPPORT STRUCTURE PREVENT PRESSURE BUILDUP AND DISTORTION OF THE SEAL RING ONTO THE LABYRINTH SEAL.	PHASE II DESIGN ADEQUATELY PREVENTS PRESSURE BUILD UP	RS007816-009 RS007801-201 -191

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