

Subsystem: HPOTP B500 - 4750000-700
 Functional Assy: Pump Section B50001

Critical Item List
 Prepared by: M.T. Spencer
 Approved by: R.L. Pugh
 CIL Item: 0102

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CIL Item Code: D102
 FMEA Item Code: 0102
 Function: Increase Energy of Preburner Flowstream
 System/Subsystem: HPOTP B500 - 4750000-700

Analyst: M.T. Spencer
 Approved by: R.L. Pugh
 Rev. No.:
 Rev. Date: December 08, 1995
 Effectivity:
 Hazard Ref.: See Listings Below

Operating Phase	Failure Mode, Description and Effect	Criticality
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Operating Phase:
s

Failure Mode:

Loss of preburner impeller head rise.

Failure Cause(s):

- A. In 28 Erosion or damage of the blades of the pre-burner impeller due to vibration, rub, thermal growth, material/mfg defect, or contamination/FOD
- B. In 053 or 29 Fracture or erosion of the pre-burner integral K.E. lands or seal due to vibration, rub, contamination, or material/mfg defect.
- C. In 244 Fracture or wear of the pre-burner impeller damper due to vibration, rub, thermal growth, erosion, contamination, or material/mfg defect.

Failure Effect:

Reduced preburner pump output results in commanding the preburner oxidizer valves further open. OPOV command limit results in controller issued MCF and vehicle commanded shutdown.

System:

Engine Shutdown

Mission/Vehicle:

Mission scrub

Redundancy Screens:

- A: Pass. Redundant hardware items are capable of checkout during normal ground turnaround.
- B: Pass. Loss of a redundant hardware item is detectable during flight
- C: Pass. Loss of redundant hardware items could not result from a single credible event.

Criticality:

1R

Hazard Ref:

- A) C1S/A/M/C (AT) 1A1.1.7.1.2.2 to 1A1.1.7.1.2.2.4
- C1S/M (AT) 1B2.1.3.2.1, 1B2.1.3.2.3
- B) C1S/M (AT) 1B2.1.3.2.2, 1B2.1.3.2.3
- C) C1S/M (AT) 1B2.1.3.2.2, 1B2.1.3.2.3

Operating Phase:
m

Failure Mode:

Loss of preburner impeller head rise.

Failure Cause(s):

- A. In 29 Erosion or damage of the blades of the pre-burner impeller due to vibration, rub, thermal growth, material/mfg defect, or contamination/FOD
- B. In 053 Fracture or erosion of the pre-burner integral K.E. lands or seals due to vibration, rub, contamination, or material/mfg defect.

Criticality:

1R

Hazard Ref:

- A) C1S/A/M/C (AT) 1A1.1.7.1.2.2 to 1A1.1.7.1.2.2.4
- C1S/M (AT) 1B2.1.3.2.1, 1B2.1.3.2.3

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C, In 244 Fracture or wear of the pre-burner impeller damper due to vibration, rub, thermal growth, erosion, contamination, or material/mfg defect.

B) C1S/M (AT) 1B2.1.3.2.2,
1B2.1.3.2.3
C) C1S/M (AT) 1B2.1.3.2.2,
1B2.1.3.2.3

Failure Effect:

Reduced preburner pump output results in commanding the preburner oxidizer valves further open. OPOV command limit results in controller issued MCF and vehicle commanded shutdown.

System:

Engine Shutdown

Mission/Vehicle:

Mission abort

Redundancy Scheme:

- A: Pass. Redundant hardware items are capable of checkout during normal ground turnaround.
- B: Pass. Loss of a redundant hardware item is detectable during flight
- C: Pass. Loss of redundant hardware items could not result from a single credible event.

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Part Name/No.	Design Considerations	Document Ref
<p>1/n 29 Preburner Impeller</p>	<p>FAILURE CAUSE A. The Preburner Impeller has four full, and four splitter integrally shrouded blades that raise the pressure, for delivery to the preburners. The impeller is splined to the shaft, and provides the mating surfaces for the various seals, damper, and mounting of the main thrust bearing.</p> <p>Two radial snaps keep the impeller concentric with the shaft. Two equally spaced slots in the front face allow flow to pass into the impeller bore to provide coolant flow to the pump and ball bearing.</p> <p>Trim balance as required is provided by balance weight 1/n 288, made of AMS 5645</p> <p>Material is PWA-SP 1146 (Inconel 718). The heat treatment, microstructure and chemistry all enhance operation at cryogenic temperatures. This material has a proven history in a LOX environment, LOX testing of this material appears in Appendix B2 of the P&W MCL Manual.</p> <p>Mission life for the P/B Impeller is greater than 1000 cycles.</p> <p>This part meets CEI requirements.</p> <p>DVS testing number 4.1.4.1.3.1 thru .3 require spin, burst, and resonance testing. As of 04/91, resonance testing (FR 20730-1B), and spin and burst tests (FR 20729-38 & 40) have been completed.</p> <p>DVS item 4.1.2.9 for structural design analysis has been completed, and can be found in FR-20729-5, and FR-20730-2, and Rotor dynamics FR-20730-27.</p>	
<p>1/n 53 Preburner K.E. Seal lands</p>	<p>FAILURE CAUSE B. Primary function of the K.E. seal is for thrust balance. Leakage to both sides of the impeller is controlled by a seal of rotating integral K.E. seals.</p> <p>Seal land material is Nickel 200 (PWA-SP 6000) brazed to a support of PWA-SP 1146 (Inconel 718) to preclude contaminants from the assembly, and then silver plated (AMS 2410) to seal the O.D. This material was selected for LOX compatibility, and rub tolerance since in the event of an unintentional rub, the soft silver will smear rather than abrade.</p> <p>Mission life for the seal is greater than 1000 cycles.</p> <p>This part is manufactured using gold-nickel brazing (PWA-SP 1B). Braze material is Au-Ni (AMS 4787).</p> <p>This part meets CEI requirements.</p> <p>Cup washers are used to lock the preburner inlet seal land retaining bolts. A standard MS configuration is used and is installed per spec PWA-SP 320 which assures proper deformation. Special tooling is used for the deformation of cup washers to minimize the possibility of cracking. Cup washer 1/n is 136, and the material is AMS 5588 Ni alloy (Inco 625) and the 12 1/n 134 bolts are AMS 7488 (MP35N) material.</p> <p>DVS testing number 4.1.4.1.3.4 rub testing, and has been completed, and can be found in EH02 (92-0545).</p>	
<p>1/n 244-02 Preburner damper</p>	<p>FAILURE CAUSE C. The hydrodynamic damper provides stable rotor dynamics. Flow control is enhanced by the use of a roughened stator. The damper surface is machined to have a convergent taper between the damper and rotor land. The seal is mated to the bearing support with 8 bolts and eight fitting dowel pins and a radial snap fit which all combine to stiffen both parts and reduce deflections. The pins (1/n 246) are AMS 5644 material for it's high strength.</p>	

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Seat material used is Nickel 200 (PWA-SF 6000) with silver plate (AMS 2410) for LOX compatibility.

The mission life is greater than 1000 cycles.

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Inspection and Test

Possible Causes	Significant Characteristics	Inspection and Test	Document Ref
Failure Cause A 1/n 29 P/B Impeller	Material Integrity	Material Integrity is verified per specification requirements. EDMR ECMR Contamination Control	PWA-SP 1146, AMS 5732 PWA-SP 97-5 PWA-SP 108 PWA-SP 381BQ-4
	INSPECTION	Impeller O.D. PEBB seating diameter is verified per drawing requirements. Impeller forward and aft shaft journal I.D.s are verified per drawing requirements.	
	Raw Material	Sortic per QAD	
	Finished Material	ECI at the detail level per QAD FPI at the detail level per QAD FPI at the assembly level per QAD Spine data verified per drawing requirements. Blade thickness is verified per drawing requirements.	SP-ECM Master SP-FPM Master SP-FPM Master
	Assembly Integrity	Vibration controlled by assembly balance. Balance weights are staked per print requirements.	REI 013 PWA-SP 361
Failure Cause B 1/n 53 K.E. Seal		Part seating is verified per specification. Cleanliness of components shall be verified per specification.	REI 013 PWA-SP 80
	Material Integrity	Material Integrity is verified per specification requirements	PWA-SP 1105, PWA-SP 6000
	Heat Treat	Heat treat is verified per specification.	PWA-SP 11-32, PWA SP 1146
	Braze Integrity	Braze integrity is verified per specification and drawing requirements.	PWA-SP 19
	INSPECTION	X-ray at assembly per QAD	SP-XPM Master
		FPI - at assembly per QAD FPI - support per QAD	SP-FPM Master SP-FPM Master
Assembly Integrity	Cupwasher deformation is verified per specification. Cleanliness of components shall be verified per specification.	PWA-SP 320 PWA-SP 80	

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	Plating	Plating integrity is verified per specification.	AMS 2410
Supporting hardware 0102b fn 134 BoH	Material Integrity	Material integrity is verified per specification requirements	AMS 746B
	INSPECTION		
	Raw Material	Sonic per QAD	
	Finished Material	FPI per QAD ECI per QAD	SP-FPM Master SP-ECM Master
	Assembly Integrity	All fasteners shall be installed in accordance with the table of limits.	
Failure Cause C fn 244 P/B Damper	Material Integrity	Material integrity is verified per specification requirements.	PWA-SP 1105, PWA-SP 6000, MS 93380
	Heat Treat	Heat treating is verified per specification, -02, and -03.	PWA-SP 11-32, PWA-SP 1146
	Plating Integrity	Silver plating is verified per specification, items -02, and -03 Chrome plating is verified per specification, item -03. Coating of fn 244 is verified per specification	AMS 2410 AMS 2406 PWA-SP 1142
	Braze Integrity	Braze integrity is verified per specification, items -02, and -03.	PWA-SP 19
	INSPECTION		
		I.D. of the pump end ball big seal land is verified per drawing. The surface profile of the damper and support set (244) and support assembly (-03) is verified per drawing requirements. The I.D. and O.D. of the -03 support is verified per drawing requirements.	
	Raw Material	Sonic - Support -02, and -03 per QAD	
	Finished Material	FPI - Support assembly item -03, and 244, per QAD FPI - Support -02, and 03 per QAD Sonic - Ring and support assembly-02 only per QAD X-ray - Support assembly item -03 per QAD FPI - Damper & support set, 244, ring & support assy, 244-02 per QAD	SP-FPM Master SP-FPM Master SP-XRM Master SP-FPM Master

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	Assembly Integrity	Cleanliness of components is verified per specification.	PWA-SP 80 PWA-SP 38180-4
All cause	General Quality Requirements:	Supplier Quality Assurance requirements are included in PW-QA-6076, and include such requirements as first piece layouts. This requires the documentation of dimensions on all characteristics represented on the delivered article. Inspection Methods Sheets for use in the inspection of purchased parts and assemblies contain the necessary information to insure that the requirements of the QADs, engineering drawings, and referenced documents are satisfied. For shop fabricated parts, the sheets are audited by Inspection Methods. The purchase orders for vendor supplied parts must comply with PWA-SP 300, 'Control of Materials Processes and Parts', which requires the vendor to provide material, process, and dimensional information to the Quality Department.	PWA-SP 300
	Acceptance	Acceptance test will be conducted as required by contract, to demonstrate specified performance.	DR SE-13
	Maintenance	Shaft rotation torque check is performed after engine operation, or HPOTP installation/reinstallation. P/B Impeller thread lock inspection is conducted if the torque check exceeds 100 lb.-in C/W or CC/W.	OMRSD-V41BSD.050 OMRSD-V41BUO.127
	Cleanliness	Cleanliness of components will be assured by compliance to Contamination Control Specification.	PWA-SP 80
	Walters	This section would contain a description of any limiting features of CIL hardware Not applicable at this time	DAR Numbers

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