

Subsystem: HPOTP B500 - 4750000-700 Functional Assy: Drive Turbine Section B50002		Critical Item List Prepared by: M.T. Spencer Approved by: R.L. Pugh CIL Item: 0202		Page: 42 Issue Date: December 23, 1993 Rev. Date: December 08, 1995	
CIL Item Code: 0202 FMEA Item Code: 0202 Function: Separate Inlet/Exit 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	

Operating Phase:

a

Failure Mode:

Loss of separation with resultant leakage.

Failure Cause(s):

- A. In 80 ASD Fracture of bellows, or damage of the seal surface due to vibration, thermal growth, over temp, excessive loads, or material/mfg defect.
- B. In 108 or 124 Fracture of the bellows seals between the preburner and inlet hsg. due to vibration, thermal growth, or material/mfg defect.
- C. In 059 Fracture of the main turbine housing (TOV8) due to vibration, thermal growth, excessive loads, or material/mfg defect

Failure Effect:

Turbine inlet flow loss reduces turbine power output, and pump output with reduced engine thrust. This is sensed by the controller, which increases oxidizer preburner flow. Excess turbine discharge temperature will cause redline shutdown.

System:

Engine shutdown

Mission/Vehicle:

Mission scrub.

Loss of vehicle due to HPOTP turbine failure may result if not detected.

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/M (AT) 1B2.1.1.1.1, 1B2.1.1.1.3, 1B2.1.1.1.4
- B) C1S/AM/C (AT) 1A1.1.6.1.2, C1S/M (AT) 1B2.1.1.1.1, 1B2.1.1.1.3, 1B2.1.1.1.4
- C) C1S/M (AT) 1B2.1.1.1.1, 1B2.1.1.1.3, 1B2.1.1.1.4

Operating Phase:

m

Failure Mode:

Loss of separation with resultant leakage.

Failure Cause(s):

- A. In 80 ASD Fracture of bellows due to vibration, thermal growth, over temp, excessive loads, or material/mfg defect.
- B. In 108 or 124 Fracture of the bellows seals between the preburner and inlet hsg. due to vibration, thermal growth, or material/mfg defect.
- C. In 059 Fracture of the main turbine housing (TOV5) due to vibration, thermal growth, excessive loads, or material/mfg defect

Criticality:

1R

Hazard Ref:

- A) C1S/M (AT) 1B2.1.1.1.1, 1B2.1.1.1.3, 1B2.1.1.1.4
- B) C1S/AM/C (AT) 1A1.1.6.1.2, C1S/M (AT) 1B2.1.1.1.1, 1B2.1.1.1.3, 1B2.1.1.1.4

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C) C18M (AT) 1B2.1.1.1.1,
1B2.1.1.1.3, 1B2.1.1.1.4

Failure Effect:

Turbine inlet flow loss reduces turbine power output, and pump output with reduced engine thrust. This is sensed by the controller, which increases oxidizer preburner flow. Excess turbine discharge temperature will cause redline shutdown.

System:

Engine shutdown

Mission/Vehicle:

Mission abort.

Loss of vehicle due to HPOTP turbine failure may result if not detected

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.

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Part Name/No.	Design Considerations	Document Ref
/In 080 Inlet bellows	<p>FAILURE CAUSE A. The primary function of the bellows is to compensate for the relative deflections between the preburner and turbine inlet due to thermal, pressure, and mechanical loads. It also serves as a pressure vessel between the preburner and the turbine exhaust.</p> <p>The bellows mates with the preburner on the fed side with gaskets, and to the outer case on the aft side.</p> <p>The bellows is PWA-SP 1143 (Incoloy 909) which was selected for its resistance to hydrogen embrittlement and low alpha which reduces thermal stresses. This is a fully machined bellows to eliminate welds and improve life.</p> <p>This part meets CEI LCF requirements, but does not meet the Fracture Mechanics Life, so a life limit and inspection requirement is imposed (DAR 0183)</p>	DAR NO. 0183
/In 108, & 124 Bellows seals	<p>FAILURE CAUSE B. The G2 flange seals were redesigned to reduce the amount of compression and load induced on the bellows. This redesign involved replacing the very stiff, low deflection Rocketdyne Omega seals with the higher deflection E-seals. With the redesigned seals incorporated, the amount of compression and loading is decreased while the E-seals maintain adequate compression.</p> <p>This part meets CEI requirements.</p>	
/In 059 Main turbine housing	<p>FAILURE CAUSE C. The Turbine Outer Vane Support (TOVS) transfers the loads from the inlet housing and turbine vane to the outlet duct. It also serves as a pressure vessel between the preburner and the turbine exhaust.</p> <p>The circumferential load imparted by the 1st stage ring is reacted thru the TOVS housing to pins in the pump-side flange.</p> <p>Material used is PWA-SP 1074 (IN 100), which was selected for its high strength in elevated temperature hydrogen.</p> <p>This part does not meet CEI requirements, so life and inspection limits have been imposed (DAR 0184).</p>	DAR NO. 0184

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Inspection and Test

Possible Causes	Significant Characteristics	Inspection and Test	Document Ref
Failure Cause A In 060 Inlet bellows	Material Integrity	Material integrity is verified per specification requirements.	PWA-SP 1143
	Heat Treat	Heat treat is verified per specification, and drawing requirements.	PWA-SP 11-32, PWA-SP 1143
	Braze Integrity	Braze integrity is verified per specification.	PWA-SP 19
	INSPECTION		
		Produce slots for locking keys per specification.	REI 006
	Raw Material	Bonic at the detail level per QAD	
	Finished Material	Bonic - Cross Drilled Holes Only per QAD	
		ECl at the detail level per QAD ECl at the assembly level per QAD	SP-ECM Master SP-ECM Master
		FPI at the detail and assy level per QAD	SP-FPM Master
		X-ray per QAD	SP-XRM Master
	In-Process Testing	Proof pressure test to verify specification requirements.	REI 005
Failure Cause B In 108 & 124 Bellows seals	Material Integrity	Material integrity is verified per specification requirements.	PWA-SP 1143
	Heat Treat	Heat treat is verified per specification, and drawing requirements.	PWA-SP 11-3, PWA-SP 1143
	Plating Integrity	Nickel plating is verified per specification.	AMS 2424
	INSPECTION		
	Finished Material	FPI per QAD	SP-FPM Master

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Failure Cause C in 059 Main turbine hsg	Material Integrity	Material integrity is verified per specification requirements.	PWA-SP 1074
	INSPECTION		
	Raw Material	Boric - housing per QAD	
	Finished Material	FPI - at the detail or assembly level per QAD	SP-FPM Master
		ECI - at the assembly level per QAD	SP-ECM Master
All Cause	General Quality Requirements:	Supplier Quality Assurance requirements are included in PW-QA-8076, and include such requirements as first piece layouts. This requires the documentation of dimensions on all characteristics represented on the delivered article.	PWA-SP 300
		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.	
	Acceptance	Acceptance test will be conducted as required by contract, to demonstrate specified performance.	DR SE-13
All Cause in : 060 Bellows, 058 TOYS	Welds	The bellows meets CEI LCF life but does not meet Fracture Mechanics life so a life limit and inspection requirement is imposed (DAR 0183).	DAR NO. 0183
		The TOYS does not meet CEI life requirements, so a life limit and inspection requirement has been imposed (DAR 0184).	DAR NO. 0184