| Subsystem: | HPOTP B500 - 4750000-700 | Critical Item List | | Page: | 9D |
|---|---|---|---|---|---|
| Functional Assy: | Structional Section B50004 | Prepared by: | M.T. Spencer | Issue Date: | December 23, 1993 |
| | | Approved by: | R.L. Pugh | Rev. Date: | December 08, 1995 |
| | | CIL Item: | 0402 | | |

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|---|---|---|---|
| CIL Item Code: | 0402 | Analyst: | M.T. Spencer |
| FMEA Item Code: | 0402 | Approved by: | R.L. Pugh |
| Function: | Maintain Rotor Position | Rev. No.: | |
| System/Subsystem: | HPOTP B500 - 4750000-700 | Rev. Date: | December 08, 1995 |
| | | Effectivity: | |
| | | Hazard Ref.: | See Listings Below |

| Operating Phase | Failure Mode, Description and Effect | Criticality |
|---|---|---|

**Operating Phase:**
s,m,c

**Failure Mode:**
Loss of rotor support and positioning.

**Failure Cause(s):**

A. I/n 207/287 Failure of pump end ball brg (PEBB) due to loss of cooling, deadband, or spring preload, contamination, debris, vibration, material/mfg defect, or excessive load.

B. I/n 244 Failure or deflecting of pump end ball brg support due to vibration, material/mfg defect, or excessive load.

C. I/n 161 Failure of turbine end ball brg (TEBB) due to loss of cooling or spring preload, contamination, debris, vibration, material/mfg defect, or excessive load.

D. I/n 023-02/024-02 Fracture, wear, or damage of the thrust balance comer seals, due to vibration, rub, thermal growth, material/mfg defect, or contamination

E. I/n 91 Fracture of the axial stacking nut due to vibration, excessive load, or material/mfg defect.

F. I/n 35 Fracture of the tie bolt due to vibration, excessive load, or material/mfg defect.

G. I/n 162 or 222 Failure of roller brg or outer ring due to loss of cooling or spring preload, contamination, debris, vibration, material/mfg defect, or excessive load.

H. I/n 22-29-10 Fracture of interpropellant housing due to vibration, thermal growth, excessive mechanical loads, or material/mfg defect.

**Criticality:**
1

**Hazard Ref:**
A) C1S/A/M/C (AT) 1A1.1.8.2.1.1.2.1, 1A1.1.8.2.1.1.2.3, 1A1.1.8.2.1.1.2.4, 1A1.1.8.2.1.1.2.6
B) C1S/A/M/C (AT) 1A1.1.8.2.1.1.1, 1A1.1.8.2.2.1
C) C1S/A/M/C (AT) 1A1.1.8.2.1.1.2.1, 1A1.1.8.2.1.1.2.3, 1A1.1.8.2.1.1.2.4, 1A1.1.8.2.1.1.2.5
D) C1S/A/M/C (AT) 1A1.1.8.2.1.2
E) C1S/A/M/C (AT) 1A1.1.8.2.3
F) C1S/A/M/C (AT) 1A1.1.8.2.3
G) C1S/A/M/C (AT) 1A1.1.8.2.2.2
H) C1S/A/M/C (AT) 1A1.1.8.2.1.1.1, 1A1.1.8.2.2.1

**Failure Effect:**
Rotor shift with rub in the pump would result in an uncontained failure and/or fire.

**System:**
Uncontained engine damage

**Mission/Vehicle:**
Loss of vehicle

**Redundancy Screens:**
Does not apply since it is a single point failure

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| Subsystem: HPOTP B500 - 4750000-700 | Critical Item List | Page: 91 |
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| Functional Assy: Structional Section B50004 | Prepared by: M.T. Spencer | Issue Date: December 23, 1993 |
| | Approved by: R.L. Pugh | Rev. Date: December 08, 1995 |
| | CIL Item: 0402 | |

| Part Name/No. | Design Considerations | Document Ref |
|---|---|---|
| f/n 207<br>Pump End Ball Brg | FAILURE CAUSE A. The pump end ball brg is located between the preburner, and main impellers, and has an axial load spring of AMS 4530 (Beryllium Copper) for LOX compatibility and good spring properties against the outer race to maintain PEBB Radial stiffness. The bearing is cooled by liquid oxygen.<br><br>The inner race is located axially with a lapped PWA-SP 1146 (Inco 718) spacer between the race and impeller shoulder, and retained by a spanner nut, and locked in place.<br><br>The outer race is retained in the hsg, and sufficient deadband is provided to allow motion between the bearing housing and support to prevent vibration.<br><br>Concurrent machining of the impeller O.D.s, and damper and bearing support I.D.s yields low tolerance stack up and tight radial gap control of the damper seal. The bearing sleeve O.D. is machined at assembly to provide tight dimensional control.<br><br>The damper and brg supports are made of PWA-SP 1105 (Inco 718) for strength and LOX compatibility. The damper and K.E. seal lands are brazed PWA-SP 6000 (Nickel 201) for LOX compatibility, and rub tolerance.<br><br>The original bearing material for the balls and races was AISI 440C (PWA-SP 36701) for its strength and resistance to corrosion. Subsequent testing revealed an unacceptable temperature rise across the bearing leading to several design changes which included features such as PWA-SP 1145 ceramic (SI3N4) material balls, an outer race riding cage, and revised cooling flow. The cage is K-Monel (PWA-SP 1157) with bronze-filled PTFE (PWA-SP 36705) cage sockets that lubricate the raceway by material transfer thru the ball action.<br><br>Material properties, test experience and inspection techniques combine to provide confidence in the use of SI3N4 ball material, which provides lower heat generation, increased heat dissipation, lower rates of thermal expansion and over twice the fracture toughness. Inspections for the detection of surface and subsurface flaws include FPI and Sonic techniques.<br><br>The total rotor axial travel is set at assembly by the classified spacer between the PEBB and the P/B impeller hub face, effectively setting the distance between the bearings. The position of the main impeller, relative to the bearings, determines the pump direction and turbine direction travel within the total rotor travel. The main impeller position is set at assembly by the spacer located between the right inducer axial face, and the IPS Vaporizer.<br><br>This part meets CEI requirements.<br><br>DVS 4.1.4.1.2.3 Bearing service life test to demonstrate 2X life is completed and can be found documented in FR 20727-08 and FR 21271.<br><br>DVS 4.1.4.1.2.3.1 Bearing stiffness for axial load deflection, and radial springrate, is completed and can be found documented in FR 20730-11, 18, & 20729-37. | |
| f/n 244<br>Pump end ball brg support | FAILURE CAUSE B. The PEBB is supported axially by the ring assembly, and located radially by the housing. These items are made of Inconel 718 (PWA-SP 1105) for it's strength, and experience in a LOX environment.<br><br>The bearing outer race is tight fit into a sleeve, or carrier, which is the interface between the bearing and housing. The sleeve O.D. forms the deadband clearance with the housing. This clearance is relatively small radially and must remain small for Rotor dynamics, yet remain loose enough to allow for axial translation. This is needed to allow the preload spring to maintain the required axial load. | |

The rotor load is reacted by tight fitting pins (t/n 22-24) between the ring and housing to eliminate deflections, and retained by bolts. The pin holes are line drilled at assembly for accurate positioning.

The housing is bolted to the main pump housing, and forms a portion of the left inducer inlet flow path. The bolts seal the snap, compress an axial seal between the two housings, and hold parts together when the pump is not operating.

These parts meet CEI requirements.

t/n 161
Turbine End Ball Brg

FAILURE CAUSE C. The Turbine End Ball Brg. inner race is retained axially by the brg load spring, and the outer race by a more lightly loaded spring of AMS 4530 (Barylco 25) to prevent skidding. This spring is kept outside the outer race I.D. to preclude cage interference.

The outer race carrier provides anti-rotation and is spaced off the housing to preclude radial load. Development testing experienced cracking of the integral outer race tang due to insufficient TEBB deadband. This has been addressed by providing sufficient deadband under tolerance extremes and high dynamic loads and a change from an outer race tang to a tang on the O.D. race sleeve. This brg is intended to bottom during start-up and shutdown to prevent rub in the pump.

The inner ring spacer has a classified width and is used to set the axial load of the inner TEBB and the roller bearing ring stack at assembly. The stack load increases during operation.

Material is 440-C (PWA-SP 1154) for both balls and rings. The cage is PWA-SP 1157 Fluorocarbon plastic for good cryogenic strength and low weight (AMS 4120). Bronze filled teflon (PWA-SP 36705) cage pockets are used for lubrication.

The intent is to have raceway lubrication provided by transfer of Salox material from the cages to the raceway through ball action. A predeposition will be provided to insure adequate start-up lubrication.

As with the roller bearing which shares the same compartment, a slot has been provided in the shaft inner race support area for improved drying.

This part meets CEI requirements.

DVS 4.1.4.1.2.4 Bearing service life test to demonstrate 2X life is completed and can be found documented in FR 20727-01.

DVS 4.1.4.1.2.4.1 Bearing stiffness for axial load deflection, and radial springrate, is completed and can be found documented in FR20729-31, and FR 20727-11.

t/n 23-02 and 24-02
Thrust balance seal

FAILURE CAUSE D. The orifices formed by the spaces between the impeller and the static seals regulate the cavity pressures as the shaft moves axially, to balance the rotor load, and provide rotor positioning .

Deswirl slots and vanes were incorporated into both the left and right thrust balance seals of the main impeller. These features reduce the cross coupled stiffness coefficient. While there is a decrease in performance, it is small compared to the improved rotordynamic response.

Both inboard and outboard static seals are machined at assembly for precise axial position and radial clearance control.

Mission life for the seals is greater than 1000 cycles.

These seals are retained by bolts through the left and to the right shroud assys, and leakage is prevented by ring seals.

Material used on the static seals is PWA-SP 1130 (Haynes 214 nickel alloy) for rub ignition resistance, and close thermal growth to Inconel 718.

This part meets CEI requirements.

DVS 4.1.3.3.7 Thrust balance capacity, and stability testing has been partially completed in Unit 2 build 1 A & B, and is in FR 20726-06.

DVS 4.1.4.3.1.3 Thrust balance erosion resistance evaluation has been partially completed in Unit 2 build 1, and will be evaluated after SSC testing.

f/n 91
Axial stacking nut

FAILURE CAUSE E. The rotor stacking nut is threaded, and locked to the pump end of the shaft, with a tabwasher. The axial preload is intended to preload and stiffen the rotor stack, and prevent rotation of the non splined components. The rotor stack consists of the following f/ns:
017, 018, 019, 020, 061, 063, 022-05, 022-06, 022-07, 022-08 156, 161, 162 069, 070, 090-03.
All snaps remain tight at running conditions. Spring-rate determination made for axial stack-up loads and movement.

Material is Inconel 718 which is PWA-SP 1148 which was selected for its high strength and proven history in a LOX environment.

This part meets CEI requirements.

f/n 35
Tie bolt

FAILURE CAUSE F. A single threaded tiebolt is utilized to secure the preburner impeller to the turbine shaft. Anti-rotation is provided by a tab lock which locks the bolt to the impeller hub. A threaded hex recessed into the bolt head provides wrenching access with which to rotate, and translate the rotor.

This part meets CEI requirements.

Tiebolt stretch prediction is documented in FR-20729-35.

f/n 162 and 222
Roller brg

FAILURE CAUSE G. The roller bearing inner race is retained axially by the interpropellant seal stack, and the turbine shaft shoulder.

The outer race is retained in the seal cartridge by the seal land (f/n 022-23), and a locked retaining spanner nut (f/n 067).

Load is transmitted thru the rollers to the outer race, and ultimately to the pump housing.

The negative IRC roller brg provides increased stiffness to preclude critical speeds in the operating range. The ball and roller bearing supports are machined at assembly to provide proper concentricity and clearance.

A torsional spring (f/n 063) and classified shim (f/n 070) assure proper load through the bearing inner races of the roller and bumper ball.

As with the PEBB, a shaft slot is provided for improved drying. Bearing coolant is introduced between the roller bearing outer race and knife edge seal land and flows towards the IPS.

The low pressure sink available at the IPS assure coolant flow through the bearings if the coolant pressure were to drop.

Material for races is AMS 6265 (9310 steel), and the rollers are PWA-SP 1154 (440-C stainless steel), and the cage PWA-SP 1156 (fiberglass/PTFE laminate). To provide corrosion protection for the races, they will be plated with thin dense chrome (PWA-SP 36961), and then copper (PWA-SP 36964)

Rig testing has demonstrated in excess of two times the required service life of 30 missions.

This part meets CEI requirements.

DVS 4.1.4.1.2.2 Bearing environmental test rig results on two roller bearings run simultaneously is complete, and can be found in FR-20727-01, 02, and -03.

DVS 4.1.4.1.2.5 Bearing service life test to demonstrate 2X life has been completed and is documented in FR 20727-09.

DVS 4.1.4.1.2.1 Roller bearing outer race hardness test has been completed and is documented in FR 20727-08.

f/n 22-29-10
Housing

FAILURE CAUSE H. Provides support for the static components of the interpropellant seal assembly, and the turbine end bearings.

Passages machined into the forged housing allow flow to the Oxidizer and Hydrogen drains, flow from the Helium supply and Roller Bearing end Turbine End Ball Bearing coolant supply. A spring assisted Teflon seal located in a seal gland between the borescope hole and primary Hydrogen seal drain prevents leakage flow through the Borescope hole and into the primary drain. The snap fit between the IPS Housing and Sleeve near the borescope is maintained as a back-up to the Teflon Seal. Another spring assisted Teflon seal located in a seal gland in the IPS Housing on the pump end side of the Oxidizer drain cavity prevents leakage directly into that drain.

The IPS Seal package is assembled into the sleeve prior to installation of the sleeve into the Main Housing Assembly. Bearing deadband diameters are machined with the sleeve installed to eliminate the assembly loads's affect on the deadbands.

A cup washer is used to lock the IPS seal land retaining nut due to the concern that the vaporizer could excite a tab, and cause it to be released into the flowstream. Locking is per PWA-SP 320.

Material is PWA 1146 (Inco 718) to reduce the tight assembly fit, and its demonstrated experience in a LOX environment.

Passages in the housing interface with the bolted plumbing which provides the helium buffer and purge flow as well as the conduit for venting the oxygen and hydrogen which leaks thru the seals safely overboard.

These parts meet CEI requirements.

DVS 4.1.3.2.2 IPS evaluation test on a simulation has been completed, and can be found in FR-20904-1, FR-20728-03, and FR-20728-2.

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| Inspection and Test | | | |
|---|---|---|---|
| **Possible Causes** | **Significant Characteristics** | **Inspection and Test** | **Document Ref** |
| Failure Cause A<br>I/n 207 and 287<br>Pump end ball bearing and shower head race | Material Integrity | Material integrity is verified per specification and drawing requirements.<br>1. Inner ring, 2. Outer ring, 3. Balls, 4.Cage, 5. Rivets, 6. Inserts, 7. Showerhead Inner Race | 1. & 2 PWA-SP 1154, 3. PWA-SP 1145, 4. PWA-SP 1157, and AMS 4676, 5. AMS 7226, 6. PWA-SP 82-72 BCX, 7. PWA-SP 1146 |
| | INSPECTION | | |
| | Raw Material | Sonic rings, balls and cages - assembly per QAD<br>Sonic cage and inner race details per QAD<br>Sonic balls - detail per QAD<br>X-ray cage - detail per QAD<br>X-ray balls - detail per QAD | <br><br><br>SP-XRM Master<br>SP-XRM Master |
| | Finished Material | FPI - Cage detail, inner race detail per QAD<br>FPI rings before honing - assembly per QAD<br>FPI - cage shroud per QAD<br>FPI - ball brg before honing, per QAD<br>ECI - inner and outer rings - assembly per QAD<br>Sonic - ball per QAD<br>X ray - ball per QAD | 1,4, 7 SP-FPM Master<br>SP-FPM Master<br>SP-FPM Master<br>SP-FPM Master<br>SP-ECM Master<br><br>SP-XRM Master |
| | | Diametral play, race way and ball surface finish, and outer race OD dimensions are all verified per the detail drawing.<br>Ball tolerance per AFBMA Grade 5 and drawing requirements. | |
| | Assembly Integrity | Select class spacer to fit, per the assembly drawing.<br>Check axial travel per assembly drawing.<br>Part seating will be verified per assembly drawing.<br>Install brg., spacer, spring, and torque nut and lock per assembly specification.<br>Cleanliness of components will be verified per specification.<br>Vacuum dry cycle verified per drawing requirements.<br>Axial force application limits are verified per drawing requirements.<br>Assembly temperature limits are verified per drawing requirements.<br>Bearing face flushness shall be verified per drawing requirements. | <br>REI 013<br><br><br>PWA-SP 80 |
| | Material Properties | LOX compatability of the cage & inserts verified per specification.<br>Mechanical and microstructure properties and finish and diameters of the balls verified per drawing.<br>Contamination control is verified per specification and drawing notes for inner race and cage. | PWA-SP 82-72 BCX<br><br>PWA-SP 38160-4 |

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|---|---|---|---|
| Supporting hardware<br>0402a<br>f/n 057<br>Washer-spring | Material Integrity | Material integrity is verified per specification requirements. | AMS 4530 |
| | Heat Treat | Heat treat is verified per drawing notes and specification. | PWA-SP 11-17 |
| | INSPECTION | | |
| | Raw material | Sonic per QAD | |
| | Finished Material | FPI per QAD | SP-FPM Master |
| Failure Cause B<br>f/n 244<br>Pump end ball bearing supports | Material Integrity | Material integrity is verified per specification requirements. | PWA-SP 1105 & PWA-SP 6000,<br>MS 9390- AMS 5735 |
| | Heat Treat | Heat treat is verified per specification, and drawing requirements.<br>Heat treat f/n 244-02 & 03 is verified per specification. | PWA-SP 11-32, & 1148<br>PWA-SP 11 |
| | Plating Integrity | Chrome plating integrity of f/n 244-03 is verified per specification.<br>Silver plating integrity is verified per specification. | AMS 2406<br>AMS 2410 |
| | Braze Integrity | Braze integrity is verified per specification. | PWA-SP 19 |
| | INSPECTION | | |
| | Raw Material | Sonic - Support 02, & 03 per QAD | |
| | Finished Material | Sonic - support assembly 244-02 per QAD | |
| | | FPI - support 244-02, & 03 per QAD<br>FPI - support assembly 244-03 per QAD<br>FPI - ring and support assy 244-02 per QAD<br>X-ray - support assembly - 244-03 per QAD<br>The brg hsg dead band, and damper surface profile tolerances are verified per drawing requirements.<br>The brg support snap dia. , seal land I.D., and brg support I.D. are all verified per drawing requirements. | SP-FPM Master<br>SP-FPM Master<br>SP-FPM Master<br>SP-XRM Master |
| Failure Cause B<br>f/n 244-02 and 244-03<br>Pump end ball bearing | Assembly Integrity | Cleanliness of components will be verified per specification. | REI 013<br>PWA-SP 60 |

B1-513

supports

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|---|---|---|---|
| Supporting hardware<br>0402b<br>f/n 039<br>Housing | Material Integrity | Material integrity is verified per specification. | PWA-SP 1146 |
| | Heat Treat | Heat treat is verified per specification. | PWA-SP 1144 |
| | INSPECTION | | |
| | Finished Material | Housing I.D. and O.D. are verified per drawing requirements.<br>FPI Per QAD | SP-FPM Master |
| Failure Cause C<br>f/n 161<br>Turbine end ball brg | Material Integrity | Material integrity is verified per specification requirements.<br>1. Inner ring, 2. Outer ring, 3. Balls, 4. Cage, 5. Rivets | 1, 2, & 3. PWA-SP 1154, 4. PWA-SP 1157/AMS 4120, 5. AMS 7228 |
| | INSPECTION | | |
| | Raw Material | Sonic rings, balls, and cages, per QAD<br>X-ray - cage per QAD | SP-XRM Master |
| | Finished Material | Diametral play, pilot dia, pocket clearance, race way and ball surface finish, and inner race ID dimension are all verified per the detail part drawing. | |
| | | FPI - cage shroud per QAD<br>ECI - inner & outer rings per QAD<br>FPI - rings before honing per QAD<br>ECI - balls per QAD | SP-FPM Master<br>SP-ECM Master<br>SP-FPM Master<br>SP-ECM Master |
| | Assembly Integrity | | |
| | | Axial dimensions of the rotor stack verified per assembly drawing. | REI 013 |
| | | Install bearing and load spring and associated parts, per assembly drawing.<br>Vacuum drying is verified per drawing requirements.<br>Axial force limits are verified per drawing requirements.<br>Assembly temperature limits are verified per drawing requirements.<br>Bearing face flushness shall be verified per drawing requirements. | REI 013 |
| Supporting hardware<br>0402c | Material Integrity | Material integrity is verified per specification requirements. | AMS 4530 |

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| f/n 064<br>Washer/Spacer | | | |
| | Heat Treat | Heat treat is verified per drawing notes & specification. | PWA-SP 11-17 |
| | INSPECTION | | |
| | Finished Material | FPI per QAD | SP-FPM Master |
| Failure Cause D<br>f/n 23-02, 24-02<br>Thrust balance seals | Material Integrity | Material integrity is verified per specification | PWA-SP 1130 |
| | Heat Treat | Heat treat is verified per specification, and drawing requirements. | PWA-SP 11-31 |
| | INSPECTION | | |
| | Finished Material | FPI - assembly per QAD<br>FPI - details per QAD | SP-FPM Master<br>SP-FPM Master |
| | Material Properties | Contamination control is verified per specification. | PWA-SP 36180-4 |
| Supporting hardware<br>0402d<br>f/n 127, 128<br>Bolt | Material Integrity | Material integrity is verified per specification | AMS 5731, and 7468 |
| | INSPECTION | | |
| | Raw Material | Sonic - f/n 128 per QAD | |
| | Finished Material | ECI - f/n 128 per QAD<br>FPI - f/n 127 per QAD | SP-ECM Master<br>SP-FPM Master |
| | Assembly Integrity | All fasteners shall be installed in accordance with REI 016, and tightened to the limits specified in the Table of Limits to insure joint integrity. | REI 013 |
| Failure Cause E<br>f/n 091<br>Axial stacking nut | Material Integrity | Material integrity is verified per specification requirements. | PWA-SP 1146 |
| | INSPECTION | | |

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|---|---|---|---|
| | Raw Material | Sonic ( if forging) per QAD<br>Sonic ( if barstock) per QAD | |
| | Finished Material | ECI per QAD | SP-ECM Master |
| | | FPI per QAD | SP-FPM Master |
| | Assembly Integrity | Stretch shaft, install nut and lock, verified per assembly drawing.<br>Measurements shall be taken to assure that the parts are seated.<br>Classified spacer selection verified per assembly drawing.<br>All fasteners shall be installed in accordance with REI 016, and tightened to the limits specified in the Table of Limits to insure joint integrity.<br>Cleanliness of components will be verified per specification | REI 013<br><br><br><br>PWA-SP 80 |
| Failure Cause F<br>I/n 035<br>Tieboit | Material Integrity | Material integrity is verified per specification requirements. | PWA-SP 95 |
| | INSPECTION | | |
| | Raw Material | Sonic per QAD | |
| | Finished Material | ECI per QAD | SP-ECM Master |
| | Assembly Integrity | Axial travel verified per assembly drawing.<br>All fasteners shall be installed in accordance with REI 016, and tightened to the limits specified in the Table of Limits to insure joint integrity<br>Cleanliness of components will be verified per specification.<br>Measurements shall be taken to assure that the parts are seated. | REI 013<br><br>PWA-SP 80 |
| Failure Cause G<br>I/n 162 and 222 (outer ring)<br>Roller bearing | Material Integrity | Material integrity is verified per specification requirements.<br>1. Raceways, 2. Rollers, 3. Cage & Insert<br>Contamination control per specification.<br><br>Rollers to be passivated per drawing requirements. | 1. AMS 6265, 2.PWA-SP 1154,<br>3. PWA-SP 1156<br>PWA-SP 36180-4 |
| | INSPECTION | | |
| | Raw Material | Sonic Inner and outer rings, and rollers per QAD | |
| | | FPI inner and outer rings after rough grind per QAD | SP-FPM Master |
| | Finished Material | FPI - inner ring before honing per QAD | SP-FPM Master |

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|---|---|---|---|
| | | ECI - inner and outer rings per QAD<br>X-ray - cage per QAD | SP-ECM Master<br>SP-XRM Master |
| | Assembly Integrity | Roller bearing axial seating is verified per assembly drawing.<br>Vacuum drying is verified per drawing requirements.<br>Assembly temperature limits are verified per drawing requirements. | REI 013 |
| Supporting hardware<br>0402g<br>f/n 063<br>Washer | Material Integrity | Material integrity is verified per specification. | PWA-SP 1074 |
| | INSPECTION | | |
| | Raw Material | Sonic per QAD | |
| | Finished Material | FPI per QAD | SP-FPM Master |
| Failure Cause H<br>f/n 22-29-10<br>Housing | Material Integrity | Material integrity is verified per specification requirements. | PWA-SP 1146 |
| | INSPECTION | | |
| | Raw Material | Sonic per QAD | |
| | Finished Material | FPI per QAD | SP-FPM Master |
| 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.<br><br>Inspection Methods Sheets for use in the inspection of purchased parts and assemblies contain the necessary information to insure that the requirements of the CADs, engineering drawings, and referenced documents are satisfied. For shop fabricated parts, the sheets are audited by Inspection Methods.<br><br>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 | DR SE-13 |

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| | performance. | |
| Maintenance | Shaft rotation torque check is performed after engine operation, or HPOTP installation/reinstallation. | OMRSD - V41BSO.050 |
| | Turbine end ball bearing, pump end ball bearing, and roller bearing will be inspected on a contingency basis as a result of any anamoly experienced during engine operation, or as a consequence of handling. | |
| | P/B impeller tierod lock inspection is conducted if the torque check exceeds 100 lb-in C/W or CC/W. | OMRSD - V41BUO.127 |
| | Turbine end bearing drying is initiated within 48 hours of landing or test termination. | OMRSD - V41CBO.085 |
| | HPOTP/AT barrier purge | OMRSD - V41GEN.553 |
| Cleanliness | Cleanliness of components will be assured by compliance to Contamination Control Specification. | PWA-SP 80 |
| Waivers | This section would contain a description of any limiting features of CIL hardware | DAR Numbers |
| | Not applicable at this time | |