

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Fuel Pump Assembly (Part of APU)

PART NO.: 740412/734579(ALT.)
(Part of 10201-0049)

FM CODE: A02

ITEM CODE: 20-01-11

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 31, 2000

CRITICAL PHASES: Boost

SUPERCEDES: March 31, 1997

FMEA PAGE NO.: A-22

ANALYST: R. Imre/S. Parvathaneni

SHEET 1 OF 7

APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: Fails to operate or remain in operation (Systems A and B) caused by:

- o Shaft failure
- o Gear fracture
- o Bearing seizure due to improper soaking and/or contamination
- o Defective shaft seal

FAILURE EFFECT SUMMARY: Loss of TVC will lead to vehicle breakup and loss of mission, vehicle and crew. One success path remains after the first failure. Operation is not affected until both paths are lost.

REDUNDANCY SCREENS AND MEASUREMENTS:

- 1) Pass - Hotfire APU turbine performance
- 2) Pass - APU turbine speed measurements B46R1406C, B46R1407C, B46R1408C, and B46R1409C.
- 3) Fail - Contamination

RATIONALE FOR RETENTION:

A. DESIGN

- o The Fuel Pump Assembly is designed and qualified in accordance with end item specification 10SPC-0050. (All failure causes)
- o Drive gear material is M-2 tool steel which has ultimate stress of 180,000 psi and yield stress of 140,000 psi. Actual stress due to pressure loading is 9,400 psi. This is a safety factor of 14 and 13.5 respectively. (Shaft Failure and Gear Failure)

- o Driven spur gear material is M-2 tool steel which has ultimate stress of 180,000 psi and yield stress of 140,000 psi. Actual stress is 11,677 psi for a safety factor of 11.3 and 9.9 respectively. (Gear Failure)
- o Fuel pump bearings are graphitar 86 and are soaked for nine hours minimum prior to lift off to ensure proper lubrication and sealing. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Hydrazine is filtered through a 25 micron filter upstream of the fuel pump. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Shaft is 15-5 PH steel heat treated to H1025. (Shaft Failure)
- o The driven spur gear is heat treated to a hardness of C62-66. (Gear Fracture)
- o Fluid procurement is controlled per SE-S-0073. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o APU surfaces exposed to hydrazine, except gas generator, are cleaned per 10PRC-0339. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Qualification testing verified design requirements as reported in Sundstrand Qualification Test Report AER-1539-6, Rev. B. (All Failure Causes)

B. TESTING

- o Acceptance testing is performed per Sundstrand ATP TS 2409 on new units. This includes a leak check of entire fuel pump assembly at 100 ± 25 psig helium, fuel pump shaft seal leak check at 350 ± 50 psig, GN2 spin, hot fire functional test, post hotfire pump shaft seal leak check at 350 ± 50 psig and decontamination and precision cleaning of APU fuel system. (All Failure Causes)
- o During refurbishment and prior to reuse the fuel pump assembly is subjected to the same acceptance testing as new units, after precision cleaning per ATP TS 2409. (All Failure Causes)
- o Helium (Influent) is verified for cleanliness and composition (purity and particulate count) prior to fuel pump shaft seal leak check per 10REQ-0021, para. 2.3.2.5. Fuel pump shaft seal static leakage is determined per 10REQ-0021, para. 2.1.3 after pump mating. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Helium is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5. (Bearing Seizure Due to Improper Soaking and/or Contamination)

- o Hydrazine is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.1 and OMRSD File V, Vol. 1 Requirement Number B42AP0.010. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Fuel pump shaft seal is checked for dynamic leakage per 10REQ-0021 para. 2.3.11.3, 2.3.15.5, and 2.3.16.4 respectively as follows: After low speed GN2 spin, after high speed GN2 spin and after hotfire. (All Failure Causes)
- o GN2 is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.2 and OMRSD File V, Vol. 1 Requirement Number B42AP0.012. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o TVC system functional test is performed during hotfire operations per 10REQ-0021, para. 2.3.16. (All Failure Causes)
- o GN2 (from MLP portable panels) is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 Requirement Number B42AP0.012. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTION

- o Vendor inspection and test records are verified per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Material certifications are verified per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Acceptance testing is witnessed per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Verifications that are required on new units are performed on refurbished units per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Critical Processes/Inspections:
 - MPI per CP 16.04-01
 - Heat Treat per CP 09.M2TS-H30-1-01
 - Heat Treat (Shaft) per MIL-H-6875
 - Silver Plate (Shaft) per QQ-S-365
 - Nitride (Shaft) per CP 09-CRES-CN-3-01
 - Chrome Plate (Shaft) per QQ-C-320

KSC RELATED INSPECTIONS

- o Helium (Influent) is verified for cleanliness and composition (purity and particulate count) prior to fuel pump shaft seal leak check per 10REQ-0021, para. 2.3.2.5. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Precision cleaning of tubes/hoses is verified by USA SRBE 10REQ-0021 para. 2.3.7.3 and 10REQ-0021, para. 2.3.0. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Helium cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Hydrazine cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.1 and OMRSD File V, Vol. 1 Requirement Number B42AP0.010. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o GN2 cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.2 and OMRSD File V, Vol. 1 Requirement Number B42AP0.012. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Verify fuel pump bearings have been soaked for the time period per 10REQ-0021, para. 2.3.7.3 and per OMRSD File V, Vol. 1 Requirement number B42AP0.080 as applicable. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Proper function of TVC system is demonstrated during Hotfire operations per 10REQ-0021 para. 2.3.16 to include Hotfire. (All Failure Causes)
- o GN2 (from MLP portable panels) cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 Requirement Number B42AP0.012. (Bearing Seizure Due to Improper Soaking and/or Contamination)

- o TVC Couplings (Both SRB and GSE) are inspected each time prior to mating per 10REQ-0021 para. 2.3. After transfer to SPC they are inspected prior to mating per File V, Vol. I, requirement number B42GEN.070. (Bearing seizure due to improper soaking and/or contamination)
- o GN2 (from servicing cart) cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 Requirement Number B42AP0.012. (Bearing Seizure Due to Improper Soaking and/or Contamination) CN 038
- o Hydrazine (from servicing cart) cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 Requirement Number B42AP0.010. (Bearing Seizure Due to Improper Soaking and/or Contamination)
- o Verification of APU Fuel system GN2 blanket pressure check per File V, Vol. I, requirement number B42APO.030 (All Failure Causes)

D. FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- o Not applicable to this failure mode.