SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: APU Hydrazine Lines and Fittings

PART NO.: Part of 10201-0049 (740414)
Includes:
Fuel Supply Line726322
Bypass Fuel Line726323
Dynatube Fitting59065-1
Dynatube Pressure Cap 57905-4
Dynatube Pressure Cap 57954
Tee Fitting 57963
Reducer Tee Fitting58559
90° Elbow 58195
60° Elbow 58196

FM CODE: A01

ITEM CODE: 20-01-13A

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 31, 2000

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: March 31, 1997

FMEA PAGE NO.: A-41

ANALYST: R. Imre/ S. Parvathaneni

SHEET 1 OF 7

APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: External leakage of hydrazine (Systems A and/or B) caused by:

- Defective or damaged seal
- Contamination
- Defective line swage
- Improper torque
- Thread failure
- Improperly lockwired

FAILURE EFFECT SUMMARY: Fire and explosion will lead to the loss of mission, vehicle and crew.

REDUNDANCY SCREENS AND MEASUREMENTS: N/A

RATIONALE FOR RETENTION:

A. DESIGN

- The APU Hydrazine Lines and Fittings are designed and qualified in accordance with end item specification 10SPC-0050. (All failure causes)

- The tubing material is 304L stainless steel per MIL-T-8606. Type 1 is .250" OD by .035" wall thickness. End fittings are attached to the tubing by mechanical internal swaging per CP17.38-01-01. (Defective Line Swage)

- The end fittings are titanium with resistoflex design for improved sealing upon application of operating pressure. (Defective or Damaged Seal)

- Tube surface imperfections are controlled per MS33611. (Defective Line Swage)

- Tube assembly installation meets minimum clearance distance requirements relative to other items to prevent vibration induced interference. (All Failure Causes)

- APU surfaces exposed to hydrazine, except gas generator, are cleaned to per 10PRC-0339. (Contamination)

- The aft skirt area is purged with GN2 prior to APU start up. This reduces the 02 concentration to less than four percent per OMRSD File II, Vol. 1, requirement number S00FM0.430. (Defective or Damaged Seal, Defective Line Swage, Thread Failure)

- Qualification testing verified design requirements as reported in Sundstrand APU Qualification Test report AER 1539-6, Rev. B. (All Failure Causes)

- Hydrazine is filtered through two 25 micron filters upstream of the lines and fittings. (Contamination)

- All threaded fittings and connectors are torqued per engineering specifications and are lockwired per MS 33540. (Improper Torque, Improperly Lockwired)

- Fluid procurement is controlled per SE-S-0073. (Contamination)

B. TESTING

- Acceptance testing is performed per Sundstrand ATP TS 2409, Rev. Y on all new units. This includes hotfire acceptance test and decontamination and precision cleaning of the fuel system. (Defective or Damaged Seal, Contamination, Defective Swage)

- During refurbishment and prior to reuse the APU and its lines and fittings are subjected to the same ATP as new units. (Defective Line Swage, Contamination, Thread Failure)

- The tube assemblies are proof pressure tested to 2200 $\pm$ 50 psig for five minutes with no leakage allowed, by vendor. (Defective or Damaged Seal, Defective Line Swage, Thread Failure)

- Hotfire test is performed during hotfire operations to demonstrate proper function per 10REQ-0021, para. 2.3.16. (Defective or Damaged Seal, Defective Line Swage, Thread Failure)

- Verification of APU Fuel system GN2 blanket pressure check per File V, Vol. I, requirement number B42APO.030 (All Failure Causes)

- 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. (Contamination)

- Helium is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board flight hardware per 10REQ-0021, para. 2.3.2.5. (Contamination)

- Hydrazine is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board flight hardware per 10REQ-0021, para. 2.3.2.1 and OMRSD File V, Vol. 1, requirement number B42AP0.010. (Contamination)

- GN2 is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board flight hardware per 10REQ-0021, para. 2.3.2.2 and OMRSD File V, Vol. 1, requirement number B42AP0.012. (Contamination)

- GN2 (from MLP portable panels) is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board flight hardware per OMRSD File V, Vol. 1, requirement number B42AP0.012. (Contamination)

- The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTIONS

- Verification of material certifications per SIP 1128 by vendor and USA SRBE PQAR (Thread Failure).

- Verification of all sealing surfaces per SIP 1128 by USA SRBE PQAR. (Defective or Damaged Seal)

- Witnessing of acceptance testing per SIP 1128 by vendor and USA SRBE PQAR. (Defective or Damaged Seal, Contamination, Defective Line Swage, Thread Failure)

- Final inspection to drawing requirements is performed by vendor and verified per SIP 1128 by USA SRBE PQAR. (All Failure Causes)

- Vendor inspection and test records are verified per SIP 1128 by USA SRBE PQAR. (All Failure Causes)

- o Torque operations are verified per SIP 1128 by USA SRBE PQAR. (Improper Torque)
- 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
  - Swaging per 10PRC-0038

KSC RELATED INSPECTIONS

- o Hydrazine cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board flight hardware per 10REQ-0021,, para. 2.3.2.1 and OMRSD File V, Vol. 1, requirement number B42APO.010. (Contamination)
- o Proper function of TVC system is demonstrated during Hotfire operations per 10REQ-0021 to include Hotfire, para. 2.3.16. (All Failure Causes)
- o Inspect all tube and hose assemblies and fittings prior to installation per 10REQ-0021, para. 2.3.0. (Defective or Damage Seal, Contamination, Defective Line Swage)
- o O-Rings, K-Seals and E-Seals (as applicable) are inspected prior to installation for absence of physical defects per 10REQ-0021, para. 2.3.0. (K-seal Failure)
- o Sealing surfaces are inspected prior to installation, verifying no contaminant or obstruction exists per 10REQ-0021, para. 2.3.0. (Defective or Damaged Sealing Surface)
- o GN2 cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board flight hardware per 10REQ-0021, para. 2.3.2.2 and OMRSD File V, Vol. 1, requirement number B42AP0.012. (All Failure Causes)
- o Post hotfire verification including inspection and leak check per 10REQ-0021, para. 2.3.16.4. (Defective Line Swage, Thread Failure)
- o Helium (influent) cleanliness and composition (purity and particulate count) are verified prior to fuel shaft seal leak check per 10REQ-0021, para. 2.3.2.5. (Contamination)
- o Helium cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board flight hardware per 10REQ-0021, para. 2.3.2.5. (Contamination)

- Inspect TVC system in aft skirt for damage. No leaks, signs of rubbing or discoloration are allowed per 10REQ-0021 following low speed GN2 spin, para. 2.3.11.3 and high speed GN2 spin, para. 2.3.15.5. (Defective or Damaged Seal, Defective Line Swage, Thread Failure)

- 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. (Contamination)

- GN2 (from servicing cart) 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. (Contamination)

- Hydrazine (from servicing cart) 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 B42AP0.010. (Contamination)

- 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. (Contamination).

- Verification of APU Fuel system GN2 blanket pressure check per File V, Vol. I, requirement number B42APO.030 (All Failure Causes) CN 038

D. FAILURE HISTORY

- Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- Not applicable to this failure mode.