SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Hydrazine Rigid Lines and Fittings, and Flush and Purge In-Line Filter

PART NO.: See Below

FM CODE: A02

ITEM CODE: 20-01-42

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: See Parts List

DATE: March. 1, 2002

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: Aug. 15, 2000

FMEA PAGE NO.: A-138

ANALYST: B. Snook/S. Finnegan

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SHEET 1 OF 6

APPROVED: S. Parvathaneni

FAILURE MODE AND CAUSES: Rupture (System A and/or B) caused by:

- Material defect
- Manufacturing defect

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

REDUNDANCY SCREENS AND MEASUREMENTS: N/A

PART NUMBERS:

Rigid Lines

Alt. 10200-0011-101
10200-0011-102
10200-0020-101
Alt. 10200-0020-105
10200-0020-109
Alt. 10200-0020-106
10200-0020-103
Alt. 10200-0020-107

10201-0002-104

10201-0002-106
10201-0002-114
10201-0002-115
10203-0003-101
10203-0004-102
10203-0005-101
10203-0005-102
10203-0005-105

Fittings

Connector
10209-0025-801 (2)

Tee
10209-0010-801
Alt. 10209-0117-801
10209-0053-801 (2)
Alt. 10209-0118-801

Elbow
10209-0068-801 (3)
Alt. 10209-0133-801
10209-0069-801
Alt. 10209-0134-801

Flush & Purge In-Line Filter
10201-0121

RATIONALE FOR RETENTION:

A. DESIGN

- The Flush and Purge In-Line Filter is designed and qualified per source control drawing 10201-0121. (All failure causes)

- All lines are 304L stainless steel tubing per MIL-T-6845 or 3AL-2,5V Titanium tubing per 13A10047. (Material Defect)

- Dynatube fittings are titanium 6AL-4V and are attached to the tubing by mechanical internal swaging. (Material Defect and Manufacturing Defect)

- All hydrazine lines and the flush and purge in-line filter are designed for proof pressure two times operating pressure and burst pressure four times operating pressure. (All Failure Causes)

- Fittings are lockwired per MS 33540. (Manufacturing Defects)

- Tube assemblies are fabricated per 10PRC-0038. This includes preparation and inspection of tube ends and fittings, assembly alignment checks and acceptance criteria of the assembled unit.

- Rigid Lines are designed per MSFC specification 13A10047 and qualified per NASA TM-78258 and TM-82439. (All Failure Causes)

- Tube/hose assemblies are mounted to the aft skirt in a 100,000 cleanroom. (Manufacturing Defects)
- Fluid procurement is controlled by SE-S-0073. (Material Defects)
- Normal operating pressure of the fuel system is 400 psig maximum. (All Failure Causes)
- Stainless steel tubing is not reused. (All Failure Causes)
- The aft skirt is purged with GN2 prior to APU start up. This reduces the O2 concentration to less than four percent per OMRSD File II, Vol. 1, requirement number S00FM0.430. (All Failure Causes)
- Tubing and Hoses were qualified for SRB application as reported in the Solid Rocket Booster TVC System verification test (V-2) TM-78258 (nominal) and TM-82439 (off-nominal). (All failure causes)
- The Flush and Purge In-Line Filter qualification testing verified design requirement, as reported in Puroflow qualifiction test report, QTR 213-1426. (All failure causes)

B. TESTING

- Flush & Purge In-Line Filter acceptance test is performed per Puroflow ATP-1426 on each new flight article. This include bubble point test, visual inspection, proof pressure test to 860 psig, leakage test to $\leq 1 \times 10^{-6}$ sccs of helium, Flow Test and Cleanliness Verification (All failure modes)
- Individual tube assemblies are hydrostatically proof tested per 10REQ-0021, para. 2.3.3.5. (All Failure Causes)
- Individual tube assemblies are helium leak tested per 10REQ-0021, para. 2.3.3.6, Hydrazine System. (Material Defect and Manufacturing Defect)
- Installed tube/hose assemblies are helium leak tested per 10REQ-0021, para. 2.3.3.3. (Material Defect and Manufacturing Defect)
- After installation, the FSM connections are helium leak verified with pressure checked to 380 +0/-10 psig helium per 10REQ-0021, para. 2.3.3.1. (Material Defect and Manufacturing Defect)
- Fuel circuit (system) passivation is performed per 10REQ-0021, para. 2.3.7.3. (Material Defects)
- Functional test is performed during hotfire operations per 10REQ-0021, para. 2.3.11, 2.3.15, and 2.3.16 respectively for: (All Failure Causes)
  - Low speed spin
  - High speed spin
  - Hotfire
- 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. (Material Defects)

- 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. (Material Defects)

- 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. (Materials Defects)

- 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. (Material Defects)

- o Verification of APU Fuel system GN2 blanket pressure check per File V, Vol. I, requirement number B42APO.030 (Material Defect and Manufacturing Defect)

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o Inspections of sealing surfaces by USA SRBE PQAR per SIP 1260. (Manufacturing Defect and Material Defect)

- o Critical processes/Inspections:

  - Swaging per 10PRC-0038
  - Tube Bending per 10PRC-0038
  - Tube End Flaring per 10PRC-0038

Flush and Purge In-line Filter Vendor Related Inspections

- o Filter dimensions are inspected by USA SRBE PQAR per SIP 1509 (Manufacturing defect)

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- o Verification of materials test report by USA SRBE PQAR per SIP 1509. (Defective material)

- o Acceptance testing is witnessed by USA SRBE PQAR per SIP 1509 (All failure causes)

- o Final inspection per drawing requirements by USA SRBE PQAR per SIP 1509 (All failure causes)

NOTE: Inspections per SIP 1509 are performed on USA SRBE procured filters.

- o Critical processes/inspections (Flush and Purge In-Line Filter):

  - Fusion Welding per PWP-502
  - Radiographic Inspection per PPS-399/MIL-STD-453
  - Penetrant Inspection per PPT-262/MIL-STD-2154
  - Passivation per ACS1002

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KSC RELATED INSPECTIONS

- FSM connections are helium leak verified per 10REQ-0021, para. 2.3.3.1. (Material Defect, Manufacturing Defect)
- In skirt tube/hose installation torque and lockwire is per 10REQ-0021, para. 2.1.4. (All Failure Causes)
- Precision cleaning of tubes/hoses is verified by USA SRBE per 10REQ-0021, para. 2.3.0. (Material Defects)
- 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. (Material Defects)
- 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. (Material Defect)
- Individual tube assemblies are inspected for the requirements of 10PRC-0038 per 10REQ-0021 para. 2.3.0. (All Failure Causes)
- 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. (Material Defect)
- Inspections for leaks, rubbing and discoloration are conducted per 10REQ-0021, para. 2.3.11.3 and 2.3.15.5 respectively, following low speed GN2 spin and high speed GN2 spin. (All Failure Causes)
- Hydrostatic test is verified per 10REQ-0021, para. 2.3.3.5. (All Failure Causes)
- Preinstallation helium leak test is verified on individual tube assemblies per 10REQ-0021, para. 2.3.3.6. (Material Defect)
- Fuel system helium leak test is performed per 10REQ-0021, para. 2.3.3.1. (Material Defect and Manufacturing Defect)
- System pressure decay test is monitored per 10REQ-0021 para. 2.3.3.1.b for the fuel system prior to hot fire. (All failure causes)
- Proper function of TVC system is demonstrated during hotfire per 10REQ-0021, para. 2.3.16. (All Failure Causes)
- Post hotfire inspection and leak check per 10REQ-0021, para. 2.3.16.4. (All Failure Causes)
- Verification of APU Fuel system GN2 blanket pressure check per File V, Vol. I, requirement number B42APO.030 (All Failure Causes)
- 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. (Material Defect)
- 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. (Material Defect).

- 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. (Material Defect)

- 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. (Material Defect)

D. FAILURE HISTORY

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

E. OPERATIONAL USE

- o Not applicable to this failure mode.