SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Hydraulic Flex Lines

PART NO.: See Below

FM CODE: A01

ITEM CODE: 20-01-41

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: See Parts List

DATE: March 1, 2001 CN 042

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: March 31, 2000 CN 042

FMEA PAGE NO.: A-135

ANALYST: B. Snook/S. Parvathaneni

SHEET 1 OF 6

APPROVED: S. Parvathaneni

FAILURE MODE AND CAUSES: External leakage of hydraulic fluid (System A and/or B) caused by:

- Contamination
- Defective or damaged sealing surface
- Defective crimping
- Misalignment of dynatube sealing surfaces
- Improper torque
- Improperly lockwired

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

REDUNDANCY SCREENS AND MEASUREMENTS: N/A

PART NUMBERS:

High Pressure Flex Lines

10200-0014-101 (Rock)
Alt. 10200-0014-103
10200-0014-102 (Tilt)
Alt. 10200-0014-104
10200-0015-101 (Tilt)
Alt. 10200-0015-103
10200-0015-102 (Rock)
Alt. 10200-0015-104
10200-0026-101
Alt. 10200-0026-102
10200-0036-101 (Rock)
Alt. 10200-0036-103
10200-0036-102 (Tilt)

Alt. 10200-0036-104
10201-0010-101

Low Pressure Flex Lines

10200-0012-101
Alt. 10200-0012-102
10200-0013-101
Alt. 10200-0013-102
10200-0017-101 (Tilt)
Alt. 10200-0017-102
10200-0019-101 (Rock)
Alt. 10200-0019-103
10200-0019-102 (Tilt)
Alt. 10200-0019-104
10200-0024-101 (Rock)
Alt. 10200-0024-102
10201-0012-101

RATIONALE FOR RETENTION:

A. DESIGN

- The flex lines are designed as per the USA SRBE source control drawings 10209-0020, 0022 and 0023. The tubes are designed as per the MSFC specification 13A10047. The qualification of these flex lines is as per NASA TM-78258 and TM-82439. (All Failure Causes)

- Dynatube fittings are titanium 6AL-4V and are attached to the hoses by mechanical swaging. (Defective or Damaged Sealing Surface)

- All hydraulic lines of less than 1.5" diameter are designed for proof pressure two times operating pressure and burst pressure four times operating pressure. (Defective crimping, Defective or Damaged Sealing Surface)

- All hydraulic lines of 1.5" or greater diameter are designed for proof pressure 1.5 times operating pressure and burst pressure 2.5 times operating pressure. (Defective Swage and Defective or Damaged Sealing Surface)

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

- Flex assemblies are fabricated per AM-B8510 and STP 303. This includes preparation and inspection of hose ends and fittings assembly alignment checks and acceptance criteria of the assembled unit. (Defective or Damaged Sealing Surface, Defective crimping)

- Normal operating pressure of the hydraulic system HP side is 3250 psig maximum with pressure relief at 3850 psig. (Defective or Damaged Sealing Surface and Defective crimping)

- Hydraulic fluid is MIL-H-83282 or MIL-PRF-83282 which was developed to reduce the potential of fire. (Contamination)

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- Flex hoses are not reused; fitting nuts are refurbished for reuse. (Defective crimping)

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

- Lines are clamped down to prevent damage from excessive vibration. (Misalignment of Dynatube Sealing Surface)

- Flex lines consist of a fluoroflex-T teflon base inner tube, four high tensile stainless steel spiral wraps and an outer braid of 304 or 302 CRES. (Defective crimping)

- Flex lines are mounted in the aft skirt in a 100,000 clean environment. (Contamination)

- 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)

B. TESTING

- Individual hose assemblies are inspected for the requirements of 10PRC-0038 per 10REQ-0021, para. 2.3.0. (All Failure Causes)

- Individual hose assemblies are hydrostatically proof tested per 10REQ-0021, para. 2.3.3.5. (Defective crimping and Defective or Damaged Sealing Surface)

- Individual hose assemblies are helium leak tested per 10REQ-0021, para. 2.3.3.6. (Defective crimping, Defective or Damaged Sealing Surface and Misalignment of Dynamic Sealing Surfaces)

- Individual hose assemblies are precision cleaned by USA SRBE per 10REQ-0021, para. 2.3.0. (Contamination)

- Hydraulic system is helium leak tested per 10REQ-0021, para. 2.3.3.3. (All Failure Causes)

- 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. (Contamination)

- o Hydraulic fluid is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydraulic circuits per 10REQ-0021, para. 2.3.2.6. (Contamination)

- o Visual leak check of hydraulic circuit (system) joints is performed per 10REQ-0021, para. 2.3.12.2. (All Failure Causes)

- o Hydraulic fluid is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board Hydraulic circuits during prelaunch operations per OMRSD File V, Vol. 1, Requirement Number B42HP0.010. (Contamination)

- o Prelaunch hydraulic system leak test is performed per OMRSD File V, Vol. 1, Requirement Number B42HP0.020. (All Failure Causes)

- o Hydraulic circuit fluid leak test is performed per 10REQ-0021, para. 2.3.12.2 prior to hotfire. (All Failure Causes)

- o 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

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o Inspections of sealing surfaces by USA SRBE PQAR per SIP 1260. (Defective or Damaged Sealing Surface)

- o Critical processes/inspections:

    - Crimping per STP 303

KSC RELATED INSPECTIONS

- o Verification of fittings and sealing surfaces for surface finishprior to installation per 10REQ-0021, para. 2.3.0. (Defective or Damaged Sealing Surface)

- o Inspect all tubing/hose assemblies, fittings connectors and sealing surfaces prior to installation per 10REQ-0021, para. 2.3.0. (Defective or Damaged Sealing Surface, Contamination, Defective crimping)

- o Individual hose assemblies are inspected for the requirements of 10PRC-0038 per 10REQ-0021, para. 2.3.0. (All Failure Causes)

- o Hydrostatic test is verified per 10REQ-0021, para. 2.3.3.5. (Defective crimping and Defective or Damaged Sealing Surface)

- Individual hose assemblies helium leak test is witnessed per 10REQ-0021, para. 2.3.3.6. (Defective crimping and Defective or Damaged Sealing Surface)

- Hose assemblies are precision cleaned by USA SRBE per 10REQ-0021, para. 2.3.0. (Contamination)

- Assembly torque and lockwire are verified per 10REQ-0021, para. 2.1.4 during upper frame assembly. (Improper Torque, Improperly Lockwired)

- Assembly torque and lockwire are verified per 10REQ-0021, para. 2.1.4 during aft skirt assembly. (Improper Torque, Improperly Lockwired)

- In skirt tube/hose installation torque and lockwire is witnessed per 10REQ-0021, para. 2.1.4. (Improper Torque, Improperly Lockwired)

- Helium cleanliness and composition (purity and particualte count) are verified prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5. (Contamination)

- Hydraulic system helium leak test is verified per 10REQ-0021, para. 2.3.3.3. (All Failure Causes)

- Hydraulic fluid cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board Hydraulic circuits per 10REQ-0021, para. 2.3.2.6. (Contamination)

- Performance of visual leak check of hydraulic circuit (system) joints per 10REQ-0021, para. 2.3.12.2. (All Failure Causes)

- Verify Rock Hydraulic Reservoir level is greater than 30 percent during low speed GN2 spin per 10REQ-0021, para. 2.3.11.2. (All Failure Causes)

- Verify Tilt Hydraulic Reservoir level is greater than 30 percent during low speed GN2 spin per 10REQ-0021, para. 2.3.11.2. (All Failure Causes)

- Verify Rock Hydraulic Reservoir level is greater than 50 percent during high speed GN2 spin per 10REQ-0021, para. 2.3.15.2. (All Failure Causes)

- Verify Tilt Hydraulic Reservoir level is greater than 50 percent during high speed GN2 spin per 10REQ-0021, para. 2.3.15.2. (All Failure Causes)

- Proper function of TVC system is demonstrated during Hotfire operations per 10REQ-0021, para. 2.3.11, 2.3.15, and 2.3.16 respectively for: (All Failure Causes)

    - Low speed GN2 spin
    - High speed GN2 spin
    - Hotfire (Includes verification of rock and tilt reservoirs between 50 and 90 percent)

- o TVC System is inspected for external leaks per 10REQ-0021, para. 2.3.11.3, 2.3.15.5 and 2.3.16.4 respectively following low speed GN2 spin, high speed GN2 spin and post Hotfire inspection by USA SRBE. (All Failure Causes)

- o Hydraulic fluid cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board Hydraulic circuits during prelaunch operations per OMRSD File V, Vol. 1, Requirement Number B42HP0.010. (Contamination)

- o Prelaunch hydraulic system leak test is verified per OMRSD File V, Vol. 1, Requirement Number B42HP0.020. (All Failure Causes)

D. FAILURE HISTORY

Criticality Category 1:

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

E. OPERATIONAL USE

- o Not applicable to this failure mode.

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