

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Hydraulic Rigid Lines and Fittings

PART NO.: See Below

FM CODE: A01

ITEM CODE: 20-01-40

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: See Parts List

DATE: March 1, 2001

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: March 31, 2000

FMEA PAGE NO.: A-131

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SHEET 1 OF 9

APPROVED: S. Parvathaneni

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

- o Contamination
- o Defective or damaged sealing surface
- o Defective line swage
- o Misalignment of dynatube sealing surface
- o Improper torque
- o 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 Rigid Lines

- 10200-0002-101 (Tilt)
- 10200-0005-101
- Alt. 10200-0005-106
- 10200-0005-103 (Tilt)
- Alt. 10200-0005-107
- 10200-0005-104 (Rock)
- Alt. 10200-0005-108
- 10200-0007-101
- Alt. 10200-0007-106
- 10200-0008-101
- Alt. 10200-0008-102
- 10200-0009-101 (Rock)
- Alt. 10200-0009-108

10200-0009-102 (Rock)
Alt. 10200-0009-109
10200-0009-103 (Tilt)
Alt. 10200-0009-110
10200-0009-104 (Tilt)
Alt. 10200-0009-111
10200-0009-105 (Tilt)
Alt. 10200-0009-112
10200-0009-106 (Rock)
Alt. 10200-0009-113
10200-0009-107 (Rock)
Alt. 10200-0009-114
10200-0070-101 (Tilt)
Alt. 10200-0070-102
10200-0072-101 (Rock)
Alt. 10200-0072-103
10200-0072-102 (Tilt)
Alt. 10200-0072-104
10201-0003-102
10201-0008-101
10201-0009-101

High Pressure Fittings

Tee

10209-0091-801
Alt. 10209-0151-801

Elbow

10209-0062-801
(Alt. 10209-0166)
Alt. 10209-0127-801
(Alt. 10209-0167)
10209-0065-801 (2)
10209-0128-801
0209-0130-801
10209-0067-801 (3)
Alt. 10209-0132-801
10209-0070-801
Alt. 10209-0135-801
10209-0103-801 (Tilt)
Alt. 10209-0155-801

Connector

10209-0027-801
10209-0032-801

Low Pressure Rigid Lines

10200-0006-101 (Rock)
Alt. 10200-0006-103
10200-0006-102 (Tilt)

Alt. 10200-0006-104
10200-0007-102 (Rock)
Alt. 10200-0007-107
10200-0007-103 (Tilt)
Alt. 10200-0007-108
10200-0007-104 (Rock)
Alt. 10200-0007-109
10200-0007-105 (Tilt)
Alt. 10200-0007-110
10200-0010-101 (Tilt)
10200-0010-102 (Rock)
10201-0005-102
10201-0007-101
10201-0008-102
Alt. 10201-0008-104
10201-0081-101
10201-0081-102

Low Pressure Fittings

Elbow

10209-0168
10209-0063-801
10209-0064-801 (Tilt)
(Alt. 10209-0164)
Alt. 10209-0129-801
(Alt. 10209-0165)
10209-0066-801
Alt. 10209-0131-801
10209-0067-801
Alt. 10209-0132-801
10209-0070-801
Alt. 10209-0135-801
10209-0072-801 (2)
Alt. 10209-0136-801
10209-0100-801
10209-0154-801

Tee

10209-0104-801
Alt. 10209-0156-801
10209-0105-801

Connectors

10209-0029-801
10209-0035-801

RATIONALE FOR RETENTION:

A. DESIGN

- o The rigid lines are designed as per MSFC specification 13A10047 and qualified per NASA TM-78258 and TM-82439. (All Failure Causes)
- o Lines are titanium 3AL-2.5V fully annealed, seamless and subjected to one hundred percent ultrasonic inspection. (Defective Line Swage)
- o Dynatube fittings are titanium 6AL-4V and are attached to the tubing by mechanical internal swaging. (Defective or Damaged Sealing Surface and Defective Line Swage)
- o Lines are clamped to the aft skirt structure to prevent damage from excessive vibration. (Misalignment of Dynatube Seals)
- o Tubes and fittings are mounted in the aft skirt in a 100K clean environment. (Contamination)
- o Fluid procurement is controlled per SE-S-0073. (Contamination)
- o All high pressure hydraulic lines are designed for proof pressure two times operating and burst pressure four times operating pressure. (Defective or Damaged Sealing Surface and Defective Line Swage)
- o All threaded fittings and connectors are torqued per engineering specifications and are lockwired per MS 33540, as applicable. (Improper Torque, Improperly Lockwired)
- o Hydraulic fluid is MIL-H-83282 or MIL-PRF-83282 which was developed to reduce fire potential. (Contamination)
- o Tube and hose assemblies are fabricated per 10PRC-0038. This includes preparation and inspection of the tube/hose ends and fittings, assembly alignment checks and acceptance criteria of the assembled unit. (Defective Line Swage, Misalignment of Dynamic Sealing Surface)
- o 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)
- o Hydraulic tube assemblies and fittings are refurbished per 10SPC-0131 (Contamination, Defective or Damaged Sealing Surface)
- o Tubes 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)

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B. TESTING

- o Low pressure hydraulic lines are hydrostatically proof tested to 1600 ± 100 psig and high pressure lines are tested to 7200 ± 200 psig. (Defective or Damaged Sealing Surface, Defective Line Swage)
- o Individual tube assemblies are hydrostatically proof tested per 10REQ-0021, para. 2.3.3.5. (Defective or Damaged Sealing Surface and Defective Line Swage)
- o Individual tubes assemblies are helium leak tested per 10REQ-0021, para. 2.3.3.6. (Defective or Damaged Sealing Surface, Defective Line Swage and Misalignment of Dynatube Sealing Surfaces)
- o Individual tube assemblies are precision cleaned per 10REQ-0021, para. 2.3.0. (Contamination)
- o Installed tube assemblies are helium leak tested during hydraulic system leak check per 10REQ-0021, para. 2.3.3.3. (Defective or Damaged Sealing Surface, Defective Line Swage and Misalignment of Dynatube Sealing Surfaces)
- o 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)
- 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 Verify effluent hydraulic fluid moisture content and cleanliness (water content and particulate count) from the actuators and the reservoirs per 10REQ-0021, para. 2.3.12.3. (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 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 which includes: (All Failure Causes)
 - Low speed spin, para. 2.3.11
 - High speed spin, para. 2.3.15
 - Hotfire, para. 2.3.16
- o Hydraulic fluid is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board flight hardware during prelaunch operations per OMRSD File V, Vol. 1, Requirement Number B42HP0.010. (Contamination)

- o Hydraulic fluid effluent is verified for moisture per OMRSD File V, Vol. 1, Requirement Number B42HP0.011. (Contamination)
- o Prelaunch hydraulic system leak test is performed per OMRSD File V, Vol. 1, Requirement Number B42HP0.020. (All Failure Causes)
- o Evacuation/removal of hydraulic fluid from the tube between the low pressure relief valve (within hydraulic manifold) and service panel is performed following high speed GN2 spin per 10REQ-0021, para. 2.3.15.5, hotfire per 10REQ-0021, para. 2.3.16.4. (All Failure Causes)

C. INSPECTION

I. VENDOR RELATED INSPECTIONS

- o Inspections of sealing surfaces by USA SRBE PQAR per SIP 1260. (Defective or Damaged Sealing Surface)
- o Critical processes/Inspections:
 - Swaging per 10PRC-0038
 - Tube Bending per 10PRC-0038
 - Tube End Flaring per 10PRC-0038
 - Annealing per MIL-H-81200

II. KSC RELATED REFURBISHMENT INSPECTION

- o Visual inspection of tube assemblies will be performed per 10SPC-0131, para. II. (All Failure Causes)
- o Functional testing of tube assemblies will be performed per 10SPC-0131, paragraph IV.

All manual tests will be witnessed by Quality or verified for those instances when controlled software is utilized and a test report is generated. (All Failure Causes)

III. KSC RELATED ASSEMBLY AND OPERATIONS INSPECTIONS

- o Inspect all tubing/hose assemblies, fittings and sealing surfaces prior to installation per 10REQ-0021, para. 2.3.0. (Defective Line Swage, Defective or Damaged Sealing Surface)
- o Individual tube 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. (All Failure Causes)

- o Individual tube assemblies helium leak test is witnessed per 10REQ-0021, para. 2.3.3.6. (Defective of Damaged Sealing Surface and Defective Line Swage Misalignment or Dynatube Sealing Surfaces)
- o Tube assemblies are precision cleaned by USA SRBE per 10REQ-0021, para 2.3.0. (Contamination)
- o In skirt tube/hose installation torque and lockwire is witnessed per 10REQ-0021, para. 2.1.4. (Improper Torque, Improperly Lockwired)
- o Torque and lockwire of fitting connectors is witnessed per 10REQ-0021, para. 2.1.4. (Improper Torque, Improperly Lockwired)
- 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)
- o Hydraulic system helium leak test is witnessed per 10REQ-0021, para. 2.3.3.3. (All Failure Causes)
- o Hydraulic fluid cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board the flight hardware per 10REQ-0021, para. 2.3.2.6. (Contamination)
- o Verification of visual leak check of hydraulic circuit (system) joints per 10REQ-0021, para. 2.3.12.2. (All Failure Causes)
- o Proper function of TVC system is verified during Hotfire operations per 10REQ-0021 to include: (All Failure Causes)
 - Low speed GN2 spin, para. 2.3.11
 - High speed GN2 spin, para. 2.3.15
 - Hotfire (Includes verification of rock and tilt reservoirs between 50 and 90 percent), para. 2.3.16
- o Inspect TVC system 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. (All Failure Causes)
- o Post hotfire inspection and leak check is performed per 10REQ-0021, para. 2.3.16.4. (All Failure Causes)
- o Low pressure relief valve overboard circuit (area between hydraulic manifold and service panel fitting) evacuation is verified following high speed GN2 spin per 10REQ-0021, para. 2.3.15.5 and hotfire per 10REQ-0021, para. 2.3.16.4. (All Failure Causes)
- o Bleeder plug is inspected for damage or contamination by SPC per OMRSD File V, Vol. 1, Requirement Number B42GEN.070 and then torqued per OMRSD File V, Vol. I, Requirement Number B42GEN.010.(Contamination, Thread Failure, Improper torque)
- o Verification of lockwiring of Bleeder Plug per OMRSD File V, Vol. I, requirement number B42GEN.020. (Improperly Lockwired)

- o Hydraulic fluid cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board flight hardware during prelaunch operations per OMRSD File V, Vol. 1, Requirement Number B42HP0.010. (Contamination)
- o Prelaunch hydraulic system leak test is witnessed per OMRSD File V, Vol. 1, Requirement Number B42HP0.020.

D. FAILURE HISTORY

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

E. OPERATIONAL USE

- o Not applicable to this failure mode.

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