

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Manual Bypass and Lock Valve Assembly,
Part of Servoactuator

PART NO.: A07401-1 (Bushing, Spool and Sleeve Assembly), A07394 (Spring Compression), 110-79220 (Spring, Compression); A23913 (Actuator Assembly), A07584 (Spool) FM CODE: A02

ITEM CODE: 20-02-10 REVISION: Basic

CRITICALITY CATEGORY: 1 REACTION TIME: Seconds

NO. REQUIRED: 2 (one per actuator) DATE: March 1, 2002

CRITICAL PHASES: Boost SUPERCEDES: March 1, 1993

FMEA PAGE NO.: A-219 ANALYST: K. Schroeder/S. Finnegan

SHEET 1 OF 7 APPROVED: S. Parvathaneni

CN 044

FAILURE MODE AND CAUSES: Valve remains in or returns to lock position when not required caused by:

- o Spool seizure due to contamination or improper clearance
- o Jammed return spring will not compress
- o System pressure blocked from spool drive area
- o Spool seizure due to sustained oscillation and resultant loss of lubrication at low pressure

FAILURE EFFECT SUMMARY: Loss of capability to operate servoactuator. Loss of Thrust Vector Control will lead to vehicle breakup and loss of mission and crew.

RATIONALE FOR RETENTION:

A. DESIGN

- o The Manual Bypass and Lock Valve Assembly is designed and qualified in accordance with end item specification 10SPC-0055. (All failure causes)
- o Material selection is in compliance with MSFC-SPEC-522A. (All Failure Causes)
- o Servoactuator piece parts, subassemblies and assemblies are cleaned and assembled in a controlled environment conforming to class 100,000 clean room. The Moog clean room is certified in accordance with Moog QAP 803-001-100. (Spool seizure due to contamination or improper clearance)

- o After the lock valve bushing, spool and sleeve are fitted and serialized, the parts become a matched assembly and are not to be separated. Traceability by serial number is required. (Spool seizure due to contamination or improper clearance)
- o Lock valve spool, bushing and sleeve are made from 440C CRES heat treated and stress relieved . (Spool seizure due to contamination or improper clearance)
- o Lock valve bushing to spool diametral clearance is controlled to 140 - 180 microinches with a maximum surface roughness of 5 rms for either part. (Spool seizure due to contamination or improper clearance)
- o Lock valve sleeve to spool diametral clearance is controlled to 200 - 250 micro inches with a maximum surface roughness of 5 rms for either part. (Spool seizure due to contamination or improper clearance)
- o The return spring is made of 17-7PH CRES, heat treated to condition CH900 and demagnetized. (Jammed return spring will not compress)
- o Fluid passages to spool drive area are of sufficient size 0.250 inches in diameter to avoid blockage by contamination. (System pressure blocked from spool drive area)
- o The spool/bushing surfaces are lubricated by laminar hydraulic fluid flow when the valve is in hydraulic lock mode. (Spool seizure due to sustained oscillation and resultant loss of lubrication at low pressure)
- o The manual bypass and lock valve assembly, as part of the servoactuator, was subjected to qualification testing which verified the design requirements, including a burst pressure conducted at Moog. The test results are reported in Qualification Test Report MSFC-RPT-900. The Moog conducted burst pressure testing results are reported in Moog Report No. MR T-2980. Two units were subjected to qualification testing. After completion of the MSFC/Moog conducted testing, the two units were torn down and inspected. There was no evidence of wear, damage or other anomalies as reported in Moog disassembly and inspection analysis reports MR M-2982 and MR M-2983. (All Failure Causes)

B. TESTING

VENDOR RELATED TESTING

- o Servoactuator acceptance tests are performed per MOOG report MR A-2406. This procedure includes lock valve test with lock valve actuation and response time measured. Allowable piston drift under load and manual cylinder bypass valve are also tested. (All Failure Causes)

- o A two minute flushing procedure is performed when a hydraulic line is removed or reinstalled per Moog ATP MR A-2406. (Spool seizure due to contamination or improper clearance)
- o Refurbished servoactuators are tested as follows: (All Failure Causes)
 - Proof Load Test per Moog EI - 1037
 - End Item Acceptance Test per Moog MR A-2406.
This is the same ATP as new hardware except some component level tests are not required when teardown does not affect the validity of the previous component test. These component tests are Power Valve Pressure Gain, Transient Load Relief Valve and Servovalve Differential Pressure Transducers.

KSC RELATED TESTING

- 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. (Spool Seizure Due To Contamination or Improper Clearance, System Pressure Blocked From Spool Drive Area)
- 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. (Spool Seizure Due to Contamination or Improper Clearance, System Pressure Blocked from Spool Drive Area)
- o Effluent hydraulic fluid is verified for moisture content and cleanliness (water content and particulate count) from the rock actuator, the tilt reservoir, the rock reservoir and the tilt actuator per 10REQ-0021, para. 2.3.12.3. (Spool Seizure Due to Contamination or Improper Clearance, System Pressure Blocked from Spool Drive Area)
- o Proper operation of actuator manual bypass function is verified by test during initial hydraulic servicing and after hotfire per 10REQ-0021, para. 2.3.10.1 and 2.3.16.4 respectively. (Spool Seizure Due to Contamination or Improper Clearance, Spool Seizure Due to Sustained Oscillation and Resultant Loss of Lubrication at Low Pressure)
- o Rock and tilt actuator unlock pressure is recorded for engineering information during hotfire operations. (All Failure Causes)
- o Functional operation of the actuators is verified during hotfire operations per 10REQ-0021, para. 2.3.16.3. (All Failure Causes)
- o Actuator null, linearity and polarity and servovalve redundancy verification tests are performed per 10REQ-0021, para. 2.3.14. (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. (System Pressure Blocked from Spool Drive Area, Spool Seizure Due to Contamination or Improper Clearance)

- o Ascent Thrust Vector Control/SRB-TVC system response are verified to predefined input commands per OMRSD File II, Vol. 1 Requirement Number S00000.650 (Gain Test). (All Failure Causes)
- o Dynamic operation of the Ascent Thrust Vector Control/SRB-TVC System Failure Detection and Isolation Circuitry are verified per OMRSD File II, Vol. 1 Requirement Numbers S00000.670 and .680 (Individual Channel Test). (All Failure Causes)
- o Frequency response (gain and phase) and step response of the Ascent Thrust Vector Control/SRB-TVC system per OMRSD File II, Vol. 1 Requirement Numbers S00000.720 and .750 respectively. (All Failure Causes)
- o Gimbal test performed after SRB HPU start under control of automated software in GLS and RSLs verifies actuator performance by monitoring actuator position, servovalve differential pressure, isolation valve events and APU turbine speed (related to actuator pressure switch). Pass/fail criteria for automated portions of terminal countdown are controlled by OMRSD File II, Vol. 1, Requirement Number S00FS0.030 and launch commit criteria. This is the last test that verifies actuator performance. (All Failure Causes)

The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o Acceptance tests are witnessed by USA SRBE PQAR according to USA SRBE SIP 1127. (All Failure Causes)
- o USA SRBE PQAR verifies hydraulic fluid is inspected for contamination before actuator loading per USA SRBE SIP 1127. (Spool Seizure Due to Contamination or Improper Clearance, System Pressure Blocked from Spool Drive Area)
- o USA SRBE PQAR verifies material certifications per USA SRBE SIP 1127. (All Failure Causes)
- o USA SRBE PQAR verifies traceability records per USA SRBE SIP 1127. (Spool Seizure Due to Contamination or Improper Clearance)
- o USA SRBE PQAR verifies bushing/spool/sleeve alignment per USA SRBE SIP 1127. (Spool Seizure Due to Contamination or Improper Clearance)

- o During refurbishment and prior to reuse, the servoactuator is disassembled, cleaned, inspected and tested to ensure proper performance per 10SPC-0131. Preliminary evaluation includes: (All Failure Causes)
 - Clean and inspect external surfaces
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 - Disassembly as required to inspect the body/cylinder interface and bushing, spool and sleeve assemblies of the: selector valve, lock valve, servovalves and power valve for evidence of seawater contamination. CN 044
- o Extent of repair is determined from this evaluation and accomplished per the following general requirements. (All Failure Causes)
 - Total disassembly is required if any wetted hydraulic surface discloses seawater contamination.
 - All repairs are processed by the cognizant Material Review Board.
 - All seals which have been removed from the installed position or exposed to seawater contamination are replaced.
 - All hydraulic surfaces that have been exposed to seawater contamination are recleaned per Moog Documents 800-000-100, supplement 32 and MR-Q-6428.
 - Reassembly per the same procedures and controls as new hardware.
- o Critical Processes/Inspections
 - Heat Treat, Lock Valve Bushing, Spool, Sleeve, per EP 3203
 - Stress Relief, Lock Valve Bushing, Spool, Sleeve, per EP 3211
 - Passivation, Return Spring, per EP 3204
 - Demagnetization, Return Spring, per 110-79220

KSC RELATED INSPECTIONS

- 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. (Spool Seizure Due to Contamination or Improper Clearance, System Pressure Blocked from Spool Drive Area)
- o 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. (System Pressure Blocked from Spool Drive Area, Spool Seizure Due to Sustained Oscillation and Resultant Loss of Lubrication at Low Pressure)
- o The moisture content and cleanliness (water content and particulate count) of the effluent hydraulic fluid from the rock actuator, the tilt reservoir, the rock reservoir and the tilt actuator are verified per 10REQ-0021, para. 2.3.12.3. (Spool Seizure Due to Contamination or Improper Clearance, System Pressure Blocked from Spool Drive Area)

- o Proper function of TVC system is demonstrated during hotfire per 10REQ-0021, para. 2.3.16. (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. (Spool Seizure Due to Contamination or Improper Clearance, System Pressure Blocked from Spool Drive Area)
- o SRB TVC actuator positioning test is performed per OMRSD File II, Vol. 1 Requirement Number S00000.650. (All Failure Causes)
- o Both SRB individual channel null test and actuator individual channel ramp test are performed per OMRSD File II Requirement Numbers S00000.670 and .680 respectively. (All Failure Causes)
- o Both SRB actuator frequency response and step response tests are performed per OMRSD File II, Vol. 1 Requirement Numbers S00000.720 and .750 respectively. (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.

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