

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Pressure Switching Valve Assembly,
Part of Servoactuator

PART NO.: A07424-1, A07405-1, A07394
A22089, A20434-3

FM CODE: A01

ITEM CODE: 20-02-01

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 2 (one per actuator)

DATE: March 1, 2002

CRITICAL PHASES: Boost

SUPERCEDES: March 1, 1996

FMEA PAGE NO.: A-178

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SHEET 1 OF 6

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FAILURE MODE AND CAUSES: Valve fails to switch hydraulic inputs when required caused by:

- o Valve spool seized due to incorrect spool/bushing tolerance
- o Spool seized due to contamination
- o Broken spring jams spool
- o Spool drilling to drive cavities blocked by contamination

FAILURE EFFECT SUMMARY: Loss of hydraulic pressure to one actuator because of inability to switch input to secondary hydraulic supply. Loss of Thrust Vector Control will lead to vehicle breakup and loss of mission and crew. One success path remains after the first failure. Operation is not affected until both paths are lost.

REDUNDANCY SCREENS AND MEASUREMENTS:

- 1) Pass - ATP is conducted on all units, redundancy is verified during ATP.
- 2) Fail - Valve capability to switch actuator to secondary hydraulic supply is not detectable.
- 3) Fail - Fluid contamination

A. DESIGN

- o The Pressure Switching 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. (Broken Spring Jams Spool)

- o The servoactuator, including pressure switching valve assembly, was subjected to pressure impulse loading applied to primary and secondary inlet ports over a pressure range of 200 to 4,000 psig for a minimum of 100,000 cycles and a burst pressure of 8125 psig which is 2.5 times maximum operating pressure. (Valve Spool Seized Due to Incorrect Spool/Bushing Tolerance)
- o Selector valve bushing, spool and sleeve are fitted to the following: (Valve Spool Seized Due to Incorrect Spool/Bushing Tolerance)
 - Bushing-to-spool diametrical clearance is 180 to 220 microinches.
 - Sleeve-to-spool diametral clearance is 200 to 250 microinches.
 - The spool and bushing sleeve surface are finished to 5 rms. The fitted assembly is traceable by serial number.
- o The spool is made of 440C CRES, heat treated, stabilized, stress relieved and passivated. The spool is traceable by lot number. (Spool Seized Due to Contamination)
- o The selector valve bushing is made of 440C CRES, heat treated, stabilized, stress relieved, and passivated. (Spool Seized Due to Contamination)
- o The selector valve sleeves are made of 440C CRES, heat treated and stress relieved. (Spool Seized Due to Contamination)
- o Servoactuator piece parts, subassemblies and assemblies are cleaned and assembled in a controlled environment conforming to Class 100,000 clean room. The clean room environment is certified per Moog QAP 803-001-100. (Spool Drilling to Drive Cavities Blocked by Contamination)
- o Fluid sampling valve ports are provided on the primary inlet and on the return side of the servoactuator. (Spool Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)
- o The spool is protected from contamination by the hydraulic system filter with 5 micron absolute entrapment capability. (Spool Seized Due to Contamination)
- o The compression spring is a true helix of constant pitch. The spring is made of 17-7 PH Cres, heat treated to condition CH900, passivated and is demagnetized. The spring is designed to a maximum corrected stress of 120,000 psi. The spring rate is 50 ± 5 lb/in. The maximum load is 65 lb. (Broken Spring Jams Spool)
- o The spool drill hole inside diameter (ID) is 0.187 inch. This diameter is approximately 47 times greater than 100 micron particle size allowed in effluent hydraulic fluid. (Spool Drilling to Drive Cavities Blocked by Contamination)
- o The pressure switching valve assembly, as part of the seroactuator, was subjected to qualification testing which verified the design

requirements, including a qualification burst pressure test 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 TESTS

- o The Pressure Switching Valve Assembly installed in the servoactuator is subjected to acceptance testing in accordance with Moog Report MR A-2406. These tests include: (All Failure Causes)
 - Proof pressure tests
 - Switching Valve Performance tests
 - Cleanliness
- o A two minute flushing procedure is followed when a hydraulic line is removed or reinstalled according to Moog Report MR A-2406. (Spool Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)
- 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 Value Pressure Gain, Transient Load Relief Valve, Servovalve Differential Pressure Transducers.

KSC RELATED TESTS

- 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 Seized Due to Contamination, Spool Drilling to Drive Cavities Blocked by 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. (Spool Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)
- 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 Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)

- o Switching valve operation for increasing and decreasing pressure conditions is verified by test during hotfire per 10REQ-0021, para. 2.3.16. (All Failure Causes)
 - This is the last test which verifies switching valve operation.
- 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, para. B42HP0.010. (Spool Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)

The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o USA SRBE PQAR witnesses final actuator ATP per USA SRBE SIP 1127. (All Failure Causes)
- o USA SRBE PQAR verifies that hydraulic fluid is inspected for contamination before servoactuator is loaded per USA SRBE SIP 1127. (Spool Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)
- o USA SRBE PQAR verifies vendor materials certification and assures vendor buy off of dimensions and cleaning per USA SRBE SIP 1127. (All Failure Causes)
- o The compression spring rates are determined by statistical sample at the spring vendor plant. Copies of records are included in the shipment of springs. (Broken Spring Jams Spool)
- o The bushing is magnetic particle inspected per ASTM E1444. (Valve Spool Seized Due to Incorrect Spool/Bushing Tolerance)
- o The spool is magnetically inspected per ASTM E1444. (Valve Spool Seized Due to Incorrect Spool/Bushing Tolerance)
- 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
 - Check main piston runout
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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.

- 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 nonhermetic electrical/electronic parts which have been exposed to seawater are replaced
 - 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, Spool, bushing, sleeves, per EP 3202
 - Stress relief, Spool, bushing, sleeves, per EP 3211
 - Passivation, Spool, bushing, spring, per EP 3204
 - Demagnetization, Compression spring, per A07394
 - Heat Treat, Compression spring, per EP 3389
 - Magnetic Particle Inspection, Bushing, spool, per ASTM E1444

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 Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)
- 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. (Spool Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)
- 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 Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)

- o Proper function of TVC System is verified, both electrically and mechanically during hotfire using hydrazine as a power source 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 Drilling to Drive Cavities Blocked by Contamination, Spool Seized Due to Contamination)

D. FAILURE HISTORY

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

E. OPERATIONAL USE

- o Not applicable to this failure mode.