

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Seals and Sampling Valves
Part of Servoactuator

PART NO.: A21160-342, (Packing, Preformed), FM CODE: A02
A23794-2 (Seal, Low Friction,
Internal Groove), A23973-3
(Body Assembly), (A71183-1
Body Assembly), A23917 (Piston),
A23913 (Actuator Assembly)

ITEM CODE: 20-02-13 REVISION: Basic

CRITICALITY CATEGORY: 1 REACTION TIME: Seconds

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

CRITICAL PHASES: Final Countdown, Boost SUPERCEDES: March 1, 2001

FMEA PAGE NO.: A-226 ANALYST: K. Schroeder/S. Finnegan

SHEET 1 OF 6 APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: External leakage of hydraulic fluid at any of two external piston rod seals caused by:

- o Seal damage
- o Defective O-ring and/or cap
- o Defective sealing surface
- o Contamination
- o Improper clearance

FAILURE EFFECT SUMMARY: Loss of hydraulic fluid leading to loss of both actuators. Fire and explosion will lead to loss of vehicle, mission and crew during final countdown boost.

RATIONALE FOR RETENTION:

A. DESIGN

- o Seals and Sampling Valves are 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 The external piston rod seals are compatible with hydraulic fluids and are designed to operate within the pressure

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environment of 3000 to 3850 psig, are compatible with seawater and are designed not to leak more than one drop of fluid per 25 full amplitude cycles with the supply pressure between 1000 and 3250 psig. (Defective O-ring and/or Cap)

- o The servoactuator, including piston and cylinder assembly and external piston rod seals, is designed to withstand without failure a burst pressure of 8125 psig which is 2.5 times the maximum operating pressure and proof tested to 4875 psig which is 1.5 times the maximum operating pressure and 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. (All Failure Causes)
- o The external piston rod seals are designed to a service life of (per 10SPC-0055): (All Failure Causes)
 - 200,000 cycles, ± 0.01 inch displacement at 10 Hz
 - 200,000 cycles, ± 0.25 inch displacement at 10 Hz
 - 4,000 cycles, ± 1.0 inch displacement at 0.25 Hz
 - 400 cycles, ± 6.0 inch displacement at 0.1 Hz
- o The external piston rod seals are designed to withstand, without damage or impairment of performance, the transmitted induced environments including nozzle induced vibration, aft skirt induced vibration, aft skirt and nozzle induced shocks (including ordnance, SRB parachute deployment and SRB water landing) and water entry loads. (All Failure Causes)
- o The cap seal is made of teflon, Type 1, Grade A. The seal surfaces are finished to 32 rms. The surfaces are to be smooth, free of irregularities with the edges sharp and clean. (Defective O-ring and/or Cap)
- o The preformed packing (o-ring), is made of nitrile with a temperature operating range of -65°F to $+275^{\circ}\text{F}$. The material is compatible with hydraulic fluid. (Defective O-ring and/or Cap) CN 044
- 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. (Contamination)
- o The SRB installed actuator is protected from contamination by a 5 micron absolute filter upstream of the actuator. (Contamination)
- o Hydraulic test fluids conform to MIL-H-83282 or MIL-PRF-83282 which was developed to minimize fire hazards. (All Failure Causes)
- o The SRB aft skirt is GN2 purged to minimize fire and explosion hazards per OMRSD File II, Vol. 1, requirement number S00FM0.430. (All Failure Causes)

- o The external piston rod seals, as part of the servoactuator, were 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. (All Failure Causes)

B. TESTING

VENDOR RELATED TESTING

- o As part of the servoactuator the external rod seals are acceptance tested in accordance with the acceptance test procedure defined in Moog Report MR A-2406. This procedure includes: (All Failure Causes)
 - Examination of Product
 - Proof Pressure
 - Return Port Back Pressure
 - Dynamic External Leakage
 - Fluid Cleanliness
 - Examination of Product
- o A two minute flushing procedure is followed when a hydraulic line is removed or reinstalled per Moog Report MR A-2406. (Contamination)
- o Refurbished servoactuators are tested as follows:
 - Proof Load Test per Moog EI - 1037 (All Failure Causes)
 - 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. (All Failure Causes)

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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. (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 per 10REQ-0021, para. 2.3.2.6. (Contamination)
- o Hydraulic circuit fluid leak test is performed per 10REQ-0021, para. 2.3.12.2 prior to hotfire. (All Failure Causes)

- o External leakage at actuator rod ends is verified by test to be less than 1 drop per minute per 10REQ-0021, para. 2.3.12.1. (All Failure Causes)
- o 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)
- 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. (All Failure Causes)
- o Prelaunch hydraulic system leak test is performed per OMRSD File V, Vol. 1, Requirement Number B42HP0.020. (All Failure Causes)
- o External leakage at actuator rod ends is verified by test to be less than 1 drop per minute per OMRSD File V, Vol. 1 Requirement Number B42AT0.030. This is the last test that verifies acceptable rod end leakage. (All Failure Causes)

The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o USA SRBE PQAR witnesses all final acceptance tests according to approved test procedures per USA SRBE SIP 1127. (All Failure Causes)
- o USA SRBE PQAR verifies inspection for external leakage of hydraulic fluid from components in the body cavity per SIP 1127. This inspection is performed before cover is installed. (All Failure Causes)
- o USA SRBE PQAR verifies material certifications, cleanliness and assembly certifications per USA SRBE SIP 1127. (All Failure Causes) CN 044
- o USA SRBE PQAR verifies hydraulic fluid is inspected for contamination requirements per USA SRBE SIP 1127. (All Failure Causes)
- o During refurbishment and prior to reuse, the servoactuator is disassembled, cleaned, inspected and tested to ensure proper performance. Preliminary evaluation includes: (All Failure Causes)
 - Clean and inspect external surfaces
 - Check main piston runout
 - 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 USA SRBE PQAR verifies dimensional inspection of the piston O.D and body bore per SIP 1127. (Improper Clearance)

- 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:

None

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. 2.3.3.5. (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. (Contamination)
- 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. (Defective O-ring, Defective Sealing Surface, Improper Clearance)
- o Performance of visual leak check of hydraulic circuit (system) joints per 10REQ-0021, para. 2.3.12.2. (All Failure Causes)
- o External leakage at the actuator rod ends is verified to be less than 1 drop per minute per 10REQ-0021, para. 2.3.12.1. (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 performed per OMRSD File V, Vol. 1 Requirement Number B42HP0.020. (Defective O-ring, Defective Sealing Surface, Improper Clearance)
- o External leakage at actuator rod ends is verified to be less than 1 drop per minute, per OMRSD File V, Vol. 1 Requirement Number B42AT0.030. (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.