

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Seals and Sampling Valves  
Part of Servoactuator

PART NO.: Cylinder Pressure Plugs - FM CODE: A03  
073-20651-4JL (Plug), A23953-4  
(Packing, Preformed); Manifold  
Plugs - A07437 (Plug, O-ring),  
A07438 (Retainer, Threaded),  
A21156-019MS (Seal, External  
Groove); Inlet Filter Retainer  
- A05762 (Plug, O-rings, Filter),  
A22360 (Retainer, Threaded), A21156-  
021MS (Seal, External Groove);  
Manifold Plug, Power Valve  
Housing - A05545 (Plug, O-ring),  
A21847 (Retainer, Threaded),  
A21156-017MS (Seal, External  
Groove)

Related Housings - A23973-3  
(Body), (A71183-1 Body),  
A05362-2 (Housing Assembly,  
Power Valve)  
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-233

ANALYST: K. Schroeder/  
S. Finnegan

SHEET 1 OF 6

APPROVED: S. Parvathaneni

CN 044

FAILURE MODE AND CAUSES: External leakage of hydraulic fluid at any of eleven pressure port plugs caused by:

- o Defective O-ring
- o Defective sealing surface
- o Improper torquing
- o Improper lockwire
- o Thread failure
- o Contamination

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.

RATIONALE FOR RETENTION:

A. DESIGN

- o The Seals and Sampling Valves are designed and qualified in accordance with end item specification 10SPC-0055.
- o Material selection is in compliance with MSFC-SPEC-522A. (All Failure Causes)
- o The O-rings are compatible with hydraulic fluids and are designed to operate within the pressure environment of 3000 to 3850 psig and are compatible with seawater. (Defective O-ring)
- o External Groove Seals (A21156 Dash Nos.) are made of nitrile (buna N) rubber. The back-up ring material is teflon. (Defective O-ring) CN 044
- o O-ring plugs (A05545, A09762 and A07437) are made of 6061-T6, T651, T6511, or T6510 material. (Thread Failure)
- o Threaded retainers (A07438, A21847 and A22360) are made of 17-4PH CRES, heat treated and passivated. (Thread Failure)
- o All threaded fittings and connectors are torqued per engineering specifications and are lockwired per MS 33540. (Improper Torquing, Improper Lockwire)
- 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 and in accordance with Moog QAP 803-001-100. (Contamination)
- o System Hydraulic fluid is supplied through the 5 micron nominal, 10 micron absolute system filter. (Contamination)
- o Hydraulic fluids conform to MIL-H-83282 or MIL-PRF-83282 which is developed to minimize fire hazard. (All Failure Causes)
- o The servoactuator, including seals and sampling valves, 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 seals and sampling valves, as part of the servoactuator, were 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 TESTING

- o As part of the servoactuator the seals and sampling valves are acceptance tested 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
  - Static 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)

CN 044 |

### 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. (Defective O-ring, Thread Failure, Defective Sealing Surface)
- 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. (Defective O-ring, Thread Failure, Defective Sealing Surface, Improper Lockwire, Improper Torquing)

The above referenced OMRSD testing is performed every flight.

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o USA SRBE 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) CN 044
- o USA SRBE verifies material cleanliness and assembly certifications per USA SRBE SIP 1127. (All Failure Causes)
- o USA SRBE PQAR verifies threads per USA SRBE SIP 1127. (Thread Failure)
- o USA SRBE verifies hydraulic fluid is inspected for contamination requirements per USA SRBE SIP 1127. (Contamination)
- 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
  - 
  - 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 Verification of torque and lockwire per USA SRBE SIP-1127. (Improper torque, Improper lockwire)
- o USA SRBE PQAR verifies external fasteners for proper lockwire per MR A-2406 para 3.6.4.6. (Improper lockwire)
- 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, Threaded retainer per EP 3233
  - Passivation, Threaded retainer per EP 3204
  - Anodizing, O-ring plugs per EP 3203

#### 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.(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 and post Hotfire inspection. (Defective O-ring, Defective Sealing Surface, Improper Torquing, Improper Lockwire, Thread Failure)
- o Performance of visual leak check of hydraulic circuit (system) joints per 10REQ-0021, para. 2.3.12.2. (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. (Defective O-ring, Defective Sealing Surface, Improper Torquing, Improper Lockwire, Thread Failure)
- 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 Torquing, Improper Lockwire, Thread Failure)

#### D. FAILURE HISTORY

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

#### E. OPERATIONAL USE

- o Not applicable to this failure mode.

THIS PAGE INTENTIONALLY LEFT BLANK