

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Seals and Sampling Valves
Part of Servoactuator

PART NO.: Power Valve/Body and Body/Cylinder
Retract Pressure Unions -- A23796
(Union), A20890-4 (Seal, Metallic,
Face), A21156-117MS (Seal, External
Groove), A20888 (Union), A20890-1
(Seal, Metallic, Face), A21156-011MS
(Seal, External Groove); Cylinder
Body Extend Pressure -- A21160-443
(Packing, Preformed), 082-45200-443
(Ring, Backup), A23934-1 (Seal Assembly
Ring); Transient Load Relief Valve
Bushing -- A21156-137MS (Seal,
External Groove), A20871-4 (Ring,
Metallic Barrier)
Related Housings -- A23973-3 (Body),
(A71183-1 Body), A05362-2 (Housing
Assembly, Power Valve), A23914-2
(Cylinder), A23917 (Piston),
A22030-1 (Spring Cap and Bushing
Assembly), A23913 (Actuator Assembly)

FM CODE: A04

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-234

ANALYST: K. Schroeder/S. Finnegan

CN 044

SHEET 1 OF 6

APPROVED: S. Parvathaneni

FAILURE MODE AND CAUSES: External leakage of hydraulic fluid at any of eight elastomeric/barrier seals caused by:

- o Defective O-ring
- o Defective barrier seals
- o Defective sealing surface
- o Improper torquing
- o Improper lockwire
- o Thread failure
- 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.

RATIONALE FOR RETENTION:

A. DESIGN

- o The 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 External groove (o-rings) seals (21156-117MS, -011MS, -137MS) are made of nitrile (buna N) rubber, are compatible with hydraulic fluid and are designed to operate within the pressure environment of 3000 to 3850 psig and compatible with seawater. (Defective O-Ring)
- o Face seals (A20890) are made of Inconel 718 and are silver plated. The faces are heat treated to a resultant yield strength of 150 to 175 ksi at 0.2 percent offset. (Defective Barrier Seals)
- o Backup rings are made of teflon. Surfaces are to be free of irregularities with clean, sharp edges. (Defective O-Ring)
- o Torque requirements for threaded fasteners and fittings are specified on the applicable Moog assembly drawing. (Improper Torque, Thread Failure)
- o Lockwire requirements for threaded fasteners and fittings per MS33540 are specified on the applicable Moog assembly drawing. (Improper Lockwire)
- o Metallic barrier rings (A20871) are made of 17-7PH CRES material and are heat treated to condition RH950. The ring surfaces are finished to 125 rms. The edges are rounded on 0.015 inch radius and surface finished to 32 rms. The I.D. and O.D. diameters and runout are inspected before ring slot is machined. (Defective Barrier Seals)
- o Metallic ring seal assemblies (A23934) are two piece construction packed together. The inner ring is made from centrifugally cast 17-4PH CRES material and heat treated to H1060 condition. The outer ring is made of aluminum bronze with a hardness range of Brinell 187 to 241. The ring tension is controlled by inner ring free gap of approximately 0.700 inches. (Defective Barrier Seals)
- o The passage union (A20888) is made of 17-4PH CRES, heat treated and passivated. The critical surfaces are surface finished to 32rms. (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 conditions. The Moog clean room is certified in accordance with Moog QAP 803-001-100. (Contamination)

CN 044

- 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 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 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 in accordance with the acceptance test procedure defined in Moog Report MR A-2406. This procedure include: (All Failure Causes)
 - Examination of Product
 - Proof Pressure
 - Return Port Back Pressure
 - Static Leakage
 - Fluid Cleanliness
- o A two minute flushing procedure is followed when a hydraulic line is removed or reinstalled according to Moog Report No. 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 test (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, Defective Sealing Surface, Improper Torquing, Thread Failure, Improper Lockwire, Improper Clearance)
- o Actuator null, linearity and polarity and 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. (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, Thread Failure, Improper Clearance, Improper Lockwire, Improper Torquing)

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 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. (Contamination)
- o USA SRBE PQAR verifies dimensional inspection of the piston O.D. and body bore per USA SRBE SIP 1127. (Improper Clearance)
- o USA SRBE PQAR verifies threads per USA SRBE SIP 1127. (Thread Failure)

- o USA SRBE PQAR verifies proper 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. (Improper Lockwire)
- o The 0.250" diameter union is magnetic particle inspected per MIL-I-6868. (Defective Sealing Surface)
- o The cylinder to actuator union is magnetic particle inspected per MIL-I-6868. (Defective Sealing Surface)
- 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.
- 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, Seal Faces per A20890
 - Heat Treat, Barrier Rings per EA 3276
 - Heat Treat, Ring Seals per MIL-I-6875, Cond. H1060
 - Silver Plating per QQ-S-3650, Grade B, Type 1

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 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 per 10REQ-0021, para. 2.3.2.6. (Contamination)
- o Hydraulic circuit fluid leak test is verified per 10REQ-0021, para. 2.3.12.2 prior to hotfire. (Defective O-Ring, Improper Torquing, Improper Lockwire, Thread Failure, Improper Clearance, Defective Sealing Surface)
- 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 GN2spin, high speed GN2 spin and post Hotfire inspection. (Defective O-Ring, Improper Torque, Improper Lockwire, Thread Failure, Improper Clearance, Defective Sealing Surface)
- 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 witnessed per OMRSD File V, Vol. 1 Requirement Number B42HP0.020. (Defective O-Ring, Improper Torquing, Improper Clearance, Improper Lockwire, Defective Sealing Surface, 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.