

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Seals and Sampling Valves,
Part of Servoactuator

PART NO.: See below

FM CODE: A05

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-235

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SHEET 1 OF 6

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CN 044

FAILURE MODE AND CAUSES: External leakage of hydraulic fluid at any one of the elastomeric (torturous path) seals caused by:

- o Defective elastomeric seals
- o Defective sealing surface
- o Improper torquing
- o Improper lockwire
- 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.

PART NUMBERS:

Power Valve Closures -- A21156-023MS, A21156-129MS (Seal, External Groove); DPF Unions and Power Valve Index Pin -- A21156-006MS (Seal, External Groove); Solenoid Installation -- A21156-018MS (Seal, External Groove); DPF Mounting Face -- A21160-008 (Packing, Preformed), 082-74415 (Retainer, Backup); Pressure Transducer Mounting Face -- A21160-007 (Packing, Preformed), A28118 (Retainer, Backup); Servovalve Mounting Face -- A21160-008 (Packing, Preformed), 082-74415 (Retainer, Backup); DPF End Cap -- A21156-024MS (Seal, External Groove); Pressure Transducer -- A21156-019MS, A21156-021MS, A21156-020MS (Seal, External Groove), A21788 (Seal, Internal Groove); Servovalve -- A21160-009 (Packing, Preformed), 082-45200-9 (Retainer, Backup), A21160-500, A21160-506, A21160-013 (Packing, Preformed), 082-79183 (Retainer, Packing Backup); Solenoid Valve Assembly -- A21160-012, A21160-017 (Packing, Preformed); Body/Cylinder Rod End Seal Vent -- A20888 (Union), A21156-011MS (Seal, External Groove); Selector and Lock Valve Knob Assembly -- A21156-132MS (Seal, External Groove), A21160-13 (Packing, Preformed), 082-45200-013 (Ring,

Backup); Cylinder Pressure Transducer or Cover Plate -- A21160-010 (Packing, Preformed); Pressure Switch -- A23953-3 (Packing, Preformed), Transient Load Relief Valve -- A21156-137MS (Seal, External Groove), A21160-128, A21160-124, A21160-015, A21160-010 (Packing, Preformed), 082-60209-128NI, 082-60209-124-1, 082-60209-015-1 (Seal, Cap), A23466, A23465 (Seal, Low Friction); Rod End Locking Device -- A21160-040, A21160-233 (Packing, Preformed)

RATIONALE FOR RETENTION:

A. DESIGN

- o The Seals and Sampling Valves are designed and qualified in accordance with end item specification 10SPC-0055 and 10SPC-0174 respectively. (All failure causes)
- o Material selection is in compliance with MSFC-SPEC-522A. (All Failure Causes)
- o The servoactuator, including seals and sampling valves is designed per 10SPC-0055 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 (Ref. 10SPC-0055). (All Failure Causes)
- o External groove seals (A21156) are made of nitrile (buna N) rubber. The dash numbers indicate various sizes. The seals are compatible with hydraulic fluids and are designed to operate within the pressure environment of 3000 to 3850 psig and compatible with seawater. (Defective Elastomeric Seals) CN 044
- o Preformed packing (O-rings) A21160, are made of nitrile (buna N) rubber. The dash numbers indicate various sizes. The o-rings are compatible with hydraulic fluids and are designed to operate over the pressure range of 3000 to 3850 psig. (Defective Elastomeric Seals) CN 044
- o Single turn backup rings (082-45200) which are used in O-ring glands are made of teflon. The surfaces are to be free of irregularities with clean, sharp edges. (Defective Elastomeric Seals)
- o Internal groove seals (A21788) are made of nitrile (buna N) rubber. The seals are compatible with hydraulic fluids conforming to MIL-H-83282. An internal groove assembly consists of one seal and two backup rings. The backup rings are made of teflon. (Defective Elastomeric Seals)
- o Internal groove seals are designed to operate within the pressure environment of 3000 to 3850 psig and are compatible with seawater. (Defective Elastomeric Seals)
- o External groove low friction seals (A23465 and A23466) are made of teflon. The surfaces are to be free of irregularities with clean, sharp edges. Surface roughness is not to exceed 63 rms. The seals are designed to operate within pressure environment of 3000 to 3850 psig and are compatible with seawater. (Defective Elastomeric Seals, Defective Sealing Surface)
- o The hydraulic fluid is MIL-H-83282 or MIL-PRF-83282 which was developed specifically to minimize the fire hazard. (Contamination) CN 044

- o Backup packing retainers (082-74415, 082-79183 and A28118) are made of teflon. (Defective Elastomeric Seals, Defective Sealing Surface)
- o Double delta cap seals (082-60209-128N-1, 082-60209-124-1 and 082-60209-015-1) corresponding to o-ring sizes are installed with a general purpose virgin teflon Turcon or Himond ring seal compound. (Defective Elastomeric Seals, Defective Sealing Surface)
- o The 0.250" diameter passage union (A20888) is made of 17-4PH CRES, heat treated and passivated. The union has a general surface finish of 125 rms with critical surfaces finished to 32 rms. (Defective Sealing Surface)
- o All threaded fittings and connectors are torqued per engineering specifications and are lockwired per MS 33540. (Improper Torquing, Improper Lockwire)
- 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 and 815 (Circle Seal) respectively. 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 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 according to Moog Report No. MR A-2406. (Contamination)
- o Refurbished servoactuators are tested as follows:

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- 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)

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. (Improper Torquing, Improper Lockwire, Defective Elastomeric Seals, 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 Elastomeric Seals, Defective Sealing Surface, Improper Torquing, Improper Lockwire)

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)
- o USA SRBE PQAR verifies hydraulic fluid is inspected for contamination requirements per USA SRBE SIP 1127. (Contamination)
- o USA SRBE PQAR verifies proper torque and lockwiring per SIP 1127. (Improper torque, Improper lockwiring)

- o Double delta seals (082-60209) are inspected at receiving. (Defective Elastomeric Seals)
- o The 0.250" diameter passage union is magnetic particle inspected per ASTM E 1444. (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, per EP 3233
 - Passivation, per EP 3204
 - Magnetic Particle Inspection, per ASTM E1444.

KSC RELATED INSPECTIONS

- o Performance of visual leak check of hydraulic circuit (system) joints per 10REQ-0021, para. 2.3.12.2. (All Failure Causes)
- 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 spin and post Hotfire inspection. (Defective Elastomeric Seals, Improper Torquing, Defective Sealing Surface, Improper Lockwire)

- o Hydraulic circuit fluid leak test is verified per 10REQ-0021, para. 2.3.12.2 prior to hotfire. (Defective Elastomeric Seals, Improper Torquing, Defective Sealing Surface, Improper Lockwire)
- o Hydraulic fluid (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 Elastomeric Seals, Improper Torquing, Defective Sealing Surface, Improper Lockwire)

D. FAILURE HISTORY

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

E. OPERATIONAL USE

- o Not applicable to this failure mode.