

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE****NUMBER: 02-2B-A01-PS -X****SUBSYSTEM NAME:** FLIGHT CONTROL MECH – SSME (TVC)**REVISION:** 1 06/29/01

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**PART DATA**

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	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: TVC ACTUATOR	MC621-0015-0026
	MOOG	A28112-3 /-4
SRU	:POWER VALVE	A23767
LRU	:TVC ACTUATOR	MC621-0015-0027
	MOOG	A28113-7 /-8
SRU	:POWER VALVE	A23854
LRU	:TVC ACTUATOR	MC621-0015-0028
	MOOG	A38114-3 /-4
SRU	:POWER VALVE	A23854

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

POWER VALVE (TWO PIECE END CAP ASSEMBLIES)

**QUANTITY OF LIKE ITEMS:** 6

ONE PER ACTUATOR

**FUNCTION:**

METERS AND DIRECTS HYDRAULIC FLUID FLOW TO THE ACTUATOR PISTON. THE VALVE IS CONTROLLED BY THE COMBINED OUTPUTS OF THE FOUR CHANNEL SERVOVALVES.

**FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE**

**NUMBER: 02-2B-A01-PS- 02**

**REVISION#: 1 06/29/01**

**SUBSYSTEM NAME: FLIGHT CONTROL - TVC ACTUATOR**

**LRU: TVC ACTUATOR**

**ITEM NAME: POWER VALVE**

**CRITICALITY OF THIS**

**FAILURE MODE: 1/1**

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**FAILURE MODE:**

JAMMED

**MISSION PHASE:**

LO LIFT-OFF  
DO DE-ORBIT

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

102 COLUMBIA  
103 DISCOVERY  
104 ATLANTIS  
105 ENDEAVOUR  
POWER VALVE WITH 2-PIECE END CAP ONLY

**CAUSE:**

MECHANICAL FAILURE, SEIZED (HYDRAULIC FLUID OVERTEMPERATURE), CONTAMINATION, EXCESSIVE SPOOL STOP MOVEMENT FROM POWER SPOOL END CAP

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

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**REDUNDANCY SCREEN**

A) N/A  
B) N/A  
C) N/A

**PASS/FAIL RATIONALE:**

A)

B)

C)

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

LOSS OF ONE ACTUATOR FUNCTION.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE****NUMBER: 02-2B-A01-PS- 02****(B) INTERFACING SUBSYSTEM(S):**

POSSIBLE LOSS OF ONE ENGINE POSITION CONTROL WHICH MAY CAUSE ENGINE COLLISION. DURING ENTRY, POSSIBLE INTERFERENCE WITH BODY FLAP FUNCTION.

**(C) MISSION:**

POSSIBLE LOSS OF MISSION, CREW/VEHICLE. LOSS OF FUNCTION CAN RESULT IN LOSS OF VEHICLE CONTROL.

**(D) CREW, VEHICLE, AND ELEMENT(S):**

LOSS OF CONTROL OF AEROSURFACE MAY RESULT IN LOSS OF CREW/VEHICLE

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

SPOOL AND SLEEVE ARE 440C MATERIAL, HARDENED AND LAPPED FOR MATCHED SET. SPOOL IS GROOVED TO CLEAR SILTING. POWER VALVE IS FILTERED WITH A 5 MICRON HYDRAULIC SYSTEM FILTER. FORCE DEVELOPED ON POWER VALVE SPOOL IS IN EXCESS OF 1,000 POUNDS TO CLEAR CONTAMINATION.

TWO SPOOL STOP CLOSURES ARE USED PER POWER VALVE TO LIMIT THE MOVEMENT OF THE POWER SPOOL TO 0.060" AT EACH END. THE ORIGINAL POWER SPOOL CLOSURE STOP WAS A TWO PIECE DESIGN CONSISTING OF A CRES STEEL SPOOL STOP PRESS FIT INTO AN ALUMINUM (6061-T6) END CAP. THIS TWO-PIECE CONFIGURATION HAD THE TENDENCY TO TRAP LUBE OIL/AIR BEHIND THE SPOOL STOP DURING THE PRESS-FIT OPERATION, MAKING IT DIFFICULT TO PRESS THE STOP COMPLETELY INTO THE END CAP. THIS MANUFACTURING ISSUE REPRESENTS A CONCERN, AS AN UNSEATED SPOOL STOP HAS THE POTENTIAL FOR FURTHER DISPLACEMENT FROM THE END CAP AND OVER TIME CAN RESTRICT THE FREE MOVEMENT OF THE POWER SPOOL. THE SUPPLIER (MOOG) RESOLVED THIS MANUFACTURING ISSUE IN 1983 BY INCORPORATING A FLAT ALONG THE CIRCUMFERENCE OF THE SPOOL STOP TO VENT LUBE OIL/AIR PRESSURE TRAPPED BETWEEN THE SPOOL STOP AND END CAP. CURRENT FLEET USES BOTH VENTED AND UNVENTED SPOOL STOPS. THE UNVENTED SPOOL STOPS DESIGN IS NO LONGER MANUFACTURED AND WILL BE RETIRED BY ATTRITION.

**(B) TEST:**

QUALIFICATION: ENDURANCE CYCLING - 400 MISSION DUTY CYCLES UNDER LOAD AT MAXIMUM TEMPERATURE OF 275 DEGREES F. ACTUATOR WAS VIBRATED AT FLIGHT LEVELS AND WAS TESTED AT -65 AND 250 DEGREES F. 100,000 PRESSURE IMPULSE CYCLES AT EACH SUPPLY AND RETURN PORT, AT 230 DEG F. SUPPLY PORTS WERE

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CYCLED FROM 3,000 PSIG TO 4,500 PSIG TO 1,500 PSIG, BACK TO 3,000 PSIG EACH CYCLE;  
RETURN PORTS, FROM 750 PSIG TO 1,500 PSIG TO 0 PSIG, BACK TO 750 PSIG. VERIFIED  
THAT ALL PARTS WERE WITHIN ACCEPTABLE LIMITS DURING DISASSEMBLY AND  
INSPECTION AT COMPLETION OF QUALIFICATION.

ACCEPTANCE: PERFORMANCE TESTS VERIFY THAT THE POWER VALVE MEETS  
OPERATIONAL REQUIREMENTS. FLUID FROM ACTUATOR IS VERIFIED TO MEET  
CLEANLINESS LEVEL 190 PER MAO110-301.

OMRSD: MPS ENGINE POSITIONING TEST, PERFORMED PRIOR TO EACH MISSION.  
HYDRAULIC FLUID SAMPLES ARE TAKEN AFTER EVERY FLIGHT AND VERIFIED TO BE WITHIN  
SPECIFIED CLEANLINESS LEVELS.

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

RAW MATERIAL CERTIFICATIONS ARE VERIFIED. SPECIAL MATERIAL REQUIREMENTS ARE  
IDENTIFIED IN CERTIFICATIONS.

NDE

PIECE PARTS EVALUATED BY SELECTED PENETRANT, MAGNETIC PARTICLE, ULTRASONIC,  
AND RADIOGRAPHIC INSPECTIONS.

SPECIAL PROCESSES

CRITICAL/CLOSE TOLERANCE DIMENSIONS AND FINISHES ARE 100 PERCENT INSPECTED  
FOLLOWING MACHINING.

CONTAMINATION CONTROL

ASSEMBLY AREA CLEANLINESS IS VERIFIED BY CONTAMINATION CONTROL PLAN.  
COMPONENTS ARE PRECLEANED PRIOR TO ASSEMBLY. PARTS AND TOOLS/AIDS ARE  
CLEANED PRIOR TO ASSEMBLY. END ITEM FLUID SAMPLE IS VERIFIED PRIOR TO  
ACTUATOR DELIVERY.

TESTING

ROCKWELL DESIGN AND QUALITY PERSONNEL, WITH NASA PARTICIPATION, CONDUCT A  
DETAILED ACCEPTANCE REVIEW OF THE HARDWARE AT THE VENDOR'S FACILITY, PRIOR  
TO THE SHIPMENT OF EACH END ITEM COVERED BY CONTROL PLAN. ATP VERIFICATION IS  
MIP FOR RI QA REPRESENTATIVE.

**(D) FAILURE HISTORY:**

THERE IS NO HISTORY OF FAILURE FOR THIS FAILURE MODE.

**(E) OPERATIONAL USE:**

NONE

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**- APPROVALS -**

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SAFETY ENGINEERING	: R. STELL	:_/S/ R. STELL_____
SAFETY ENGINEERING ITM	: P.A. STENGER-NGUYEN	:_/S/ R. STELL, FOR_____
HYDRAULICS ENGINEER	: W. VARGAS	:_/S/ W. VARGAS_____
HYDRAULICS SSM	: S. NAMVARI	:_/S/ S. NAMVARI_____
MOD	: J. DAVIS	:_/S/ J. DAVIS_____
USA SAM	: M. J. BURGHARDT	:_/S/ M. J. BURGHARDT_____
USA	: S. LITTLE	:_/S/ J. WILDER, FOR_____