

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION FMEA NO 03-1 -0606 -2 REV:06/01/88P

ASSEMBLY :EG&G WRIGHT COMPONENTS

P/N RI :MC284-0403-0003

P/N VENDOR:12201

QUANTITY :2

:TWO

:

CRIT. FUNC: 1R

CRIT. HDW: 2

VEHICLE

102 103 104

EFFECTIVITY:

X X X

PHASE(S): PL X LO X OO DO LS

REDUNDANCY SCREEN: A-PASS B-FAIL C-PASS

PREPARED BY:

DES J E OSLUND

REL L H FINEBERG

QE R WILLIAMS

APPROVED BY:

DES

REL

QE

APPROVED BY (NASA):

SSM

REL

QE

ITEM:

VALVE, 2-WAY, DIRECT ACTING SOLENOID, LH2 MANIFOLD REPRESSURIZATION, NORMALLY CLOSED (0.5 INCH) (LV42,43).

FUNCTION:

TWO VALVES IN SERIES ISOLATE PNEUMATIC SYSTEM HELIUM PRESSURE (750 PSIA) FROM THE 20 PSIG REGULATOR (PR6). THE TWO VALVES ARE OPENED TO PROVIDE A FLOW PATH TO THE REGULATOR FOR PRESSURIZING THE LH2 MANIFOLD AS AN AID IN DUMPING PROPELLANTS AND IN REPRESSURIZING THE LH2/GH2 SYSTEMS FOR ENTRY.

FAILURE MODE:

FAILS TO REMAIN CLOSED, INTERNAL LEAKAGE.

CAUSE(S):

PIECE PART STRUCTURAL FAILURE.

EFFECT(S) ON:

(A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE

(A,B) NO EFFECT. THE SERIES REDUNDANT VALVE WILL PREVENT LEAKAGE OF GHe INTO THE MANIFOLD.

FAILS B SCREEN DUE TO LACK OF POSITION INDICATION.

(C,D) NO EFFECT.

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(E) FUNCTIONAL CRITICALITY EFFECT

1R/2, 2 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT.  
1,2) REPRESS SOLENOIDS LV42 AND LV43 FAIL TO REMAIN CLOSED.

REPRESS REGULATOR (PR6) DOES NOT PROVIDE REDUNDANT HELIUM ISOLATION SINCE REGULATOR CONTROLS TO A MANIFOLD PRESSURE OF 17-30 PSIG AND THE MANIFOLD PRESSURE DURING ASCENT IS IN THIS RANGE. RESULTS IN HELIUM ENTERING THE FEEDLINE MANIFOLD. THIS MAY CAUSE MULTIPLE UNCONTAINED ENGINE FAILURES DUE TO HELIUM BUBBLE INGESTION AND TURBOPUMP CAVITATION. POSSIBLE LOSS OF CREW/VEHICLE.

DISPOSITION & RATIONALE:

(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE

(A) DESIGN

THE SOLENOID VALVE IS A NORMALLY CLOSED, DIRECT-ACTING VALVE. WHEN DEENERGIZED, THE VALVE POPPET IS HELD AGAINST THE VALVE SEAT BY A SPRING AND A BELLOWS, EITHER OF WHICH CAN MAINTAIN THE CLOSED POSITION. THE BELLOWS ASSEMBLY INTERIOR IS EXPOSED TO OUTLET PRESSURE BY VENT HOLES THROUGH THE POPPET, PROVIDING A FORCE BALANCE WHICH ALLOWS THE SOLENOID, WHEN ENERGIZED, TO DEVELOP SUFFICIENT FORCE TO OPEN THE VALVE.

STRUCTURAL FAILURE OF THE BELLOWS (NOT BELLOWS LEAKAGE, BUT MAJOR STRUCTURAL LOSS) IN COMBINATION WITH EITHER THE LOSS OF THE POPPET-TO-PLUNGER PIN OR THE SPRING WOULD CAUSE VALVE FAILURE TO REMAIN CLOSED.

THE BELLOWS ARE MADE OF NICKEL-COBALT-COPPER USING AN ELECTRO DEPOSITING PROCESS AND ARE ASSEMBLED INTO A SUB-ASSEMBLY. THIS SUB-ASSEMBLY IS PROOF PRESSURE TESTED AT 1550 PSIG AND LEAK CHECKED AT 850 PSID PRIOR TO VALVE FINAL ASSEMBLY.

WHEN THE VALVE IS IN THE CLOSED (DEENERGIZED) POSITION, THE ONLY LOADS EXPERIENCED BY THE POPPET-TO-PLUNGER PIN ARE THOSE EXERTED BY THE SPRING (13.5 LB IN THE INSTALLED CONFIGURATION). THE PIN IS MADE OF 17-7PH CRES, IS HEAT TREATED, AND HAS A 0.093 INCH DIAMETER.

THE SPRING IS FORMED FROM 0.035 DIAMETER ELGILOY SPRING WIRE AND IS HEAT TREATED FOLLOWING FORMING. IT HAS A SPRING RATE OF 40 LB/INCH.

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(B) TEST

ATP

EXAMINATION OF PRODUCT

AMBIENT TEMPERATURE TESTS:

PROOF PRESSURE (1550 PSIG)

EXTERNAL LEAKAGE (850 PSIG)

INTERNAL LEAKAGE

(INLET-TO-OUTLET AT 825 PSID AND OUTLET-TO-INLET AT 150 PSID)

ELECTRICAL CHARACTERISTICS

(PULL-IN/DROPOUT VOLTAGE, CURRENT SIGNATURE AT 850 PSIG)

VALVE RESPONSE TIMES (850 PSIG)

REVERSE PRESSURE VALVE RESPONSE TIMES (150 PSIG)

REDUCED TEMPERATURE TESTS (-160 DEG F)

INTERNAL LEAKAGE

(INLET-TO-OUTLET AT 825 PSID AND OUTLET-TO-INLET AT 150 PSID)

ELECTRICAL CHARACTERISTICS (PULL-IN/DROPOUT VOLTAGE AT 850 PSIG)

VALVE RESPONSE TIMES (850 PSIG)

REVERSE PRESSURE VALVE RESPONSE TIMES (150 PSIG)

ELECTRICAL TESTS

ELECTRICAL BONDING

DIELECTRIC WITHSTANDING VOLTAGE

INSULATION RESISTANCE

CERTIFICATION

PORT AND FITTING TORQUE (2 UNITS)

(TWICE NORMAL INSTALLATION TORQUE)

SALT FOG TEST (1 UNIT)

PER MIL-STD-810

SHOCK

PER MIL-STD-810

BENCH HANDLING

DESIGN

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VIBRATION (2 UNITS)

TRANSIENT: 5 TO 35 Hz

RANDOM:

ONE UNITS TESTED ENERGIZED AND FLOWING 100 SCIM, SECOND UNIT TESTED DEENERGIZED

INLET PRESSURE: 750 PSIG AMBIENT HELIUM  
13.3 HOURS FOR EACH OF 2 AXES

PANEL MOUNTED (2 UNITS)

INLET PRESSURE: 750 PSIG AMBIENT HELIUM  
13.3 HOURS FOR EACH OF 3 AXES

ELECTRICAL CHARACTERISTICS, VALVE RESPONSE, AND INTERNAL LEAKAGE AFTER EACH AXIS

FLOW TEST

DIFFERENTIAL PRESSURE TEST (1 UNIT)

INLET PRESSURE: 525 PSIG AMBIENT HELIUM  
FLOW RATES: 0.15 TO 0.25 LBS/SEC  
PRESSURE DROP NOT TO EXCEED 125 PSID

HIGH FLOW CLOSURE TEST (1 UNIT)

3 CYCLES:  
INLET PRESSURE: 850 PSIG AMBIENT HELIUM  
FLOW RATE: 0.3 LB/SEC  
CYCLE VALVE CLOSED AND VERIFY BY LEAKAGE TEST

CONTINUOUS CURRENT TEST (2 UNITS)

50 HOURS WITH SOLENOID ENERGIZED  
TEMPERATURE: +130 DEG F SURROUNDING ENVIRONMENT  
INSULATION RESISTANCE TEST (+130 DEG F MAINTAINED)  
INSULATION RESISTANCE TEST (AMBIENT TEMPERATURE)

THERMAL VACUUM AND ENDURANCE TEST (2 UNITS)

9000 CYCLES: 850 PSIG, AMBIENT HELIUM  
500 CYCLES: 850 PSIG, +130 DEG F HELIUM  
500 CYCLES: 850 PSIG, -160 DEG F HELIUM

OPERATIONAL CYCLE TEST

3 CYCLES PERFORMED DURING EXPOSURE TO FOLLOWING CONDITIONS:  
VALVE ENERGIZED/DEENERGIZED  
INLET PRESSURE: 750 TO 200 PSIG  
TEMPERATURE: +130 TO +250 DEG F HELIUM  
SURROUNDING TEMPERATURE: AMBIENT TO +275 DEG F  
SURROUNDING ENVIRONMENT: AMBIENT TO VACUUM

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ELECTRICAL CHARACTERISTICS AND INTERNAL LEAKAGE AFTER EACH SET OF CYCLES AT APPROPRIATE TEMPERATURE CONDITIONS

BURST TEST (1 UNIT)  
3400 PSIG

OMRSD

V41AZO.100 MPS PNEUMATIC LOW PRESSURE DECAY TEST (EVERY FLIGHT)

V41BCO.020 LV40-43 MANIFOLD REPRESS VALVE SEAT LEAK CHECK (I10)

(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESSES CERTIFICATION. BODY HOUSING BAR STOCK IS ULTRASONICALLY INSPECTED.

CONTAMINATION CONTROL

CLEANLINESS LEVEL IS VERIFIED TO 100A. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL DETAIL PARTS AND ASSEMBLIES ARE EXAMINED FOR BURRS, DAMAGE AND CORROSION (AT 10X MAGNIFICATION) AND INSPECTED FOR CORRECT DIMENSIONS PRIOR TO ASSEMBLY. CRITICAL SURFACE FINISHES ARE INSPECTED USING A COMPARATOR AT 10X MAGNIFICATION. OTHER SURFACE FINISHES ARE INSPECTED AND VERIFIED WITH A PROFILOMETER. TORQUES ARE VERIFIED TO BE IN ACCORDANCE WITH DRAWING REQUIREMENTS. BELLOWS ASSEMBLY IS PROOF PRESSURE TESTED AND LEAK CHECKED. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

CRITICAL PROCESS

THE FOLLOWING ARE VERIFIED BY INSPECTION:

WELDING  
HEAT TREATMENT  
PARTS PASSIVATION  
POTTING OF SOLDER CUPS  
ELECTRICAL WIRE STRIPPING  
DRY FILM LUBRICATION  
CHROME PLATING

NONDESTRUCTIVE EVALUATION

ALL WELDS ARE VISUALLY EXAMINED AND VERIFIED BY X-RAY OR DYE PENETRANT INSPECTIONS. THE SOLENOID ASSEMBLY IS SUBJECTED TO LEAKAGE VERIFICATION USING RADIOACTIVE TRACER TECHNIQUES. SOME VALVE BODIES WERE SUBJECTED TO 10X MAGNIFICATION INSPECTION ONLY. OTHER VALVE BODIES WERE SUBJECTED TO EDDY CURRENT INSPECTION, IN ADDITION TO 10X MAGNIFICATION. REFURBISHED VALVE BODIES ARE SUBJECTED TO 40X MAGNIFICATION INSPECTION.

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TESTING  
ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING  
HANDLING, PACKAGING, STORAGE AND SHIPPING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

DURING QUALIFICATION TESTING, (VIBRATION ALONG THE SOLENOID PLUNGER AXIS), INTERNAL LEAKAGE WAS GREATER THAN 200 SCCM (REFERENCE CAR A6053). MAXIMUM ALLOWED IS 20 SCCM. THE PLUNGER POPPET WAS FOUND TO BE MOVING OFF THE SEAT AT CERTAIN FREQUENCIES. MCR 4352 AUTHORIZED THE USE OF VIBRATION ISOLATORS TO REDUCE VIBRATION LEVELS FOR THE SOLENOID VALVE.

(E) OPERATIONAL USE

PNEUMATIC ACTUATION HELIUM BOTTLE PRESSURE IS ON A DEDICATED DISPLAY IN COCKPIT. CREW ACTION IS TO FOLLOW NORMAL LEAK ISOLATION PROCEDURE. PRIOR TO MECO, ISOLATION VALVES (LV7, LV8) WILL BE REOPENED AND THE LEFT ENGINE HELIUM CROSSOVER VALVE (LV10) WILL BE OPENED.

EFFECTIVE FOR OI-8D SOFTWARE, CR 89397B "MPS PNEUMATIC SYSTEM FDA AND DISPLAY - BFS" ADDS PNEUMATIC TANK, REGULATOR, AND ACCUMULATOR PRESSURE TO THE S/M ALERT FDA SYSTEM AND ADDS THE 3 PRESSURE MEASUREMENTS TO THE BFS SYSTEM SUMMARY DISPLAY. THIS ALLOWS THE FLIGHT CREW TO RESPOND TO A PNEUMATIC HELIUM SYSTEM LEAK INDEPENDENT OF GROUND CONTROL.