



SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION

FMEA NO 03-1 -0432 -2

REV:05/03/88

(E) FUNCTIONAL CRITICALITY EFFECTS

1R/2, 2 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) DISCONNECT (PD17) FAILS TO CLOSE/REMAIN CLOSED.
- 2) HIGH POINT BLEED VALVE (PV22) FAILS TO REMAIN CLOSED.

LH2 WILL DUMP OVERBOARD RESULTING IN LOSS OF 230 POUNDS OF PROPELLANT. THIS WILL NOT EFFECT ENGINE INLET CONDITIONS OR CAUSE A LOW LEVEL CUTOFF. FIRE/EXPLOSIVE HAZARD EXTERIOR TO THE VEHICLE. POSSIBLE LOSS OF CREW/VEHICLE.

DISPOSITION & RATIONALE:

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

(A) DESIGN

FLIGHT HALF - THIS FAILURE COULD BE CAUSED BY STRUCTURAL FAILURE OF THE POPPET SPRING OR BINDING AT THE POPPET/HOUSING INTERFACE. THE DISCONNECT POPPET IS SPRING LOADED TO THE CLOSED POSITION WITH AN 0.070 DIAMETER ELGILOY TEMPERED COIL SPRING HAVING A SPRING RATE OF 10.34 LB/INCH. SLIDING SURFACES ARE DRY FILM LUBRICATED TO PREVENT BINDING.

STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS. AT NO TIME DURING THE DISCONNECT'S 2000 CYCLE LIFE TEST DID THE POPPET FAIL TO CLOSE OR REMAIN CLOSED.

SYSTEM CONTAMINATION IS MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, PREVALVE SCREENS, A GSE DEBRIS PLATE, A GSE FILTER, AND MAINTAINING A CLEANLINESS LEVEL OF 400.

GROUND HALF - N/A.

(B) TEST

ATP

DISCONNECT DISENGAGED

ORBITER HALF

AMBIENT PROOF (520 PSIG)

AMBIENT HOUSING LEAKAGE (400 PSIG)

AMBIENT CLOSURE DEVICE LEAKAGE (20 & 400 PSIG)

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GROUND HALF

AMBIENT PROOF (200 PSIG)

AMBIENT HOUSING LEAKAGE (100 PSIG)

AMBIENT CLOSURE DEVICE LEAKAGE (100 PSIG)

DISCONNECT ENGAGED (WITH RADIAL AND ANGULAR MISALIGNMENT AT MINIMUM AND MAXIMUM BELLOWS COMPRESSION)

PROOF PRESSURE (200 PSIG)

AMBIENT EXTERNAL LEAKAGE (25 & 100 PSIG)

CRYO (-255 DEG F) EXTERNAL LEAKAGE (100 PSIG)

ENGAGE - DISENGAGE CYCLE

CERTIFICATION

DURING ALL MATED TESTS THE ORBITER HALF IS RIGIDLY MOUNTED AND THE GROUND HALF IS MOUNTED WITH RADIAL AND ANGULAR MISALIGNMENT.

CRYO LEAKAGE (-400 DEG F)

MATED: 100 PSIG

ORBITER HALF: 25 AND 100 PSIG

GROUND HALF: 25 AND 100 PSIG

AMBIENT LEAKAGE

MATED: 25 AND 100 PSIG

ORBITER HALF: 20 AND 400 PSIG

GROUND HALF: 25 AND 100 PSIG

AMBIENT EXTERNAL BODY LEAKAGE

ORBITER HALF: 400 PSIG

GROUND HALF: 100 PSIG

LIFE CYCLES

2000 CYCLES (10 SERIES):

199 CYCLES AT AMBIENT TEMPERATURE

ONE CYCLE AT CRYO TEMPERATURE (-255 DEG F)

VIBRATION

TRANSIENT SINUSOIDAL VIBRATION

ORBITER HALF: 5 TO 35 HZ AT ZERO PSIG AND AMBIENT TEMPERATURE

RANDOM VIBRATION IN EACH OF TWO AXES AT -280 DEG F

MATED: 40 PSIG, 9 MINUTES

ORBITER HALF: 80 PSIG, 52 MINUTES

GROUND HALF: 0 PSIG, 9 MINUTES

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THERMAL CYCLE TEST: 3 CYCLES (+70 TO -280 TO +70 TO +350 DEG F)

SALT FOG, BENCH HANDLING SHOCK AND DESIGN SHOCK PER MIL-STD-810, SAND AND DUST TEST

FLOW CAPACITY TEST (8 TO 18.5 LBS/SEC)

BURST TEST

MATED: 400 PSIG

ORBITER HALF: 600 PSIG

GROUND HALF: 400 PSIG

OMRSD

V41AYO.140 LH2 PROPELLANT SYSTEM DECAY TEST (EVERY FLIGHT)

V41BEO.070 PD17 LH2 BLEED DISCONNECT SEAT LEAK (EVERY FLIGHT)

V41BUO.161 LH2 FEEDLINE SCREEN INSPECTION (I5)

V41BUO.163 LH2 FEEDLINE SCREEN INSPECTION - VERTICAL (I25)

V41BVO.040 PD17 LH2 BLEED DISCONNECT INSPECTIONS (EVERY FLIGHT)

(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIALS, INCLUDING CHEMICAL AND MECHANICAL REQUIREMENTS, ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. INSPECTION VERIFIES CERTIFICATION OF ULTRASONIC INSPECTION OF BODY HOUSING FORGING.

CONTAMINATION

CLEANING PROCEDURES AND CONTAMINATION CONTROL REQUIREMENTS ARE VERIFIED BY INSPECTION. CLEANLINESS TO LEVEL 400A IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION. ALL CRITICAL DIMENSIONS AND FINISHES ARE VERIFIED BY INSPECTION. SEALING SURFACE OF THE POPPET IS INSPECTED USING 10X MAGNIFICATION. DRAWING TORQUE REQUIREMENTS ARE VERIFIED. SEALS ARE VISUALLY EXAMINED, PRIOR TO INSTALLATION, FOR DAMAGE AND CLEANLINESS USING 10X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS REQUIRED AND VERIFIED. ALL SPRINGS ARE LOAD TESTED AND VERIFIED BY INSPECTION.

CRITICAL PROCESS

HEAT TREATMENT, PARTS PASSIVATION, AND ANODIZING ARE VERIFIED. CHEMICAL FILM PROTECTANT AND DRY FILM LUBRICANT ARE VERIFIED.

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NONDESTRUCTIVE EVALUATION

BODY HOUSING IS FLUORESCENT PENETRANT INSPECTED. WELDS ARE VISUALLY EXAMINED AND VERIFIED BY X-RAY AND DYE PENETRANT. BELLOWS ASSEMBLY IS PROOF PRESS TESTED AND LEAK CHECKED.

TESTING

ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPPING IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

INTERNAL LEAKAGE WAS DETECTED DURING ATP AT THE SUPPLIER. AN ERROR IN MACHINING OF THE POPPET SEAL WAS DETERMINED TO BE THE CAUSE OF THE LEAKAGE (REF CAR AC8591). 100% INSPECTION IS NOW REQUIRED ON ALL CRITICAL DIMENSIONS.

GENERAL SYSTEM CONTAMINATION

THIS FAILURE MODE HAS NOT OCCURRED ON THIS COMPONENT DUE TO CONTAMINATION. HOWEVER, GENERAL MPS SYSTEM CONTAMINATION HAS OCCURRED WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MODE (REFERENCE THE FOLLOWING PARAGRAPHS).

CONTAMINATION FAILURES HAVE OCCURRED AT ALL PHASES OF MANUFACTURING AND PARTS REPLACEMENT. IN ALL CASES, STRICT ADHERENCE TO CLEANLINESS CONTROL PROCEDURES IS THE PRIMARY METHOD OF CONTAMINATION PREVENTION.

NUMEROUS LARGE PARTICLES OF BLACK RUBBER MATERIAL WERE FOUND DURING A POST FLIGHT EXAMINATION OF THE LH2 17 INCH DISCONNECT OF OV099 (FLIGHT 7, REFERENCE CAR AC9800). THE LO2 AND LH2 SYSTEMS OF ALL VEHICLES WERE EXAMINED. NO RUBBER WAS FOUND IN ANY OTHER VEHICLES. AFTER EXTENSIVE INVESTIGATION THE ORIGIN WAS NOT DETERMINED.

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WAS MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARs AC9868, A9654, AC2210, AB1706; DR AD2226). METHODS ARE BEING REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACING COMPONENTS, LINES, AND FITTINGS REQUIRING WELDED OR BRAZED JOINTS (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONED. ROCKWELL PROBLEM ACTION CENTER WILL CONTINUE TO MONITOR BRAZING/WELDING REWORK CONTAMINATION. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENENCE PROCEDURES HAVE BEEN IMPROVED.

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A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV-099 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARS AC2111, AB2538). STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PSIG HELIUM RELIEF VALVE (REF CAR AC2229). FOR BOTH FAILURES CORRECTIVE ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLIES TO IMPROVE THE QUALITY OF FINAL CLOSEOUT BRAZES.

SEVERAL FOREIGN MATERIALS WERE INTRODUCED INTO THE MPS SYSTEM DURING MANUFACTURE AND PARTS REPLACEMENT. EXAMPLES ARE: GLASS CLOTH IN LINE TO PREVENT TRAVEL OF CHIPS DOWN LINE; POLYSTYRENE OBJECT TO HOLD VALVE POPPET OPEN WHILE PURGING; COTTON SWAB MATERIAL AND GLASS BEADS FROM CLEANING OPERATION; MISCELLANEOUS PLASTIC; FOAM; AND TAPE (REFERENCE CARS AB4751, AC2217, AC6768, AC9868, MPS3A0005, AC7912, AB0530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. GRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

ONE PIECE OF WIRE WAS FOUND IN THE INTERNAL RELIEF VALVE OF THE LO2 PREVALVE ON OV103 (REFERENCE CAR AC9101). THE SOURCE OF THE CONTAMINATION WAS NEVER FOUND, BUT IT WAS BELIEVED TO BE FROM THE ET. OTHER CONTAMINATION HAS BEEN FOUND ON THE FEEDLINE SCREENS, SUCH AS AN UNIDENTIFIED ROUND OBJECT AND VARIOUS METALLIC PARTICLES (REFERENCE CARS AB0529 AND AB0530). SOURCE OF CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

(E) OPERATIONAL USE

NO CREW ACTION CAN BE TAKEN.