

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0405 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 08/08/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:LH2 4" DISCONNECT, RECIRC RTN (ET) VACCO INDUSTRIES	MC284-0390-0014
LRU	:LH2 4" DISCONNECT, RECIRC RTN (ORB) VACCO INDUSTRIES	MC284-0390-0056

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

DISCONNECT, LH2 RECIRCULATION RETURN, 4 INCH DIAMETER, ORBITER & ET HALF

REFERENCE DESIGNATORS: PD3

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

ET/ORBITER RECIRCULATION RETURN DISCONNECT PROVIDES THE PATH FOR LH2 RECIRCULATION. THE DISCONNECT IS A PNEUMATICALLY ACTUATED VALVE THAT IS DESIGNED TO REMAIN IN THE LAST ACTUATED POSITION (BISTABLE). THE DISCONNECT PROVIDES A MEANS FOR TOPPING AND REPLENISHING THE ET TANK, AND RECIRCULATION LH2. THE DISCONNECT VALVE IS CLOSED AFTER MAIN ENGINE CUT-OFF (MECO). THE DISCONNECT VALVE IS CLOSED FOR A PREMATURE ENGINE SHUTDOWN DURING ASCENT OR FOR A PAD ABORT. THE DISCONNECT VALVE IS CLOSED TO PREVENT PROPELLANT LEAKAGE THROUGH THE ENGINE FUEL BLEED VALVE (BLEED VALVE OPENS 16 SECONDS AFTER ENGINE SHUTDOWN). FLUID TRAPPED BETWEEN THE CLOSED ET AND ORBITER HALVES IS RELIEVED THROUGH EITHER THE ET OR ORBITER FLAPPERS. A SEVEN PLY NEGATOR SPRING CONFIGURATION, ATTACHED TO THE MAIN SHAFT, WILL CLOSE THE VALVE MECHANICALLY AT SEPARATION IF THE VALVE WAS NOT CLOSED BY RETRACTION OF THE ACTUATOR ARM.

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: LH2 4" DISCONNECT, RECIRC RTN (PD3)

ITEM NAME: LH2 4" DISCONNECT, RECIRC RTN (PD3)

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

FAILS TO CLOSE/REMAIN CLOSED/EXTERNAL LEAKAGE - POST MECO

MISSION PHASE: LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:	102	COLUMBIA
	103	DISCOVERY
	104	ATLANTIS
	105	ENDEAVOUR

CAUSE:

FAILS TO CLOSE - PIECE PART STRUCTURAL FAILURE, BINDING, CONTAMINATION.

FAILS TO REMAIN CLOSED - PIECE PART STRUCTURAL FAILURE.

EXTERNAL LEAKAGE - CONTAMINATION, DEFECTIVE SEAL/SEAT.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN	A) N/A
	B) N/A
	C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO CONSTRAINT TO ET SEPARATION SINCE PROPULSIVE FORCES FROM H2 VENTING ARE NEGLIGIBLE. HYDROGEN FROM THE ET AND ORBITER RECIRCULATION RETURN SYSTEM

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WILL LEAK INTO THE UMBILICAL DURING UMBILICAL RETRACT. RESULTS IN POSSIBLE TILE AND DOOR DAMAGE AT THE UMBILICAL AREA DUE TO CRYO EXPOSURE.

ALSO RESULTS IN LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESS CAUSING POSSIBLE LOSS OF AFT COMPARTMENT ENTRY PURGE.

FOR ANY PREMATURE ENGINE OUT OCCURRENCE (INCLUDING PAD ABORT), FAILS TO ISOLATE ET PROPELLANT SUPPLY FROM AN ENGINE WITH UNCONTAINED DAMAGE.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

POSSIBLE LOSS OF CREW/VEHICLE/PUBLIC.

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

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

1R/2 2 SUCCESS PATHS. TIME FRAME – ABORT.

- 1) SSME SHUTDOWN AND LEAKAGE (ASSUMES DAMAGE SUCH THAT ISOLATION OF THE SSME CAN SAVE THE SYSTEM).
- 2) 4" DISCONNECT FAILS TO CLOSE/INTERNAL LEAKAGE.

RESULTS IN FAILURE TO ISOLATE A LEAKING SSME SYSTEM FROM LH2 SUPPLY. LH2 WILL DUMP OVERBOARD RESULTING IN LOSS OF OF PROPELLANT. THIS MAY AFFECT ENGINE INLET CONDITIONS OR CAUSE A LOW LEVEL CUTOFF. LH2 MAY LEAK INTO THE AFT FUSELAGE CAUSING, POSSIBLE AFT COMPARTMENT OVERPRESS, AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

A PNEUMATIC ACTUATOR MOUNTED ON THE ORBITER HALF OF THE DISCONNECT DRIVES THE ET FLAPPER THROUGH A GEAR LINKAGE ASSEMBLY. THIS ACTION IN TURN DRIVES A SECOND GEAR WHICH OPERATES THE ORBITER FLAPPER AND THE POSITION INDICATOR ASSEMBLY.

THE DISCONNECT HAS REDUNDANT MEANS TO CLOSE THE FLAPPERS: PNEUMATICALLY (DURING ACTUATION) OR MECHANICALLY (DURING SEPARATION). WHEN COMMANDED CLOSED THE ACTUATOR PNEUMATICALLY RETRACTS THE LATCH. A SEVEN PLY NEGATOR SPRING (HIGH YIELD 301 CRES) LOCATED IN THE ACTUATOR HOUSING CLOSSES THE

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FLAPPERS. FOUR OF THE SEVEN PLIES ARE NEEDED TO CLOSE THE FLAPPER. IF THE PNEUMATIC SYSTEM FAILS TO FUNCTION THE FLAPPER CLOSING MECHANISM IS FULLY RELEASED WHEN SEPARATION OCCURS. THIS ALLOWS THE FLAPPERS TO BE CLOSED BY THE NEGATOR SPRINGS. SYSTEM PRESSURE ALSO ASSISTS IN CLOSING AND IMPROVES FLAPPER SEALING CAPABILITY.

THE DISCONNECT FLAPPER VALVE LINKAGE IS MANUFACTURED FROM INCONEL 718 AND 304 CRES (POWER TRAIN) AND 304L (LATCH). THE FLAPPER UTILIZES 6061 ALUMINUM WITH 304L SUPPORTS AND KEL-F SEALS. THE DISCONNECT HOUSING IS MADE FROM A-356 ALUMINUM. THE DISCONNECT BODY ASSEMBLY IS PROOF PRESSURE TESTED AT 1.3 TIMES OPERATING PRESSURE WITH A DESIGN BURST OF 1.5 TIMES OPERATING PRESSURE. THE ULTIMATE FACTOR OF SAFETY FOR ALL STRUCTURE IS 1.5. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS; FRACTURE/FATIGUE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE.

BINDING OF THE CLOSURE DRIVE SHAFT IS PREVENTED BY USE OF BEARINGS MADE FROM SP-21 VESPEL AND FLUOROGOLD.

LH2 SYSTEM CONTAMINATION IS MINIMIZED BY MAINTAINING THE CLEANLINESS LEVEL TO 400 AND BY USE OF AN ET SCREEN, A GSE FILTER, AND A FACILITY DEBRIS PLATE.

(B) TEST:
ATP

EXAMINATION OF PRODUCT

PROOF PRESSURE:

ACTUATOR: 1720 PSIG
ORBITER HOUSING: 156 PSIG, FLAPPERS OPEN AND CLOSED
ET HOUSING: 48 PSIG, FLAPPERS OPEN AND CLOSED

LEAKAGE - AMBIENT AND CRYO (-300 DEG F):

ACTUATOR (OPEN AND CLOSED POSITION) - 740 PSIG

BUMPER SEAL LEAKAGE; 740 PSIG

SHAFT SEAL LEAKAGE; 740 PSIG

CAP SEAL LEAKAGE; 740 PSIG (AMBIENT ONLY)

VALVE BODY

SHAFT SEAL LEAKAGE
ORBITER SECTION: 5, 20, 37, AND 120 PSIG
ET SECTION: 5, 20, AND 37 PSIG

CLOSURE SEAL (INTERNAL) LEAKAGE

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ORBITER SECTION: 5, 20, 37, AND 120 PSIG
ET SECTION: 5, 20, AND 37 PSIG

MATING SEAL LEAKAGE (47 PSIG)

EXTERNAL LEAKAGE (37 PSIG)

RELIEF FUNCTION:

CRYO (-300 DEG F) CRACK AND RESEAT (.75 TO 10 PSID)

POSITION INDICATOR (AMBIENT):

VERIFICATION OF OPERATION

ELECTRICAL CHARACTERISTICS:

CONTACT RESISTANCE
INSULATION RESISTANCE
DIELECTRIC STRENGTH

RESPONSE TIME:

AMBIENT AND CRYO (-300 DEG F)
400 AND 740 PSIG ACTUATION PRESSURE

CERTIFICATION

COMPONENT QUALIFICATION

INTERFACE CLAMPING FORCE APPLIED DURING ALL AMBIENT AND CRYO TESTING.

OPERATING LIFE:

AMBIENT
800 FLAPPER CLOSURE CYCLES AT 740 PSIG
200 FLAPPER CLOSURE CYCLES AT 400 PSIG

CRYO
300 CLOSURE CYCLES AT 750 PSIG (-400 DEG F)
100 CLOSURE CYCLES AT 400 PSIG (-400 DEG F)

VIBRATION - 3 AXES:

RANDOM VIBRATION (48 MINUTES IN EACH OF THREE AXES WITH CLOSURE IN OPEN POSITION WHILE PRESSURIZED TO 37 PSIG AND AT -300 DEG F (OPEN PRESSURE REMOVED IN LAST 10 MINUTES OF EACH AXIS).

ELECTRICAL CHARACTERISTICS:

CONTACT RESISTANCE
INSULATION RESISTANCE

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DIELECTRIC STRENGTH

BONDING:

ELECTRICAL CONDUCTIVITY SHALL NOT EXCEED 100 MILLIOHMS.

CRYOGENIC RELIEF OPERATION:

CRACK AND RESEAT PRESSURE SHALL BE BETWEEN 0.75 AND 10 PSIG

ENGAGE/DISENGAGE CYCLING:

AMBIENT

100 DISENGAGEMENT CYCLES:

15 CYCLES WITH FLAPPERS OPEN USING ACTUATOR PRESSURE

15 CYCLES WITH FLAPPERS MECHANICALLY LATCHED OPEN

70 CYCLES WITH FLAPPERS CLOSED USING ACTUATOR PRESSURE

CRYO

300 DISENGAGEMENT CYCLES, CRYO (-320 DEG F):

12 CYCLES WITH FLAPPERS OPEN USING ACTUATOR PRESSURE

12 CYCLES WITH FLAPPERS MECHANICALLY LATCHED OPEN

276 CYCLES WITH FLAPPERS CLOSED USING ACTUATOR PRESSURE

10 DISENGAGEMENT CYCLES, CRYO (-400 DEG F):

3 CYCLES WITH FLAPPERS OPEN USING ACTUATOR PRESSURE

3 CYCLES WITH FLAPPERS MECHANICALLY LATCHED OPEN

4 CYCLES WITH FLAPPERS CLOSED USING ACTUATOR PRESSURE

LEAKAGE - AMBIENT AND CRYO (-300 DEG F):

ACTUATOR (OPEN AND CLOSED POSITION)

BUMPER SEAL LEAKAGE; 740 PSIG

SHAFT SEAL LEAKAGE; 740 PSIG

VALVE BODY

SHAFT SEAL LEAKAGE

ORBITER SECTION: 5, 20, 37, AND 120 PSIG

ET SECTION: 5, 20, AND 37 PSIG

CLOSURE SEAL (INTERNAL) LEAKAGE

ORBITER SECTION: 5, 20, 37, AND 120 PSIG

ET SECTION: 5, 20, AND 37 PSIG

MATING SEAL LEAKAGE (47 PSIG)

EXTERNAL LEAKAGE (37 PSIG)

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VALVE RESPONSE TIMES:

CRYO (-300 DEG F) AND AMBIENT
VALVE PRESSURIZED TO 5 PSIG AND AMBIENT PRESSURE
ACTUATOR PRESSURIZED TO 740 PSIG AND 400 PSIG

BURST TEST:

ORBITER SECTION 180 PSIG; FLAPPER IN CLOSED POSITION
ET SECTION 56 PSIG; FLAPPER IN CLOSED POSITION
ACTUATOR 3400 PSIG; SIMULTANEOUSLY APPLIED TO OPEN AND CLOSED PORTS.

THE CONSOLIDATED CONTROL VALVES WERE QUALIFIED BY SIMILARITY TO THE FOLLOWING TESTS THAT WERE PERFORMED ON AMETEK/CALMEC VALVES:

VIBRATION - 3 AXES:

TRANSIENT VIBRATION (SINUSOIDAL SWEEP): 5 TO 35 HZ AT AMBIENT CONDITIONS

RANDOM VIBRATION (48 MINUTES IN EACH OF THREE AXES WITH CLOSURE IN OPEN POSITION WHILE PRESSURIZED TO 37 PSIG AND AT -300 DEG F (OPEN PRESSURE REMOVED IN LAST 10 MINUTES OF EACH AXIS).

SALT FOG: 48 HOURS, INTERNALLY PRESSURIZED TO 5 PSIG

SHOCK, BENCH HANDLING (DEMATED)

THERMAL CYCLE (3 CYCLES): +70 TO -400 TO -20 TO +70 DEG F

OPERATING LIFE:

AMBIENT

1500 FLAPPER CLOSURE CYCLES AT 740 PSIG
1000 FLAPPER CLOSURE CYCLES AT 400 PSIG

300 DISENGAGEMENT CYCLES:

50 CYCLES WITH FLAPPERS OPEN USING ACTUATOR PRESSURE
50 CYCLES WITH FLAPPERS MECHANICALLY LATCHED OPEN
150 CYCLES WITH FLAPPERS CLOSED USING ACTUATOR PRESSURE
50 CYCLES WITH ACTUATOR OPENING AND CLOSING PORTS PRESSURIZED SIMULTANEOUSLY AND CLOSURE DEVICES OPEN

CRYO

700 CLOSURE CYCLES AT 740 PSIG (-400 DEG F)
300 CLOSURE CYCLES AT 400 PSIG (-400 DEG F)

10 DISENGAGEMENT CYCLES (-400 DEG F):

2 CYCLES WITH FLAPPERS OPEN USING ACTUATOR PRESSURE
2 CYCLES WITH FLAPPERS MECHANICALLY LATCHED OPEN
4 CYCLES WITH FLAPPERS CLOSED USING ACTUATOR PRESSURE

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2 CYCLES WITH ACTUATOR OPENING AND CLOSING PORTS PRESSURIZED
SIMULTANEOUSLY AND CLOSURE DEVICES OPEN

290 DISENGAGEMENT CYCLES (-300 DEG F):
50 CYCLES WITH FLAPPERS OPEN USING ACTUATOR PRESSURE
50 CYCLES WITH FLAPPERS MECHANICALLY LATCHED OPEN
140 CYCLES WITH FLAPPERS CLOSED USING ACTUATOR PRESSURE
50 CYCLES WITH ACTUATOR OPENING AND CLOSING PORTS PRESSURIZED
SIMULTANEOUSLY AND CLOSURE DEVICES OPEN

ELECTRICAL CHARACTERISTICS:

CONTACT RESISTANCE
INSULATION RESISTANCE
DIELECTRIC STRENGTH

BONDING:

ELECTRICAL CONDUCTIVITY SHALL NOT EXCEED 100 MILLIOHMS.

BURST TEST:

ORBITER SECTION 180 PSIG; FLAPPER IN CLOSED POSITION
ET SECTION 56 PSIG; FLAPPER IN CLOSED POSITION
ACTUATOR 3400 PSIG; SIMULTANEOUSLY APPLIED TO OPEN AND CLOSED PORTS.

UMBILICAL SEPARATION TEST

THE DISCONNECT WAS INSTALLED IN THE UMBILICAL ASSEMBLY DURING THE SEPARATION TEST PROGRAM. THE UMBILICAL ASSEMBLY WAS SUBJECTED TO RANDOM VIBRATION TESTS (4.4 HOURS PER AXIS) WHILE FILLED WITH LH2. THE DISCONNECT WAS ALSO SUBJECTED TO UMBILICAL RETRACT TESTS AT BOTH NOMINAL CONDITIONS AND SIMULATED HYDRAULIC RETRACT ACTUATOR FAILURE CONDITIONS. THE DISCONNECT WAS ALSO SUBJECTED TO 5 BACKUP MODE CLOSURE TESTS.

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESSES AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. INTERNAL SURFACES CLEANING TO LEVEL 400 IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

COMPONENT

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ALL DETAIL PARTS ARE INSPECTED UNDER 40X MAGNIFICATION FOR BURRS, DAMAGE, AND CONTAMINATION. CRITICAL DIMENSIONS, CLEARANCE, AND SURFACE FINISHES ARE VERIFIED. SEALS ARE VISUALLY EXAMINED PRIOR TO INSTALLATION FOR DAMAGE AND CLEANLINESS. FLAPPER SPRINGS ARE INSTALLED AND VERIFIED BY INSPECTION AFTER LOAD TEST. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

UMBILICAL ASSEMBLY

HEAT TREATED AND DRY FILM LUBE COATED BELLEVILLE SPRINGS ARE VISUALLY INSPECTED AND LOAD TESTED PRIOR TO ASSEMBLY. CORRECT INSTALLATION OF THE BELLEVILLE WASHERS IS A MANDATORY INSPECTION POINT. THE SHIMS, WHICH ARE REQUIRED TO SET THE HEIGHT OF THE 4 INCH DISCONNECT MATING SURFACE ABOVE THE 17 INCH DISCONNECT MATING SURFACE AS EXTERNAL FORCE IS APPLIED TO THE 4 INCH DISCONNECT, ARE DIMENSIONALLY INSPECTED. THE SHIMS, WHICH ARE REQUIRED TO SET THE PRELOAD IN THE UNMATED CONDITION, ARE DIMENSIONALLY INSPECTED.

CRITICAL PROCESS

PARTS PASSIVATION, HEAT TREATMENT, AND ANODIZING ARE VERIFIED. ETCHING OF AL ALLOY, CLEANING AL SAND CASTINGS, BRUSH CLEANING, AND SOLDERING ARE VERIFIED BY INSPECTION. DRY FILM LUBRICANT APPLICATION IS VERIFIED.

NONDESTRUCTIVE EVALUATION

CASTING AND ROUGH MACHINING OF THE BODY ARE INSPECTED BY X-RAY AND DYE PENETRANT.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

IN-PROCESS OPERATIONS ARE VERIFIED BY INSPECTION TO PROTECT PARTS AND PRECLUDE MISHANDLING. PARTS PACKAGING IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

DURING QUALIFICATION TEST DISCONNECT MATING OPERATION THE DISCONNECT VALVE FAILED TO CLOSE. ACTUATOR SHAFT MUST BE IN THE RETRACTED POSITION PRIOR TO MATING. AN INSPECTION REQUIREMENT WAS INCORPORATED INTO THE OMRSD (V41BU0.370) TO VERIFY THE SHAFT POSITION PRIOR TO MATING.

AT SUPPLIER THE VALVE FAILED TO CLOSE (REFERENCE CAR AC7509, AC7528) DUE TO THE INSTALLATION OF UNSPLIT RACK BEARING WHICH PUT EXCESSIVE FRICTION ON THE ET HALF DRIVESHAFT. THE FLAPPER NEGATOR SPRING FORCES WERE INSUFFICIENT TO CLOSE THE DISCONNECT. THE ASSEMBLY PROCEDURE WAS REVISED TO INSURE THAT BEARING WILL BE SPLIT PRIOR TO BEING INSTALLED.

DURING ATP TESTING OF EARLIER CONFIGURATIONS, EXTERNAL LEAKAGE OCCURRED ON AN UNMATED ET HALF (REFERENCE CAR AB7646) DUE TO THE IRREGULAR TEXTURE OF THE KEL-F FLAPPER CLOSURE SEAL. THE SEAL WAS MADE OF EXTRUDED MATERIAL. THE SEAL DRAWING WAS CHANGED TO REQUIRE THE USE OF PRESSURE-FORMED KEL-F.

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DURING SUPPLIER ASSEMBLY, WHEN INSTALLING THE CAM ON THE PISTON SHAFT, THE SHAFT BROKE OFF IN THE PLANE OF THE SHAFT THREAD UNDERCUT. IT WAS DETERMINED THAT THE INSTALLATION TORQUE OF 90 IN-LBS CAUSED A HIGH STRESS IN THE PISTON SHAFT WHICH REDUCED CROSS-SECTIONAL AREA AT THE THREAD UNDERCUT. LOOSE PARTS FROM A FRACTURED SHAFT COULD JAM THE MECHANISM AND PREVENT DISCONNECT CLOSURE. THE CAM INSTALLATION TORQUE WAS REDUCED FROM 90 TO 30 IN-LBS (REFERENCE CAR AC6252).

DURING THE SUPPLIER ACCEPTANCE TEST FOR THE MPTA DISCONNECT, THE UNIT FAILED TO CLOSE WITH 400 PSIG APPLIED TO THE ACTUATOR (REFERENCE CAR AB1322). THE FAILURE WAS ATTRIBUTED TO THE MARGINAL PRESSURE DIFFERENTIAL ACROSS THE PNEUMATIC ACTUATOR'S PISTON. THE ORIFICE RESTRICTION OF GAS FLOW IN AND OUT OF THE ACTUATOR PREVENTED THE NEEDED PRESSURE DIFFERENTIAL FROM BUILDING UP ACROSS THE PISTON, WHICH LIMITED THE FORCE OUTPUT OF THE ACTUATOR. THE NEW CONFIGURATION CONSISTS OF CHANGING THE TWO FILTER ASSEMBLIES IN THE PNEUMATIC ACTUATOR PORTS TO A LARGER SIZE ORIFICE AND INSTALLING A STATIC SEAL BETWEEN THE FILTER ASSEMBLIES AND THE BODY TO CONTROL THE POTENTIAL LEAKAGE BYPASSING THE ORIFICE.

DURING QUALIFICATION UMBILICAL SEPARATION TESTS AT DOWNEY, THE DISCONNECT FAILED TO PNEUMATICALLY ACTUATE CLOSED (REF CAR AB4760). FAILURE ANALYSIS SHOWED THE LATCH HOOK TO BE BENT AND MARRED. THE LATCH HOOK WAS OF AN OLD CONFIGURATION AND DID NOT HAVE THE NEW REQUIRED MINIMUM CLEARANCE OF 0.020 BETWEEN LATCH HOOK AND STOP. THE LATCH HOOK WAS MODIFIED TO INSURE PROPER MINIMUM CLEARANCE. DISCONNECTS WITH THE NEW REQUIRED MINIMUM CLEARANCE HAVE A NEW DASH NUMBER.

A SECOND FAILURE OCCURRED DURING THE LH2 SEPARATION TESTS AT DOWNEY. WHILE DEMONSTRATING THE BACKUP SEPARATION MODE, AFTER SEPARATION, THE ET FLAPPER FAILED TO CLOSE. THIS FAILURE WAS ATTRIBUTED TO MOISTURE IN THE DRIVE MECHANISM WHICH HAD FROZEN AND CAUSED A JAM. THIS WAS NOT A FAILURE APPLICABLE TO THE FLIGHT ENVIRONMENT AND WAS CORRECTED BY INSTALLING A PURGE FOR THE TEST FIXTURE (REF CAR AB5728) (REF CARS WITH ICE RELATED PROBLEMS AC1518, AC1519, AC7528).

DURING QUALIFICATION TESTING, PORTIONS OF THE KEL-F FLAPPER SEAL WERE FOUND CRACKED OR SPLIT AFTER VIBRATION TEST. THE SEAL FAILURE WAS ATTRIBUTED TO EXCESSIVE IMPACT FORCE WHEN CLOSING AT CRYOGENIC TEMPERATURE. CLOSING TIME WAS 0.1 SECOND. A VISCOJET ORIFICE WAS INSTALLED IN THE OPEN PORT OF THE ACTUATOR TO SLOW CLOSING TIME TO 0.4 SECOND MINIMUM AND 0.7 SECOND MAXIMUM. THE CLOSURE SEAL PROBLEM PERSISTED WHEN A SEAL CRACK OCCURRED AFTER 240 LH2 CRYO CLOSURE CYCLES. SINCE THE DISCONNECT IS CLOSED ONLY ONE TIME EACH MISSION, THE FLAPPER SEAL HAS BEEN CYCLE LIFE LIMITED TO 50 MISSIONS. A SEAL LEAK CHECK IS PERFORMED EVERY MISSION AND A SEAL INSPECTION PER OMRSD EVERY 5 MISSIONS. THE SEAL IS TO BE REPLACED AS NECESSARY (REF CAR AC5050 AND AC6105).

GENERAL SYSTEM CONTAMINATION

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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 MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

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

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CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:
NO ACTION CAN BE TAKEN.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	: /S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	: /S/ P. A. STENGER-NGUYEN
DESIGN ENGINEERING	: MIKE FISCHER	: /S/ MIKE FISCHER
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: BILL LANE	: /S/ BILL LANE
USA SAM	: MIKE SNYDER	: /S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	: /S/ ERICH BASS