SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :MAIN PROPULSION FMEA NO:03-1 -0454 -3 REV:12/18/87

ASSEMBLY :
P/N RI :MC284-0389-0451,0551
P/N VENDOR:
QUANTITY :ONE EACH
:LO2,LH2
:

	CRIT. FUNC:	1R
	CRIT. HDW:	2
VEHICLE EFFECTIVITY:	102	103 104
	X	X X

PHASE(S): PL LO X OO DO LS

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

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ITEM
VALVE LATCH ASSEMBLY, LH2/LO2 FEED DISCONNECT (FD1, FD2)
ORBITER HALF ONLY

FUNCTION
A PNEUMATICALLY ACTUATED LATCH MECHANISM IS PROVIDED TO PREVENT THE VALVE FLAPPERS FROM CLOSING DURING FLOW CONDITIONS. THE LATCH IS BISTABLE AND IS CONTROLLED BY A SEPARATE PNEUMATIC ACTUATOR ASSEMBLY WITH REDUNDANT LOCK AND UNLOCK (TWO EACH) POSITION SWITCHES. LATCH IS PLACED IN UNLOCKED POSITION FOR ALL FLAPPER OPEN OR CLOSE OPERATIONS. LATCH MECHANISM INCORPORATES A TOGGLE PIVOT WHICH ALLOWS FLAPPER CLOSURE DURING BACKUP MECHANICAL SEPARATION IF LATCH IS IN LOCKED POSITION. SEE DISCONNECT FMEA/CIL 0407/0408 FOR ADDITIONAL INFORMATION.

FAILURE MODE
FAILS TO UNLOCK POST MECO

CAUSE(S)
PIECE PART STRUCTURAL FAILURE, ACTUATOR LEAKAGE, BINDING, ACTUATOR PORT FILTER CLOGGING

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

(A,B) THE 17-INCH DISCONNECT VALVE WILL NOT BE CLOSED PNEUMATICALLY. VEHICLE SOFTWARE WILL NOT COMMAND THE DISCONNECT CLOSED IF THE LATCH IS NOT UNLOCKED. DISCONNECT VALVE WILL AUTOMATICALLY BE CLOSED (MECHANICALLY) DURING THE UMBILICAL RETRACT.

PASSES SCREEN B BECAUSE THE LATCH FAILURE TO UNLOCK IS DETECTABLE USING THE LATCH POSITION INDICATORS; THE DISCONNECT VALVE CLOSURE BY THE MECHANICAL BACKUP MODE IS DETECTABLE USING THE DISCONNECT VALVE POSITION INDICATORS.

(C,D) NO EFFECT.

(E) FUNCTIONAL CRITICALITY EFFECTS

CASE I: 1R/2, 2 SUCCESS PATHS. TIME FRAME - POST MECO

1) LATCH FAILS TO UNLOCK.
2) MECHANICAL CLOSURE SEPARATION DEVICE FAILS TO CLOSE VALVE. (ET OR ORB FORK STRUCTURAL FAILURE)

VEHICLE SOFTWARE WILL INHIBIT ET STRUCTURAL SEPARATION SINCE BOTH DISCONNECT CLOSED SWITCHES WILL PROPERLY INDICATE ORBITER FLAPPER FAILURE TO CLOSE. FOR NOMINAL, ATO, AND AOA MISSIONS ET SEPARATION IS DELAYED FOR SIX MINUTES TO VENT RESIDUAL PROPELLANT THROUGH FAILED DISCONNECT. THIS IS TO PREVENT ORB/ET RECONTACT DUE TO PROPULSIVE VENTING AT SEPARATION. POSSIBLE TILE AND DOOR DAMAGE AT THE ORB/ET UMBILICAL AREA DUE TO CRYO EXPOSURE. FOR RTLS, TAL, AND MISSIONS WHERE OMS BURN CANNOT BE DELAYED ET STRUCTURAL SEPARATION IS NOT DELAYED AND ET/ORB RECONTACT IS LIKELY. ALSO RESULTS IN LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESS CAUSING POSSIBLE LOSS OF AFT COMPARTMENT PURGE (RTLS AND TAL ABORT CRITICAL). POSSIBLE LOSS OF CREW/VEHICLE.

CASE II: 1R/2, 2 SUCCESS PATHS. TIME FRAME - POST MECO

1) LATCH FAILS TO UNLOCK.
2) LATCH TOGGLE FAILS TO ROTATE/PIVOT.

POSSIBLE FAILURE TO CLOSE FLAPPERS DURING BACKUP MODE UMBILICAL SEPARATION DUE TO MECHANICAL INTERFERENCE BETWEEN ORBITER FLAPPER FORK AND ET ROLLER ARM ASSEMBLY. FAILURE TO SEPARATE ET FROM ORBITER. POSSIBLE LOSS OF CREW/VEHICLE.

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

(A) DESIGN
THE ACTUATOR SWING ARM (INCONEL 718) TRANSFERS LATERAL MOVEMENT OF THE ACTUATOR PISTON INTO CIRCULAR MOVEMENT OF THE LATCH ARM ASSEMBLY AND ROTATION OF THE POSITION SWITCH CAM. THE LATCH ARM AND TOGGLE ASSEMBLY IS SUPPORTED BY THE FLEXURE ASSEMBLY AND A BEARING INSERTED IN THE DISCONNECT HOUSING.

DESIGN FACTORS OF SAFETY FOR INTERNAL PRESSURES ARE 1.5 PROOF AND 2.0 BURST FOR THE LATCH ACTUATOR. THE ACTUATOR CONSISTS OF COMPONENTS MANUFACTURED FROM 2219-T852 AL ALLOY (BODY), MULTIPHASE MP35N ALLOY STEEL (PISTON), VESPEL SP-21 (BEARING), INCONEL 718 (ARM PIN), ALUMINUM ALLOY 6061-T6 (CAM), AND 318 CRES (FLANGE ASSEMBLY). THE SEALS ARE OF KEL-F (BUMPER), RULON "A" (PISTON AND CAP). CAP SEAL SPRING IS LOCATED WITHIN CONFINES OF JACKET. THE SPRING PROVIDES THE PRELOAD NECESSARY FOR POSITIVE SEAL. THE PISTON HAS REDUNDANT SEALS AND THE SHAFT HAS REDUNDANT SEALS.

THE LATCH ARM ASSEMBLY CONSISTS OF THE LATCH, LATCH PIN, COVER SPRING, LATCH SPRING, RETAINER SPRING, AND ROLL PIN. THE LATCH IS CONSTRUCTED OF HEAT TREATED INCONEL 718 AND HAS DRY FILM LUBRICANT ON ALL SURFACES. THE LATCH PIN IS OF INCONEL 718 WITH A 32 MICROINCH SURFACE FINISH AND IS LUBRICATED WITH MICROSEAL 100-1. THE COVER SPRING IS OF 316 CRES PASSIVATED AND MICROSEAL LUBRICANT TO ALL SURFACES. LATCH SPRING IS OF 302 CRES TYPE B. THE SPRING IS STABLE WITH RESPECT TO BUCKLING. SPRING COIL PITCH AT INSTALLED HEIGHT IS LESS THAN WIRE SIZE, SO IF IT FRACTURES, ONLY ONE EFFECTIVE COIL IS LOST. THE RETAINER SPRING IS OF CRES 302 PASSIVATED. THE ROLL PIN IS OF CRES 302.

THE LATCH IS DESIGNED FOR 2500 CYCLES (LOCKED TO UNLOCKED TO LOCKED) AT AMBIENT AND 1000 CYCLES AT -423 DEG F. FOR MECHANICAL LATCH LOADS, THE PROOF FACTOR OF SAFETY IS 1.1 AND THE ULTIMATE FACTOR OF SAFETY IS 2.0. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF LATCH OPERATION; FRACTURE/FATIGUE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE.

(B) TEST

ATP

LATCH ACTUATOR PROOF, AMBIENT 1275 PSIG

LATCH/SHAFT ASSEMBLY PROOF LOAD TEST:
- ORBITER FLAPPER/ET FLAPPER CLOSURE LOAD, 750 LBS
- ET FLAPPER CLOSURE LOAD, 596 LBS
- ET OVER TRAVEL RESTRAINT LOAD, 596 LBS

OPERATIONAL CYCLE: AMBIENT: 400 PSIG, 1 CYCLE; 740 PSIG, 5 CYCLES

OPERATIONAL: LN2 TEMPERATURE, 450 PSIG, 5 CYCLES; 740 PSIG, 5 CYCLES

LATCH SHAFT SEAL LEAKAGE: AMBIENT AND LN2 TEMPERATURES, 10 AND 50 PSIG, 80 SCIMS OF GHE

LATCH ACTUATOR EXTERNAL LEAKAGE: AMBIENT AND LN2 (BODY TEMPERATURES), 740 PSIG, STATIC SEAL, 150 SCIMS OF GHE; PISTON SHAFT SEAL, 1000 SCIMS OF GHE

LATCH ACTUATOR INTERNAL LEAKAGE: AMBIENT AND LN2 TEMPERATURES, 740 PSIG, 400 SCIMS OF GHE

LH2 UNIT ADDITIONAL TESTS:

OPERATIONAL CYCLES: AMBIENT TEMPS, 10 CYCLES AT 740 PSIG AND 10 CYCLES AT 400 PSIG

OPERATIONAL CYCLES: LH2 TEMPS, 10 CYCLES AT 740 PSIG AND 10 CYCLES AT 450 PSIG

LATCH SHAFT SEAL LEAKAGE: LH2 TEMPS, 0 TO 50 PSIG, 80 SCIMS OF GH2

LATCH ACTUATOR EXTERNAL LEAKAGE: LH2 TEMPS (BODY), 740 PSIG, STATIC SEAL, 150 SCIMS OF GHE; PISTON SHAFT SEAL, 1000 SCIMS OF GHE

LATCH ACTUATOR INTERNAL LEAKAGE: LH2 TEMPS (BODY), 740 PSIG, 400 SCIMS OF GHE

ELECTRICAL CHARACTERISTICS: INSULATION RESISTANCE, VOLTAGE DROP, AND DIELECTRIC STRENGTH

EXAMINATION OF PRODUCT:

VERIFY THE CLEARANCE BETWEEN TOE OF THE LATCH TO EDGE OF FLAPPER FAIRING DOME.

VERIFY THE DEMATED VALVE FLAPPER MOVEMENT PAST LATCH TOGGLE.

MEASURE EDGE CLEARANCE FROM FULL OVER TOGGLE TO THE FLAPPER.

TOGGLE SHALL MOVE FREELY AT AMBIENT AND CRYOGENIC CONDITIONS.

POSITION INDICATOR SWITCH REDUNDANCY SWITCH PICKUP WITHIN THE LIMITS BAND.

LATCH ACTUATOR SWITCH HOUSING VENT CHECK VALVE RELIEF SET PRESSURE.

MEASURE GAP BETWEEN BOTTOM OF LATCH AND TOP OF FLAPPER SEAL RETAINER RINGS.

MEASURE OVERLAP BETWEEN END OF LATCH AND END OF ET FLAPPER SEAL RETAINER RING.

CLEANLINESS: MOISTURE FREE AND CLEANED TO LEVEL 400A OF MA0110-301

CERTIFICATION

COMPONENT QUALIFICATION

THERMAL CYCLE; 3 CYCLES, AMBIENT TO -400 DEG F TO AMBIENT

VIBRATION: RANDOM 20 TO 2000 HZ
5.0 GRMS FOR Z-AXIS
5.2 GRMS FOR X AND Y-AXIS
48 MINUTES PER AXIS

CONDITIONS: MATED, NO FLOW, FLAPPERS OPEN, LATCH LOCKED, PRESSURIZED TO 10 PSIG, AND FILLED WITH LN2 (DONE PRIOR TO LH2 LEAKAGE TEST). DURING THE LAST TWO MINUTES OF RANDOM VIBRATION IN EACH AXIS, LATCH ACTUATOR PNEUMATIC SUPPLY PRESSURE IS RELIEVED.

ELECTRICAL CHARACTERISTICS: INSULATION RESISTANCE AND VOLTAGE DROP

BONDING; ELECTRICAL BONDING PER MIL-B-5087

ULTIMATE LOADS; LATCH ASSEMBLY, TOGGLE LOAD, ET SIDE AND FLAPPER OVER TRAVEL RESTRAINT, ET SIDE

ACTUATOR BURST PRESSURE: 1700 PSIG

SEQUENCE ERROR/RIGGING ERROR:

DOWNSTRIKE IMPACT: 8 CYCLES, FLAPPERS CLOSED, ACTUATE LATCH TO LOCKED POSITION, ACTUATE FLAPPERS OPEN, THEN CLOSE
FLAPPERS CLOSED AGAINST LATCH: 8 CYCLES, FLAPPER OPEN AND LATCHED, COMMAND FLAPPER CLOSED, THEN OPEN
MISRIGGING: 4 CYCLES, ACTUATE FLAPPERS OPEN, COMMAND LATCH TO ENGAGED POSITION, COMMAND LATCH TO DISENGAGE

ORBITER ANGLE LOW:
ORB: 1.46 DEG
ET: 4.5 DEG

ET ANGLE LOW:
ORB: 3.0 DEG
ET: 2.85 DEG

ET ANGLE HIGH:
ORB: 3.0 DEG
ET: 8.16 DEG

MECHANICAL CLOSURE (LO2, ORBITER, DEMATED): MANUALLY OPEN FLAPPER, ENGAGE LATCH, MANUALLY CLOSE FLAPPER. AT POINT WHERE LATCH BEGINS TO RELEASE FLAPPER, HOLD FLAPPER IN PLACE WHILE ROTATING TOGGLE TO EXTREME POSITION. MEASURE TOGGLE/FLAPPER CLEARANCE AT POINT OF RELEASE.

LIFE CYCLE, AMBIENT: 2400 CYCLES (UNLOCK TO LOCK TO UNLOCK)
CRYOGENIC: 1000 CYCLES, -400 DEG F BODY TEMPERATURE

ACTUATOR AND LATCH SHAFT SEAL LEAKAGE: AMBIENT AND CRYO (LN2 AND LH2)

UMBILICAL SEPARATION TEST: (WITH LATCH)

FLAPPER PNEUMATICS/LATCH PNEUMATICS/PYROS/RETRACTOR HYDRAULICS

(1) PNEUMATIC CLOSURE (NORMAL) - 4 CYCLES
(2) MECHANICAL CLOSURE (BACKUP) - 5 CYCLES

BOTH PERFORMED AT AMBIENT, LN2 AND LH2 CONDITIONS.

LATCH WATER FLOW TESTS: (LH2 CONFIGURATION)

ELEVEN (11) EXPLORATORY TEST SERIES (FLOW 4,000 TO 14,800 GPM)

CERTIFICATION TEST RUN AT NOMINAL PRODUCTION SETTING (FLOW RANGE TO 109% POWER LEVEL).

TWO PROOF TESTS - 15,650 GPM AND 15,850 GPM

LATCH WATER FLOW TESTS: (LO2 CONFIGURATION)

TWENTY-FOUR (24) EXPLORATORY TEST SERIES (FLOW 4,000 TO 22,100 GPM)

CERTIFICATION TEST RUN AT MINIMUM PRODUCTION SETTING (FLOW RANGE TO 109% POWER LEVEL).

TWO TEST SERIES IN FILL DIRECTION (FLOW 4,000 TO 6,400 GPM), LATCH PNEUMATIC PRESSURE VENTED (BISTABILITY)

PROOF TEST - 23,200 GPM

LATCH CRYO FLOW TESTS: (LH2 VALVE QUALIFIED BY SIMILARITY TO LO2)

SIXTEEN (16) TESTS WITH LN2/LO2 (FLOWS VARY FROM ONE ENGINE AT 65% TO THREE AT 109%).

DISCONNECT FLAPPER STABILITY/LOADS

CAVITATION

FRICTION PRESSURE LOSS

ENGINE CUTOFF SENSOR RESPONSE

STEADY STATE TEST: LN2 (65% AND 109% OF RATED POWER LEVEL), LATCH ENGAGED. LO2 (100%, 104% AND 109% OF RATED POWER LEVEL), LATCH ENGAGED AND NOT ENGAGED.

TERMINAL DRAIN: (SATURATED LO2) (65% AND 109%) LATCH ENGAGED AND NOT ENGAGED.

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OMRSD

V41AY0.360 LO2 17" DISC LATCH SHAFT SEAL LEAK TEST (I5)
V41AY0.370 LH2 17" DISC LATCH SHAFT SEAL LEAK TEST (I5)
V41AZ0.100 MPS PNEUMATIC LOW PRESSURE DECAY TEST (EVERY FLT)
V41AZ0.130 PROPELLANT ACTUATOR VALVE LEAK TEST (I5)
V41AZ0.230 MPS PNEUMATIC LOW PRESSURE DECAY TEST - VERT (EVERY FLT)
V41BI0.290 PD1 LO2 17" DISC LATCH RESPONSE TIME (EVERY FLT)
V41BI0.300 PD2 LH2 17" DISC LATCH RESPONSE TIME (EVERY FLT)
V41BU0.370 ORB/ET DISC PREP FOR OPF ROLLOUT (EVERY FLT)
V41BU0.460 PD2 LH2 DISC LATCH INSPECTION AND TORQUE VERIF (EVERY FLT)
V41BU0.470 PD1 LO2 DISC LATCH INSPECTION AND TORQUE VERIF (EVERY FLT)
S00000.090 LO2 17" (PD1) LATCH RESPONSE TIME (EVERY FLT)
S00000.091 LH2 17" (PD2) LATCH RESPONSE TIME (EVERY FLT)

(C) INSPECTION

RECEIVING INSPECTION

ALL HARDWARE 100% DIMENSIONALLY INSPECTED.

INSPECTION VERIFIES (TYP - 11 PLACES) VERIFY CERTIFICATIONS OF RAW MATERIAL ARE PART PROTECTION, COATING, AND PLATING REQUIREMENTS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

INSPECTION VERIFY CLEANLINESS TO LEVEL 400A.

INSPECTION VERIFY THE CONTAMINATION CONTROL PLAN.

ASSEMBLY/INSTALLATION

MANUFACTURING PROCESSES, INSTALLATION, AND ASSEMBLY OPERATIONS VERIFIED BY INSPECTION, INCLUDING PARTS PROTECTION.

INSPECTION VERIFY FASTENERS ARE TORQUED TO REQUIREMENTS.

INSPECTION VERIFY IMPLEMENTATION OF CORROSION PROTECTION PROVISIONS.

INSPECTION VERIFY SURFACE FINISHES TO DRAWING REQUIREMENTS.

INSPECTION VERIFY SEAL INSTALLATION WHICH INCLUDES:
SEAL MATING PART (MATERIAL, SURFACE FINISH, 100% DIMENSIONAL INSPECTION
ASSEMBLY (COMPONENT INTEGRITY, SEALS AND SURFACE LUBRICATED, ASSEMBLY TECHNIQUE, SEAL INSTALLATION IN CLEANROOM

QUALIFIED AND CERTIFIED PERSONNEL AND SPECIAL DESIGNATED TOOLS UTILIZED

SEAL PHOTOS (BLIND INSTALLATION, SINGLE BACKUP RINGS, AND "L" SEALS) AND CORRECT SEAL IDENTIFICATION (PART NO., LOT NO., MATERIAL CONDITION, AGE, CRITICAL CHARACTERISTICS).

CRITICAL PROCESSES

INSPECTION VERIFY PARTS PASSIVATION AND HEAT TREATMENT

INSPECTION VERIFY SOLDERING MEETS REQUIREMENTS IMPOSED

NONDESTRUCTIVE EVALUATION

100% DYE PENETRANT AND X-RAY INSPECTION IS PERFORMED ON ANY PARTS DESIGNATED FRACTURE CRITICAL.

TESTING

INSPECTION VERIFY ATP REQUIREMENTS (NOTE PRIMARY VERIFICATIONS AND WITNESSING).

HANDLING/PACKAGING

INSPECTION VERIFY IMPLEMENTATION OF HANDLING, PACKAGING, AND STORAGE REQUIREMENTS.

(D) FAILURE HISTORY
THIS HARDWARE IS NEW TO THE PROGRAM. THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES IN THIS FAILURE MODE.

(E) OPERATIONAL USE
NO CREW ACTION IS REQUIRED (FIRST FAILURE).