

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : ACTUATION MECH-PBD FMEA NO 02-4B -001 -1 REV:03/08/88

ASSEMBLY : LATCHING MECHANISMS PBD CRIT. FUNC: 1R
 P/N RI : V070-594160/V070-594260 CRIT. HDW: 2
 P/N VENDOR: VEHICLE: 102 103 104
 QUANTITY : 4 EFFECTIVITY: X X X
 PHASE(S): PL LO OO X DO LS

REDUNDANCY SCREEN: A-PASS B-FAIL C-PASS
 PREPARED BY: APPROVED BY: APPROVED BY (NASA):
 DES M. A. ALLEN DES *D. Campbell* SSM *R.C. Moore 3/12/88*
 REL M. B. MOSKOWITZ REL *M.B. Moskowitz* REL *M.B. Moskowitz*
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ITEM:

LATCH ASSEMBLY, FORWARD-AFT BULKHEAD GANGED

FUNCTION:

GANGED LATCH SYSTEM CONTAINS A POWER DRIVE UNIT (PDU) MC287-0039 (REF. FMEA/CIL NO. 02-4B-007-3) PROVIDING THE ROTARY MOTION AND DRIVES THE PUSHRODS AND BELLCRANKS FOR PIVOTING THE HOOKS SEQUENTIALLY TO LATCH OR UNLATCH THE DOOR TO THE FORWARD AND AFT BULKHEAD ROLLER ASSEMBLIES.

FAILURE MODE:

FAILS TO ENGAGE

CAUSE(S):

ADVERSE TOLERANCES/WEAR, THERMAL DISTORTION OF STRUCTURE, CONTAMINATION/ FOREIGN OBJECT/DEBRIS, PHYSICAL BINDING/JAMMING, LOSS OF LUBRICANT

EFFECTS ON:

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

(A) 4-GANGED LATCH FAILS TO SECURE IN CLOSED POSITION. POSSIBLE DAMAGE TO LINKAGE OR STRUCTURE IF JAM OCCURS WITH LINKAGE AT OR NEAR ON CENTER POSITION.

(B) DOOR TO AIRFRAME STRUCTURAL INTEGRITY DEGRADED.

(C) WORKAROUND IS TO RECYCLE LATCHES OPEN AND CLOSED. HOWEVER, MAY PROCEED WITH ANY ONE OF FOUR BULKHEAD LATCH GANGS DISENGAGED, REF. JSC08934.

(D) FIRST FAILURE - NO EFFECT ON CREW/VEHICLE. ENTRY MAY PROCEED WITH ANY ONE OF FOUR BULKHEAD LATCH GANGS DISENGAGED. FAILURE OF A SECOND GANG OF BULKHEAD LATCHES MAY RESULT IN UNSAFE CONFIGURATION AND POSSIBLE LOSS OF CREW/VEHICLE.

SHUTTLE CRITICAL ITEMS LIST - CREITER

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FAILS REDUNDANCY SCREEN "B" SINCE THE INDICATION SWITCHES INDICATE ALL LATCHES ARE ENGAGED ONLY WHEN THE ACTUATOR HAS COMPLETED ITS TRAVEL, REGARDLESS IF ONE OR MORE LATCHES ARE NOT ENGAGED.

DISPOSITION & RATIONALE:

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

(A) DESIGN

LATCH AND MECHANISM MATERIALS (6AL-4V TITANIUM, INCONEL 718, A286 CRES) CHOSEN FOR HIGH STRENGTH/LOW WEAR CHARACTERISTICS. MECHANISM DESIGNED WITH POSITIVE MARGIN OF SAFETY FOR ACTUATOR STALL CONDITION AT MAXIMUM REACH TO 42 DEGREES FOR LATCH 1, 30 DEGREES FOR LATCH 2, 30 DEGREES FOR LATCH 3, AND 16 DEGREES FOR LATCH 4 FROM ACTUATOR BELLCRANK POSITION. LATCH REACH CAPABILITY EXCEEDS PREDICTED GAPS (LATCHES 1 AND 2 HAVE 1.17 AND 0.20 INCH MARGINS - LATCHES 3 AND 4 DRIVE AFTER 1 AND 2 HAVE ALREADY BEGUN DOOR CINCHING). ALL LINKAGES DESIGNED WITH DUAL ROTATING SURFACES AND DUAL LOCKING DEVICES ON PIVOT SHAFTS. DESIGN OF THE ACTUATION SYSTEM PERMITS PARTIAL WORKAROUND OF THIS FAILURE MODE BY EXTRAVEHICULAR ACTIVITY (EVA) CREW (PAYLOADS MAY EFFECT LATCH ACCESSIBILITY). LATCH MECHANISM DESIGNED FOR WORST CASE THERMAL CONDITION.

(B) TEST

QUALIFICATION TEST: THE QUALIFICATION ACTUATOR IS CERTIFIED PER CR-29-287-0039-0001D (REF FMEA/CIL 02-4B-007-3). THE PBD LATCHING MECHANISM IS CERTIFIED PER CR-29-594160-001D FOR FORWARD MECHANISM AND CR-29-594260-001E FOR AFT MECHANISM. SYSTEM QUALIFICATION TESTS ON 15 FOOT PAYLOAD BAY DOOR TEST ARTICLE INCLUDED: ACCEPTANCE (TO CONFIRM ALL COMPONENTS HAVE BEEN ASSEMBLED AND RIGGED PER MLO308-0022); THERMAL CYCLE TEST (THERMALLY CYCLED 5 TIMES BETWEEN -40 DEG F AND +282 DEG F AT DOOR AND BETWEEN -120 DEG F AND +100 DEG F AT THE FORWARD BULKHEAD. THERMALLY CYCLED 5 TIMES BETWEEN +15 DEG F AND +325 DEG F AT DOOR AND BETWEEN -180 DEG F AND +120 DEG F AT AFT BULKHEAD); (THE FORWARD LATCHES WERE CYCLED AT -55 DEG F AND +50 DEG F AT BULKHEAD AND AT 0 DEG F AND +190 DEG F AT DOOR. THE AFT LATCHES WERE CYCLED AT -35 DEG F AND +60 DEG F AT BULKHEAD AND AT +40 DEG F AND +245 DEG F AT DOOR); HUMIDITY TEST ON AFT LATCH MECHANISM (PER MIL-STD-810B, METHOD 507 PROCEDURE IV, CYCLE ONE TIME AT EACH MOTOR CONDITION DURING THE SECOND CYCLE); ORBITAL FUNCTIONS (3 THERMAL CONDITIONS WITH SIMULATED THERMAL DISTORTIONS OF THE BULKHEAD); OPERATING LIFE TEST (MECHANICAL SYSTEMS CYCLED 262 TIMES AT FORWARD BULKHEAD AND 265 TIMES AT AFT BULKHEAD); ACOUSTIC TEST (PER MF0004-014C FOR 5 MINUTES). CERTIFICATION BY ANALYSIS/SIMILARITY INCLUDED FUNGUS, OZONE PACKAGING, THERMAL VACUUM, SALT SPRAY, SAND/DUST SHOCK-BASIC DESIGN, ULTIMATE LOADS, ACCELERATION, MARGIN OF SAFETY AND MISSION ACOUSTIC LIFE.

ACCEPTANCE TEST: THE LATCHING, MECHANISMS WERE RIGGED PER CONTROLLED SPECIFICATION MLO308-0022. OPERATION WHICH INCLUDED PAYLOAD BAY DOOR FUNCTIONAL AND FINAL CHECKOUT PRIOR TO FLIGHT.

OMRSD: GROUND TURNAROUND INCLUDES VISUAL INSPECTION FOR EVIDENCE OF BINDING OR JAMMING DURING DUAL MOTOR LATCHING FUNCTIONAL CHECK.

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(C) INSPECTION

RECEIVING INSPECTION

RECEIVING INSPECTION VERIFIES MATERIAL AND PROCESS CERTIFICATIONS.

CONTAMINATION CONTROL

CLEANLINESS VERIFICATION OF MATING SURFACE IS PERFORMED PRIOR TO INSTALLATION.

ASSEMBLY/INSTALLATION

ADJUSTING SHIMS DIMENSIONS ARE VERIFIED BY INSPECTION. THREADED FASTENER INSTALLATION INCLUDING TORQUE, LOOP PIN INSTALLATION AND SAFETY WIRING OF REQUIRED FASTENERS VERIFIED BY INSPECTION. RIGGING AND ALIGNMENT IS VERIFIED BY INSPECTION. LUBRICANT APPLICATION VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

PENETRANT INSPECTION VERIFIED BY INSPECTION.

CRITICAL PROCESSES

HEAT TREATMENT IS VERIFIED BY INSPECTION.

TESTING

ACCEPTANCE TESTING VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

CAR NO. 03F006 : IN OV102 FLIGHTS 3 AND 4, THE AFT BULKHEAD LATCHES DID NOT FULLY LATCH WHEN THE LEFT-HAND PAYLOAD BAY DOOR WAS CLOSED; FAILURE RESULTED FROM INSUFFICIENT DOOR-TO-BULKHEAD CLEARANCE AFTER ATTITUDE HOLDS WHICH CAUSED BOWING OF THE ORBITER STRUCTURE (FAILURE WAS DUE TO STRUCTURAL INTERFERENCE AND NOT DUE TO MECHANISM); PAYLOAD BAY DOORS WERE TRIMMED, LATCH BELLCRANKS MODIFIED, AND SHOULDER BOLTS REWORKED TO ACCOMMODATE MODIFIED BELLCRANKS. FAILURE WAS DUE TO STRUCTURAL INTERFERENCE AND NOT DUE TO MECHANISM AND WAS REMEDIED ON ALL ORBITERS.

(E) OPERATIONAL USE

THERMAL CONDITIONING OF VEHICLE CAN BE DONE TO ATTEMPT TO ALLEVIATE PROBLEM. LATCH TOOLS ARE AVAILABLE FOR EVA WORKAROUND EXCEPT IN THE CASE OF CERTAIN PAYLOADS WHICH LIMIT ACCESS.