

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**  
**NUMBER: 02-5E-S15 -X**

**SUBSYSTEM NAME: PAYLOAD RETEN & DEPLOY - LATCHES**  
**REVISION: 1**      **10/16/00**

**PART DATA**

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: STANDARD LONGERON LATCH ASSEMBLY (PRLA) WITH EVA CAPABILITY	V073-544550
SRU	: SWITCH MECHANISM (LATCH OPEN)	

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
 SWITCH MECHANISM, LATCH OPEN LIMIT SWITCH. TWO "LATCH OPEN" LIMIT SWITCHES ARE INSTALLED IN SWITCH MODULE AND ARE ACTUATED BY SAME LEVER.

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS:**  
 2 "LATCH OPEN" LIMIT SWITCHES PER LATCH

**FUNCTION:**  
 STANDARD LONGERON LATCH REACTS FLIGHT LOADS ON PAYLOAD HORIZONTAL TRUNNION HELD BETWEEN TWO SPHERICAL HALF BEARINGS. THE SWITCH MECHANISM CONSISTS OF DUAL LIMIT SWITCHES ACTIVATED BY A COMMON LEVER. WHEN LATCH IS OPEN, LATCH OPEN LIMIT SWITCH ASSEMBLY VERIFIES LATCH IS OPENED SUFFICIENTLY TO ALLOW PAYLOADS TO BE BERTHED OR DEPLOYED. LIMIT SWITCH SIGNAL REMOVES POWER FROM THE MOTORS AND GIVES THE CREW AN INDICATION THAT THE LATCH IS OPEN.

STANDARD LONGERON LATCH NOW INCORPORATES AN EXTRAVEHICULAR ACTIVITY (EVA) MECHANISM TO DISCONNECT THE LATCH LINKAGES FROM THE MOTOR GEARBOX AND MANUALLY DRIVE LATCH LINKAGES/HOOK OPEN OR CLOSED.

**FAILURE MODES EFFECTS ANALYSIS FMEA -- NON-CIL FAILURE MODE**

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**REVISION#: 1 10/16/00**

**SUBSYSTEM NAME: PAYLOAD RETEN & DEPLOY - LATCHES**

**LRU: STANDARD LONGERON LATCH ACT**

**ITEM NAME: SWITCH MECHANISM**

**CRITICALITY OF THIS**

**FAILURE MODE: 2R3**

**FAILURE MODE:**

**TRANSFERS PREMATURELY/INADVERTENTLY (LATCH OPEN)**

**MISSION PHASE: OO ON-ORBIT  
DO DE-ORBIT**

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

**CAUSE:**

**ACCELERATION, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/  
MATERIAL OR MANUFACTURING DEFECT, TEMPERATURE, VIBRATION**

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

**REDUNDANCY SCREEN**

- A) PASS
- B) PASS
- C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

**FAILURE WILL RESULT IN SWITCH OUTPUT INDICATING LATCH OPEN REGARDLESS OF  
ACTUAL LINKAGE POSITION. FAILURE WILL PREVENT LATCH FROM DRIVING IN THE  
OPEN DIRECTION. REQUIRES CREW TO PERFORM EVA FOR MANUAL LATCH OPEN.**

**(B) INTERFACING SUBSYSTEM(S):**

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FAILURE MAY RESULT IN INABILITY TO RELEASE PAYLOAD. REQUIRES CREW TO PERFORM EVA FOR MANUAL LATCH OPEN.

**(C) MISSION:**  
FAILURE WITH LATCH CLOSED OR PARTIALLY OPEN MAY RESULT IN LOSS OF MISSION DUE TO INABILITY TO RELEASE PAYLOAD. REQUIRES CREW TO PERFORM EVA FOR MANUAL LATCH OPEN.

**(D) CREW, VEHICLE, AND ELEMENT(S):**  
REQUIRES CREW TO PERFORM EVA FOR MANUAL LATCH OPEN. OTHERWISE, LATCH CAN BE COMMANDED CLOSED TO SECURE THE RETURNED PAYLOAD FOR ENTRY.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**  
LOSS OF MISSION OBJECTIVE IF THE LATCH CANNOT BE OPENED EITHER BY COMMAND OR BY EVA FOR DEPLOYING THE PAYLOAD. DRIVE THE LATCH CLOSED TO SECURE THE PAYLOAD FOR RETURN/ENTRY.

**DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 2/2**

**(F) RATIONALE FOR CRITICALITY DOWNGRADE:**  
CRITICALITY IS DOWNGRADED FROM THE DESIGN CRITICALITY, 2/2, TO 2R/3 DUE TO CONSIDERATION OF THE EVA OPERATIONAL WORKAROUND CAPABILITY. WITH EVA CAPABILITY BUILT IN, THE CREW CAN OPEN OR CLOSE LATCHES MANUALLY

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**  
THE SWITCH MECHANISM CONSISTS OF DUAL LIMIT SWITCHES ACTIVATED BY A COMMON LEVER. ONLY ONE SWITCH IS REQUIRED FOR SIGNAL ACTUATION. TWO SPRINGS ARE USED TO MAINTAIN SWITCH MODULE ACTUATION ARM IN UNACTUATED POSITION.

**(B) TEST:**  
**ACCEPTANCE TESTS:** THE FOLLOWING TESTS ARE PERFORMED FOR ALL FLIGHT ARTICLES AND WERE PERFORMED FOR EACH QUALIFICATION TEST ARTICLE: VIBRATION - RANGE 20 TO 2,000 HZ MAXIMUM LEVEL OF 0.04 G<sup>2</sup>/HZ FROM 80 TO 350 HZ, ALL AXES. THERMAL - STABILIZED RANGE FROM -100 DEG F TO +275 DEG F. FUNCTIONAL TESTS CONDUCTED AT -100 DEG F, +70 DEG F AND +275 DEG F. LOADS/ALIGNMENT - VERIFY RETENTION OF LATCHED POSITION AT 60% LIMIT LOAD, AS WELL AS SPHERICAL BEARING TORQUE RESISTANCE AND TRAVEL LIMITS. ELECTRICAL - VERIFY (WITHIN DESIGN LIMITS) CONTINUITY, DIELECTRIC STRENGTH, INSULATION RESISTANCE, AND SWITCH OPERATION.

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**EVA MODIFIED PRLA ACCEPTANCE TEST:** THE FOLLOWING TESTS ARE PERFORMED ON ALL FLIGHT ARTICLES AND ARE PERFORMED ON QUALIFICATION TEST ARTICLE: ELECTRICAL CONTINUITY, FUNCTIONAL PERFORMANCE, FLIGHT VIBRATION, DIELECTRIC STRENGTH & INSULATION RESISTANCE, THERMAL CYCLING.

**QUALIFICATION TESTS:** THE FOLLOWING IS A SUMMARY OF TESTS CONDUCTED PER CR 44-287-0025-0001 TO INCLUDE BOTH NATURAL AND INDUCED ENVIRONMENTAL EFFECTS TO THE LATCH ASSEMBLY AND THE LATCH-TO- BRIDGE/TRUNNION FRICTION/LOAD INTERFACE. FUNCTIONAL TESTS WERE CONDUCTED DURING AND FOLLOWING EACH PHASE OF TESTING TO DETERMINE EFFECTS. ENVIRONMENTS ACCEPTED BY ANALYSIS INCLUDE FUNGUS, OZONE, SALT SPRAY, ACCELERATION, SOLAR RADIATION (THERMAL AND NUCLEAR), METEOROIDS, SAND AND DUST, STORAGE, FACTOR OF SAFETY, RELIABILITY, MAINTAINABILITY, MATERIALS AND PROCESSES, ELECTRICAL DESIGN AND SAFETY. CERTIFICATION BY SIMILARITY INCLUDED VACUUM, HUMIDITY, TRUNNION FRICTION AND EXPLOSIVE ATMOSPHERE. VIBRATION - QUALIFICATION ACCEPTANCE VIBRATION TEST (QAVT) RANGE OF 20 TO 2,000 HZ WITH MAXIMUM LEVEL OF 0.067 G<sup>2</sup>/HZ AT 80 TO 350 HZ, FOR ALL AXES. FLIGHT VIBRATION LEVEL - 20 TO 2,000 HZ WITH MAXIMUM LEVEL OF 0.03 G<sup>2</sup>/HZ AT 100 TO 250 HZ, ALL AXES, WHILE UNDER LOAD. SHOCK BENCH HANDLING TEST IN ACCORDANCE WITH MIL-STD-810C. THERMAL - STABILIZED RANGE FROM -100 DEG F TO +275 DEG F. FUNCTIONAL TESTS CONDUCTED AT -100 DEG F, AMBIENT, AND +275 DEG F, THERMAL VACUUM, AND HUMIDITY. LOAD TESTS - COMBINED AXIS LOADING TO 100% LIMIT LOAD. LIFE CYCLE TESTS - 1,000 CYCLES IN ADDITION TO CYCLES CONDUCTED DURING VARIOUS QUALIFICATION TESTING AT VARIOUS LOAD AND MOTOR CONDITIONS. TRUNNION/BRIDGE INTERFACE FRICTION - SINGLE AND COMBINED AXIS LOADING UP TO LIMIT IN BOTH DIRECTIONS THROUGHOUT THE ENTIRE TEMPERATURE RANGE, IN COMPLIANCE WITH INTERFACE CONTROL DOCUMENT.

**EVA MODIFIED PRLA QUALIFICATION TEST:** FOLLOWING TESTS WERE PERFORMED PER CR 60-44-544550-007 ON THE EVA MODIFIED PRLA: ELECTRICAL CONTINUITY, FUNCTIONAL PERFORMANCE WITH OPPOSING FORCE FROM TRUNNION WITH SINGLE MOTOR AND DUAL MOTORS OPERATIONS, FLIGHT VIBRATION QUALIFICATION ACCEPTANCE VIBRATION TEST (QAVT) RANGE OF 20 TO 2,000 HZ WITH MAXIMUM LEVEL OF 0.04G<sup>2</sup>/HZ AT 80 TO 350 HZ, FOR ALL AXES WHILE NO LOAD APPLIED. OPERATING LIFE CYCLE 100 CYCLES IN ADDITION TO CYCLES CONDUCTED DURING QUALIFICATION TESTING AT VARIOUS LOAD AND MOTOR CONDITIONS, MECHANICAL STOPS/STALL WITH BOTH MOTORS DRIVEN AT NO-LOAD SPEED INTO THE MECHANICAL STOP THREE (3) TIMES IN EACH DIRECTION, DIELECTRIC STRENGTH AT 750 VAC, 60 HZ FOR 10±2 SECONDS, INSULATION RESISTANCE AT 500VDC, THERMAL CYCLING STABILIZED RANGE FROM -200 DEG F TO +275 DEG F FIVE (5) TIMES, EVA OPERATION TESTS CONDUCTED AT -100 DEG F, AMBIENT, AND +275 DEG F FOR LATCH OPEN AND CLOSE OPERATIONS. THE LATCH WAS THEN PARTIALLY DISASSEMBLED AND INSPECTED

**GROUND TURNAROUND TEST:** ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

TEST RECORDS AND REPORTS ARE MAINTAINED CERTIFYING MATERIALS AND PHYSICAL PROPERTIES. RECEIVING INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATION OF ALL INCOMING PARTS.

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**CONTAMINATION CONTROL**  
CORROSION PROTECTION REQUIREMENTS VERIFIED BY INSPECTION. QUALITY CONTROL VERIFIES PROPER MAINTENANCE AND OPERATION OF THE ENVIRONMENTALLY CONTROLLED MANUFACTURING AREA. ULTRASONIC CLEANING VERIFIED BY INSPECTION. CONTAMINATION CONTROL PROCEDURES INCLUDING USE OF COVERED TOTE PANS IS VERIFIED.

**ASSEMBLY/INSTALLATION**  
DETAILED INSPECTION PERFORMED ON ALL PARTS PRIOR TO NEXT ASSEMBLY. ASSEMBLY OPERATIONS VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**  
X-RAY INSPECTION UNDER MINIMUM 7X MAGNIFICATION FOR EVIDENCE OF WELD FLASH, LOOSE PARTS, AND ASSEMBLY ANOMALIES.

**CRITICAL PROCESSES**  
CRITICAL PROCESSES INCLUDING WELDING, BRAZING, AND PASSIVATION ARE MONITORED AND VERIFIED BY INSPECTION.

**TESTING**  
ATP IS VERIFIED PER PROCEDURE.

**HANDLING/PACKAGING**  
HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**  
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE

**(E) OPERATIONAL USE:**  
CREW CAN PERFORM EXTRAVEHICULAR ACTIVITY (EVA) PROCEDURES FOR MANUAL LATCH OPEN/CLOSE.

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**- APPROVALS -**

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