

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-5E-S09 -X**

SUBSYSTEM NAME: PAYLOAD RETEN & DEPLOY - LATCHES

REVISION: 1

10/16/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: STANDARD LONGERON LATCH ASSEMBLY (PRLA) WITH EVA CAPABILITY	V073-544550
SRU	: SWITCH MECHANISM (LATCH CLOSED)	

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
SWITCH MECHANISM, LATCH CLOSED LIMIT SWITCH**

REFERENCE DESIGNATORS:

**QUANTITY OF LIKE ITEMS:
2 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. LATCH CLOSED LIMIT SWITCH ASSEMBLY VERIFIES LATCH IS OVER-CENTER LOCKED. LIMIT SWITCH SIGNAL REMOVES POWER FROM THE MOTORS AND GIVES THE CREW AN INDICATION THAT LATCH IS CLOSED.

STANDARD LONGERON LATCH INCORPORATES AN EXTRAVEHICULAR ACTIVITY (EVA) MECHANISM TO DISCONNECT THE LATCH LINKAGES FROM THE MOTOR GEARBOX AND MANUALLY DRIVE LATCH LINKAGES/HOOK OPEN OR CLOSED. THIS IS A FEATURE TO PERMIT MANUAL LATCH OPERATION TO BYPASS PREVIOUS FAILURE OF MOTOR OR GEARBOX.

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SUBSYSTEM NAME: PAYLOAD RETEN & DEPLOY - LATCHES

LRU: STANDARD LONGERON LATCH ACT

ITEM NAME: SWITCH MECHANISM

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

TRANSFERS PREMATURELY/INADVERTENTLY (LATCH CLOSED)

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) N/A
B) N/A
C) N/A**

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

**FAILURE WILL PREVENT LATCH CLOSURE. IF THE PROBLEM IS DETECTED, PRLA EVA
MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE.**

(B) INTERFACING SUBSYSTEM(S):

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FAILURE WILL RESULT IN PAYLOAD INADEQUATELY RESTRAINED IN PAYLOAD BAY. IF THE PROBLEM IS DETECTED, PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE.

(C) MISSION:

FAILURE WITH LATCH OPEN WILL RESULT IN POSSIBLE LOSS OF MISSION AND/OR ORBITER/CREW DUE TO INABILITY TO RESTRAIN PAYLOAD. IF THE PROBLEM IS DETECTED, PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE.

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

FAILURE LATE IN LATCH CYCLE (IMMEDIATELY BEFORE LINKAGE IS OVER-CENTER LOCKED) MAY GO UNOBSERVED AND WILL RESULT IN LOSS OF CREW/VEHICLE DURING ENTRY DUE TO UNRESTRAINED PAYLOAD. IF THE PROBLEM IS DETECTED, PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(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 G²/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.

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

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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 G²/HZ AT 80 TO 350 HZ, FOR ALL AXES. FLIGHT VIBRATION LEVEL - 20 TO 2,000 HZ WITH MAXIMUM LEVEL OF 0.03 G²/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 0.04G²/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.

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.

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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 EVA PROCEDURES FOR MANUAL LATCH OPEN/CLOSE IF THE
PROBLEM IS DETECTED.

- APPROVALS -

S&R ENGINEER
CARGO/INTEG ITM
DESIGN ENGINEER
SUBSYSTEM MANAGER
MOD
USA SAM
USA ORBITER ELEMENT
USA CARGO ELEMENT

:A. T. NGUYEN
:C. VONGSOUTHY
:D. E. HAEHLKE
:P. REESE
:K. SMITH
:W. WOODWORTH
:
:

: *A. T. Nguyen*
: *C. Vongsouthy*
: *D. E. Haehlke*
: *P. Reese*
: *K. Smith*
: *W. Woodworth*
: *[Signature]*
: *[Signature]*