

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE  
NUMBER: 02-5E-S01 -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 (PAYLOAD RETENTION LATCH ASSEMBLY, PRLA)	V073-544550
SRU : DRIVE MECHANISM	V073-544605

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
DRIVE MECHANISM

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS:  
ONE PER LATCH

FUNCTION:

THE LATCH REACTS FLIGHT LOADS ON PAYLOAD HORIZONTAL TRUNNION HELD BETWEEN TWO SPHERICAL HALF BEARINGS. REDUNDANT MOTORS ACT THROUGH A DIFFERENTIAL AND GEARBOX TO ACTUATE THE DRIVE LINKAGES AND HOOK. THERE IS NO TORQUE LIMITER IN THE LATCH.

THE 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. THIS IS A FEATURE TO PERMIT MANUAL LATCH OPERATION TO BYPASS PREVIOUS FAILURE OF TWO MOTORS OR GEARBOX.

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

**NUMBER: 02-5E-S01- 06**

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

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

**LRU: STANDARD LONGERON LATCH (PRLA)**

**ITEM NAME: DRIVE MECHANISM**

**CRITICALITY OF THIS FAILURE MODE: 1/1**

**FAILURE MODE:**

**FAILS FREE**

**MISSION PHASE:**

- LO LIFT-OFF
- OO ON-ORBIT
- DO DE-ORBIT

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

- 102 COLUMBIA
- 103 DISCOVERY
- 104 ATLANTIS
- 105 ENDEAVOUR

**CAUSE:**

**CORROSION, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, EXCESSIVE LOAD, FAILURE/DEFLECTION OF INTERNAL PART, FATIGUE**

**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:**

**LOSS OF ABILITY TO OPEN OR CLOSE LATCH. PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE OF MOTOR OR GEARBOX BUT DOES NOT WORK IN THE CASE OF BROKEN LINKAGE.**

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

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INABILITY TO RESTRAIN OR RELEASE LONGERON TRUNNION OF A STOWED PAYLOAD. PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE OF TWO MOTORS OR GEARBOX BUT DOES NOT WORK IN THE CASE OF BROKEN LINKAGE.

**(C) MISSION:**

POSSIBLE LOSS OF MISSION DUE TO INABILITY TO RESTRAIN OR RELEASE PAYLOAD. PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE OF TWO MOTORS OR GEARBOX BUT DOES NOT WORK IN THE CASE OF BROKEN LINKAGE.

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

POSSIBLE LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED PAYLOAD DURING ENTRY/LANDING. PRLA EVA MODIFICATION FEATURE CAN BE USED TO BYPASS FAILURE OF TWO MOTORS OR GEARBOX BUT IT DOES NOT WORK IN THE CASE OF BROKEN LINKAGE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

COMPONENTS OF THE DRIVE MECHANISM ARE MADE OF HIGH STRENGTH, CORROSION RESISTANT NICKEL ALLOY (INCONEL 718). ALL COMPONENTS SHOW POSITIVE MARGINS BY ANALYSIS AND CARRY MINIMUM OF 1.4 SAFETY FACTOR. DUAL ROTATION SURFACES HAVE BEEN EMPLOYED ON ALL PIVOT POINTS. DUAL DRIVE MOTORS AND MICROSWITCHES ARE USED FOR REDUNDANCY REQUIREMENT. COMPONENTS OF THE EVA MECHANISM ARE MADE OF NICKEL ALLOY (INCONEL 718) OR STAINLESS STEEL AND CARRY A MINIMUM OF 1.4 SAFETY FACTOR.

**(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.

**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

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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 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: MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL: CLEANLINESS AND CORROSION PROTECTION REQUIREMENTS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION: DIMENSIONS OF DETAIL PARTS VERIFIED BY INSPECTION. FASTENER INSTALLATION VERIFIED BY INSPECTION. ASSEMBLY AND RIGGING OF LATCH IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION: PENETRANT INSPECTION OF DETAIL PARTS IS VERIFIED BY INSPECTION.

