PRINT DATE: 02/26/01

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-5E-S04 -X

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

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: STANDARD LONGERON LATCH (PAYLOAD RETENTION LATCH ASSEMBLY, PRLA) WITH EVA CAPABILITY	V073-544550
SRU	:EVA DRIVE	V073-544605

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
EVA DRIVE MECHANISM NOW BEING INCORPORATED INTO EXISTING LATCH AS A MODIFICATION. BY ROTATING THE EVA DRIVE SHAFT (7/16 IN HEX) WITH APPROXIMATELY 45 IN-POUNDS OF TORQUE, A PIN IS SHEARED AND THE LATCH ASSEMBLY CAN BE MANUALLY OPERATED IN EITHER DIRECTION. A LOCKING CAP ON THE EVA DRIVE SHAFT WILL RETAIN THE LATCH IN EITHER THE OPEN OR CLOSED POSITION WHICHEVER IS REQUIRED.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS:
1 PER LATCH

FUNCTION:

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-S04- 01

REVISION#: 2 01/17/01
SUBSYSTEM NAME: PAYLOAD RETENTION& DEPLOY LATCHES
LRU: STANDARD LONGERON LATCH ASSEMBLY (PRLA) **CRITICALITY OF THIS**
ITEM NAME: EVA DRIVE **FAILURE MODE:** 1R2

FAILURE MODE:
FAILS TO FUNCTION

MISSION PHASE:
OO ON-ORBIT
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:
102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:
EXCESSIVE FRICTION, JAMMED MECHANISM, CONTAMINATION/FOREIGN OBJECT/ DEBRIS, THREAD BINDING, SHEAR PIN WILL NOT SHEAR

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) FAIL
B) N/A
C) PASS

PASS/FAIL RATIONALE:
A)
FAILS REDUNDANCY SCREEN "A" SINCE THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING A FAILURE OF THE EVA DRIVE ASSEMBLY ON GROUND

B)
STANDBY REDUNDANCY

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

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FAILURE OF EVA MECHANISM AFTER PREVIOUS LATCH FAILURE (IN THE GEARBOX) WILL RESULT IN A LOSS OF ABILITY TO DISCONNECT GEARBOX DURING EVA AND DRIVE THE LATCH OPEN OR CLOSED.

(B) INTERFACING SUBSYSTEM(S):
FAILURE OF EVA MECHANISM AFTER PREVIOUS LATCH FAILURE (IN THE GEARBOX) WILL RESULT IN AN INABILITY TO EVA DRIVE THE LATCH TO EITHER CLOSED OR OPEN POSITION, AND UNRESTRAINED PAYLOAD IF THE LATCH WAS IN A PARTIALLY OPENED POSITION.

(C) MISSION:
FAILURE OF EVA MECHANISM AFTER PREVIOUS LATCH FAILURE (IN THE GEARBOX) WILL RESULT IN LOSS OF MISSION DUE TO INABILITY TO UNBERTH OR RESTRAIN PAYLOADS.

(D) CREW, VEHICLE, AND ELEMENT(S):
FAILURE OF EVA MECHANISM AFTER PREVIOUS LATCH FAILURE (IN THE GEARBOX) WILL RESULT IN LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED PAYLOAD DURING ENTRY/LANDING. REQUIRES TWO FAILURES INCLUDING FAILURE OF THE EVA MECHANISM WITH THE EXCEPTION OF FAILURE IN THE LINKAGES OR HOOK.

(E) FUNCTIONAL CRITICALITY EFFECTS:
LOSS OF LATCH OPERATION IN MID-TRAVEL POSITION WOULD RESULT IN UNRESTRAINED PAYLOAD DURING ENTRY/LANDING, AND COULD RESULT IN LOSS OF VEHICLE AND CREW. REQUIRES FAILURE IN THE GEARBOX OR TWO MOTORS AND FAILURE OF EVA CAPABILITY.

-DISPOSITION RATIONALE-

(A) DESIGN:
EVA DISCONNECT CAN BE OPERATED MANUALLY WITH 35 LB FORCE ON 8 INCH HANDLE OF STANDARD 7/16 INCH SOCKET WRENCH. ALUMINUM SHEAR PIN PREVENTS PREMATURE ROTATION OF DISCONNECT SHAFT. BELLCRANK FOR LATCH DRIVE CAN BE DISCONNECTED FROM GEARBOX BY SHEARING PIN WITH 45 INCH-LB TORQUE AND ROTATING SHAFT 5 REVOLUTIONS IN RELEASE DIRECTION. ADDITIONAL 160 DEG. IN RELEASE DIRECTION OPENS LATCH. OPPOSITE ROTATION WILL ALLOW MANUAL CLOSING OF LATCH. DESIGN FACTOR OF SAFETY IS 1.4 X LIMIT LOAD.

(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 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 $0.04G^2/HZ$ 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.

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(C) INSPECTION:
RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS REQUIREMENTS VERIFIED BY INSPECTION. CORROSION PROTECTION PER MAO608-301 VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
DIMENSIONS AND SURFACE FINISHES OF DETAIL PARTS, INCLUDING EXTERNAL AND INTERNAL SPLINE DATA, ARE VERIFIED BY INSPECTION. ASSEMBLY PER DETAILED DRAWING GENERAL NOTES ARE VERIFIED BY INSPECTION. THREADS PER MIL-S-8879

NONDESTRUCTIVE EVALUATION
NDE OF DETAIL PARTS IS PER MTO501-504

CRITICAL PROCESSES
HEAT TREATING IS VERIFIED BY INSPECTION. INSPECTION VERIFIES CERTIFICATIONS OF SHEAR PIN, RAW MATERIAL, CHEMISTRY AND ANNEALED CONDITION.

TESTING
ACCEPTANCE TESTING IS VERIFIED PER PROCEDURE.

HANDLING/PACKAGING
DOUBLE BAGGING AND SEALING FOR STORAGE IS 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:
NONE.

- APPROVALS -

S&R ENGINEER	: T. T. AI	: 2/26/01
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	: 3/5/01
DESIGN ENGINEER	: D. E. HAEHLKE	: 2/26/01
SUBSYSTEM MANAGER	: P. REESE	: 2/27/01
MOD	: D. B. LYLE	: 3/6/01
USA SAM	: B. BOURGEOIS	: 3/8/01
USA ORBITER ELEMENT	: S. LITTLE	: 3/8/01