SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :P/L RETEN & DEPLOY-LATCHES FMEA NO 02-5E -T07 -1 REV:04/04/88

ASSEMBLY :ACTIVE KEEL ACTUATOR
P/N RI :V073-544560
P/N VENDOR:61300
QUANTITY :5 MAX

CRIT. FUNC: 1
CRIT. HDW: 1

VEHICLE	102	103	104
EFFECTIVITY:	X	X	X

PHASE(S): PL LO X OO X DO X LS

REDUNDANCY SCREEN: A- B- C-

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ITEM:
DRIVE MECHANISM

FUNCTION:
KEEL LATCH REACTS FLIGHT LOADS ON PAYLOAD VERTICAL TRUNNION HELD BETWEEN TWO SPHERICAL HALF BEARINGS. MOTORS ACT THROUGH A DIFFERENTIAL AND GEARBOX TO ACTUATE THE DRIVE LINKAGES, BALLSCREW AND SECONDARY FRAME. THERE IS NO TORQUE LIMITER IN THE LATCH.

FAILURE MODE:
FAILS FREE

CAUSE(S):
CORROSION, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, EXCESSIVE LOAD, FAILURE/DEFLECTION OF INTERNAL PART, FATIGUE

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

(A) LOSS OF ABILITY TO MAINTAIN OR ACHIEVE AN OVERCENTER CONDITION.

(B) INABILITY TO RESTRAIN THE KEEL TRUNNION OF A BERTHED PAYLOAD.

(C) POSSIBLE LOSS OF MISSION DUE TO INABILITY TO RESTRAIN PAYLOAD.

(D) POSSIBLE LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED PAYLOAD DURING ASCENT/ENTRY.

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DISPOSITION & RATIONALE:
(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE

(A) DESIGN
LINKAGE HAS DUAL ROTATING SURFACES AT PIVOTS, BALLSCREW ASSEMBLY HAS THREAD SEALS, ICE SCRAPER, SHIELDS AT EACH END OF BALL NUT, FACTOR OF SAFETY OF ALL COMPONENTS IS 1.4 OVER LIMIT LOADS, POSITIVE MARGINS ON ALL COMPONENTS SHOWN BY ANALYSIS, REDUNDANT ELECTRIC MOTORS PROVIDED, GEARBOX IS SEALED TO EXCLUDE CONTAMINATION.

(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, OPEN AND CLOSED POSITIONS, WHILE UNDER LOAD. THERMAL - STABILIZED RANGE FROM -100 DEG F TO +350 DEG F. FUNCTIONAL TESTS CONDUCTED AT -100 DEG F, +70 DEG F AND +350 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.

QUALIFICATION TESTS: THE FOLLOWING IS A SUMMATION OF TESTS CONDUCTED PER CR 44-147-0017-0001 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 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 ALL AXES. FLIGHT VIBRATION LEVEL - 20 TO 2,000 HZ WITH MAXIMUM LEVEL OF 0.15 g2/HZ AT 100 TO 400 HZ ALL AXES, OPEN AND CLOSED POSITIONS. SHOCK BENCH HANDLING PER MIL STD-810C. THERMAL - STABILIZED RANGE FROM -100 DEG F TO +350 DEG F. FUNCTIONAL TESTS CONDUCTED AT -100 DEG F, +70 DEG F, +350 DEG F, THERMAL VACUUM AT 10 -6 TORR, AND HUMIDITY. LOAD TESTS - COMBINED AXIS LOADING TO 100% LIMIT LOAD. LIFE CYCLE TESTS - 1,018 CYCLES IN ADDITION TO CYCLES CONDUCTED DURING QUALIFICATION TESTING WITH 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.

OMRSD: GROUND TURNAROUND INCLUDES RELEASE OPERATION (SYSTEMS 1 AND 2) AND LATCHING OPERATION (SYSTEMS 1 AND 2).

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(C) INSPECTION

RECEIVING INSPECTION
MATERIAL AND PROCESS CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS AND CORROSION PROTECTION REQUIREMENTS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
DIMENSIONS OF DETAIL PARTS ARE 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.

CRITICAL PROCESSES
APPLICATION OF VITROLUBE IS VERIFIED BY INSPECTION. HEAT TREATING IS VERIFIED BY INSPECTION.

TESTING
ACCEPTANCE TESTING IS VERIFIED PER PROCEDURE.

HANDLING/PACKAGING
HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

CAR NO. AB8505 : WALL OF STATIC HALF OF KEEL LATCH FRAME YIELDED AND BUCKLED DURING IRREVERSIBILITY TEST IN SUPPLIER ACCEPTANCE TESTS; REVISED STRESS ANALYSIS INDICATED STRENGTH OF FRAME WAS INADEQUATE FOR REQUIRED LOAD; FRAME STRUCTURES WERE REDESIGNED TO INCREASE STRENGTH AND STATIC LATCHES REINFORCED.

CAR NO. AC5916 : DURING ULTIMATE LOAD TEST OF KEEL BRIDGE FITTING, THE ACTIVE KEEL LATCH ASSEMBLY FAILED STRUCTURALLY; FAILURE WAS ATTRIBUTED TO EXCESSIVE YIELDING OF THE STATIC HALF LATCH RESULTING IN REDISTRIBUTION OF TRUNNION LOAD, MISALIGNMENT OF OVERCENTER LINK ON STOP SCREW, SHEARING OF CORNER OF STOP SCREW, AND DISENGAGEMENT OF SHEAR PIN; KEEL LATCH Y-AXIS LOAD CAPABILITY WAS REDUCED FROM +/- 103,170 LB TO +/- 73,690 LB.

(E) OPERATIONAL USE
NONE.