SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :P/L RETEN & DEPLOY-~~MPM~~, MRL FMEA NO 02-5C-R04-2 REV:04/04/88

ASSEMBLY :MANIPULATOR RETENTION LATCH (MRL) CRIT. FUNC: 1R
P/N RI :MC287-0027-0006 CRIT. HDW: 3
P/N VENDOR:A10S9C010-6
QUANTITY :3

VEHICLE	102	103	104
EFFECTIVITY:	X	X	X

PHASE(S): PL LO OO X DO LS

REDUNDANCY SCREEN: A-FAIL B-FAIL C-PASS

PREPARED BY:		APPROVED BY:	APPROVED BY (NASA):
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ITEM:
TORQUE LIMITER

FUNCTION:
THE MANIPULATOR RETENTION LATCHES (MRL) ARE LOCATED AT EACH MANIPULATOR POSITIONING MECHANISM (MPM) PEDESTAL AND PROVIDE STRUCTURAL SUPPORT FOR THE MANIPULATOR ARM DURING THE LAUNCH AND ENTRY/LANDING MISSION PHASES. EACH LATCH MECHANISM IS INDEPENDENT AND IS DRIVEN BY A DUAL MOTOR/ DIFFERENTIAL/TORQUE LIMITER/GEARBOX ASSEMBLY. THE TORQUE LIMITER IS LOCATED BETWEEN THE DIFFERENTIAL AND GEARBOX AND PROTECTS THE MRL LINKAGES BY SLIPPING WHEN THE LATCH IS STALLED OR JAMMED.

FAILURE MODE:
FAILS TO SLIP AT MAXIMUM ALLOWABLE TORQUE

CAUSE(S):
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, TEMPERATURE

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

(A) FAILURE MAY RESULT IN DAMAGE OF MRL MECHANISMS RESULTING IN LOSS OF ABILITY TO LATCH/UNLATCH SINGLE MRL.

(B) SUBSEQUENT FAILURES (SEE ABOVE) WILL RESULT IN LOSS OF ABILITY TO LATCH/UNLATCH MRL. ENTRY/LANDING CAN SAFELY BE PERFORMED WITH ANY TWO OF THREE MRL LATCHED (REF. JSC 08934). ENTRY/LANDING WITH MULTIPLE MRL UNLATCHED MAY CAUSE POSSIBLE DAMAGE TO REMOTE MANIPULATOR SYSTEM (RMS), RADIATOR PANELS OR PAYLOAD.

(C) SUBSEQUENT FAILURES (SEE ABOVE) WILL RESULT IN POSSIBLE LOSS OF MISSION DUE TO INABILITY TO RELEASE MRL AND UNBERTH RMS.

SUBSYSTEM :P/L RETEN & DEPLOY-~~MPM~~, MRL FMEA NO 02-5C-R04-2 REV:04/04/88

(D) MULTIPLE PEDESTAL MRL FAILURES WILL REQUIRE EXTRAVEHICULAR ACTIVITY (EVA) OR JETTISON OF RMS TO PREVENT POSSIBLE LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED RMS DURING ENTRY.

FAILS REDUNDANCY SCREEN "A" SINCE THERE ARE NO TURNAROUND TESTS TO VERIFY TORQUE SLIPPAGE AND FAILS SCREEN "B" SINCE THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING TORQUE SLIPPAGE IN FLIGHT.

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

(A) DESIGN
THE TORQUE LIMITER HAS BEEN DESIGNED TO SLIP, WITHIN THE RANGE OF 33 INCH-OUNCES TO 40 INCH-OUNCES TORQUE TO PROVIDE ACTUATOR TORQUE OUTPUT MARGIN AS WILL AS PREVENT SYSTEM OVERLOAD.

(B) TEST
QUALIFICATION TESTS: THE LATCH HAS BEEN CERTIFIED BY CR-44-287-0027-0003D. QUALIFICATION TESTS INCLUDE: ACCEPTANCE TEST - TO VERIFY CONFORMANCE WITH THE REQUIREMENTS NOTED BELOW FOR ACCEPTANCE TEST. HUMIDITY TEST - TESTED IN ACCORDANCE WITH MIL-STD-810B, METHOD 507, PROCEDURE IV. QUALIFICATION ACCEPTANCE VIBRATION TEST (QAVT) - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.067 g2/HZ FROM 80 TO 350 HZ FOR 5 MINUTES PER AXIS. ORBITAL FLIGHT VIBRATION TEST - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.047 g2/HZ FROM 50 HZ TO 250 H FOR 5 MINUTES PER AXIS AT LEVEL "A" AND WITH MAXIMUM OF 0.05 g2/HZ FROM 40 HZ TO 150 HZ FOR 2 MINUTES PER AXIS AT LEVEL "B". SHOCK TEST - TESTED IN ACCORDANCE WITH MIL-STD-810C, METHOD 516.2 PROCEDURE I. EXPLOSIVE ATMOSPHERE TEST - TESTED IN ACCORDANCE WITH MIL-D-810C, METHOD 511.1, PROCEDURE I EXCEPT USING BUTANE AS THE TEST FLUID. THERMAL CYCLE TEST - THE ASSEMBLY WAS THERMALLY CYCLED 5 TIMES FROM +70 DEG F TO +280 DEG F TO +180 DEG F TO -100 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE EXTREME WAS 60 MINUTES MINIMUM AFTER STABILIZATION. AT EACH TEMPERATURE +180 DEG F AND -100 DEG F, THE ASSEMBLY WAS CYCLED 2 TIMES EACH AT THE MAXIMUM HEAT DISSIPATING MODE AND MINIMUM HEAT DISSIPATING MODE.

QUAL TESTS ALSO INCLUDE: OFT OPERATION LIFE -THE ASSEMBLY WAS CYCLED 125 TIMES EACH INDIVIDUALLY FOR 18 SECONDS WITH SYSTEMS 1 AND 2 AT AMBIENT TEMPERATURE. IT WAS ALSO CYCLED 540 TIMES WITH BOTH SYSTEMS 1 AND 2 FOR 7.5 SECONDS. MECHANICAL STOP TEST - THE ASSEMBLY WAS OPERATED AT FULL RATE AND NO LOAD INTO ITS MECHANICAL STOP FOR 100 TIMES IN EACH DIRECTION. PACKAGE QUALIFICATION - INSPECTED PER FED-STD-101 FOR EVIDENCE OF DAMAGE OR DEGRADATION. POWER CONSUMPTION - VERIFIED INPUT POWER TO THE DEPLOYMENT MOTOR TO BE 345 VA; POWER FACTOR NOT LESS THAN 0.7 LAGGING; STARTING POWER FACTOR NOT LESS THAN 0.25 LAGGING; STARTING CURRENT NOT LESS THAN 400% OF THE CURRENT AT RATED LOAD.

QUAL TESTS ALSO INCLUDE: STALL/MAXIMUM TORQUE - VERIFIED THE TORQUE LIMITER NOT TO SLIP WITH 33 INCH-OUNCES TORQUE APPLIED AND SLIP WITH 40 INCH-OUNCES TORQUE OR GREATER APPLIED. IRREVERSIBILITY - THE ACTUATOR WAS CHECKED FOR IRREVERSIBILITY WITH A LOAD OF 40 INCH-OUNCES MINIMUM. MECHANICAL LIMIT - THE ASSEMBLY HOOKS WERE CHECKED BY MOVING THROUGH THEIR FULL MECHANICAL TRAVEL TO VERIFY COMPLIANCE WITH THE MAXIMUM HOOK ENVELOPE. CERTIFIED BY ANALYSIS - THESE INCLUDED STORAGE/OPERATING LIFE, FACTOR OF SAFETY, RELIABILITY, MAINTAINABILITY, OZONE, FUNGUS, SALT FOG, ELECTRICAL DESIGN REQUIREMENT, SAFETY, ACCELERATION AND THERMAL VACUUM. THE ASSEMBLY WAS SUBJECTED TO SYSTEM QUALIFICATION TESTS PER MANIPULATING POSITIONING MECHANISM INSTALLATION V082-000002 (REF CR-44000002-001E).

ACCEPTANCE TESTS: EXAMINATION OF PRODUCTION - WEIGHT, WORKMANSHIP, DIMENSION, CONSTRUCTION, CLEANLINESS, FINISH, IDENTIFICATION MARKING, TRACEABILITY AND USE OF APPROVED MATERIALS AND PROCESSES. VIBRATION TEST - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.04 g2/HZ FROM 80 HZ TO 350 HZ FOR 30 SECONDS PER AXIS. THERMAL TEST - THE ASSEMBLY WAS THERMALLY CYCLED FROM +70 DEG F TO +260 DEG F TO +180 DEG F TO +70 DEG F. DWELL AT EACH LIMIT TEMPERATURE WAS AT LEAST 60 MINUTES AFTER THERMAL STABILIZATION. AT TEMPERATURE +180 DEG F AND -80 DEG F, THE ASSEMBLY WAS CYCLED 10 TIMES EACH FOR SINGLE MOTOR OPERATIONS AND 30 TIMES FOR 30 TIMES FOR DUAL MOTORS OPERATIONS. POWER CONSUMPTION - SEE QUALIFICATION TEST ABOVE. INSULATION RESISTANCE TEST - THE INSULATION RESISTANCE AT 500 VDC WAS MEASURED BETWEEN MUTUALLY INSULATED CONDUCTORS AND BETWEEN CONDUCTORS AND THE FRAME, CASE, OR GROUND.

ACCEPTANCE TESTS ALSO INCLUDE: CYCLING TEST - THE ASSEMBLY WAS CYCLED 10 TIMES EACH INDIVIDUALLY WITHIN 18 SECONDS/STROKE. IT WAS ALSO CYCLED 30 TIMES WITH BOTH MOTORS DRIVING TOGETHER WITHIN 7.5 SECONDS/STROKE. BONDING (ELECTRICAL) - ELECTRICAL BONDING PER MF0004-002 TO VERIFY THE RESISTANCE NOT TO EXCEED 0.0025 OHMS BETWEEN ENCLOSURES OR STRUCTURAL COMPONENTS. FREEPLAY TEST - THE ASSEMBLY WAS CHECKED TO VERIFY FREEPLAY TO BE 0.008 MAXIMUM IN THE VERTICAL DIRECTION AND 0.020 MAXIMUM IN THE HORIZONTAL DIRECTION. STALL/MAXIMUM TORQUE - SEE QUALIFICATION TEST ABOVE. IRREVERSIBILITY - SEE QUALIFICATION TEST ABOVE. MECHANICAL LIMIT - SEE QUALIFICATION TEST ABOVE.

OMRSD: NONE.

(C) INSPECTION

RECEIVING INSPECTION
MATERIAL AND PROCESS CERTIFICATIONS ARE VERIFIED BY INSPECTION. ALL PURCHASED PART DATA PAKS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS PER SPECIFICATION TO LEVEL 300 OF MA0110-301 AND A CLASS 100,000 CLEAN ROOM IN ACCORDANCE WITH FED-STD-209 ARE VERIFIED BY INSPECTION. PARTS ARE TRANSPORTED IN STAINLESS STEEL TRAYS OR TOTE BOXES. POLYETHYLENE SHEETING, USED TO BAG AND SEAL PARTS AFTER CLEANING, IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
DIMENSIONS ARE VERIFIED BY INSPECTION. INSPECTION VERIFIES AND RECORDS DIMENSION OF ALL DETAIL PARTS. GEARS ARE HARDNESS CHECKED AND VERIFIED BY INSPECTION. ALL BEARING AND GEARBOX AREAS ARE VERIFIED BY INSPECTION TO RECEIVE GREASE.

NONDESTRUCTIVE EVALUATION
MAGNETIC PARTICLE AND PENETRANT INSPECTION ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
HEAT TREAT AND PASSIVATION OF STAINLESS STEEL ARE VERIFIED BY INSPECTION.

TESTING
ATP IS VERIFIED PER PROCEDURE.

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

(D) FAILURE HISTORY
THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE
ACTUATOR MAY BE RECYCLED TO ATTEMPT TO CLEAR JAM. MULTIPLE PEDESTAL MRL FAILURES WILL REQUIRE EVA OR JETTISON OF RMS TO PREVENT POSSIBLE LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED RMS DURING ENTRY.