

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : P/L RETEN & DEPLOY-MPM, MRL FMEA NO 02-5C-R03-1 REV:07/28/88

ASSEMBLY : MANIPULATOR RETENTION LATCH (MRL)	CRIT. FUNC:	1R
P/N RI : MC287-0027-0006	CRIT. HDW:	2
P/N VENDOR: A1059CD10-6	VEHICLE	102 103 104
QUANTITY : 3	EFFECTIVITY:	X X X
	PHASE(S):	PL LO X OO DO X LS

PREPARED BY:		REDUNDANCY SCREEN: A-PASS B-FAIL C-PASS		
DES	D. S. CHEUNG	APPROVED BY:	APPROVED BY (NASA):	
REL	M. B. MOSKOWITZ	DES	<i>[Signature]</i>	SSM <i>[Signature]</i>
QE	W. J. SMITH	REL	<i>[Signature]</i>	REL <i>[Signature]</i>
		QE	<i>[Signature]</i>	QE <i>[Signature]</i>

ITEM:  
LATCH MECHANISM

FUNCTION:  
EACH MANIPULATOR RETENTION LATCH (MRL) GEARBOX DRIVES TWO LINKAGES/HOOKS WHICH LATCH TO THE REMOTE MANIPULATOR SYSTEM (RMS) STRUCTURE TO RETAIN THE ARM DURING ASCENT, ON-ORBIT, AND ENTRY/LANDING. A SINGLE HOOK CAN NEITHER CAPTURE NOR RETRACT AN RMS STRIKER BAR. HOWEVER, A SINGLE HOOK CAN RETAIN A STRIKER BAR THAT HAS BEEN PREVIOUSLY CAPTURED/RETRACTED. THEREFORE THE LINKAGES/HOOKS ONLY HAVE REDUNDANCY WHEN THE MRL IS LATCHED.

FAILURE MODE:  
FAILS FREE

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

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

(A) FAILURE WILL RESULT IN LOSS OF ABILITY TO CAPTURE AND RETRACT A RELEASED RMS. FAILURE MAY OCCUR SUCH THAT EXPECTED MICROSWITCH POSITION INDICATIONS ARE RECEIVED AT EXPECTED TIMES.

(B) ENTRY/LANDING CAN SAFELY BE PERFORMED WITH ANY TWO OF THREE MRL LATCHED (REF. JSC 08934). SUBSEQUENT FAILURES CAUSING MULTIPLE UNLATCHED MRL MAY CAUSE POSSIBLE DAMAGE TO RMS, RADIATOR PANELS OR PAYLOAD DURING ENTRY/LANDING.

(C) NONE.

(D) TWO LATCH FAILURES WILL RESULT IN POSSIBLE LOSS OF CREW/VEHICLE DUE TO UNRESTRAINED RMS DURING ASCENT/RE-ENTRY.

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FAILS REDUNDANCY SCREEN "B" SINCE THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING IF ONE OR MORE OF THE THREE LATCH MECHANISMS FAILS FREE IN FLIGHT.

DISPOSITION & RATIONALE:

(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE

(A) DESIGN

LATCH HOOK HAS BEEN DESIGNED WITH A FACTOR OF SAFETY OF 1.4 MINIMUM. EACH LATCH HOOK IS CAPABLE OF WITHSTANDING FULL LATCH LOAD. MATERIAL FOR THE LATCH HOOKS ARE MADE WITH HIGH STRENGTH, HEAT AND CORROSION RESISTANT NICKEL ALLOY (INCONEL 718).

(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 g<sup>2</sup>/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 g<sup>2</sup>/HZ FROM 50 HZ TO 250 HZ FOR 5 MINUTES PER AXIS AT LEVEL "A" AND WITH MAXIMUM OF 0.05 g<sup>2</sup>/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: OPT OPERATION LIFE -THE ASSEMBLY WAS CYCLED 12 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.

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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 MANIPULATION 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 G<sup>2</sup>/HZ FROM 80 HZ TO 35 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 -60 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 30 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 MP0004-002 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: GROUND TURNAROUND INCLUDES RELEASE PORT MRL (SYSTEMS 1 AND 2) AND LATCH PORT MRL (SYSTEMS 1 AND 2).

**(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. CORROSION PROTECTION REQUIREMENTS VERIFIED BY INSPECTION.

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ATTACHMENT  
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**ASSEMBLY/INSTALLATION**

LATCH FORCES AND VOLTAGES ARE VERIFIED BY INSPECTION. GEARBOX ASSEMBLY AND BEARING INSTALLATION ARE VERIFIED BY INSPECTION. GEARS ARE HARDNESS CHECKED AND VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**

MAGNETIC PARTICLE AND DYE-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**

CAR NO. AB6571 : DURING QUALIFICATION LIFE TEST WITH SINGLE MOTOR OPERATION, TORQUE LIMITER SLIPPED (WHICH CAUSED THE GEARBOX TO FAIL FREE) AND LATCH FAILED TO COMPLETE TRAVEL IN LATCHED DIRECTION (LATCH FAILED FREE); FAILURE CAUSED BY EXCESSIVE FRICTION RESULTING FROM AN INTERFERENCE BETWEEN TWO GEARS IN THE LATCH ACTUATOR; ONE GEAR WAS RE-DESIGNED TO PROVIDE CLEARANCE UNDER MOST ADVERSE TOLERANCE CONDITIONS (ALL LATCH ACTUATORS INCORPORATED THIS CHANGE).

**(E) OPERATIONAL USE**

NONE - THE EVA JETTISON CAPABILITY CANNOT BE USED DURING ASCENT/RE-ENTRY