SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P06-2 REV:04/05/88

ASSEMBLY :MPM DEPLOYMENT MECHANISM
P/N RI :V082-544600
P/N VENDOR:
QUANTITY :1

CRIT. FUNC: 1
CRIT. HDW: 1

VEHICLE EFFECTIVITY:	102	103	104
	X	X	X

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

REDUNDANCY SCREEN: A- B- C-

PREPARED BY:		APPROVED BY:	APPROVED BY (NASA):
DES	D. S. CHEUNG	DES	SSM
REL	M. B. MOSKOWITZ	REL	REL
QE	W. J. SMITH	QE	QE

ITEM:
DRIVE LINKAGE, SHOULDER

FUNCTION:
REDUNDANT POWER DRIVE UNIT (PDU) MOTORS DRIVE THROUGH TORQUE LIMITERS AND THE PDU GEARBOX TO PROVIDE TORQUE TO THE MANIPULATOR POSITIONING MECHANISM (MPM) DRIVESHAFT WHICH IN TURN DRIVES THE SHOULDER AND FORWARD/MID/AFT PEDESTAL ROTARY DRIVE GEARBOX/DRIVE LINKAGES. THE SHOULDER DRIVE LINKAGE ALSO INCLUDE THE SHOULDER HOOK WHICH IS ENGAGED DURING DEPLOYMENT TO ESTABLISH THE PRIMARY LOAD BEARING PATH.

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) THE FAILURE WILL ALLOW THE SHOULDER HOOK TO BECOME DISENGAGED FROM THE ROLLER (BREAK IN PRIMARY LOAD PATH) AND, DURING REMOTE MANIPULATOR SYSTEM ~~SYSTEM~~ (RMS) OPERATIONS, WILL RESULT IN UNCOMMANDED MOTION DUE TO THE UNCONSTRAINED SHOULDER MPM. IT WILL ALSO RESULT IN A LOSS OF ABILITY TO INDICATE DESIRED POSITION OF MPM (MAY MAINTAIN OR GET STOW/DEPLOY INDICATIONS AT EXPECTED TIMES DESPITE FAILURE).

(B) FAILURE WILL RESULT IN UNCOMMANDED AND UNCONTROLLED MOTION OF THE SHOULDER MPM/RMS/PAYLOAD SYSTEM AND POSSIBLE ORBITER CONTACT DAMAGE.

(C) FAILURE WILL RESULT IN POSSIBLE LOSS OF MISSION DUE TO LOSS OF RMS CAPABILITY.

SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P06-2 REV:04/05/88

(D) FAILURE WILL RESULT IN UNCOMMANDED AND UNCONTROLLED MOTION OF THE SHOULDER MPM/RMS/PAYLOAD SYSTEM AND POSSIBLE ORBITER CONTACT DAMAGE. FAILURE ON ORBIT MAY REQUIRE JETTISON OF MPM TO PREVENT LOSS OF CREW/VEHICLE DUE TO ORBITER CONTACT DAMAGE.

DISPOSITION & RATIONALE:
(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE

(A) DESIGN
DUAL ROTATING SURFACES PROVIDED AT ALL JOINTS. LATCH MECHANISM POSITIVELY DRIVEN BY SAME ACTUATOR WHICH PROVIDES POSITIONING FORCES. LINKAGE REQUIRED TO EXHIBIT STRUCTURAL FACTORS EXCESS OF 1.4.

(B) TEST
QUALIFICATION TESTS: THE MPM DEPLOYMENT ACTUATOR MC287-0037-0006/-0007 IS CERTIFIED PER CR-29-287-0037-0001G (REF FMEA/CIL 02-5B-P01-3) THE MANIPULATOR POSITIONING MECHANISM INSTALLATION IS CERTIFIED PER CR-44-000002E. THE SYSTEM INSTALLATION QUALIFICATION TEST INCLUDED: ACCEPTANCE (TO CONFIRM ALL COMPONENTS HAVE BEEN ASSEMBLED AND RIGGED PER APPLICABLE DRAWINGS AND SPECIFICATIONS); FLIGHT VIBRATION - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.006 g2/HZ FROM 100 TO 250 HZ FOR 49.5 MINS/AXIS AT LEVEL "A", AND WITH MAXIMUM OF 0.047 g2/HZ FROM 50 TO 250 HZ FOR 49.5 MINS/AXIS AT LEVEL "B"; STIFFNESS TEST - APPLIED LOADS AND MOMENTS (11 CONDITIONS) TO THE SHOULDER MECHANISM (8 CONDITIONS) AND RETENTION FITTING (3 CONDITIONS); LIMIT LOAD - APPLIED LIMIT LOAD AND 115% OF LIMIT LOAD TO THE RETENTION FITTING AND SHOULDER MECHANISM (STOWED AND DEPLOYED POSITIONS); FUNCTIONAL CHECKOUT WITHOUT MANIPULATOR ARM - CYCLED MPM WITH BOTH MOTORS, 40 SEC MAX/DEPLOY STROKE AND 50 SEC MAX/STOWED STROKE; FUNCTIONAL CHECKOUT WITH MANIPULATOR ARM - CYCLED EACH RETENTION LATCH TO THE LATCHED AND UNLATCHED POSITION WITH BOTH MOTORS, 7.5 SEC MAX/LATCH AND UNLATCH STROKE AND REPEATED DEPLOY AND STOW CYCLES OF MPM.

QUAL TESTS ALSO INCLUDE: HORIZONTAL OPERATION - CYCLED 115 TIMES AT +70 DEG F, 60 TIMES AT +25 DEG F, 100 TIMES AT +168 DEG F WITH ENGINEERING ARM INSTALLED CYCLED 100 TIMES AT -100 DEG F AND 100 TIMES AT +250 DEG F WITHOUT THE ENGINEERING ARM INSTALLED; SEPARATION SHOULDER/PEDESTAL - PERFORMED 4 PYRO SEPARATIONS (2 FOR SHOULDER AND 2 FOR RETENTION FITTING); READY-TO-LATCH INDICATION - OPERATED STRIKER BAR 500 TIMES AT AMBIENT TEMPERATURE, 20 TIMES AT -50 DEG F, 500 TIMES AT -100 DEG F AND 500 TIMES AT +168 DEG F; LIMIT LOAD (LANDING CASE) - APPLIED LIMIT LOADS AND 115% LIMIT LOADS TO SHOULDER MECHANISM IN STOWED POSITION; MECHANICAL STOP TEST - THE MPM DRIVE MECHANISM WAS OPERATED INTO ITS STOPS TEN TIMES; DELTA QUAL TEST - WITH DOWEL PIN INSTALLED THE SHOULDER MECHANISM IN DEPLOYED POSITION WAS SUBJECTED TO LIMIT LOADS; VERTICAL OPERATIONS - CONDUCTED 75 CYCLES AT ROOM AMBIENT CONDITIONS; ULTIMATE LOADS - CONDUCTED ULTIMATE LOADS ON RETENTION FITTING AND ON SHOULDER MECHANISM; PYRO SEPARATION - WITH DOWEL PIN INITIATED PYRO SEPARATION.

ACCEPTANCE TESTS: THE MPM ACCEPTANCE TEST CONSISTED OF CONFIRMATION OF ACCEPTANCE DATA APPLICABLE TO ASSEMBLY AND RIGGING.

SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P06-2 REV:04/05/88

OMRSD: GROUND TURNAROUND INCLUDES MPM DEPLOY (SYSTEMS 1 AND 2) AND MPM STOW (SYSTEMS 1 AND 2).

(C) INSPECTION

RECEIVING INSPECTION
MATERIAL AND PROCESS CERTIFICATIONS ARE VERIFIED BY RECEIVING INSPECTION.

CONTAMINATION CONTROL
CORROSION PROTECTION IS REQUIRED AND VERIFIED BY INSPECTION. CLEANLINESS IS MAINTAINED PER APPLICABLE SPECIFICATION AND VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
ALL DETAILS AND ASSEMBLY COMPONENTS ARE MADE TO DRAWING REQUIREMENTS AND APPLICABLE SPECIFICATIONS. ALL ARE VERIFIED BY INSPECTION ON MANUFACTURING ORDERS. INSTALLATION OF THREADED FASTENERS VERIFIED BY INSPECTION. PLANNED SEQUENCES TO ACHIEVE RIGGING CONFIGURATION ARE VERIFIED BY INSPECTION, INCLUDING TORQUING VERIFICATION AND SAFETY WIRING PER DRAWING. ELECTRICAL OPERATION IS PERFORMED BY USING GSE GROUND OPERATION CHECKOUT CONSOLE C70-0863, OR EQUIVALENT TEST; MANUFACTURING ORDER IS REQUIRED AND VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
PENETRANT INSPECTION IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
ELECTRICAL BOND AND TEST ARE VERIFIED BY INSPECTION. APPLICATION OF DRY FILM LUBE IS VERIFIED BY INSPECTION.

TESTING
ATP IS OBSERVED AND VERIFIED PER PROCEDURE.

HANDLING/PACKAGING
PARTS ARE PACKAGED PER APPLICABLE SPECIFICATION AND VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

CAR NO. AC4697 : DRIVE LINK FAILED AT 115% OF LIMIT LOAD DURING ULTIMATE LOAD TEST (SHOULD WITHSTAND ULTIMATE LOAD OF 140% WITHOUT FAILURE) AND THE ROD END FRACTURED AND PIN SHEARED; FAILURE CAUSED BY WEAK (NON-AGED) BE-CU BUSHING WHICH WAS UNABLE TO SUPPORT THE COMPRESSIVE LOAD; AN E.O. WAS RELEASED BY ENGINEERING TO CHANGE THE DRY FILM LUBE PROCESS.

CAR NO. AC5470 : DURING QUALIFICATION TESTING, THE MANIPULATOR POSITIONING MECHANISM SHOULDER SUPPORT DRIVE LINK BUCKLED AND SHAFT SHEARED AT 90% LIMIT LOAD (SHOULD WITHSTAND ULTIMATE LOAD OF 140% WITHOUT FAILURE); FAILURE CAUSED BY A SMALL DEVIATION FROM THE CORRECTLY RIGGED CONFIGURATION WHICH RESULTED IN A LARGE REDUCTION IN LOAD-CARRYING CAPABILITY; THE FAILED QUALIFICATION TEST UNIT WAS SUBSEQUENTLY REWORKED BY REPLACEMENT OF BROKEN AND DAMAGED PARTS AND MANUFACTURING PERSONNEL BEGAN MORE STRICT REQUIREMENTS FOR RIGGING.

SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P06-2 REV:04/05/88

(E) OPERATIONAL USE
THE MPM MAY BE JETTISONED IF PREVENTING PAYLOAD BAY DOOR CLOSURE.