

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P09-1 REV:04/05/88

ASSEMBLY : MPM SHOULDER MECHANISM	CRIT. FUNC:	1
P/N RI : V082-544835	CRIT. HDW:	1
P/N VENDOR:	VEHICLE	102 103 104
QUANTITY : 1	EFFECTIVITY:	X X X
	PHASE(S):	PL LO OO X DO LS

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

ITEM:

SWITCH MECHANISM, SHOULDER DEPLOYED LIMIT SWITCH

FUNCTION:

SHOULDER DRIVE LINKAGE ACTUATES SWITCH MECHANISM WHEN SHOULDER IS FULLY DEPLOYED, DRIVE LINKAGES ARE OVER-CENTER, AND DEPLOY HOOK ENGAGED. BOTH DEPLOY INDICATION LIMIT SWITCHES ARE ACTUATED BY THE SAME ARM. SHOULDER DEPLOY LIMIT SWITCHES CONTROL POWER DRIVE UNIT (PDU) MOTORS.

FAILURE MODE:

TRANSFERS PREMATURELY/INADVERTENTLY

CAUSE(S):

ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, FAILURE/DEFLECTION OF INTERNAL PART, TEMPERATURE, VIBRATION

EFFECTS ON:

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

(A) FAILURE WILL RESULT IN SWITCH OUTPUT INDICATING SHOULDER DEPLOYED REGARDLESS OF ACTUAL SITUATION.

(B) FAILURE WILL RESULT IN LOSS OF ABILITY TO DRIVE SHOULDER AND PEDESTALS IN THE DEPLOYED DIRECTION.

(C) FAILURE WILL RESULT IN LOSS OF MISSION DUE TO BLOCKAGE OF PAYLOAD DEPLOY ENVELOPE OR INABILITY TO DEPLOY REMOTE MANIPULATOR SYSTEM (RMS).

(D) FAILURE LATE IN DEPLOY CYCLE (IMMEDIATELY BEFORE SHOULDER LINKAGE IS OVER-CENTER LOCKED AND SHOULDER HOOK ENGAGED) MAY GO UNOBSERVED ONBOARD AND WILL RESULT IN LOSS OF CREW/VEHICLE DUE TO UNCOMMANDED MOTION DURING SUBSEQUENT RMS OPERATIONS.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P09-1 REV:04/05/88

DISPOSITION & RATIONALE:

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

(A) DESIGN

LIMIT SWITCHES ARE ADJUSTED PRIOR TO INSTALLATION. SWITCH ACTUATION LEVER IS OPERATED BY A PLUNGER AND ROLLER DRIVEN BY A CAM ON BELLCRANK. LIMIT SWITCHES ARE PROTECTED AND OPERATING FORCES ARE LOW.

(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.

OMRSD: GROUND TURNAROUND INCLUDES MPM DEPLOY (SYSTEM 1), MPM STOW (SYSTEM 1), MPM DEPLOY (SYSTEM 2), MPM STOW (SYSTEM 2), MPM DEPLOY (SYSTEMS 1 AND 2), AND MPM STOW (SYSTEMS 1 AND 2). GROUND TURNAROUND ALSO INCLUDES MONITORING SUBSYSTEM CHECKOUT TESTS TO DETECT LOSS OF CIRCUIT FUNCTIONS.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P09-1 REV:04/05/88

(C) INSPECTION

RECEIVING INSPECTION

MATERIAL AND PROCESS CERTIFICATIONS ARE VERIFIED BY RECEIVING INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS IS MAINTAINED PER APPLICABLE SPECIFICATION AND VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

DETAILS ARE MACHINED PER SPECIFICATION AND DETAIL MANUFACTURING PLANNING DOCUMENT, AND ARE VERIFIED BY INSPECTION. THREADED FASTENERS ARE INSTALLED AND TORQUED PER SPECIFICATION, VERIFIED BY INSPECTION. ELECTRICAL CONTINUITY IS PER MLO SPECIFICATION AND VERIFIED BY INSPECTION. RIGGING OPERATIONS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

DYE-PENETRANT INSPECTION IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

HEAT TREAT AND APPLICATION OF DRY FILM LUBE ARE VERIFIED.

TESTING

ATP IS OBSERVED AND VERIFIED BY INSPECTION INCLUDING BEARING PROOF LOAD.

HANDLING/PACKAGING

PARTS ARE PACKAGED PER APPLICABLE SPECIFICATION AND VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

CAR NO. AC0675 : DURING QUALIFICATION LOW TEMPERATURE CYCLING TEST OF THE MPM, INDICATOR LIGHTS ON TEST CONSOLE GAVE ERRONEOUS INDICATIONS OF PEDESTAL STOW/DEPLOY POSITIONS; CAUSE OF ALL INDICATOR LIGHT ANOMALIES WAS MARGINAL SWITCH ADJUSTMENT COMBINED WITH LOW TEMPERATURE; AN ENGINEERING ORDER WAS RELEASED TO REQUIRE THE USE OF SHIMS WHEN ADJUSTING SWITCHES IN PEDESTAL SWITCH MODULES AND TO REQUIRE SEALING SET SCREWS WITH EPOXY AFTER FINAL ADJUSTMENT.

CAR NO. 08P017 : DURING INITIAL DEPLOYMENT OF THE MPM IN STS-8, THE SYSTEM 1 DEPLOY INDICATOR SWITCH IN THE FORWARD PEDESTAL DID NOT TRANSFER; FAILURE CAUSED BY MISRIGGING AS THERE WAS INSUFFICIENT TRAVEL OF THE PEDESTAL DRIVE LINKAGE AND IMPROPER ADJUSTMENT OF THE PLUNGER AND SET SCREW; FORWARD AND APT PEDESTAL DEPLOY INDICATION LIMIT SWITCHES WERE READJUSTED AND RECHECKED AT KSC AND A LONGER SET SCREW WAS INSTALLED IN THE DEPLOY SWITCH ARM OF THE SWITCH MODULE IN THE APT PEDESTAL.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : P/L RETEN & DEPLOY-MPM DEPLOY PMAA NO 02-5B-P09-1 REV:04/05/88

CAR NO. 13F004 : AFTER MPM DEPLOYMENT IN STS-41C, THE "DEPLOY" INDICATION WAS LOST FROM BOTH LIMIT SWITCHES IN THE SHOULDER MECHANISM; FAILURE CAUSED BY MISSRIGGING AS THERE WAS FREEPLAY AND BACKING OFF OF THE SWITCH ACTUATION MECHANISM, ALLOWING THE LIMIT SWITCHES TO TRANSFER AWAY FROM THE "DEPLOY" POSITION; MPM RE-INSTALLED AND RE-RIGGED AT KSC AND WORKAROUND DURING FUTURE OCCURRENCES IS A REPEAT OF THE DEPLOY COMMAND UNTIL "DEPLOY" INDICATION IS REGAINED.

(E) OPERATIONAL USE

IF MECHANISM FAILS PRIOR TO DEPLOYMENT OF MPM/RMS, POWER CAN BE REMOVED FROM MAIN B MAIN MOTOR CONTROL 4 OR MAIN C MAIN MOTOR CONTROL 2 TO REMOVE LIMIT SWITCH INHIBIT TO HYBRID RELAY AND CREW COULD COMMAND THE MPM TO DEPLOY AGAIN USING SWITCH, S5. ALSO, THE MPM CRT OVERLAY CAN BE USED TO VERIFY MPM POSITION. HOWEVER, LOSS OF OVERCENTER LOCK CANNOT BE DETECTED.