# SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P03-1 REV:07/26/

ASSEMBLY :MPM SHOULDER/PEDESTAL DEPLOY MECH CRIT. FUNC: 1R
P/N RI :MC147-0016-0003 CRIT. HDW: 2
P/N VENDOR:181780-3 CURTISS-WRIGHT VEHICLE 102 103 104
QUANTITY :4 EFFECTIVITY: X X X
PHASE(S): FL LO OO X DO X LS

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

| 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:
GEARBOX, ROTARY DRIVE

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.

FAILURE MODE:
PHYSICAL BINDING/JAMMING

CAUSE(S):
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, FAILURE/DEFLECTION OF INTERNAL PART, LOSS OF LUBRICANT, TEMPERATURE

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

(A) FAILURE WILL RESULT IN LOSS OF ABILITY TO POSITION THE MPM. TORQUE WILL FEED BACK INTO SYSTEM AND SLIP THE TORQUE LIMITERS IN THE PDU.

(B) FAILURE WILL RESULT IN LOSS OF ABILITY TO POSITION MPM CAUSING POTENTIAL INTERFERENCE WITH PAYLOAD BAY (PLB) DOOR CLOSURE.

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

(D) FAILURE WILL REQUIRE JETTISON OF MPM TO PREVENT POSSIBLE LOSS OF CREW/VEHICLE DUE TO INTERFERENCE WITH PLB DOOR CLOSURE.

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SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P03-1 REV:07/28/

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

(A) DESIGN
GEARS ARE DESIGNED WITH HIGH MARGINS. MAXIMUM CALCULATED TOOTH BENDING STRESS APPROXIMATELY 80,000 PSI, ULTIMATE ALLOWABLE 180,000 PSI. RECYC CAPABILITY TO CLEAR JAM. GEARBOX IS DESIGNED TO PRECLUDE ENTRY OF FOREIGN MATERIALS THAT CAN JAM THE GEARS. BEARINGS INCORPORATE MULTIPL ROTATING SURFACES. TORQUE LIMITER PREVENTS EXCESSIVE STALL TORQUE. TH DRIVE ACTUATOR IS DESIGNED TO WITHSTAND FULL STALL TORQUE AT FULL INVERTOR AC POWER WITHOUT DAMAGE FOR A LIMITED TIME.

(B) TEST
QUALIFICATION TESTS: THE ACTUATOR IS CERTIFIED BY CR-29-147-0016-0001A QUALIFICATION TESTS INCLUDE: ACCEPTANCE TEST TO CONFIRM ALL REQUIREMEN SPECIFIED ON PARAGRAPH 4.2.2 OF PROCUREMENT SPEC ARE MET; VIBRATION TES - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 1.0 g2/HZ FROM 200 TO 400 HZ FOR MINUTES PER AXIS AT LEVEL "A" AND 0.6 g2/HZ FROM 200 TO 400 HZ FOR 34 MINUTES PER AXIS AT LEVEL "B"; THERMAL CYCLE - THE ACTUATOR IS THERMALL CYCLED FIVE TIMES FROM +70 DEG F TO +330 DEG F TO +220 DEG F TO -100 DEG F TO -167 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE WAS AT LEAST 60 MINUTES AFTER THERMAL STABILIZATION AT EACH -100 DEG F AND +22 DEG F. THE ACTUATOR WAS CYCLED TWICE WITH 50 INCH-LB INPUT; STOPS TEST THE ACTUATOR OPERATED AT 14.25 RPM AND NO LOAD INTO SIMULATED STRUCTURA STOPS 100 TIMES IN EACH DIRECTION; FREEPLAY - THE ACTUATOR MOUNTED IN TEST FIXTURE WITH THE INPUT SHAFT FIXED WITH A TORQUE OF 100 INCH-LB APPLIED TO OUTPUT ARM; OPERATING LIFE TEST - THE ACTUATOR CYCLED 1,820 TIMES WITH A 50 INCH-LB INPUT; CERTIFICATION BY ANALYSIS/SIMILARITY - THESE INCLUDE: FUNGUS, OZONE, PACKAGING, ULTIMATE LOAD/LIMIT LOAD, TRANSIENT SHOCK, LANDING SHOCK AND DESIGN SHOCK, THERMAL VACUUM, HUMIDITY, AND ACCELERATION. THE ACTUATORS WERE SUBJECTED TO SYSTEM QUALIFICATION TESTS PER MANIPULATOR POSITIONING MECHANISM INSTALLATION V082-000002 (REF CR-44-000002-001E).

ACCEPTANCE TESTS: ACCEPTANCE TESTS INCLUDE: EXAMINATION OF PRODUCT - WEIGHT, WORKMANSHIP, DIMENSIONS, CONSTRUCTION, CLEANLINESS, FINISH, IDENTIFICATION MARKING, TRACEABILITY, AND USE OF APPROVED MATERIALS AND PROCESS; NO-LOAD DRIVING TEST - THE INPUT DRIVE SHAFT ROTATED SLOWLY TO DRIVE THE ACTUATOR THROUGH ITS FULL TRAVEL AND RETURN WITH NO LOAD ON T OUTPUT. THE PEAK TORQUE DID NOT EXCEED 2.0 INCH-LB. FREEPLAY TEST - SEE QUALIFICATION TEST ABOVE; LOAD TEST - THE ROTARY ACTUATOR CYCLED 10 TIMES WITH A 75 INCH-LB INPUT; EFFICIENCY TEST - THE ACTUATOR WAS MOUNT IN A TEST FIXTURE AND CYCLED 3 TIMES AGAINST A 500 INCH-LB LOAD. EFFICIENCY WAS CALCULATED WITH INPUT AND OUTPUT TORQUE MEASUREMENTS (INPUT TORQUE DID NOT EXCEED 17.1 INCH-LB).

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

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(C) INSPECTION

RECEIVING INSPECTION
MATERIALS CERTIFICATIONS ARE VERIFIED BY INSPECTION. ALL PURCHASED P
DATA PACKAGES INSPECTED BY RECEIVING INSPECTION.

CONTAMINATION CONTROL
SUPPLIER CONTAMINATION CONTROL AND CORROSION PROTECTION PROVISIONS
VERIFIED BY INSPECTION. CLEANLINESS PER SPECIFICATION TO LEVEL 300 C
MA0110-301 VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
ALL MACHINED PARTS ARE DEBURRED AND VERIFIED PER DRAWING REQUIREMENTS
INSTALLATION PROCEDURE VERIFIED BY INSPECTION. DEFENSE CONTRACT
ADMINISTRATION SERVICES (DCAS) MANDATORY INSPECTION POINTS (MIPS) IMP
ON MANUFACTURING, INSTALLATION, AND ASSEMBLY OF ACTUATORS. ROCKWELL
HARDNESS VERIFIED ON GEARS. BEARING LUBRICATION AND SEAL INSTALLATIO
VERIFIED BY INSPECTION. GEARS ARE SHOT PEENED TO PRECLUDE FATIGUE.

NONDESTRUCTIVE EVALUATION
MAGNETIC PARTICLE INSPECTION IS VERIFIED BY INSPECTION AT THE DETAIL
LEVEL.

CRITICAL PROCESSES
HEAT TREATING 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
THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLI
FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE
ACTUATOR MAY BE RECYCLED TO CLEAR JAM OR THE MPM MAY BE JETTISONED I
PREVENTING PLB DOOR CLOSURE. EXTRAVEHICULAR ACTIVITY (EVA) PROCEDUR
WILL NOT BYPASS THIS FAILURE.