SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :P/L RETEN & DEPLOY-MPM DEPLOY FMEA NO 02-5B-P02-2 REV:04/05/88

ASSEMBLY :MPM DEPLOYMENT MECHANISM CRIT. FUNC: 1R
P/N RI :MC287-0037-0006/-0007 CRIT. HDW: 2
P/N VENDOR:15820-33/-7 HOOVER ELECTRIC VEHICLE 102 103 104
QUANTITY :1 EFFECTIVITY: X X X
PHASE(S): PL LO OO X DO X LS

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

PREPARED BY:		APPROVED BY:		APPROVED BY (NASA):
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ITEM:
GEARBOX (WITH TORQUE LIMITERS)

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:
FAILS FREE

CAUSE(S):
SLIPS AT LESS THAN MINIMUM ALLOWABLE TORQUE, FAILURE/DEFLECTION OF INTERNAL PART, FATIGUE, VIBRATION

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

(A) FAILURE WILL RESULT IN LOSS OF OUTPUT TO ALL MPM GEARBOXES AND HENCE RESULT IN A LOSS OF ABILITY TO POSITION THE MPM.

(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 OR EXTRAVEHICULAR ACTIVITY (EVA) TO PREVENT LOSS OF CREW/VEHICLE DUE TO INTERFERENCE WITH PLB DOOR CLOSURE.

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

(A) DESIGN
ACTUATOR IS DESIGNED TO PRODUCE A MINIMUM OF 50 INCH-LB OUTPUT TORQUE. 5 INCH-LB OUTPUT TORQUE IS REQUIRED FOR NORMAL OPERATION. TORQUE LIMITER IS SPRING LOADED BALL CLUTCH WITH VESPEL AND STEEL CLUTCH DISKS. THE DRIVE ACTUATOR IS DESIGNED TO WITHSTAND FULL STALL TORQUE FOR LIMITED TIME AT FULL INVERTOR AC POWER WITHOUT DAMAGE. MAXIMUM STALL TIMES FOR DEPLOYMENT ACTUATOR ARE 100 SECONDS FOR ONE MOTOR AND 50 SECONDS FOR TWO. TWO TORQUE LIMITERS ARE INCLUDED IN THE POWER DRIVE UNIT (PDU). FAILURE OF EITHER TORQUE LIMITER WILL RESULT IN LOSS OF OUTPUT TORQUE. DESIGN OF THE ACTUATION SYSTEM PERMITS PARTIAL WORKAROUND OF THE FAILURE MODE BY EXTRAVEHICULAR ACTIVITY (EVA) CREW.

(B) TEST
QUALIFICATION TEST: THE ACTUATOR HAS BEEN CERTIFIED BY CR-29-287-0037-0001G. QUALIFICATION TESTS OF A SIMILAR ACTUATOR MC287-0037-0001 INCLUDE: ACCEPTANCE TEST TO VERIFY CONFORMANCE WITH THE REQUIREMENTS NOTED BELOW FOR ACCEPTANCE TEST. HUMIDITY TEST - TEST 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 2.5 MINUTES PER AXIS; ORBITAL FLIGHT TEST - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.2 g2/HZ FROM 60 TO 300 HZ FOR 27 MINUTES PER AXIS AT LEVEL "B" AND WITH MAX OF 0.75 g2/HZ FROM 65 TO 300 HZ FOR 51 MINUTES PER AXIS AT LEVEL "A"; SHOCK TEST - 5 TO 35 HZ +/- 0.25 g PEAK; THERMAL VACUUM - THE ACTUATOR WAS THERMALLY CYCLED FIVE TIMES FROM +70 DEG F TO +330 DEG F TO -167 DEG F TO -100 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE EXTREME WAS 60 MINUTES MINIMUM AFTER STABILIZATION. AT EACH +250 DEG F AND -100 DEG F, THE ACTUATOR WAS CYCLED 6 TIMES FOR DUAL MOTOR OPERATIONS AND 4 TIMES FOR SINGLE MOTOR OPERATIONS.

QUAL TESTS ALSO INCLUDE: ELECTRICAL CONTINUITY - MONITORED THROUGHOUT THE TEST. CYCLING AT HIGH TEMPERATURE +250 DEG F EXTREME INCLUDED OPERATION AT THE MAXIMUM HEAT DISSIPATING MODE; CYCLING AT THE LOW TEMPERATURE -100 DEG F EXTREME INCLUDED OPERATION AT THE MINIMUM HEAT DISSIPATING MODE; OPERATING LIFE TEST - THE ACTUATOR WAS CYCLED 1,500 TIMES AT ROOM TEMPERATURE. MOTOR NO. 1 AND NO. 2 WERE CYCLED 250 TIMES EACH INDIVIDUALLY WITHIN 60 SEC/STROKE. IT WAS ALSO CYCLED 100 TIMES WITH BOTH MOTORS DRIVING TOGETHER WITHIN 30 SECONDS/STROKE; MECHANICAL STOP TEST - THE ACTUATOR WAS OPERATED AT FULL RATE AND NO LOAD INTO MECHANICAL STOP FOR 100 TIMES IN EACH DIRECTION; CERTIFICATION BY ANALYSIS - THESE INCLUDED FUNGUS, OZONE, SALT SPRAY, SAND/DUST, TRANSPORTATION PACKAGING, ACCELERATION, LANDING SHOCK, EXPLOSIVE ATMOSPHERE AND MARGIN OF SAFETY. 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, DIMENSION, CONSTRUCTION, CLEANLINESS, FINISH, IDENTIFICATION MARKING, TRACEABILITY AND USE OF APPROVED MATERIALS AND PROCESSES; ACCEPTANCE VIBRATION TEST - 20 TO 2,000 HZ WITH MAXIMUM OF 0.04 g2/HZ FROM 80 TO 350 HZ FOR 30 SECOND PER AXIS; ACCEPTANCE THERMAL TEST - THERMALLY CYCLED FROM +70 DEG F TO +310 DEG F TO +250 DEG F TO -147 DEG F TO -100 DEG F TO +310 DEG F TO +250 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE WAS AT LEAST 60 MINUTES AFTER THERMAL STABILIZATION. AT EACH +250 DEG F AND -100 DEG F THE ACTUATOR WAS CYCLED 6 TIMES FOR DUAL MOTOR OPERATIONS AND 4 TIMES FOR SINGLE MOTOR OPERATIONS; POWER CONSUMPTION TEST - VERIFIED THE INPUT POWER DID NOT EXCEED 62 WATTS PER MOTOR AND THE INPUT CURRENT DID NOT EXCEED 0.36 AMP PER PHASE PER MOTOR WHEN OPERATING AT THE MAXIMUM LOAD. THE INPUT POWER REQUIREMENT OF 117 WATTS AND INPUT CURRENT OF 0.67 AMP WERE ALSO VERIFIED UNDER STARTING CONDITIONS.

ACCEPTANCE TESTS ALSO INCLUDE: INSULATION RESISTANCE TEST - THE INSULATION RESISTANCE AT 500 VDC WAS MEASURED BETWEEN MUTUALLY INSULATED CONDUCTORS AND BETWEEN CONDUCTORS AND THE FRAME, CASE OR GROUND; DIELECTRIC STRENGTH TEST - 750 VRMS AT 60 HZ APPLIED BETWEEN EACH CONDUCTOR AND THE CASE; CYCLING - ACTUATOR WAS CYCLED 80 TIMES TOTAL WITH MOTORS NO. 1 AND NO. 2 CYCLED 10 TIMES EACH INDIVIDUALLY WITHIN 60 SECONDS/STROKE. IT WAS ALSO CYCLED 60 TIMES WITH BOTH MOTORS DRIVING TOGETHER WITHIN 40 SECOND/STROKE; FREEPLAY TEST - FREEPLAY AT THE ACTUATOR OUTPUT SHAFT NOT TO EXCEED 2.0 DEGREES WITH 10 INCH-LB LOAD APPLIED IN EACH DIRECTION; STALL/MAXIMUM TORQUE - THE ACTUATOR'S STALL/MAXIMUM OUTPUT NOT TO EXCEED 200 INCH-LB OR BE LESS THAN 50 INCH-LB; IRREVERSIBILITY - THE ACTUATOR WAS CHECKED TO BE IRREVERSIBLE TO LOAD OF 50 INCH-LB; MECHANICAL STOP TEST - ACTUATOR OPERATED AT FULL RATE AND NO LOAD INTO MECHANICAL STOPS FOR 100 TIMES IN EACH DIRECTION; MECHANICAL LIMIT TEST - THE OUTPUT ARM OF THE ACTUATOR MOVED THROUGH THE FULL CLOCKWISE TO COUNTER-CLOCKWISE TO CLOCKWISE ELECTRICAL LIMIT TRAVEL.

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

(C) INSPECTION

RECEIVING INSPECTION
RECEIVING INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATION OF ALL INCOMING PARTS. QUALITY CONTROL MAINTAINS SURVEILLANCE OF RAW MATERIAL, LIMITED LIFE MATERIALS, CHEMICAL AND METALLURGICAL TESTS AND REPORTS.

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. FINAL INSPECTION INCLUDES CHECKS FOR CONTAMINATION USING BORESCOPES OR SIMILAR EQUIPMENT, 5X-10X MAGNIFICATION DEVICES, AND MEMBRANE FILTRATION METHODS. PARTS ARE TRANSPORTED IN STAINLESS STEEL TRAYS OR TOTE BOXES. POLYETHYLENE SHEETING, USED TO BAG AND SEAL PARTS AFTER CLEANING, IS VERIFIED BY INSPECTION.

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

NONDESTRUCTIVE EVALUATION
DETAIL PARTS ARE MAGNETIC OR FLUORESCENT PENETRANT INSPECTED.

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 FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE
THE MPM MAY BE JETTISONED IF PREVENTING PLB DOOR CLOSURE. CREW CAN PERFORM EVA PROCEDURES FOR MANUAL MPM ROLL-IN/OUT.