SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ACTUATION MECH-ET/ORB DOOR FMEA NO 02-4D-012600-1 REV:02/17/88

ASSEMBLY :ET/ORBITER UMBILICAL DOOR MECHANISMS CRIT. FUNC: 1R
P/N RI :MC287-0020 CRIT. HDW: 2
P/N VENDOR:15600 HOOVER ELECTRIC VEHICLE 102 103 104
QUANTITY :4 (2 LH2 & 2 LO2) EFFECTIVITY: X X X
:(2 PER ACTUATOR) PHASE(S): PL LO X OO DO X LS

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

PREPARED BY:		APPROVED BY:	APPROVED BY (NASA):
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ITEM:
ELECTRIC MOTOR/BRAKE, DOOR DRIVE ACTUATOR

FUNCTION:
TO PROVIDE POWER FOR THE ACTUATOR TO CYCLE THE DOORS (OPEN OR CLOSED).

FAILURE MODE:
LOSS OF OUTPUT, FROM ELECTRIC MOTOR

CAUSE(S):
CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, ELECTRICAL FAILURE (OPEN CIRCUIT, SHORT CIRCUIT, ETC.), FAILURE/DEFLECTION OF INTERNAL PART, BRAKE FAILS TO DISENGAGE

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

(A) LOSS OF REDUNDANCY, ACTUATOR WILL OPERATE AT HALF-SPEED WITH ONLY ONE MOTOR.

(B,C,D) NONE, REDUNDANT MOTOR AVAILABLE. ADDITIONAL FAILURE OF REDUNDANT MOTOR WILL RESULT IN INABILITY TO CLOSE DOORS. POSSIBLE LOSS OF CREW/VEHICLE DUE TO DAMAGE CAUSED BY THERMAL EFFECTS IF THE DOORS CANNOT BE CLOSED AND FULLY LATCHED FOR A SAFE RE-ENTRY.

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

(A) DESIGN
EACH ORBITER/ET UMBILICAL DOOR IS OPENED OR CLOSED (TO WITHIN APPROX 2 INCHES) BY FOUR-BAR/OVER-CENTER HINGE/ACTUATION LINKAGES THAT ARE DRIVEN BY AN ELECTROMECHANICAL ACTUATOR THROUGH A TORQUE TUBE, BELLCRANKS, AND CONNECTING-RODS. EACH DOOR DRIVE ACTUATOR CONSISTS OF A PLANETARY GEARBOX/DIFFERENTIAL DRIVEN BY TWO (REDUNDANT) 3-PHASE ELECTRIC MOTORS; EACH MOTOR HAS AN INTEGRAL SPRING-LOADED FRICTION CLUTCH/BRAKE; AN INTEGRAL SPRING-LOADED DUAL-DISC PLATE FRICTION TORQUE LIMITER; WITH LIMIT SWITCHES AND MECHANICAL STOPS TO CONTROL/LIMIT ACTUATOR MOVEMENT/ROTATION. THE ACTUATOR HOUSING IS DESIGNED TO PRECLUDE THE ENTRY OF FOREIGN PARTICLES. PARTS ARE CLEANED TO LEVEL 300, PER MA0110-301 (PRIOR TO ASSEMBLY); ASSEMBLED IN A CLASS 100,000 CLEAN ROOM (PER FED-STD-209). DUAL ROTATING SURFACES ON BEARINGS. SAFETY FACTOR 1.4 MINIMUM. PROVISION EXISTS TO CYCLE THE ACTUATOR (TO LOOSEN STALLED/JAMMED MECHANISM). BRAKES MUST BE ELECTRICALLY ENERGIZED TO DISENGAGE AND ARE DESIGNED TO FAIL IN THE ENGAGED POSITION. DIFFERENTIAL IS DESIGNED TO DISTRIBUTE POWER FROM EITHER ONE OR BOTH (REDUNDANT) MOTORS. MOTORS DESIGNED TO OPERATE IN EMERGENCY 2-PHASE CONDITION. LIMIT SWITCHES ARE HERMETICALLY SEALED. EACH TORQUE LIMITER IS DESIGNED TO PROTECT ITS MOTOR AND DRIVE TRAIN FROM AN OVERLOAD FAILURE.

(B) TEST
QUALIFICATION TESTS: QUAL-CERTIFIED PER CR-45-287-0020-0001. QUALIFICATION TESTS INCLUDED: HUMIDITY TEST, SHOCK TEST, QUALIFICATION ACCEPTANCE VIBRATION TESTS (QAVT), THERMAL VACUUM TEST, THERMAL CYCLING TEST, OPERATING LIFE TEST (2,000 CYCLES, 100-MISSION, 10-YEAR LIFE; EXPECT 500 CYCLES PER 100 MISSIONS), MECHANICAL STOP TEST, POWER CONSUMPTION TEST, FREE-PLAY TEST, AND IRREVERSIBILITY TEST.

ACCEPTANCE TESTS: INCLUDES EXAMINATION OF PRODUCT (FOR WEIGHT, DIMENSIONS, CONSTRUCTION, CLEANLINESS AND FINISH), ACCEPTANCE VIBRATION TESTS (AVT)(20-2,000 HZ, 30 SEC TO 5 MINUTES, IN EACH OF THREE ORTHOGONAL AXES, WITH ELECTRICAL CIRCUITS MONITORED FOR CONTINUITY), ACCEPTANCE THERMAL TESTS (ATT)(CYCLED BETWEEN -80 DEG F AND +330 DEG F; MOTOR 1, MOTOR 2 AND DUAL MOTOR), POWER CONSUMPTION TEST (OPERATED AT RATED LOAD AT -50 DEG F, SINGLE MOTOR DEPLOYED WITHIN 48 SEC, DUAL MOTORS DEPLOYED WITHIN 24 SEC, 165 WATTS/MOTOR MAX, 0.75 AMPS/PHASE/MOTOR MAX; 616 WATTS/MOTOR MAX STARTING POWER AND 3.5 AMPS/PHASE/MOTOR MAX STARTING CURRENT; OPERATED AT MAXIMUM LOAD AT -50 DEG F, 186 WATTS/MOTOR MAX AND 0.77 AMPS/PHASE/MOTOR MAX), INSULATION RESISTANCE TEST AND DIELECTRIC STRENGTH TEST (PER MP0004-002), CYCLING TEST (OPERATED AT RATED LOAD; SINGLE MOTOR, 13 CYCLES EACH FROM CW-CCW-CW ROTATION AT 48 SEC/DIRECTION; DUAL MOTOR, 70 CYCLES FROM CW-CCW-CW ROTATION AT 24 SEC/DIRECTION), FREEPLAY TEST (MAX ANGULAR FREEPLAY AT OUTPUT SHAFT +/-1.0 DEGREES ROTATION, WITH 10 INCH-LB OF REVERSING TORQUE), STALL/MAXIMUM TORQUE TEST (MAX ACTUATOR OUTPUT 14,000 INCH-LB, AT -75 DEG F MINIMUM), IRREVERSIBILITY TEST (ACTUATOR MUST BE IRREVERSIBLE TO THE OPERATING LOAD OF 1,875 INCH-LB, IN EITHER DIRECTION), MECHANICAL LIMITS TEST AND ELECTRICAL LIMITS TEST (ACTUATOR CYCLED THROUGH ITS FULL TRAVEL TO VERIFY COMPLIANCE WITH MECHANICAL AND ELECTRICAL LIMITS).

OMRSD: OPEN/CLOSE (1-"G") OPERATIONAL CHECKOUT OF RIGHT-HAND/LEFT-HAND ET DOORS; SINGLE MOTOR OPERATION (MOTOR 1, MOTOR 2). INCLUDING CURRENT DRAWS TO ENSURE THREE-PHASE POWER. FREQUENCY - ALL VEHICLES AT GROUND TURNAROUND.

(C) INSPECTION

RECEIVING INSPECTION
CERTIFICATION OF COMPLIANCE, TEST COUPONS, PHYSICAL AND CHEMICAL RECORDS ARE VERIFIED BY INSPECTION. RECEIVING INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATION OF ALL INCOMING PARTS.

CONTAMINATION CONTROL
A CLASS 100,000 CLEAN ROOM FACILITY IS USED FOR ASSEMBLY. ALL METAL PARTS ARE VERIFIED BY INSPECTION TO BE CLEAN. FINAL INSPECTION INCLUDES CHECKS FOR CONTAMINATION USING BORESCOPES, 5X AND 10X MAGNIFICATION DEVICES, AND MEMBRANE FILTRATION METHODS.

ASSEMBLY/INSTALLATION
ASSEMBLY OF ELECTRIC MOTOR/BRAKE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
ALL DETAIL PARTS MACHINED TO HOOVER DRAWINGS ARE MAGNETIC PARTICLE INSPECTED PER MIL-I-6868 OR FLUORESCENT PENETRANT INSPECTED PER MIL-I-6866, DEPENDING ON ALLOY, VERIFIED BY INSPECTION.

CRITICAL PROCESSES
CRIMPING CONTROLS ARE MAINTAINED IN ACCORDANCE WITH MSC-SPEC-Q-1A. SOLDERING IS VERIFIED BY INSPECTION IN ACCORDANCE WITH NHB5300.4(3A).

TESTING
ACCEPTANCE TESTING VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING TO MAINTAIN CLEANLINESS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

CAR NO. 24F009-010 : ON FLIGHT 51-B OV-099, MOTOR "B" WAS INOPERATIVE DURING DOOR CLOSURE; THE CAUSE OF THE PROBLEM WAS ATTRIBUTED TO AN IMPROPERLY INSTALLED CONNECTOR - NOT THE MECHANISM OR ACTUATOR; CORRECTIVE ACTION INCLUDED INSTALLING A COVER GUARD TO PROTECT THE CONNECTOR DURING TURNAROUND.

(E) OPERATIONAL USE
NONE.