

**SHUTTLE CRITICAL ITEMS LIST - ORBITER**

SUBSYSTEM :ACTUATION MECH-ET/ORB DOOR FMEA NO 02-4D-012600-3 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-FAIL C-PASS

PREPARED BY:	APPROVED BY:	APPROVED BY (NASA):
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**ITEM:**

ELECTRIC MOTOR/BRAKE, DOOR DRIVE ACTUATOR

**FUNCTION:**

TO KEEP MOTOR AND DRIVE TRAIN FROM ROTATING AFTER ELECTRICAL POWER IS REMOVED.

**FAILURE MODE:**

BRAKE FAILS TO ENGAGE

**CAUSE(S):**

ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, FAILURE/DEFLECTION OF INTERNAL PART, ELECTRICAL FAILURE (SHORT CIRCUIT, ETC.)

**EFFECT(S) ON:**

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

(A) LOSS OF REDUNDANCY.

(B) NO EFFECT UNLESS POWER IS LOST TO ASSOCIATED MOTOR.

(C,D) FIRST FAILURE OF MOTOR OR BRAKE ON SAME SHAFT - NO EFFECT. SECOND FAILURE OF REMAINING MOTOR OR BRAKE ON SAME SHAFT - LOSS OF FUNCTION. REDUNDANT MOTOR WILL BACKDRIVE THROUGH FAILED BRAKE. POSSIBLE LOSS OF CREW/VEHICLE DUE TO DAMAGE CAUSED BY THERMAL EFFECTS IF THE DOORS CANNOT BE CLOSED AND FULLY LATCHED FOR SAFE RE-ENTRY.

FAILS REDUNDANCY SCREEN "B" SINCE A BRAKE FAILURE CANNOT BE VISUALLY DETECTED WHILE IN FLIGHT.

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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).

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OMRSD: OPEN/CLOSE (1-"G") OPERATIONAL CHECKOUT OF RIGHT-HAND/LEFT-HAND ET DOORS; SINGLE MOTOR OPERATION (MOTOR 1, MOTOR 2) TO ALSO ENSURE THAT THE BRAKE ON THE SECOND MOTOR IS OPERATING PROPERLY. 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. GEARS ARE HARDNESS CHECKED AND VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

ALL METAL PARTS ARE VERIFIED BY INSPECTION TO BE CLEAN. A CLASS 100,000 CLEAN ROOM FACILITY IS USED FOR ASSEMBLY. 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-IA. 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

THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE

NONE.