

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : ACTUATION MECH-ET/ORB DOOR FMEA NO 02-4D-014600-3 REV:02/17/88

ASSEMBLY	: ET/ORB SEPARATION DOOR MECH	CRIT. FUNC:	1R
P/N RI	: MC147-0013	CRIT. HDW:	2
P/N VENDOR:	15650 HOOVER ELECTRIC	VEHICLE	102 103 104
QUANTITY	: 4 (2 FORWARD & 2 AFT)	EFFECTIVITY:	X X X
	: (2 PER ACTUATOR)	PHASE(S):	PL LO X OO DO LS

PREPARED BY:		REDUNDANCY SCREEN:	A-PASS B-FAIL C-PASS
DES	R. H. YEE	APPROVED BY:	APPROVED BY (NASA):
REL	J. S. MULLEN	DESC	<i>R. Hyle for A. G. Ord...</i> SSM <i>J. C. Moore 2/25/88</i>
QE	W. S. SMITH	REL	<i>J. S. Mullen</i>
		QE	<i>W. S. Smith 2/25/88</i>

ITEM:
ELECTRIC MOTOR/BRAKE, CENTERLINE LATCH ACTUATOR

FUNCTION:
TO KEEP MOTOR AND DRIVE TRAIN FROM ROTATING AFTER ELECTRICAL POWER IS OFF.

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. 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 THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING A FAILURE OF THE BRAKE WHILE IN FLIGHT.

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DISPOSITION & RATIONALE:

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

(A) DESIGN

TWO CENTERLINE LATCHES, DRIVEN BY INDIVIDUAL ELECTROMECHANICAL ACTUATORS, EXTEND AND ROTATE (TO ENGAGE AND HOLD BOTH ORBITER/ET UMBILICAL DOORS FULLY OPEN FOR LIFT-OFF AND ASCENT) AND THEN ROTATE AND RETRACT FLUSH WITH THE OUTER MOLDLINE (OML); TO RELEASE THE DOORS FOR CLOSURE AFTER ORBITER/ET SEPARATION. EACH CENTERLINE LATCH 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; 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 MAQ110-301 (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. DESIGN DOES NOT INCORPORATE A TORQUE LIMITER (IN ORDER THAT OUTPUT TORQUE NOT BE MECHANICALLY RESTRICTED).

(B) TEST

QUALIFICATION TESTS: QUAL-CERTIFIED PER CR-45-147-0013-0001.
QUALIFICATION TESTS INCLUDED: HUMIDITY TEST, SHOCK TEST, QUALIFICATION ACCEPTANCE VIBRATION TESTS (QAVT), THERMAL VACUUM TEST, THERMAL CYCLING TEST, OPERATING LIFE TEST (2,000 CYCLES AT 65 INCH-LB LOAD, 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 TEST (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 12 SEC, DUAL MOTORS DEPLOYED WITHIN 6 SEC, 83 WATTS/MOTOR MAX, 0.41 AMPS/PHASE/MOTOR MAX; 160 WATTS/MOTOR MAX STARTING POWER AND 0.83 AMPS/PHASE/MOTOR MAX STARTING CURRENT), INSULATION RESISTANCE TEST AND DIELECTRIC STRENGTH TEST (PER MF0004-002), CYCLING TEST (OPERATED AT RATED LOAD; SINGLE MOTOR, 20 CYCLES EACH FROM LATCHED-UNLATCHED-LATCHED AT 12 SEC/DIRECTION; DUAL MOTOR, 60 CYCLES FROM LATCHED-UNLATCHED-LATCHED AT 6 SEC/DIRECTION), FREEPLAY TEST (MAX ANGULAR FREEPLAY AT THE OUTPUT GEAR NOT TO EXCEED 1.5 DEGREES ROTATION, WITH 10 INCH-LB OF REVERSING TORQUE), STALL/MAXIMUM TORQUE TEST (MAX ACTUATOR OUTPUT 281 INCH-LB), IRREVERSIBILITY TEST (ACTUATOR MUST BE IRREVERSIBLE TO THE ULTIMATE STATIC LOAD IN EITHER DIRECTION), COAST TEST (OPERATED AT RATED LOAD, MAX OUTPUT GEAR ROTATION AFTER REMOVAL OF ELECTRICAL POWER IS 20 DEGREES) AND MANUAL DRIVE TEST (ACTUATOR MUST BE CAPABLE OF MEETING OUTPUT LOAD/STROKE REQUIREMENTS WITH A MAXIMUM OF 50 TURNS AT THE MANUAL INPUT DRIVE).

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OMRSD: OPERATIONAL CHECKOUT OF ET DOOR CENTERLINE LATCH (EXTEND/LOCK); 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.

CONTAMINATION CONTROL

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

ASSEMBLY/INSTALLATION

INSPECTION VERIFIES DIMENSIONS OF ALL DETAIL PARTS.

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 TO NH85300.4(3A) AND IS VERIFIED BY INSPECTION.

TESTING

ACCEPTANCE TESTING IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

ALL METAL PARTS ARE VERIFIED BY INSPECTION TO BE PROPERLY PACKAGED.

(D) FAILURE HISTORY

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

(E) OPERATIONAL USE

NONE.