

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ACTUATION MECH-ET/ORB DOOR FMEA NO 02-4D-012000-1 REV:02/17/88

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

	REDUNDANCY SCREEN:	A-	B-	C-
PREPARED BY:	APPROVED BY:	APPROVED BY (NASA):		
DES R. H. YEE	DES <i>R. H. Yee for A.C. Ordway</i>	SSM	<i>AC Wood 2/25/88</i>	
REL J. S. MULLEN	REL <i>J.S. Mullen</i>	REL	<i>DES/REL</i>	
QE W. S. SMITH	QE <i>W.S. Smith</i>	QE	<i>DES/REL 2/25/88</i>	

ITEM:

GEARBOX/DIFFERENTIAL, DOOR DRIVE ACTUATOR

FUNCTION:

TO TRANSMIT/DISTRIBUTE PROPER POWER/TORQUE FROM EITHER OR BOTH ELECTRIC MOTORS TO THE DOOR DRIVE MECHANISM (TO OPEN/CLOSE THE DOORS).

FAILURE MODE:

PHYSICAL BINDING/JAMMING

CAUSE(S):

ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, FAILURE/DEFLECTION OF INTERNAL PART, LOSS OF LUBRICANT, TEMPERATURE

EFFECT(S) ON:

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

(A) LOSS OF FUNCTION - DOOR UNABLE TO BE CLOSED.

(B) THERMAL LEAKAGE INTO COMPARTMENT.

(C,D) 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.

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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. 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 MFG004-002), 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; MOTORS 1, MOTOR 2 AND DUAL MOTOR OPERATION. FREQUENCY - ALL VEHICLES AT GROUND TURNAROUND.

(C) INSPECTION

RECEIVING INSPECTION

CERTIFICATION OF COMPLIANCE, TEST COUPONS, PHYSICAL AND CHEMICAL RECORDS ARE MAINTAINED IN THE MASTER FILE. 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. GEARS ARE HARDNESS CHECKED AND VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

POLYETHYLENE SHEETING, USED TO BAG AND SEAL PARTS AFTER CLEANING, IS VERIFIED BY INSPECTION. A CLASS 100,000 CLEAN FACILITY IS USED FOR ASSEMBLY AND VERIFIED BY INSPECTION. ALL METAL PARTS ARE VERIFIED BY INSPECTION TO BE CLEANED. FINAL INSPECTION INCLUDES CHECKS FOR CONTAMINATION USING BORESCOPES, 5X AND 10X MAGNIFICATION DEVICES, AND FILTRATION METHODS.

ASSEMBLY/INSTALLATION

INSPECTION VERIFIES AND RECORDS DIMENSIONS OF ALL DETAIL PARTS.

NONDESTRUCTIVE EVALUATION

PARTS ARE MAGNETIC OR FLUORESCENT PENETRANT INSPECTED.

CRITICAL PROCESSES

HEAT TREATING AND LUBRICANT APPLICATION ARE VERIFIED BY INSPECTION. INSPECTION VERIFIES THAT GEARBOXES ARE PROPERLY LUBRICATED.

TESTING

ACCEPTANCE TESTING IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING REQUIREMENTS ARE 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

CREW WILL CYCLE DOOR TO ATTEMPT TO DISLodge DEBRIS OR LOOSEN STALLED/JAMMED MECHANISM.