

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ACTUATION MECH-STAR TRACK FMEA NO 02-47-032001-3 REV:02/17/88

ASSEMBLY :STAR TRACKER DOOR SUBSYSTEM

P/N RI :MC621-0066

P/N VENDOR:1047A010 ELLANEF

QUANTITY :2

:ONE UPPER-ONE LOWER

CRIT. FUNC: 1R

CRIT. HDW: 3

VEHICLE 102 103 104

EFFECTIVITY: X X X

PHASE(S): PL LO OO X DO X IS

PREPARED BY:

DES R. H. YEE
REL J. S. MULLEN
QE W. S. SMITH

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

APPROVED BY:

DES R. H. YEE For A. G. Ordone
REL [Signature]
QE [Signature]

APPROVED BY (NASA):

SSM [Signature] 2/27/88
REL [Signature]
QE [Signature]

ITEM:

ELECTRIC MOTOR/BRAKE, DOOR DRIVE ACTUATOR

FUNCTION:

TO PROVIDE TORQUE REQUIRED TO OPEN/CLOSE DOORS.

FAILURE MODE:

BRAKE FAILS TO ENGAGE

CAUSE(S):

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

EFFECT(S) ON:

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

(A,B,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; INABILITY TO OPEN ASSOCIATED STAR TRACKER DOOR.

FAILS REDUNDANCY SCREEN "B" SINCE NORMAL FUNCTION CALLS FOR DUAL MOTOR OPERATION WHILE IN FLIGHT.

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DISPOSITION & RATIONALE:

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

(A) DESIGN

THE STAR TRACKER DOOR SUBSYSTEM CONSISTS OF A SEALED DOOR AND AN ELECTROMECHANICAL DOOR DRIVE ACTUATOR. THE DOOR DRIVE ACTUATOR THAT CONSISTS OF A PLANETARY GEARBOX/DIFFERENTIAL AND A SPRING LOADED (4) BALL-DETENT TORQUE LIMITER DRIVEN BY TWO (REDUNDANT) 3-PHASE ELECTRIC MOTORS; EACH WITH AN INTEGRAL SPRING-LOADED BRAKE. LIMIT SWITCHES, SOFT (LEAF SPRING) STOPS AND HARD MECHANICAL STOPS CONTROL/LIMIT ACTUATOR MOVEMENT/ROTATION. HOUSING FABRICATED OF 6AL-4VT TI AND DESIGNED TO PRECLUDE THE ENTRY OF FOREIGN PARTICLES. GEARS MADE OF PH13-8MO AND 455 CRES; 4340 AND 9NI-4CO-.2C STL. BEARINGS MADE OF 440 AND OTHER CRES. DOORS AND TRACKS MADE OF 2219 AL. PARTS CLEANED TO LEVEL 300, PER MAC101-301 (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 ACTUATOR (TO LOOSEN STALLED/JAMMED MECHANISM). BRAKES ARE DESIGNED TO FAIL IN THE ENGAGED POSITION. DIFFERENTIAL IS DESIGNED TO DISTRIBUTE POWER FROM EITHER ONE OR BOTH (REDUNDANT) MOTORS. TORQUE LIMITER IS DESIGNED TO PROTECT MOTORS AND DRIVE TRAIN FROM AN OVERLOAD FAILURE. REF. STRESS ANALYSIS REPORT SD77-SH-0178, VOL. II.

(B) TEST

QUALIFICATION TESTS: COMPONENT QUAL-CERTIFIED PER CR-28-621-0066-0007. QUALIFICATION TESTS INCLUDE: HUMIDITY TEST (PER MIL-STD-810B), METHOD 507, PROCEDURE I), QUAL-ACCEPTANCE VIBRATION TEST (QAVT) (ACOUSTIC VIBRATIONS FROM 16-8,000 HZ FOR 5 MINUTES; ELECTRICAL CIRCUITS CHECKED WITH ACTUATOR CYCLED FROM CLOSED, TO OPEN, TO CLOSED POSITION), FLIGHT VIBRATION TEST (20-2,000 HZ FOR 71 MINUTES; 16-8,000 HZ FOR 34 MINUTES), EXPLOSIVE ATMOSPHERE TEST (ACTUATOR NOT TO EXCEED +352 DEG F OR EXPLODE IN WHICH BUTANE ENVIRONMENT, DURING ONE EXTEND OR RETRACT STROKE), THERMAL CYCLING TEST (CYCLED FIVE TIMES BETWEEN -100 DEG F AND +350 DEG F, WITH AT LEAST 60 MINUTES DWELL AT EACH EXTREME), OPERATING LIFE TEST (ACTUATOR CYCLED 2,000 TIMES AT ROOM TEMP; INCLUDES MOTOR 1 AND MOTOR 2 CYCLED 200 TIMES EACH, ALONE, AND WITHIN 20 SEC/STROKE; AND 1,000 CYCLES WITH BOTH MOTORS AND WITHIN 10 SEC/STROKE) AND STALL/MAXIMUM TORQUE TEST (TORQUE LIMITER HOLDS AT 1,246 INCH-LB AND SLIPS AT 1,450 INCH-LB). POWER CONSUMPTION TEST, PRESSURE LEAK TEST AND FREE-PLAY TEST WERE CONDUCTED AS DEFINED IN THE ACCEPTANCE TESTS. CERTIFICATION BY ANALYSIS/SIMILARITY INCLUDED: FUNGUS, OZONE, ACCELERATION, TRANSPACKAGE, SAND/DUST, SALT SPRAY, LIGHTNING, SHOCK AND THERMAL VACUUM.

ACCEPTANCE TESTS: INCLUDES EXAMINATION OF PRODUCT (FOR WEIGHT, DIMENSIONS, CONSTRUCTION, CLEANLINESS AND FINISH), ACCEPTANCE VIBRATION TESTS (AVT) (16-8,000 HZ FOR 1 MINUTE: WITH DOORS CYCLED AND ELECTRICAL CIRCUITS VERIFIED), ACCEPTANCE THERMAL TESTS (ATT) (CYCLED BETWEEN -80 DEG F AND +330 DEG F), BONDING TEST (PER MF0004-002), POWER CONSUMPTION TEST (WITH TEMPERATURE BETWEEN -80 DEG F AND +330 DEG F, SINGLE MOTOR CYCLED WITHIN 20 SEC, DUAL MOTORS CYCLED WITHIN 10 SEC, 22 WATTS/MOTOR MAXIMUM, 400% MAXIMUM STARTING CURRENT AT RATED LOAD), INSULATION RESISTANCE TEST AND DIELECTRIC WITH STANDING VOLTAGE TEST (PER MF0004-002), PRESSURE LEAKAGE TEST (MAXIMUM 0.0148 LB/SEC FOR LOWER DOOR, MAXIMUM 0.0173 LB/SEC FOR UPPER DOOR, AT 5.5 PSID), CYCLING TEST (SINGLE

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MOTOR, 40 CYCLES EACH AT 20 SEC/STROKE; DUAL MOTOR, 120 CYCLES AT 10 SEC/STROKE), PREEPLAY TEST (MAXIMUM OF TWO DEGREES WITH 100 INCH-LB REVERSING TORQUE ON OPEN DOOR; NONE WITH DOOR CLOSED), STALL/MAXIMUM TORQUE (TORQUE LIMITER HOLD AT 1,246 INCH-LB AND SLIPS AT 1,450 INCH-LB), IRREVERSIBILITY TEST (DOOR IRREVERSIBLE FROM CLOSED POSITION, WITH MAXIMUM OPERATING LOAD PLUS A 5.5 PSI AIRLOAD ON EXTERIOR OF DOOR) AND TRAVEL LIMITS TEST (DOOR CYCLED OPEN AND CLOSED; STOPPED BY LIMIT SWITCHES).

OMRSD: Y/2-STAR TRACKER DOORS CYCLED OPEN/CLOSED (TO VERIFY SATISFACTORY OPERATION OF DOORS AND LIMIT SWITCHES); SINGLE MOTOR (TO TEST FOR REDUNDANT MOTOR BRAKE ENGAGEMENT) AND DUAL MOTOR OPERATION. INSPECT DOORS FOR EVIDENCE OF BINDING, GALLING, DEFORMATION, LOOSE/NON-FUNCTIONAL/MISSING HARDWARE OR OTHER ANOMALIES. FREQUENCY: ALL VEHICLES AT GROUND TURNAROUND, AFTER ALL FLIGHTS.

(C) INSPECTION

RECEIVING INSPECTION

MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION. CHEMICAL ANALYSIS OF RECEIVED RAW MATERIAL VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS AND CORROSION CONTROL REQUIREMENTS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

MOTOR/BRAKE ASSEMBLY VERIFIED BY INSPECTION. SPRING DIAMETER AND MEASUREMENT OF SPRING UNDER FORCE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

SOLDERING, NICKEL PLATING, VACUUM BAKING, EPOXY POTTING, LOCTITE APPLICATION AND BEARING INSTALLATION ARE VERIFIED BY INSPECTION. ABILITY OF LOCTITE TO WITHSTAND BACKDRIVE WITH TORQUE WRENCH VERIFIED BY INSPECTION.

TESTING

ATF 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.