

PRINT DATE: 01/12/89

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 02-4E-052000-X

SUBSYSTEM NAME: ACTUATION MECH - AIR DATA PROBE

REVISION : 0 01/12/89 W

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	GEARBOX/DIFFERENTIAL ELLANEF	MC147-0012
SRU :	GEARBOX ELLANEF	A1045A010 SAME
SRU :	TORQUE LIMITER ELLANEF	A1045A014 SAME
SRU :	ELECTRIC MOTOR/BRAKE ELLANEF	SA9999A009 TYPE VII SAME

QUANTITY OF LIKE ITEMS: 2  
1 PER SIDE

**DESCRIPTION/FUNCTION:**

ELECTRIC MOTOR/BRAKE PROVIDES POWER TO CYCLE THE AIR DATA PROBES (DEPLOY/STOW);  
BRAKE PROVIDES REACTION/TORQUE TO HOLD PROBES IN PLACE. (REF: CIL NO.  
02-4E-052000-4).

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## SUMMARY

SUBSYSTEM NAME: ACTUATION MECH - AIR DATA PROBE  
 LRU GEARBOX/DIFFERENTIAL  
 LRU PART #: MC147-0012  
 ITEM NAME: ELECTRIC MOTOR/BRAKE

FMEA NUMBER	ABBREVIATED FAILURE MODE DESCRIPTION	CIL FLG	CRIT	SIS FLG
02-4E-052000-02	PHYSICAL BINDING/JAMMING	X	1R2	
02-4E-052000-04	FAILS TO ENGAGE	X	1R2	
02-4E-052000-05	SLIPS AT LESS THAN MINIMUM ALLOWABLE TORQUE	X	1R2	
02-4E-052000-06	FAILS TO SLIP AT MAX ALLOWABLE TORQUE	X	-1R3	

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SUBSYSTEM: ACTUATION MECH - AIR DATA PROBE

LRU GEARBOX/DIFFERENTIAL

CRITICALITY OF THIS

ITEM NAME: ELECTRIC MOTOR/BRAKE

FAILURE MODE: 1R2

## FAILURE MODE:

BRAKE FAILS TO ENGAGE

## MISSION PHASE:

DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:	102	COLUMBIA
	: 103	DISCOVERY
	: 104	ATLANTIS

## CAUSE:

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

CRITICALITY 1/1 DURING INTACT ABORT ONLY? N

REDUNDANCY SCREEN A) PASS  
 B) PASS  
 C) PASS

## PASS/FAIL RATIONALE:

A)

B)

C)

## - FAILURE EFFECTS -

## (A) SUBSYSTEM:

FIRST FAILURE - (LOSS OF MOTOR BRAKE TO ENGAGE). END OF TRAVEL SPRING FORCE AND AERODYNAMIC LOADS MAY CAUSE THE ACTUATOR TO BACKDRIVE RESULTING IN LOSS OF FUNCTIONAL DATA FROM ONE AIR DATA PROBE.

## (B) INTERFACING SUBSYSTEM(S):

SAME AS (A).

## (C) MISSION:

SECOND (REDUNDANT) ADP IS ADEQUATE FOR LANDING BY FLIGHT CONTROL.

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POTENTIAL LOSS OF CREW/VEHICLE DUE TO FLIGHT CONTROL INSTABILITIES  
WHEN ALL AIR DATA IS LOST.

(D) CREW, VEHICLE, AND ELEMENT(S):  
SAME AS (D).

(E) FUNCTIONAL CRITICALITY EFFECTS

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- DISPOSITION RATIONALE -  
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(A) DESIGN:

THE DEPLOYMENT ACTUATOR 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. HOUSING FABRICATED OF 6AL-4V TI AND DESIGNED TO PRECLUDE THE ENTRY OF FOREIGN PARTICLES. GEARS MADE OF PH13-8MO CRES; 4340 AND 9NI-4CO-.2C STL. BEARINGS MADE OF 440 AND OTHER CRES. PARTS 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 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.

(B) TEST:

QUALIFICATION TESTS: QUAL-CERTIFIED PER CR-28-147-0012-0001.  
QUALIFICATION TESTS INCLUDED: SHOCK TEST (BASIC DESIGN SHOCK PER MIL-STD-810, METHOD 916.1, PROCEDURE I; TRANSIENT SHOCK AT +/-0.25 G'S PEAK AND 5 TO 35 HZ SINUSOIDAL VIBRATION), QUAL-ACCEPTANCE VIBRATION TEST (QAVT) (ACOUSTIC VIBRATIONS FROM 20-2,000 HZ FOR 30 SECONDS TO 1 MINUTE IN EACH OF THREE ORTHOGONAL AXES; ELECTRICAL CIRCUITS CHECKED WITH ACTUATOR CYCLED FROM STOWED, TO DEPLOYED, TO STOWED POSITION), RANDOM VIBRATION TEST (OFT) (20-2,000 HZ; 5 MIN. IN EACH X, Y AND Z-AXIS), 100-MISSION RANDOM VIBRATION TEST (20-2,000 HZ; 48 MINUTES IN EACH X, Y AND Z-AXIS), THERMAL CYCLING TEST (CYCLED FIVE TIMES BETWEEN -100 DEG F AND +350 DEG F, WITH 60 MINUTES DWELL AT EACH EXTREME) AND OPERATING LIFE TEST (ACTUATOR CYCLED 2,000 TIMES AT ROOM TEMPERATURE; INCLUDES MOTOR 1 AND MOTOR 2 CYCLED 400 TIMES EACH, ALONE, AND WITHIN 30 SEC/STROKE; AND 1,200 CYCLES WITH BOTH MOTORS AND WITHIN 15 SEC/STROKE). EXPECT 500 CYCLES PER 100-MISSION LIFE. POWER CONSUMPTION TEST, PRESSURE LEAK TEST, FREE-PLAY TEST AND IRREVERSIBILITY TEST WERE CONDUCTED AS DEFINED IN THE ACCEPTANCE TESTS. CERTIFICATION BY ANALYSIS/SIMILARITY INCLUDED: FUNGUS, OZONE, ACCELERATION, TRANSPACKAGE, SAND/DUST, SALT SPRAY, MARGIN OF SAFETY, HUMIDITY, THERMAL VACUUM, AND EXPLOSIVE ATMOSPHERE.

ACCEPTANCE TESTS: INCLUDES EXAMINATION OF PRODUCTS (FOR WEIGHT, DIMENSIONS, CONSTRUCTION, CLEANLINESS AND FINISH), ACCEPTANCE VIBRATION

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TESTS (AVT) (20-2,000 HZ, 30 SEC TO 1 MINUTE, 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), BONDING TEST (PER MF0004-002), POWER CONSUMPTION TEST (WITH TEMPERATURE BETWEEN -80 DEG F AND +330 DEG F, SINGLE MOTOR DEPLOYED WITHIN 30 SEC, DUAL MOTORS DEPLOYED WITHIN 15 SEC, 22 WATTS/MOTOR MAXIMUM, 400% MAXIMUM STARTING CURRENT AT RATED LOAD), INSULATION RESISTANCE TEST AND DIELECTRIC WITHSTANDING VOLTAGE TEST (PER MF0004-002), PRESSURE LEAKAGE TEST (PNEUMATIC CHANNEL LEAKAGE IS 0.010 INCH-HG/MIN AT 80 INCH-HG APPLIED AIR PRESSURE), CYCLING TEST (SINGLE MOTOR, 40 CYCLES EACH AT 30 SEC/STROKE; DUAL MOTOR, 120 CYCLES AT 15 SEC/STROKE), FREEPLAY TEST (MAXIMUM ANGULAR FREEPLAY AT OUTPUT SHAFT +/-0.025 DEGREES, WITH 75.8 INCH-LB REVERSING TORQUE; MAXIMUM LATERAL FREEPLAY OF ROTARY CARRIER +/-0.001 INCH, WITH REVERSING LOAD OF 10 LB), STALL/MAXIMUM TORQUE TEST, IRREVERSIBILITY TEST (ACTUATOR MUST BE IRREVERSIBLE TO THE MAXIMUM OPERATING LOAD IN EITHER DIRECTION) AND TRAVEL LIMITS TEST (ACTUATOR AND OUTPUT ARM CYCLED FULL TRAVEL TO VERIFY COMPLIANCE WITH MECHANICAL AND ELECTRICAL LIMITS).

OMPSD: DEPLOY/STOW RIGHT-HAND/LEFT-HAND ADP, SINGLE MOTOR AND DUAL MOTOR OPERATION - CHECK FOR OPERATING TIME AND EVIDENCE OF BINDING OR GALLED, DEFORMED, LOOSE/MISSING PARTS, OR OTHER ANOMALIES. SINGLE MOTOR TEST WILL CHECK FOR PROPER OPERATION OF THE OPPOSING BRAKE. FUNCTIONAL INCLUDES DRIVING ADP MECHANISM AGAINST END OF TRAVEL SPRING. 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

ATP VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CAR AD1244 : DURING A MOTOR #1 DEPLOY CYCLE OF LEFT HAND AIR DATA

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PROBE, MOTOR #1 FLUCTUATED ON & OFF 5 TIMES; A FLAKE OF EPOXY WEDGED BETWEEN THE SPRING AND BRAKE HOUSING LIMITING THE MOTION OF THE BRAKE ASSEMBLY CAUSING ERRATIC ENGAGEMENT/DISENGAGEMENT; EXPLAINED AIR CAR CLOSED OUT FOR THE PROGRAM ON THE BASIS THAT THE MOTOR/BRAKE ASSEMBLY WILL BE REDESIGNED.

(E) OPERATIONAL USE:  
IF ALL AIR DATA IS LOST, CREW MUST MAINTAIN PITCH ATTITUDE WITHIN "THETA" LIMITS DISPLAYED ON THE CATHODE RAY TUBE (CRT).

- APPROVALS -

RELIABILITY ENGINEERING: J. S. MULLEN  
DESIGN ENGINEERING : R. H. YEE  
QUALITY ENGINEERING : W. J. SMITH  
NASA RELIABILITY :  
NASA SUBSYSTEM MANAGER :  
NASA QUALITY ASSURANCE :

*[Handwritten signatures and dates]*  
11.0/89  
11.18.89  
1-18-89