

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 02-4H-R100-X

SUBSYSTEM NAME: KU-BAND DEPLOY MECHANISM

REVISION : 2 12/17/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU : ■	ACTUATOR, KU-BAND DEPLOY BALL AEROSPACE	MC287-0026-0003
■ LRU : ■	ACTUATOR, KU-BAND DEPLOY ROCKWELL	V740-544110-002

PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

■ QUANTITY OF LIKE ITEMS: 1

■ FUNCTION:

REDUNDANT MOTORS IN THE ACTUATOR DRIVE THROUGH A DIFFERENTIAL AND GEARBOX TO DRIVE THE KU-BAND ANTENNA DEPLOYMENT MECHANISM. THERE ARE NO TORQUE LIMITERS IN THE KU-BAND DRIVE TRAIN. THE TWO MOTORS INCORPORATE INTEGRAL BRAKE MECHANISMS AND ARE CONTROLLED BY POSITION SWITCHES LOCATED WITHIN THE DEPLOYMENT MECHANISM. TWO OF THREE AC PHASES WILL RELEASE THE BRAKE AND DRIVE THE MOTOR. THE BRAKE PREVENTS BACKDRIVING IN THE EVENT OF ASSOCIATED MOTOR FAILURE.

NOTE: THE V740-544110-002 ACTUATOR MANUFACTURED AND QUALIFICATION TESTED BY ROCKWELL IS A SIMILAR DESIGN AND IS INTERCHANGEABLE WITH THE MC287-0026-0003 ACTUATOR MANUFACTURED AND QUALIFICATION TESTED BY BALL AEROSPACE.

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NUMBER: 02-4H-R100-04

SUBSYSTEM: KU-BAND DEPLOY MECHANISM
LRU :ACTUATOR, KU-BAND DEPLOY
ITEM NAME: ACTUATOR, KU-BAND DEPLOY

REVISION# 2 12/17/91 R

CRITICALITY OF THIS
FAILURE MODE:1R3

- FAILURE MODE:
MOTOR BRAKE FAILS TO ENGAGE

MISSION PHASE:

00 ON-ORBIT
00 DE-ORBIT

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

- CAUSE:
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, FAILURE/DEFLECTION OF INTERNAL PART

- CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

- A)
MOTOR BRAKE FAILURE WOULD BE DETECTABLE DURING SINGLE MOTOR FUNCTIONAL CHECK IN TURNAROUND.
- B)
FAILS REDUNDANCY SCREEN "B" SINCE THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING A BRAKE FAILURE IN FLIGHT.
- C)
MOTOR/BRAKE ASSEMBLIES ARE INDEPENDENT SEALED UNITS.

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- FAILURE EFFECTS -

(A) SUBSYSTEM:

FIRST FAILURE - NO EFFECT. SUBSEQUENT FAILURE OF ASSOCIATED MOTOR WILL ALLOW REDUNDANT MOTOR TO BACKDRIVE THROUGH THE FAILED BRAKE AND KU-BAND POSITIONING CAPABILITY WOULD BE LOST.

(B) INTERFACING SUBSYSTEM(S):

FIRST FAILURE - NO EFFECT. SUBSEQUENT FAILURE OF ASSOCIATED MOTOR WILL RESULT IN LOSS OF ABILITY TO DRIVE KU-BAND.

(C) MISSION:

FIRST FAILURE - NO EFFECT. SUBSEQUENT FAILURE WILL RESULT IN A POSSIBLE LOSS OF MISSION DUE TO INABILITY TO USE KU-BAND.

(D) CREW, VEHICLE, AND ELEMENT(S):

FIRST FAILURE - NO EFFECT. SUBSEQUENT FAILURE WILL REQUIRE JETTISON OF KU-BAND TO ALLOW PAYLOAD BAY DOOR CLOSURE. LOSS OF ALL REDUNDANCY RESULTS IN POSSIBLE LOSS OF CREW/VEHICLE DUE TO AN INABILITY TO CLOSE PAYLOAD BAY DOORS.

(E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

(A) DESIGN:

THE MOTOR BRAKE IS A COMBINED THREE-PHASE MOTOR AND SPRING-LOADED BRAKE WITH THE MOTOR AND BRAKE WINDINGS CONNECTED IN SERIES TO PROVIDE FAIL SAFE BRAKING IF POWER IS LOST ON ANY WINDING. IT IS FREE OF ANY SINGLE POINT FAILURE THAT WOULD PREVENT THE BRAKE FROM SUPPLYING THE REQUIRED HOLDING TORQUE. THE MATERIALS USED PROVIDE MINIMUM WEAR AND MAXIMUM STABILITY. HOUSING IS SEALED TO PREVENT CONTAMINATION.

(B) TEST:

ACCEPTANCE TESTS: THE FOLLOWING TESTS ARE PERFORMED FOR ALL FLIGHT ARTICLES AND ARE PERFORMED FOR EACH QUALIFICATION TEST ARTICLE. VIBRATION-RANGE 20 TO 2,000 HZ MAXIMUM LEVEL OF 0.04 g²/HZ FROM 80 TO 350 HZ ALL AXES. THERMAL - STABILIZED RANGE FROM -200 DEG F TO +350 DEG F. FUNCTIONAL TESTS CONDUCTED AT -100 DEG F, +70 DEG F AND +350 DEG F. TORQUE - MINIMUM TORQUE 17.60 INCH-OUNCES. MAXIMUM TORQUE 32.0 INCH-OUNCES. MINIMUM TWO-PHASE STALL TORQUE 12.80 INCH-OUNCES. MINIMUM HIGH SPEED TORQUE AT -100 DEG F 4.0 INCH-OUNCES, +70 DEG F 1.28 INCH-OUNCES, AND +350 DEG F 0.48 INCH-OUNCES. BRAKE STATIC HOLDING TORQUE 25.60 INCH-OUNCES MINIMUM VERIFIED DURING BRAKE OPERATION TEST.

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ELECTRICAL - VERIFY (WITHIN DESIGN LIMITS) CONTINUITY, DIELECTRIC STRENGTH, INSULATION RESISTANCE, AND POWER CONSUMPTION.

QUALIFICATION TESTS: THE FOLLOWING IS A SUMMARY OF TESTS CONDUCTED ON THE MC287-0026-0003 ACTUATOR PER CR 44-287-0026-0002 TO INCLUDE BOTH NATURAL AND INDUCED ENVIRONMENTAL EFFECTS TO THE MOTOR/BRAKE ASSEMBLY. FUNCTIONAL TESTS WERE CONDUCTED DURING AND FOLLOWING EACH PHASE OF TESTING TO DETERMINE EFFECTS. ENVIRONMENTS AND REQUIREMENTS ACCEPTED BY ANALYSIS INCLUDE FUNGUS, OZONE, SALT SPRAY, ACCELERATION, SOLAR RADIATION (THERMAL AND NUCLEAR), METEORIODS, SAND AND DUST, STORAGE, FACTOR OF SAFETY, RELIABILITY, MAINTAINABILITY, MATERIALS AND PROCESSES, ELECTRICAL DESIGN AND SAFETY. FLIGHT VIBRATION LEVEL 20 TO 2,000 HZ WITH MAXIMUM LEVEL OF 0.27 g²/HZ AT 80 TO 350 HZ ALL AXES. BRAKE HOLD DURING VIBRATION AT 0.10 g²/HZ. SHOCK - BASIC DESIGN PER MIL-STD-810C, METHOD 516.2, PROCEDURE I. THERMAL - STABILIZED RANGE FROM -100 DEG F TO +350 DEG F. FUNCTIONAL TESTS CONDUCTED AT -100 DEG F, +70 DEG F, AND +350 DEG F. THERMAL VACUUM AT 10 -6 TORR, HUMIDITY, EXPLOSIVE ATMOSPHERE PER MIL-STD-810C, METHOD 511.1, PROCEDURE I. STALL TEST-STALL TORQUE AT +350 DEG F AND 10 -6 VACUUM. LIFE CYCLE TESTS - 1,750 CYCLES IN ADDITION TO CYCLES CONDUCTED DURING VARIOUS QUALIFICATION TESTING.

NOTE: QUALIFICATION TESTS TO BE CONDUCTED ON THE V740-544110-002 ACTUATOR PER CR44-544110-002 INCLUDE ALL OF THE PRECEDING TESTS EXCEPT THAT THE FOLLOWING ENVIRONMENTS WILL BE CERTIFIED BY ANALYSIS OR SIMILARITY: HUMIDITY, EXPLOSIVE ATMOSPHERE, THERMAL VACUUM, LOAD TEST - COMBINED AXIS LOADING TO 100% LIMIT LOAD. A TOTAL OF 1461 OPERATIONAL CYCLES WILL BE PERFORMED.

OMRSD: DEPLOY MOTORS' PERFORMANCE IS VERIFIED DURING NORMAL IN-FLIGHT OPERATIONS. GROUND TESTING WOULD BE ACCOMPLISHED WHEN A VALID VERIFICATION IS UNOBTAINABLE DURING FLIGHT, OR FOLLOWING LRU REPLACEMENT. ALSO, SINGLE MOTOR OPERATION IS VERIFIED EVERY FLOW: DEPLOY MOTOR 1/STOW MOTOR 2 IS VERIFIED ON ODD FLOWS; AND DEPLOY MOTOR 2/STOW MOTOR 1 IS VERIFIED ON EVEN FLOWS.

(C) INSPECTION:

RECEIVING INSPECTION

MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION. INSPECTION VERIFIES THAT A SAMPLE FROM EACH LOT OF MATERIAL IS SPECTROSCOPICALLY ANALYZED TO VERIFY MATERIAL CHEMISTRY.

CONTAMINATION CONTROL

ALL PARTS ARE CLEANED BEFORE ENTERING STOCK ROOM AND RECLEANED BEFORE ENTERING CLEAN ROOM, VERIFIED BY INSPECTION. INSPECTION VERIFIES THAT PARTS ARE CLEANED TO LEVEL "VISIBLELY CLEAN" OF MA0110-301 PRIOR TO ASSEMBLY. MOTOR/BRAKE ASSEMBLY IS ASSEMBLED IN A CLASS 10,000 CLEAN

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ROOM, VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL PARTS ARE DIMENSIONALLY INSPECTED, VERIFIED BY INSPECTION.
ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. RTV APPLICATION TO
KEEP MOISTURE OUT OF THE MOTOR IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

HEAT TREATING AND SOLDERING ARE VERIFIED BY INSPECTION. PASSIVATION OF
STAINLESS STEEL PARTS IS VERIFIED BY INSPECTION. EXAMINATION OF SOLDER
JOINTS BEFORE THEY ARE CLOSED UP AND SEALED IN WINDINGS IS A MANDATORY
INSPECTION POINT. HEAT TREATING OF SHAFTS IS VERIFIED BY HARDNESS
TEST.

TESTING

ATP (INCLUDING TESTING AT EXTREME TEMPERATURES, AT VARIOUS LOADS AND AT
VARIOUS POSITIONS) IS VERIFIED PER PROCEDURE. WINDING RESISTANCE TEST
IS VERIFIED BY INSPECTION. HIGH POTENTIAL TEST IS VERIFIED BY
INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING PER DRAWING AND SPECIFICATION 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:

FLIGHT RULES INSTRUCT STOWAGE OF THE KU-BAND DUE TO SINGLE MOTOR DRIVE
OPERATION, UNLESS OTHERWISE IDENTIFIED IN THE FLIGHT SPECIFIC ANNEX.
SUBSEQUENT FAILURE WILL REQUIRE JETTISON OF KU-BAND TO ALLOW PAYLOAD
BAY DOOR CLOSURE AND PREVENT LOSS OF CREW/VEHICLE DURING ENTRY.

- APPROVALS -

RELIABILITY ENGINEERING: D. M. MAYNE
DESIGN ENGINEERING : S. L. SHARP
QUALITY MANAGER : O. J. BUTTNER
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

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