

## FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 05-2F-22400-X

SUBSYSTEM NAME: COMM &amp; TRACK: MICROWAVE SCAN BEAM LANDING SYS

REVISION : 2 04/12/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
□ LRU	: DECODER ASSEMBLY	MC409-0017-0006
□ LRU	: DECODER ASSEMBLY	MC409-0017-0008

## PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
DECODER ASSEMBLY, MICROWAVE SCAN BEAM LANDING SYSTEM (MSBLS).

REFERENCE DESIGNATORS: 81V74A40  
: 82V74A41  
: 82V74A42

QUANTITY OF LIKE ITEMS: 3  
THREE, REDUNDANT

## FUNCTION:

PROVIDES DME INTERROGATION TRIGGERS FOR RF ASSEMBLY AND DECODES RECEIVED RF. PROVIDES VEHICLE ANGULAR (AZIMUTH AND ELEVATION) POSITION DATA, AND RANGE DURING THE TERMINAL AREA APPROACH AND LANDING PHASE. PROVIDES AZIMUTH, ELEVATION AND RANGE UPDATES TO THE G&N SUBSYSTEM.

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SUBSYSTEM: COMM & TRACK: MICROWAVE SCAN BEAM LANDING SYS  
LRU :DECODER ASSEMBLY  
ITEM NAME: DECODER ASSEMBLY  
REVISION# 2 04/12/90  
CRITICALITY OF THIS FAILURE MODE:1R2

FAILURE MODE:  
ERRONEOUS OUTPUT

MISSION PHASE:  
LO LIFT-OFF  
DO DE-ORBIT

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

CAUSE:  
VIBRATION, TEMPERATURE, MECHANICAL SHOCK, CONTAMINATION, MISHANDLING.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS  
B) PASS  
C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:  
LOSS OF REDUNDANCY PATH.

(B) INTERFACING SUBSYSTEM(S):  
THE FAILED MSBLS OUTPUTS ARE DISCARDED AND THE OUTPUTS FROM THE  
REMAINING MSBLS DECODERS ARE USED.

(C) MISSION:  
NO EFFECT.

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

POSSIBLE LOSS OF CREW/VEHICLE AFTER A SECOND ERRONEOUS - OUTPUT FAILURE DUE TO DEGRADATION OF THE TERMINAL AREA APPROACH AND LANDING FUNCTIONS.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

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- DISPOSITION RATIONALE -  
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**(A) DESIGN:**

PROCURED AS MODIFIED OFF-THE-SHELF EQUIPMENT. ORIGINALLY DESIGNED (LATE 1970 FOR ARMY HELICOPTER USE.) BUILT TO MIL SPECS IN EFFECT AT THAT TIME. BECAUSE OF INHERENT SINGLE FAILURE POINTS, SYSTEM WAS IMPLEMENTED ON ORBITER AS THREE REDUNDANT END-TO-END STRINGS WITH SOFTWARE CONTROL, SELECTION AND EDITING OF DATA. MILITARY AND OPPL APPROVED PARTS MATERIALS AND PROCESSES WERE USED. NASA SOLDERING REQUIREMENTS & EEE PARTS TRACEABILITY HAVE BEEN WAIVED FOR THE MSBLS PER OVEI PARA. 3.5.17 (REGARDING SOLDERING) AND PER IPAR RIBC-017, AMENDMENT A (REGARDING EEE PARTS).

**(B) TEST:**

QUALIFICATION WAS BY SIMILARITY TO THE TESTED MILITARY DESIGN, EXCEPT THAT RANDOM VIBRATION WAS PERFORMED TO ORBITER REQUIREMENTS. DEVELOPMENT TESTING INCLUDED ADL (INTERFACES) AND SAIL (INTEGRATION). ATP FOR FUNCTIONAL PERFORMANCE VERIFICATION AND WORKMANSHIP (INCLUDING AVT AND ATT) WERE PERFORMED ON EACH LRU. TESTING AT PALMDALE TO VERIFY PROPER PERFORMANCE ON THE ORBITER WAS PERFORMED. OPERATION DURING ALT DEMONSTRATED PERFORMANCE IN FLIGHT. PRIOR TO INITIAL SPACE FLIGHT OF EACH VEHICLE ALL PERTINENT PARAMETERS WERE VERIFIED. GROUND TURNAROUND TEST - PERFORM MSBLS SELF-TEST TO VERIFY MSBLS AZIMUTH, ELEVATION, AND RANGE ACCURACY, CHANNELS AND FLAGS - PERFORMED EVERY FLIGHT. VERIFY THAT MSBLS MAINTAINS RANGE LOCK - PERFORMED BY ANALYSIS OF IN-FLIGHT DATA.

**(C) INSPECTION:**

RECEIVING INSPECTION  
RECEIVING INSPECTION VERIFIES ALL INCOMING PARTS AND MATERIALS, INCLUDING THE PERFORMANCE OF VISUAL AND DIMENSIONAL EXAMINATIONS. ALL ELECTRICAL, MECHANICAL, AND RAW MATERIAL RECORDS THAT CERTIFY MATERIALS AND PHYSICAL PROPERTIES PER DRAWING/SPECIFICATION REQUIREMENTS ARE RETAINED BY RECEIVING INSPECTION AS REQUIRED BY CONTRACT.

**CONTAMINATION CONTROL**

QUALITY ASSURANCE (QA) ARRANGES FOR INITIAL VERIFICATION OF THE ASSEMBLY WORK AREA AND SUBSEQUENTLY AUDITS THE AREA ON A REGULARLY

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SCHEDULED BASIS FOR MAINTENANCE OF CONTAMINATION CONTROLS.

ASSEMBLY/INSTALLATION

ALL DETAILED INSPECTIONS ARE PLANNED OUT BY THE METHODIZATION DEPARTMENT FOR ALL NEW BUILDS, SPARES, AND REPAIRS FOR THE MSBLS NAV-SET PROGRAM. INSPECTION POINTS ARE DESIGNATED TO PERMIT INSPECTION BEFORE THE APPLICABLE PORTIONS OF THE ASSEMBLY BECOME INACCESSIBLE AND PRIOR TO THE NEXT ASSEMBLY OPERATION.

CRITICAL PROCESSES

ALL PROCESSES AND CERTIFICATIONS ARE MONITORED AND VERIFIED BY INSPECTION. THE CRITICAL PROCESSES ARE SOLDERING, CONFORMAL COATING, TORQUING, APPLICATION OF ADHESIVES/SEALANTS, AND APPLICATION OF CHEMICAL FILM.

TESTING

ALL PARTS OF THE ATP ARE OBSERVED AND VERIFIED BY QA.

HANDLING/PACKAGING

ALL PARTS AND ASSEMBLIES ARE PROTECTED FROM DAMAGE OR CONTAMINATION FROM THE POINT OF RECEIVING INSPECTION TO FINAL SHIPMENT, THROUGH METHODS DETAILED IN A DOCUMENTED PROCEDURE. THIS HANDLING PROCEDURE IS IN EFFECT FOR ALL NEWLY BUILT HARDWARE AS WELL AS FOR REPAIR UNITS. QA AUDITS CONFORMANCE TO THIS PROCEDURE IN ACCORDANCE WITH ITS INTERNAL AUDIT SCHEDULE, AND ALL AREAS ARE CONSIDERED UNDER CONTINUOUS AUDIT BY QA WITH RESPECT TO MATERIAL HANDLING. THE MAINTENANCE OF ELECTROSTATIC DISCHARGE PREVENTION METHODS IS VERIFIED BY QA THROUGH PERIODIC AUDITS. ALL HARDWARE ITEMS ARE PACKAGED AND PROTECTED ACCORDING TO CONTRACT REQUIREMENTS AND ARE VERIFIED BY INSPECTION. EVIDENCE OF INSPECTION OF PACKAGING IS RECORDED ON THE APPLICABLE SHIPPING DOCUMENT.

(D) FAILURE HISTORY:

ALL ACCEPTANCE TEST, QUALIFICATION TEST, FIELD, AND FLIGHT FAILURES WERE REVIEWED. THERE HAVE BEEN TWO FAILURES WHICH RESULTED IN ERRONEOUS OUTPUT. THE FAILURES IDENTIFIED OCCURRED IN CIRCUITRY IDENTICAL TO PRESENT FLIGHT CONFIGURATION.

CAR A1854, OUTPUT WENT OUT OF SPECIFICATION DURING QTP. PROBLEM WAS ISOLATED TO AN IC (NAND GATE), WHICH HAD BROKEN BOND WIRES AT THE DIE. NO OTHER FAILURE OF THIS TYPE HAS OCCURRED TO DATE ON THE ORBITER MSBLS PROGRAM WITH THIS TYPE OF IC.

CAR A00770, SAIL UNIT INDICATED INCORRECT ELEVATION OPERATIONS ON COO CHANNELS. REPEATED TESTING COULD NOT DUPLICATE THE PROBLEM. PROBLEM WAS RESOLVED BY ATTRIBUTING IT TO TEST EQUIPMENT NOT OF PROPER CONFIGURATION, AND IT WAS DISPOSITIONED AS AN UNEXPLAINED ANOMALY.

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UNIT SUBSEQUENTLY PASSED BURN-IN AND PERFORMANCE TESTS AT THE VENDOR. THIS UNIT IS CURRENTLY ASSIGNED TO THE SHUTTLE TRAINING AIRCRAFT PROGRAM.

IT WAS DETERMINED THAT NO GENERIC ISSUE EXISTS REGARDING THE EEE PART FAILURE. THE UNEXPLAINED ANOMALY OCCURRED WITH A TEST SET NOT OF PROPER CONFIGURATION.

■ (E) OPERATIONAL USE:

FLIGHT RULES PERMIT DE-ORBIT WHEN CEILING IS BETWEEN 10,000 AND 8,000 FEET IF THE LANDING SITE IS EQUIPPED WITH MSBLS AND THE ORBITER MSBLS IS OPERATIONAL. DE-ORBIT IS NOT ATTEMPTED IF CEILING IS LESS THAN 8,000 FEET TO ENSURE GOOD VISIBILITY AT LOW ALTITUDE. MSBLS IS A REDUNDANT SOURCE OF LOW ALTITUDE DATA DOWN TO 50 FEET (RADAR ALTIMETER IS THE PRIMARY SOURCE OF ACCURATE LOW ALTITUDE DATA). MSBLS DATA IS REQUIRED FOR AUTOLAND, BUT THIS CAPABILITY IS NOT USED OPERATIONALLY. MSBLS REDUNDANCY MANAGEMENT SOFTWARE AUTOMATICALLY SAFES AND/OR RECONFIGURES THE SYSTEM AFTER MSBLS FAILURES. NAVIGATION SOFTWARE KALMANN FILTER PROVIDES SOME PROTECTION AGAINST INCORPORATION OF BAD MSBLS DATA INTO THE STATE VECTOR. IF RADAR TRACKING DATA (AVAILABLE AT EDWARDS, KSC, AND NORTHROP ONLY) AND COMMUNICATIONS WITH THE GROUND ARE AVAILABLE, THE MCC CAN RESOLVE A MSBLS DILEMMA AND PROTECT AGAINST THE USE OF BAD DATA IF THE LAST UNIT FAILS. MCC PERSONNEL ARE TRAINED TO ISOLATE A FAILED MSBLS BY COMPARING MSBLS DATA WITH RADAR TRACKING DATA.

- APPROVALS -

RELIABILITY ENGINEERING: J. H. RESSIA <sup>4-12</sup> *J. H. Ressler*  
 DESIGN ENGINEERING : W. H. STEPHENS <sup>4-12</sup> *W. H. Stephens*  
 QUALITY ENGINEERING : J. COURSEN <sup>4-16</sup> *J. Courson*  
 NASA RELIABILITY : *Francis W. Adams*  
 NASA SUBSYSTEM MANAGER : *W. H. Stephens*  
 NASA QUALITY ASSURANCE : *B. J. Anten*