

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: M8-1SS-BM024-X

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 1 DEC, 1996

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: GUIDE RING ASSEMBLY RSC-ENERGIA	33U.6271.011-09 ("SOFT") 33U.6271.011-05 (PMA1) 33U.6201.008-08 (PMA2/3)
SRU	: SENSOR RSC-ENERGIA	33U.5319.027 33U.5319.027

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

CAPTURE SENSOR

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3

THREE

FUNCTION:

THREE SENSORS, LOCATED ON THE GUIDE RING ASSEMBLY, ARE USED TO MONITOR THE RING MATCHING OF BOTH THE ORBITER/PMA1 AND ISS (PMA2/FGB) DOCKING RING ASSEMBLIES. EACH SENSOR CONTAINS TWO REDUNDANT SHORT CONTACTS AND TWO REDUNDANT LONG CONTACTS. THE SHORT CONTACTS OF THE THREE SENSORS ARE CONNECTED IN SERIES AND THE LONG CONTACTS OF THE THREE SENSORS ARE CONNECTED IN PARALLEL. TOGETHER THEY SENSE THE MATING OF THE TWO DOCKING RINGS AND SEND A SIGNAL TO THE DSCU TO ACTIVATE THE HIGH ENERGY (AND LOW ENERGY FOR THE "SOFT" MECHANISM) DAMPERS AND TO ILLUMINATE THE "CAPTURE" INDICATOR LIGHT ON THE DOCKING CONTROL PANEL WHEN ALL THREE SENSORS ACTUATE SIMULTANEOUSLY. THE LONG CAPTURE SIGNAL IS DOWNLINKED TO GROUND PERSONNEL. THESE SENSORS SENSE THE SECOND POINT IN THE AUTOMATIC DOCKING SEQUENCE - MATING OF THE TWO DOCKING RINGS. THE SIGNAL FROM THE PMA2/3 PASSIVE MECHANISM CAPTURE SENSORS IS TRANSFERRED TO ISS (FGB) TO TURN OFF DYNAMIC REGIME (DOESN'T APPLY TO THE 2A MISSION).

SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:

VISUAL INSPECTION, SERVICEABILITY CONTROL, DOCKING WITH CALIBRATING DOCKING MECHANISM.

MAINTAINABILITY

REPAIR METHOD - REPLACEMENT.

REFERENCE DOCUMENTS: 33U.5319.027
33U.6271.011-09 ("SOFT")

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL-CIL-HARDWARE

NUMBER: M8-1SS-BM024-M8-1SS-

BM024-X

33U.6271.011-05 (PMA1)
33U.6201.008-08 (PMA2/3)

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: M8-1SS-BM024- 02**

REVISION# 2 JAN, 1997

SUBSYSTEM NAME: MECHANICAL - EDS
LRU: GUIDE RING ASSEMBLY
ITEM NAME: SENSOR, CAPTURE

CRITICALITY OF THIS
FAILURE MODE: 2R3

FAILURE MODE:
ONE CONTACT SET FAILS CLOSED

MISSION PHASE:
OO ON-ORBIT

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

CAUSE:
CONTAMINATION, PIECE PART STRUCTURAL FAILURE DUE TO MECHANICAL/THERMAL SHOCK, VIBRATION, OR MANUFACTURER/MATERIAL DEFECT

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? NO

REDUNDANCY SCREEN A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
SCREEN "B" FAILS BECAUSE ONE CAPTURE SENSOR "SHORT CONTACT" CONTACT SET FAILING CLOSED IS NOT DETECTABLE IN FLIGHT. (HOWEVER, ONE CAPTURE SENSOR "LONG CONTACT" CONTACT SET FAILING CLOSED IS DETECTABLE.)

C)

METHOD OF FAULT DETECTION:
NONE FOR FIRST THREE FAILURES. FOURTH FAILURE CAN BE DETECTED THROUGH VISUAL OBSERVATION (PREMATURE CAPTURE INDICATION WHEN NOT REQUIRED) AND INSTRUMENTATION (TELEMETRY DATA WILL INDICATE POWER TO THE HIGH ENERGY (AND LOW ENERGY FOR THE "SOFT" MECHANISM) DAMPERS WHEN PREMATURELY-ENGAGED).

MASTER MEAS. LIST NUMBERS: V53X0757E

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REMARKS/RECOMMENDATIONS:

AT LEAST ONE SHORT CONTACT SET ON EACH OF THE THREE CAPTURE SENSORS ALONG WITH ONE LONG CONTACT SET ON ANY ONE OF THE THREE CAPTURE SENSORS MUST BE CLOSED TO GET A CAPTURE INDICATION.

- FAILURE EFFECTS -

(A) SUBSYSTEM:

INADVERTENT "RING SHORT CAPTURE" OR "RING LONG CAPTURE" SIGNAL TO DSCU. NO EFFECT FIRST FAILURE. A FAILS CLOSED CONDITION ON ONE "SHORT" CONTACT SET ON ALL THREE CAPTURE SENSORS ACCOMPANIED WITH A FAILS CLOSED CONDITION ON A "LONG" CONTACT SET ON ONE OF THREE SENSORS WILL RESULT IN PREMATURE HIGH ENERGY (AND LOW ENERGY FOR THE "SOFT" MECHANISM) DAMPER ACTIVATION AND A FALSE "CAPTURE" INDICATION ON THE DOCKING CONTROL PANEL AND TO THE GROUND THROUGH TELEMETRY DATA. PREMATURE SHUTDOWN OF ISS DYNAMIC REGIME.

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT UNTIL FOURTH FAILURE. AT WHICH TIME EXCESSIVE LOADS INCURRED DURING DOCKING, AS THE RESULT OF THE HIGH ENERGY (AND LOW ENERGY FOR THE "SOFT" MECHANISM) DAMPERS BEING ACTIVATED PRIOR CAPTURE, COULD PROPAGATE TO EXTERNAL AIRLOCK AND ORBITER/PMA1/PMA2 STRUCTURE.

(C) MISSION:

NO EFFECT FIRST FAILURE. IF SIMILAR FAILURE ON ONE "SHORT" CONTACT SET ON THE REMAINING TWO CAPTURE SENSORS AND ONE "LONG" CONTACT SET ON ANY ONE SENSOR OCCURS PRIOR TO CAPTURE, DAMAGE THAT COULD OCCUR AS THE RESULT OF THE DAMPERS BEING ENGAGED COULD IMPEDE THE DOCKING PROCESS.

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

NO EFFECT ON CREW OR VEHICLE. POTENTIAL DAMAGE TO ORBITER/PMA1 AND ISS (PMA2/FGB) DOCKING MECHANISMS DUE TO HIGH LOADS INCURRED DURING CAPTURE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NO EFFECT FIRST, SECOND, AND THIRD FAILURES (FAILED CLOSED CONDITION ON ONE "SHORT" CONTACT SET OF ALL THREE CAPTURE SENSORS). FOURTH FAILURE (ONE "LONG" CONTACT SET OF ANY ONE CAPTURE SENSOR FAILING CLOSED) WOULD RESULT IN THE FOLLOWING: (1) A PREMATURE CAPTURE INDICATION; (2) PREMATURE SHUTDOWN OF ISS DYNAMIC REGIME; (3) PREMATURE ENGAGEMENT OF HIGH ENERGY (AND LOW ENERGY FOR THE "SOFT" MECHANISM) DAMPERS PRIOR TO CAPTURE RESULTING IN HIGH DOCKING LOADS. THESE HIGH LOADS COULD PREVENT CAPTURE OR CAUSE DAMAGE TO BOTH ORBITER/PMA1 AND ISS DOCKING MECHANISMS. POTENTIAL DAMAGE TO ORBITER/PMA1 DOCKING MECHANISM COULD PRECLUDE RING MOVEMENT RESULTING IN LOSS OF DOCKING. WORST CASE, LOSS OF MISSION OBJECTIVES..

DESIGN CRITICALITY (PRIOR TO OPERATIONAL DOWNGRADE, DESCRIBED IN F): N/A

(F) RATIONALE FOR CRITICALITY CATEGORY DOWNGRADE:

N/A (THERE ARE NO WORKAROUNDS TO CIRCUMVENT THIS FAILURE.)

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- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: N/A

**IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
N/A**

**RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION TO THIS FAILURE SINCE A HIGH ENERGY (AND LOW ENERGY FOR THE "SOFT" MECHANISM) DAMPER BEING ENGAGED IS NOT DETECTABLE UNTIL AFTER CAPTURE, AT WHICH TIME THE RESULTING HIGH LOADS COULD DAMAGE BOTH ORBITER/PMA1 AND ISS (PMA2/FGB) DOCKING MECHANISMS TO THE POINT OF PRECLUDING DOCKING.**

HAZARDS REPORT NUMBER(S): ORBI 402B

**HAZARD(S) DESCRIPTION:
DAMAGE TO BOTH ORBITER/PMA1 AND ISS DOCKING MECHANISMS.**

-DISPOSITION RATIONALE-

(A) DESIGN:

DESIGN OF THE SENSOR, SELECTION OF MATERIALS, AND SMALL ELECTRICAL LOADS REDUCE THE FAILURE PROBABILITY OF BOTH CONTACTS. DESIGN OF THE CONTACT PAIR (DUAL CHANNEL) HAS PASSED MAGNITUDES OF GROUND FUNCTIONAL TESTING AND MULTIPLE USES DURING PILOTED VEHICLE OPERATIONS IN SPACE. WIRE REDUNDANCY FOR EACH CONTACT, CHOICE OF MATERIALS AND COATINGS FOR THE CONTACT PAIR, AND MAXIMUM SPACING BETWEEN LEADS OF EACH CONTACT PAIR ASSURES A HIGH LEVEL OF RELIABILITY. SPRING WHICH RETURNS THE INTERNAL ROD TO THE INITIAL POSITION IS DESIGNED TO OPERATE BEYOND LIMITS OF FATIGUE AND THUS, POSSIBILITY OF SPRING FAILURE IS VERY LOW. MISALIGNMENT OF THE ROD IS NOT POSSIBLE BY DESIGN.

ANALYSIS HAS SHOWN THAT THE MAXIMUM AXIAL LOADS INCURRED AS THE RESULT OF THE HIGH ENERGY DAMPERS BEING ACTIVATED PRIOR TO CAPTURE ARE 5097KG (TENSION) AND 2906 KGF (COMPRESSION) IN THE Z-AXIS. ANALYSIS HAS INDICATED THAT THE CAPTURE LATCHES WILL DISENGAGE WHEN THE AXIAL LOAD ON THIS AXIS REACHES 3698 KGF. DAMAGE TO THE CAPTURE LATCH, THAT WOULD PREVENT IT FROM BEING ACTUATED OPEN, WILL NOT OCCUR PRIOR TO THE DISENGAGEMENT AXIAL LOAD OF 3698 KGF. THESE LOADS WILL NOT EXCEED EXTERNAL AIRLOCK/ORBITER STRUCTURAL LIMITS.

(B) TEST:

REFER TO "APPENDIX B" FOR DETAILS OF THE FOLLOWING ACCEPTANCE AND QUALIFICATION TESTS OF THE DOCKING MECHANISMS RELATIVE TO THIS FAILURE MODE.

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DOCKING MECHANISM ACCEPTANCE TESTS:

1. ELECTRICAL CIRCUIT VERIFICATION TEST
2. INSULATION ELECTRICAL RESISTANCE TEST
3. INTERFACE SENSOR FUNCTIONAL PERFORMANCE TEST
4. CAPTURE LATCH FORCE LOAD TEST
5. VIBRATION TEST
6. THERMAL VACUUM TEST

DOCKING MECHANISM QUALIFICATION TESTS:

1. ELECTRICAL CIRCUIT VERIFICATION TEST
2. INSULATION ELECTRICAL RESISTANCE TEST
3. TRANSPORTABILITY STRENGTH TEST
4. VIBRATION TEST
5. SHOCK-BASIC DESIGN TEST
6. THERMAL VACUUM TEST
7. SIX-DEGREE-OF-FREEDOM TEST
8. SERVICE LIFE TEST
9. DISASSEMBLY INSPECTION

OMRSD - TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

ALL INCOMING PARTS ARE SUBJECTED TO EXTERIOR INSPECTION.

CONTAMINATION CONTROL

CORROSION PROTECTION PROVISIONS AND CONTAMINATION CONTROL VERIFIED BY INSPECTION. CHECK OF ROOM CLEANLINESS; PARTS WASHING AND OTHER OPERATIONS OF THE TECHNOLOGICAL PROCESS WHICH PROVIDES CLEANLINESS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

HEAT TREATING, SOLDERING, CHEMICAL PLATING, AND CURING VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ASSEMBLY/INSTALLATION VERIFIED BY INSPECTION.

TESTING

ATP/OTP/OMRSD TESTING VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PROPER PACKAGING, STORAGE, AND TRANSPORTATION VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CURRENT DATA ON TEST FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING OF ODS DOCKING MECHANISMS CAN BE FOUND IN PRACA DATA BASE.


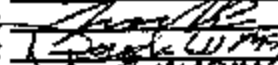
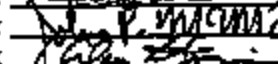

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(E) OPERATIONAL USE:

GIVEN SUFFICIENT TIME CREW COULD CONTROL CLOSING PARAMETERS TO AVOID HIGH LOADS DURING CAPTURE. CREW MUST NOT RELY 100% ON THE CAPTURE INDICATION. VISUAL OBSERVATION THROUGH ORBITER CREW HATCH AND REMOTE TV VIEWING THROUGH EXTERNAL AIRLOCK UPPER HATCH WINDOW COULD PROVIDE INDICATION AS TO THE PROXIMITY BETWEEN BOTH DOCKING MECHANISMS DURING THE CAPTURE PROCESS. UNDER NORMAL CONDITIONS AN INITIAL CONTACT INDICATION WILL PRECEED THE CAPTURE INDICATION AND ONLY UNDER IDEAL CLOSING CONDITIONS WILL IT NOT APPEAR FIRST. THERE IS NO WORKAROUND FOR A PREMATURE ACTIVATION OF HIGH ENERGY DAMPERS IF NOT DETECTED PRIOR TO CONTACT.

- APPROVALS -

PRODUCT ASSURANCE ENGR.	:	M. NIKOLAYEVA	:	
DESIGN ENGINEER	:	E. BOBROV	:	
NASA SS/MA	:		:	
NASA SUBSYSTEM MANAGER	:		:	
JSC MOD	:		:	