

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

NUMBER: MB-1MR-BM006-X

SUBSYSTEM NAME: MECHANICAL - EDS

REVISION: 2 9/1/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: GUIDE RING ASSEMBLY NPO-ENERGIA	33U.6271.011-05 33U.6271.011-05
SRU	: ASSEMBLY, CAPTURE LATCH NPO-ENERGIA	33U.6322.025 33U.6322.025

**PART DATA****EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
CAPTURE LATCH ASSEMBLY****REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS: 3**  
THREE (ONE PER GUIDE PEDAL)

**FUNCTION:**

THREE ACTIVE (CAPTURE) LATCHES, ONE ON EACH GUIDE PEDAL OF THE ORBITER DOCKING RING, PROVIDES POSITIVE CAPTURE TO THREE PASSIVE (BODY MOUNTED) LATCHES LOCATED ON THE MIR DOCKING MECHANISM. CAPTURE LATCH ROLLER MECHANISMS MOVE ASIDE DURING CLOSING CONTACT WITH THEIR OPPOSING BODY MOUNTED LATCHES AND ARE SPRING DRIVEN TO LOCK AFTER PASSING THE THREE PASSIVE BODY LATCHES (LUGS). TWO ROLLER MECHANISMS LOCATED ON EACH CAPTURE LATCH ASSEMBLY PROVIDE A REDUNDANT MEANS OF CAPTURE.

UPON RECEIPT OF A "CLOSE CAPTURE LATCH" COMMAND, POWER IS APPLIED THROUGH REDUNDANT "LATCH MOTOR OPEN" SENSOR CONTACT SETS TO A SINGLE ACTUATOR MOTOR TO EXTEND BOTH ROLLERS OF ONE CAPTURE LATCH ASSEMBLY. A "LATCH INDICATION CLOSED" SENSOR ON EACH ACTUATOR SENSES THE CLOSED POSITION OF THE LATCH AND SENDS REDUNDANT SIGNALS TO THE DOCKING CONTROL PANEL VIA THE DSCU TO ILLUMINATE THE "LATCHES CLOSED" LIGHT WHEN ALL THREE CAPTURE LATCHES ARE CLOSED.

UPON RECEIPT OF AN "OPEN CAPTURE LATCH" COMMAND (FOLLOWING COMPLETION OF THE DOCKING PROCESS), POWER IS APPLIED THROUGH REDUNDANT "LATCH MOTOR CLOSED" SENSOR CONTACT SETS TO A SINGLE ACTUATOR MOTOR TO RETRACT BOTH ROLLERS OF THE CAPTURE LATCH ASSEMBLY FOR UNDOCKING OF THE MIR AND ORBITER. A "LATCH INDICATION OPEN" SENSOR LOCATED ON EACH CAPTURE LATCH ACTUATOR SENSES THE OPEN POSITION OF THE LATCH AND SENDS REDUNDANT SIGNALS TO THE DSCU TO ILLUMINATE THE "LATCHES OPEN" INDICATOR LIGHT ON THE DOCKING CONTROL PANEL AND COMMAND RING TO RETRACT WHEN THE SENSOR ON ALL THREE CAPTURE LATCH ACTUATORS IS CLOSED.

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THE THIRD CONTACT SET OF EACH "LATCH INDICATION OPEN" AND "LATCH INDICATION CLOSED" SENSOR IS UTILIZED FOR GROUND MONITORING OF CAPTURE LATCH POSITION. CAPTURE LATCH "INITIAL POSITION" IS ALSO DOWNLINKED FOR GROUND MONITORING.

IN THE EVENT A CAPTURE LATCH FAILS TO OPEN, THE MANUAL LATCH/UNBLOCKING DEVICE CONTAINED BEHIND THE CAPTURE LATCH ASSEMBLY WILL PROVIDE MANUAL RELEASE OF THE LATCH. A BUTTON ON EACH SIDE OF THE DEVICE, WHEN DEPRESSED SIMULTANEOUSLY, WILL RELEASE LATCH CONTROL BY THE LATCH ACTUATOR, THUS ALLOWING BOTH CAPTURE LATCH ROLLERS TO RETRACT TO THEIR OPEN POSITION.

**SERVICE IN BETWEEN FLIGHT AND MAINTENANCE CONTROL:**

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

**MAINTAINABILITY**

REPAIR METHOD - REPLACEMENT.

**REFERENCE DOCUMENTS:** 33U.6322.025  
33U.6271.011-05

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NUMBER: M8-1MR-BM005-08

REVISION# 1 9/1/95

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

CRITICALITY OF THIS  
 FAILURE MODE: 2R3

**FAILURE MODE:**

ROLLER FAILS TO RETURN TO INITIAL (EXTENDED) POSITION

**MISSION PHASE:**

OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

**CAUSE:**

MULTIPLE SPRING FAILURES DUE TO MECHANICAL/THERMAL SHOCK OR MANUFACTURE/MATERIAL DEFECT, JAMMED ROLLER DUE TO CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? N/A

**REDUNDANCY SCREEN**

A) PASS  
 B) FAIL  
 C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

FAILS REDUNDANCY SCREEN "B" SINCE A SINGLE ROLLER FAILING TO RETURN TO ITS INITIAL POSITION IS NOT DETECTABLE IN FLIGHT.

C)

**METHOD OF FAULT DETECTION:**

NONE FOR A SINGLE ROLLER. VISUAL OBSERVATION WOULD DETECT AN INABILITY TO CAPTURE DUE TO BOTH ROLLERS ON SAME PEDAL FAILING TO RETURN TO THEIR INITIAL POSITION.

**- FAILURE EFFECTS -****(A) SUBSYSTEM:**

NO EFFECT FIRST FAILURE. A FAILURE OF A SPRING ON ONE ROLLER MECHANISM ACCOMPANIED WITH FAILURE OF A SPRING ON A SECOND MECHANISM WOULD PREVENT EITHER LATCH ROLLER FROM RETURNING TO ITS INITIAL POSITION ONCE INITIAL CONTACT IS MADE WITH THE OPPOSING BODY MOUNTED LATCH ON THE MIR DOCKING MECHANISM. A FAILURE OF SECOND LATCH ROLLER TO RETURN TO ITS INITIAL EXTENDED (CLOSED) POSITION MAY ALLOW CAPTURE TO OCCUR BUT RING ALIGNMENT FOR STRUCTURAL MATING OF THE INTERFACE WOULD BE IMPOSSIBLE.

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**(B) INTERFACING SUBSYSTEM(S):**

NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS.

**(C) MISSION:**

NO EFFECT FIRST FAILURE. SIMILAR FAILURE OF SECOND ROLLER ON AFFECTED CAPTURE LATCH ASSEMBLY WILL RESULT IN LOSS OF DOCKING CAPABILITIES.

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

NO EFFECT ON CREW AND VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

FIRST ROLLER FAILURE - NO EFFECT, REDUNDANT ROLLER WILL ENABLE CAPTURE.  
 SECOND ROLLER FAILURE - INABILITY OF ONE CAPTURE LATCH ON ORBITER DOCKING MECHANISM TO LATCH TO IT'S OPPOSING BODY MOUNTED LATCH ON THE MIR DOCKING MECHANISM. ALTHOUGH CAPTURE AND RING RETRACTION IS POSSIBLE IT IS QUESTIONABLE WHETHER THE TWO DOCKING MECHANISMS CAN BE PROPERLY ALIGNED DURING MATING FOR CLOSING THE STRUCTURAL HOOKS. WORST CASE, LOSS OF DOCKING RESULTING IN LOSS OF ORBITER/MIR MISSION OBJECTIVES.

**DESIGN CRITICALITY (PRIOR TO OPERATIONAL DOWNGRADE, DESCRIBED IN F): 2R3****(F) RATIONALE FOR CRITICALITY CATEGORY DOWNGRADE:**

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

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

EACH CAPTURE LATCH ASSEMBLY CONTAINS REDUNDANT LATCH ROLLERS, EITHER OF WHICH CAN ENABLE CAPTURE. EACH ROLLER MECHANISM CONTAINS A SET OF THREE SPRINGS TO EXTEND THE ROLLER TO IT'S INITIAL (CAPTURE) POSITION. THE CAPTURE LATCH ASSEMBLY IS COMPLETELY ENCASED TO PREVENT INTRODUCING CONTAMINATION LARGE ENOUGH TO CAUSE A JAMMING.

**(B) TEST:****DOCKING MECHANISM ACCEPTANCE TESTS:**

1. VIBRORESISTENT TEST - APDS SUBJECTED TO THE FOLLOWING VIBRATION LEVELS FOR 2 MINUTES PER AXIS:

FREQUENCY (HZ)	SPECTORAL DENSITY ACCELERATION
FROM 20 TO 80	INCREASING 3DB OCTAVE TO 0.04G <sup>2</sup> /HZ
FROM 80 TO 350	PERMANENT 0.04G <sup>2</sup> /HZ
FROM 350 TO 2000	DECREASING 30B OCTAVE WITH 0.04G <sup>2</sup> /HZ

SUBSEQUENT TO THIS TEST AN INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

2. DOCKING MECHANISM CHECKOUT (STATIC) TEST - CAPTURE LATCH ROLLER OPERATION IS VERIFIED WHEN THE DM SIMULATOR COMES IN CONTACT WITH THE RING ASSEMBLY. CAPTURE OF THE LATCHES OF THE RING ASSEMBLY WITH THE BODY LATCHES OF THE SIMULATOR IS MAINTAINED DURING RING RETRACTION.

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3. THERMO VACUUM TEST - DOCKING OF THE MECHANISM IS THERMALLY CYCLED, UNDER LOAD CONDITIONS, FROM +20°C TO -50/-55°C TO +50/+55°C TO +20°C IN A VACUUM AT  $10^{-4}$  TO  $10^{-5}$  TORR. DWELL AT EACH TEMPERATURE AND BETWEEN OPERATIONS AT EACH TEMPERATURE IS A MINIMUM OF 60 MINUTES AFTER STABILIZATION. OPERATIONS INCLUDES PERFORMING CAPTURE. PROPER OPERATION OF THE CAPTURE LATCH ROLLERS IS VERIFIED FOR A TEMPERATURE RANGE OF -50°C/-55°C TO 50°C/55°C.

4. CONTROLLED DOCKING TEST - CONTROLLED DOCKING IS PERFORMED UNDER LOAD CONDITIONS. CAPTURE LATCH ROLLERS WILL ENGAGE OPPOSING BODY MOUNTED LATCH ON DM SIMULATOR. THIS TEST WILL VERIFY PROPER OPERATION OF THE CAPTURE LATCH ROLLERS DURING RING RETRACTION FOLLOWING CAPTURE.

DOCKING MECHANISM QUALIFICATION TESTS:

1. VIBRATION STRENGTH TEST - APDS SUBJECTED TO THE FOLLOWING VIBRATION LEVELS IN EACH AXIS FOR A 400 SECOND DURATION.

FREQUENCY (HZ)	SPECTORAL DENSITY ACCELERATION
FROM 20 TO 80	INCREASING 3DB OCTAVE TO $0.067G^2/HZ$
FROM 80 TO 350	CONSTANT $0.067G^2/HZ$
FROM 350 TO 2000	DECREASING 3DB OCTAVE WITH $0.067G^2/HZ$

SUBSEQUENT TO THIS TEST AN INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

2. TRANSPORTABILITY STRENGTH TEST - SHIPPING LOADS ARE SIMULATED ON A VIBRATING TABLE TO VERIFY THAT THE DOCKING MECHANISM WILL NOT BE DAMAGED DURING SHIPMENT. THIS TEST IS CONDUCTED UNDER THE CONDITIONS CONTAINED IN THE FOLLOWING TABLE.

VIBRATION ACCELER DIRECTION	VIBRATION ACCELER AMPLITUDE	FREQUENCY SUBBAND, HZ					TOTAL TEST DURATION	
		5-7	7-15	15-30	30-40	40-80	HR	MIN
		TEST DURATION, MIN						
ALONG X-AXIS	1.4	-	4	-	-	-	-	4
	1.2	76	93	32	61	39	5	7
ALONG Y-AXIS	1.1	-	4	-	-	-	-	4
	1.0	19	16	7	10	7	-	53
ALONG Z-AXIS	1.1	-	4	-	-	-	-	4
	1.0	32	40	16	26	18	2	10

SUBSEQUENT TO THIS TEST AN INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

3. SHOCK AND SAWTOOTH LOADING STRENGTH TEST - DOCKING MECHANISM IS SUBJECTED TO 20G TERMINAL SAWTOOTH SHOCK PULSES IN EACH AXIS, 3 PULSES IN EACH DIRECTION FOR A TOTAL OF 6 PULSES/AXIS. AFTER COMPLETION AN INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

4. APDS SERVICEABILITY TEST IN A SIX-DEGREE-OF-FREEDOM DYNAMIC TEST - THE SIX-DEGREE-OF-FREEDOM DYNAMIC TEST VERIFIES APDS DOCKING AND

RSC  
Energia

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UNDOCKING OPERATIONS UNDER CLOSE-TO-FULL-SCALE CONDITIONS. STATIC MOTION OF ENTITIES IS SIMULATED UNDER SPECIFIC INERTIAL AND GEOMETRICAL PARAMETERS FOR VARIOUS INITIAL CONDITIONS FOR MIR/SHUTTLE DOCKING. A TOTAL OF 20 DOCKINGS IS PERFORMED. THE ABILITY OF THE CAPTURE LATCH ROLLERS TO MAINTAIN THEIR POSITION ONCE THEY HAVE ENGAGED THE OPPOSING BODY MOUNTED LATCH IS VERIFIED DURING CAPTURE OF EACH DOCKING. SUBSEQUENT TO THIS TEST AN ENGINEERING INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

5. COLD AND HEAT RESISTANCE TEST - DOCKING OF THE MECHANISM IS THERMALLY CYCLED FROM +20°C TO -60/-55°C TO +50/+55°C TO +20°C IN A VACUUM AT  $10^{-4}$  TO  $10^{-5}$  TORR. DWELL AT EACH TEMPERATURE AND BETWEEN OPERATIONS AT EACH TEMPERATURE IS A MINIMUM OF 60 MINUTES AFTER STABILIZATION. CAPTURE LATCH ROLLER OPERATION IS VERIFIED DURING EACH DOCKING, AS SHOWN BELOW.

SEQ NO.	DOCKING RATE, M/S	SIMULATOR ROTATIONAL ANGLE		TEMP °C	VOLTAGE VOLTS	PRESS INTEGRITY CHECKOUT
		PITCH	ROLL			
1	0.10	0°	0°	25 +/-10	23	YES
2	0.10	0°	4°	25 +/-10	34	NO
3	0.12	4°	4°	25 +/-10	27	NO
4*	---	---	---	+60+/-5	---	YES
4	0.10	4°	0°	+50+/-5	27	YES
5*	---	---	---	-60+/-5	---	YES
5	0.10	4°	0°	-30+/-5	27	YES
6*	---	---	---	+60+/-5	---	YES
6	0.12	0°	4°	+50+/-5	23	YES
7*	---	---	---	-60+/-5	---	YES
7	0.10	0°	4°	-30 +/-5	23	YES
8*	---	---	---	+60+/-5	---	YES
8	0.12	4°	4°	50 +/-5	34	YES
9*	---	---	---	-60+/-5	---	YES
9	0.12	4°	4°	-30 +/-5	34	YES
10*	---	---	---	+60+/-5	---	YES
10	0.10	4°	0°	+50+/-5	27	YES
11*	---	---	---	-60+/-5	---	YES
11	0.10	0°	4°	-30 +/-5	27	YES
12*	---	---	---	+60+/-5	---	YES
12*	0.10	0°	4°	+50+/-5	27	YES
13*	---	---	---	-60+/-5	---	YES
13*	0.12	4°	4°	-30 +/-5	27	YES
14*	---	---	---	+60+/-5	---	YES
14*	0.12	4°	4°	+50+/-5	27	YES
15*	0.12	4°	4°	+25 +/-10	23	YES

\*MC821-0087-2001, -4001, & -5001 ONLY.



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AFTER COMPLETION AN INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

6. TARGET SERVICE LIFE TEST - TESTS ARE PERFORMED TO VERIFY PROPER DOCKING AND UNDOCKING OPERATIONS OVER ITS LIFE OF 100 DOCKINGS. PROPER OPERATION OF THE CAPTURE LATCH ROLLERS IS VERIFIED DURING 100 DOCKING AND UNMATING CYCLES (FOR MC621-0087-1001/-3001 UNITS ONLY). FOR MC621-0087-2001, -4001, & -5001 UNITS PROPER OPERATION VERIFIED DURING 388 CYCLES (44 VACUUM/LOAD CYCLES, 16 LOAD CYCLES, & 324 NO-LOAD CYCLES). AFTER COMPLETION AN INSPECTION IS PERFORMED TO IDENTIFY BROKEN OR LOOSE HARDWARE.

7. CONTROL DISASSEMBLY - UPON COMPLETION OF ALL QUAL TESTING THE DOCKING MECHANISM IS DISMANTLED AND CAPTURE LATCH ASSEMBLIES ARE CHECKED FOR EVIDENCE OF WEAR OR FAILURE.

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

**(C) INSPECTION:****RECEIVING INSPECTION**

COMPONENTS ARE SUBJECTED TO A 100% RECEIVING INSPECTION PRIOR TO INSTALLATION.

**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**

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

**ASSEMBLY/INSTALLATION**

TORQUE, ADJUSTMENTS AND TOLERANCES ACCORDING TO TECHNICAL REQUIREMENTS OF THE DRAWINGS ARE VERIFIED BY INSPECTION.

**TESTING**

ATP/QTP TESTING VERIFIED BY INSPECTION.

**HANDLING/PACKAGING**

HANDLING/PACKAGING PROCEDURES AND REQUIREMENT FOR SHIPMENT VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

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

**(E) OPERATIONAL USE:**

NONE. REDUNDANT LATCH ROLLER WILL PROVIDE CAPTURE.

**Proprietary Data**

