

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 05-6-2491-02

REVISION#: 1 03/31/99

SUBSYSTEM NAME: ELECTRICAL POWER DISTRIBUTION & CONTROL

LRU: MEC 1 AND 2

CRITICALITY OF THIS

ITEM NAME: MEC 1 AND 2

FAILURE MODE: 1R2

FAILURE MODE:

PREMATURE OUTPUT OF FIRE 2/3 INTERLOCK CIRCUITRY, POST ARMING

MISSION PHASE: PL PRE-LAUNCH
LO LIFT-OFFVEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

PIECE PART FAILURE, CONTAMINATION, VIBRATION, MECHANICAL SHOCK, PROCESSING ANOMALY, THERMAL STRESS

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

A)

B)

"B" SCREEN FAILS BECAUSE MEC OUTPUT STATUS IS NOT INSTRUMENTED.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

FIRST FAILURE RESULTS IN A DEGRADATION OF REDUNDANCY AGAINST INADVERTENT SEPARATION. (SCENARIO ASSUMES FAILURES OCCUR POST-ARMING. FOR PRE-ARMED SCENARIO REFERENCE CIL 05-6-2490-02).

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(B) INTERFACING SUBSYSTEM(S):

DEGRADATION OF INTERFACING SUBSYSTEM. FIRST FAILURE RESULTS IN LOSS OF REDUNDANCY AND DEGRADED PROTECTION AGAINST THE ISSUANCE OF PREMATURE OUTPUTS.

(C) MISSION:

FIRST FAILURE - NO EFFECT. PRELAUNCH - PROBABLE LAUNCH DELAY OR SCRUB.

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

SAME AS (C)

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE LOSS OF CREW/VEHICLE AFTER SECOND FAILURE: 1) FIRE 2/3 INTERLOCK CIRCUIT FAILS ON, 2) FIRE 1 COMMAND FAILS ON RESULTING IN PREMATURE INITIATION OF A CRITICAL EVENT.

-DISPOSITION RATIONALE-

(A) DESIGN:

FUNCTIONAL DESCRIPTION

THE MASTER EVENTS CONTROLLER (MEC) CONSISTS OF AN UPLINK WHICH RECEIVES COMMANDS FROM THE GENERAL PURPOSE COMPUTERS (GPC'S) VIA SEPARATE MULTIPLE INTERFACE ADAPTERS (MIA'S) AND WHICH TRANSMITS TEST AND MEASUREMENT DATA ON ONE CHANNEL TO ONE OF THE GPC'S. VALID COMMANDS ARE DECODED AND USED TO ENABLE THE REQUIRED PYRO INITIATOR CONTROLLER (PIC) INPUT COMMANDS. THERE ARE A MAXIMUM OF 57 CRITICAL COMMAND DATA WORDS AND ASSOCIATED DRIVERS TO THE INTERNAL AND REMOTE PIC'S. THE ELECTRICAL, ELECTRONIC AND ELECTROMECHANICAL COMPONENTS ARE SELECTED FROM OR IN ACCORDANCE WITH THE ORBITER PREFERRED PARTS LIST (OPPL) REQUIREMENTS. COMPONENT APPLICATIONS ARE EVALUATED TO ASSURE COMPLIANCE WITH DERATING REQUIREMENTS.

PHYSICAL DESCRIPTION

THE DESIGN INCORPORATES RELIABILITY, MAINTAINABILITY, ENVIRONMENTAL AND TRANSPORTABILITY REQUIREMENTS AND OTHER DESIGN AND CONSTRUCTION PER SPECIFICATION MC450-0016.

THE CERTIFIED PART NUMBERS ARE MC450-0016-0006 MC450-0016-0008. DASH NUMBERS -0001 THROUGH -0005 ARE INACTIVE.

DESIGN EVOLUTION

THE -0001 CONFIGURATION WAS INITIALLY BUILT FOR OV-102.

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THE -0002 CONFIGURATION WAS INITIALLY BUILT FOR OV-99 AND CONTAINED AN UPGRADED MIA (MC615-0040-0004).

THE -0003 CONFIGURATION (INITIALLY BUILT FOR OV-103) WAS NEVER RELEASED FROM MANUFACTURING AND WAS REPLACED BY THE -0004 CONFIGURATION.

THE -0004 CONFIGURATION INCORPORATED A NUMBER OF CHANGES TO PRECLUDE INTERACTION BETWEEN INACTIVE DATA REGISTERS AND ACTIVE DATA REGISTERS CREATED BY TIME SKEW CONDITIONS. THIS PREVENTS SPURIOUS SIGNALS ON NON-CRITICAL OUTPUTS WITH NORMAL SYSTEM SKEWING. ADDITIONAL CIRCUIT CHANGES WERE IMPLEMENTED TO PRECLUDE INADVERTENT FIRING OF PIC CIRCUITS AND TO TOLERATE PREMATURE FIRE 2 COMMAND FAILURES. ANOTHER CHANGE WAS TO DELETE PIC'S 9 AND 10.

THE -0005 CONFIGURATION MODIFICATION CONSISTED OF ADDING BLEED RESISTORS ACROSS THE FIRE 2 PULSE TRANSFORMER OUTPUT CAPACITORS. THIS MODIFICATION INSURED THE PROPER MEC OUTPUTS TO PYRO DEVICES IN THE CASE OF AN INCOMPLETE FIRST FIRE 2/3 MESSAGE TO THE MEC FROM THE GPC.

THE -0006 CONFIGURATION INCORPORATED A SHIM MODIFICATION TO ELIMINATE A MODULE BOARD STRESS PROBLEM THAT CAUSED CRACKED SOLDER JOINTS IN SOME OF THE MODULE BOARD COMPONENTS.

THE -0008 CONFIGURATION INCORPORATES A MODIFICATION TO THE BOTTOM COVER TO PREVENT POTENTIAL INTERFERENCE WITH COMPONENTS

**(B) TEST:
QUALIFICATION/CERTIFICATION**

CERTIFICATION TESTING AND ANALYSIS ARE COMPLETED AND APPROVED. QUALIFICATION TESTING (QUAL TEST REPORT C79-738/201) INCLUDING FULL FUNCTIONAL, THERMAL, VIBRATION, SHOCK, POWER, ELECTROMAGNETIC COMPATIBILITY (EMC), THERMAL VACUUM, AND LIFE HAS BEEN PERFORMED.

ACCEPTANCE AND SCREENING

EACH UNIT IS SUBJECTED TO ACCEPTANCE TEST PROCEDURE (MLD101-0105) AT THE REPAIR CENTER INCLUDING VISUAL EXAMINATION, FULL FUNCTIONAL, ACCEPTANCE THERMAL TEST (ATT) AND ACCEPTANCE VIBRATION TEST (AVT).

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:
RECEIVING INSPECTION**

RECEIVING INSPECTION VERIFIES ALL INCOMING PARTS AND MATERIALS, INCLUDING PERFORMANCE OF VISUAL AND DIMENSIONAL EXAMINATIONS, IN ACCORDANCE WITH

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REQUIREMENTS. CERTIFICATION RECORDS AND TEST REPORTS ARE MAINTAINED CERTIFYING MATERIALS AND PHYSICAL PROPERTIES.

| **CONTAMINATION CONTROL**

A CONTROLLED WORK AREA IS UTILIZED FOR ASSEMBLY AND TEST. QUALITY CONTROL (QC) VERIFIES PROPER MAINTENANCE OF CLEANLINESS CONTROL.

| **ASSEMBLY/INSTALLATION**

INSPECTION POINTS ARE DETERMINED BY QUALITY ENGINEERING IN ACCORDANCE WITH APPLICABLE REQUIREMENTS AND ARE DOCUMENTED ON INSPECTION PLANNING. WORK STATION DISCIPLINES ADHERED TO AND OBSERVED MORE THAN FIVE TIMES PER WEEK BY QC.

| **CRITICAL PROCESSES**

ALL CRITICAL PROCESSES AND CERTIFICATIONS ARE MONITORED AND VERIFIED BY QC AS PROCESS CONTROL SURVEILLANCE ACTIVITY (OPERATIONS AUDIT). THE CRITICAL PROCESSES ARE SOLDERING, BONDING OF COMPONENTS FOR MECHANICAL STABILITY/THERMAL CONDUCTIVITY, COMPONENT PLACEMENT, WIRE ROUTING, AND CRIMPING. FORMAL CERTIFICATION FOR SOLDERING AND QUALIFICATION FOR CRIMPING ARE MAINTAINED.

TESTING

ACCEPTANCE TESTS, INCLUDING VIBRATION, THERMAL AND INSULATION RESISTANCE (IR), ARE OBSERVED AND VERIFIED BY QC.

| **HANDLING/PACKAGING**

HANDLING OF CMOS/MOS DEVICES TO PRECLUDE ELECTROSTATIC DISCHARGE (ESD) VERIFIED BY QC. PARTS PACKAGED AND PROTECTED ARE VERIFIED BY INSPECTION TO APPLICABLE REQUIREMENTS.

(D) FAILURE HISTORY:

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE.

MC450-0016-0001 CONFIGURATION

FAILURE MODE: INTERMITTENT, PREMATURE OUTPUT

CAR AB1785

DURING ACCEPTANCE THERMAL TEST THE MEC PROVIDED RESPONSE DATA WORD (RDW) ERRORS. TROUBLESHOOTING ALSO DISCLOSED A PREMATURE OUTPUT CONDITION. THE FAILURES WERE ISOLATED TO INHERENT TIMING PROBLEMS, A SHORTED RESISTOR AND A BROKEN SURFACE CONDUCTOR. THE TIMING ERROR PROBLEMS WERE CORRECTED BY INCORPORATION WIRING CHANGES AND THE IMPLEMENTATION OF THERMAL SCREENING OF CMOS DEVICES. ASSEMBLY PERSONNEL

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WERE MADE AWARE OF WORKMANSHIP PROBLEMS. DESIGN CHANGES WERE INCORPORATED INTO ALL FLIGHT MEC'S.

CAR'S AB2530 AND AB2531 (OV-102)
DURING THE REDUNDANCY PATH TEST, THE SOLENOID DRIVER INDICATED "ON" WHEN IT SHOULD HAVE BEEN "OFF". THE ANOMALY CAUSED A VOLTAGE BUILD-UP CONDITION ON THE ARM DRIVER CIRCUIT. THE CONDITION WAS CORRECTED BY REMOVING 2 DIODES (1 EACH POWER SUPPLY IN ALL FLIGHT MEC'S).

CAR'S AB8712 AND AB8852 (SAIL)
DURING A SPECIAL SYSTEMS TEST, NUMEROUS NON-CRITICAL SIGNALS WERE OBSERVED FROM THE MEC WITH NO ASSOCIATED COMMANDS BEING GIVEN. THE EXPERIENCED CONDITION IS A RESULT OF SYSTEM INCOMPATIBILITIES. OV-102 MEC'S WERE MODIFIED TO PRECLUDE INTERACTIONS BETWEEN INACTIVE DATA REGISTERS AND ACTIVE DATA REGISTERS. NUMEROUS DESIGN CHANGES WERE MADE AND INCORPORATED INTO THE -0004 MEC CONFIGURATION.

MC450-0016-0002 CONFIGURATION

FAILURE MODE: PREMATURE OUTPUT

CAR AC2082 (OV-099)
DURING OV-099 SUBSYSTEM CHECKOUT TESTS, THE MEC INDICATED "ON" WHEN IT SHOULD HAVE BEEN "OFF". THE FAILURE WAS DUE TO THE MALFUNCTION OF TWO NAND GATES WHICH RESULTED FROM EXCESSIVE SOLDER RESIDUE ON THE SOLDER DIPPED LEADS. OTHER IC'S WERE CHECKED FOR A SIMILAR FAILURE MODE. THE FAILURE IS CONSIDERED TO BE AN ISOLATED INCIDENT.

MC450-0016-0006 CONFIGURATION

FAILURE MODE: INTERMITTENT, PREMATURE OUTPUT

CAR AD3274
DURING THE ATP PIC CAPACITOR VOLTAGE TEST, THE OUTPUT OF THE MEC READ 1.19672 WHEN IT SHOULD BE LESS THAN 0.1 VOLT. THE PROBLEM WAS ISOLATED TO PIC NO. 5 WHICH FAILED THE PIC CAPACITOR VOLTAGE MEASUREMENT AND ALSO FAILED TO "FIRE" AS REQUIRED. THE PIC WAS REPLACED AND THE DEFECTIVE UNIT WAS SENT TO MARTIN MARIETTA FOR ANALYSIS/REPAIR. THE PIC IS GOVERNMENT FURNISHED EQUIPMENT (GFE) AND WILL BE TRACKED BY JSC.

CAR AD3717
DURING CONFIDENCE TESTING, THE MEC HAD RESPONSE DATA WORD 0, BIT 11 SET TO "1" WHEN IT SHOULD BE "0". SUBSEQUENT TESTING SESSIONS AND TROUBLE SHOOTING COULD NOT ISOLATE THE PROBLEM. MODULE I (S/N JVU0022) WAS REPLACED WHEN IT WAS DETERMINED THAT IT WAS THE ONLY POSSIBLE PLACE THAT THE PROBLEM COULD OCCUR. THE AFFECTED MODULE I WAS REMOVED FROM FLIGHT STATUS AND WILL BE USED AT AUTONETICS FOR GROUND TESTING ONLY. IT WAS POSSIBLE THAT THIS FAILURE WAS A ONE TIME ANOMALY CAUSED BY A GLITCH IN THE TEST EQUIPMENT AND WAS NOT BOX RELATED.

CAR AD4958
WHILE PERFORMING ATP AFTER INSTALLATION OF MODULE V, A FAILURE WAS DETECTED WHERE RESPONSE DATA WORD 0, BIT 10 WAS A "1" WHEN IT SHOULD HAVE

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BEEN A "0". THE SUPPLIER HAD PREVIOUSLY ISOLATED THE FAILURE TO U71 (A J-K MASTER/SLAVE FLIP-FLOP) WHICH HAD AN INCORRECT OUTPUT. ANALYSIS ON THE REMOVED U71 COULD NOT DUPLICATE THE ANOMALY. THE FAILURE CAUSE COULD NOT BE DETERMINED ONCE THE PART WAS REMOVED FROM THE MODULE.

CAR AD5025

DURING ATP, A CONTINUOUS LOW STATE WAS FOUND ON CHANNEL 3 AT J25, PIN 11. THE PROBLEM WAS ISOLATED TO A BROKEN PIECE OF A CONNECTOR PIN AND TWO OTHER SMALL METAL PARTICLES IN CONNECTOR J25. THESE PARTICLES WERE MOST LIKELY THE RESULT OF A PREVIOUS PIN REPLACEMENT. THE ASSEMBLY SUPERVISOR WAS NOTIFIED OF THE FAILURE CAUSE AND WARNED OF THE IMPORTANCE OF PERFORMING REWORK WITHOUT LEAVING PARTICLES IN THE EQUIPMENT.

CAR AD5753

DURING ACCEPTANCE VIBRATION TEST IN THE X-AXIS, DRIVER OUTPUTS WOULD NOT RESET WHEN THE MASTER RESET COMMAND WAS SENT. INVESTIGATION DISCLOSED A FRACTURED SOLDER JOINT ON ONE INDUCTOR. THIS WAS PROBABLY CAUSED BY AN EXCESSIVE AMOUNT OF EPOXY FILLET UNDER TWO INDUCTORS WHICH CONTACTED THE CHASSIS RAILS OF THE MEC DURING MODULE INSERTION/REMOVAL SUBSEQUENTLY WEAKENING THE BOND. THE SUPPLIER HAS INCORPORATED ADDITIONAL INSPECTION POINTS TO INSURE CLEARANCE BETWEEN THE INDUCTOR AND THE CHASSIS RAILS. THIS INSPECTION WILL OCCUR FOLLOWING COMPONENT REPLACEMENT PRIOR TO COVER INSTALLATION ON THE MEC. OPERATORS WERE ALERTED TO USE THE MODULE ALIGNMENT TOOL WHICH WILL PREVENT COMPONENTS FROM CONTACTING THE CHASSIS RAILS AFTER SECURING THE MODULE.

CAR AD8405

DURING ACCEPTANCE VIBRATION TEST, AN INTERMITTENT OUTPUT WAS DETECTED. THE PROBLEM WAS TRACED TO A RECESSED CONNECTOR PIN WHICH WAS NOT LOCKED INTO POSITION. THIS IS A WORKMANSHIP CONDITION WHICH WOULD NORMALLY BE SCREENABLE DURING ATP.

**(E) OPERATIONAL USE:
NONE**

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: <u>J. Kamura 3/31/99</u>
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-021_05-6