

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 05-6-E2490 -X****SUBSYSTEM NAME:** ELECTRICAL POWER DISTRIBUTION & CONTROL**REVISION:** 2 11/12/01

PART DATA

| PART NAME | PART NUMBER |
|--------------------|----------------------------------|
| VENDOR NAME | VENDOR NUMBER |
| LRU : EMEC 1 AND 2 | MC450-0016-0007 1640-507-1 |
| LRU : AMEC 1 AND 2 | MC450-0016-0009 17850-507-101 |

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

ENHANCED MASTER EVENTS CONTROLLER (EMEC) OR ADVANCED MASTER EVENTS CONTROLLER (AMEC) CRITICAL OUTPUTS, - CORE A AND B PIC INPUTS (ARM, FIRE 1, FIRE 2 COMMANDS)

REFERENCE DESIGNATORS: 54V76A13
55V76A14

QUANTITY OF LIKE ITEMS: 2

TWO EMECS (OR AMECS) PER VEHICLE AND TWO CORES (A AND B) PER EMEC (OR AMEC)

FUNCTION:

EACH ENHANCED (OR ADVANCED) MASTER EVENTS CONTROLLER CORE A OR B PROVIDES REQUIRED SIGNAL OUTPUT TO SUPPLY INDIVIDUAL PYROTECHNIC INITIATOR CONTROLLER (PIC) INPUTS (ARM, FIRE 1 AND FIRE 2) FOR ALL PYRO FUNCTIONS ASSOCIATED WITH SRB IGNITION, SEPARATION AND EXTERNAL TANK/ORBITER SEPARATION. ADDITIONALLY, EMEC'S 1 AND 2 (OR AMEC'S 1 AND 2) ARE PROGRAMMED TO RETRACT ORB/ET UMBILICALS FOR LH2/LOX AFTER MAIN ENGINE CUTOFF. EACH EMEC (AMEC) PROVIDES REDUNDANT POWER TO THE RETRACT INDIVIDUALLY THE LH2 AND THE LOX UMBILICALS - ORB/ET LH2 UMBILICAL HYDRAULIC ACTUATORS 1, 2, AND 3, ORB/ET LOX UMBILICAL HYDRAULIC ACTUATORS 1, 2, AND 3 (REFERENCE ASSOCIATED MEC/PIC CILS: 05-6-2509-01, 05-6-2509-02, 05-6-2510-01 AND 05-6-2510-02).

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 05-6-E2490- 01

REVISION#: 3 01/17/02

SUBSYSTEM NAME: ELECTRICAL POWER DISTRIBUTION & CONTROL

LRU: EMEC 1 AND 2, AMEC 1 AND 2

CRITICALITY OF THIS

ITEM NAME: EMEC 1 AND 2, AMEC 1 AND 2

FAILURE MODE: 1R2

FAILURE MODE:

LOSS OF OUTPUT CRITICAL OUTPUT (ARM, FIRE 1 AND FIRE 2 COMMANDS)

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF

VEHICLE/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)

FAILS "B" SCREEN BECAUSE NO INSTRUMENTATION EXISTS TO MONITOR REDUNDANT CORE OUTPUT COMMANDS DURING FLIGHT.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

FIRST FAILURE NO EFFECT, LOSS OF REDUNDANCY, SECOND EMEC (OR AMEC) PROVIDES COMMANDS.

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SAME AS (A).

(C) MISSION:

FIRST FAILURE - NO EFFECT

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

FIRST FAILURE - NO EFFECT

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE LOSS OF CREW/VEHICLE AFTER TWO FAILURES:

- (1) LOSS OF RETURN SIGNAL DUE TO FAILED OPEN INDUCTOR, TRACES, ETC., WILL RESULT IN LOSS OF BOTH REDUNDANT EMEC (OR AMEC) CORE OUTPUTS TO THE ASSOCIATED PIC AND LOSS OF THAT PIC.
- (2) FAILURE OF REDUNDANT PIC WILL RESULT IN INABILITY TO PERFORM SRB IGNITION, SEPARATE ET FROM ORBITER, OR RETRACT ORB ET LOX/LH2 UMBILICALS AND LOSS OF CREW/VEHICLE.

ALSO POTENTIAL LOSS OF CREW/VEHICLE AFTER THREE FAILURES :

- (1) LOSS OF ONE EMEC (OR AMEC) CORE OUTPUT TO A PIC COMMAND
- (2) LOSS OF THE SECOND EMEC (OR AMEC) CORE OUTPUT TO THE SAME PIC COMMAND, AND (3) FAILURE OF REDUNDANT PIC RESULTING IN LOSS OF ASSOCIATED EMEC (OR AMEC)
- (3) FAILURE OF REDUNDANT PIC MAY RESULT IN INABILITY TO PERFORM SRB IGNITION, SEPARATE ET FROM ORBITER, OR RETRACT ORB ET LOX/LH2 UMBILICALS AND LOSS OF CREW/VEHICLE.

ALSO POTENTIAL LOSS OF CREW/VEHICLE AFTER FOUR FAILURES :

- (1) LOSS OF ONE EMEC (OR AMEC) CORE OUTPUT TO A PIC COMMAND
- (2) LOSS OF REDUNDANT CORE OUTPUT TO THE SAME PIC COMMAND
- (3,4) LOSS OF CRITICAL PIC COMMANDS FROM BOTH CORES IN THE REDUNDANT EMEC (OR AMEC) RESULTING IN LOSS OF ASSOCIATED EMEC (OR AMEC) AND INABILITY TO PERFORM SRB IGNITION, SEPARATE ET FROM ORBITER, OR RETRACT ORB ET LOX/LH2 UMBILICALS AND LOSS OF CREW/VEHICLE.

ALSO, POTENTIAL LOSS OF CREW/VEHICLE WITH FIVE FAILURES ASSOCIATED WITH THE ORBITER TO ET UMBILICAL PLATE.

- (1,2) LOSS OF BOTH EMEC (OR AMEC) CORE FUNCTIONS TO COMMAND TWO HYDRAULIC ET UMBILICAL ACTUATORS ON THE SAME UMBILICAL PLATE
- (3,4) LOSS OF REDUNDANT EMEC CORE FUNCTIONS TO COMMAND THE SAME TWO HYDRAULIC ACTUATORS,

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- (5) FAILURE OF PNEUMATIC VALVE CLOSURE FUNCTION ON 17 INCH QUICK DISCONNECT RESULTING IN LOSS OF ASSOCIATED EMEC (OR AMEC) OR FAILURE OF REDUNDANT PIC RESULTING IN INABILITY TO PERFORM SRB IGNITION, SEPARATE ET FROM ORBITER, OR RETRACT ORB ET LOX/LH2 UMBILICALS AND LOSS OF CREW/VEHICLE.

RESULT: THE MAXIMUM ALLOWABLE CERTIFIED PLATE RETRACT VELOCITY OF 1.1 IN/SEC COULD BE EXCEEDED WITH POSSIBLE DAMAGE TO THE VALVE CLOSURE LINKAGE. DAMAGE TO THE VALVE CLOSURE LINKAGE COULD (1) INTERFERE WITH FULL ET 17 INCH QUICK DISCONNECT CLOSURE AND RESULT IN POSSIBLE RECONTACT BETWEEN THE EXTERNAL TANK AND THE ORBITER (CRITICALITY 1 - NO ET QD CLOSURE TELEMETRY EXISTS); OR (2) INTERFERE WITH ET UMBILICAL DOOR CLOSURE AND RESULT IN CRITICAL HEATING DURING REENTRY (CRITICALITY 1).

-DISPOSITION RATIONALE-

(A) DESIGN:

FUNCTIONAL DESCRIPTION

THE ENHANCED MASTER EVENTS CONTROLLER (EMEC) OR ADVANCE MASTER EVENTS CONTROLLER (AMEC) CONSISTS OF AN INTERFACE WHICH RECEIVES COMMANDS FROM THE GENERAL PURPOSE COMPUTER (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 (EEE) COMPONENTS FOR EMEC ARE SELECTED IN ACCORDANCE WITH ORBITER PREFERRED PARTS LIST (OPPL) REQUIREMENTS, EXCEPT WHERE THE USE OF NON-OPPL HAD BEEN AUTHORIZED. FOR THE AMEC, THE EEE COMPONENTS ARE SELECTED IN ACCORDANCE WITH ORBITER PROJECT PARTS REQUIREMENTS (OPPR), EXCEPT WHERE THE USE OF NON-OPPR HAD BEEN AUTHORIZED. 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 NUMBER FOR EMEC IS MC450-0016-0007, AND THE CERTIFIED PART NUMBER FOR AMEC IS MC450-0016-0009.

DESIGN EVOLUTION

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THE -0007 (EMEC) CONFIGURATION INCORPORATED EXTENSIVE REDESIGN AND UTILIZED CURRENT TECHNOLOGY IN COMPONENTS AND ASSEMBLY WITH A NEW BOX MECHANICAL DESIGN WHICH WOULD BE PHYSICALLY INTERCHANGEABLE WITHOUT MODIFICATION WITH THE -0006 CONFIGURATION AND WOULD BE FUNCTIONALLY TRANSPARENT IN FLIGHT AND DURING GROUND TEST. THIS ENHANCED MEC (EMEC) WEIGHS LESS, REQUIRES LESS POWER, AND UTILIZES FEWER COMPONENTS THAN THE -0006 CONFIGURATION.

THE -0009 (AMEC) CONFIGURATION IS SIMILAR TO THE -0007 (EMEC) CONFIGURATION IN DESIGN REQUIREMENTS, MECHANICAL CONSTRUCTION, ELECTRICAL INTERFACES, MANUFACTURING PROCESSES, PRODUCTION TECHNIQUES & SEQUENCES, AND MATERIALS EXCEPT FOR CIRCUIT BOARD SOLDERING USING CONVECTION REFLOW RATHER THAN VAPOR PHASE REFLOW FOR THE EMEC. THE AMEC HAS SAME LOGIC AS EMEC, BUT PARTIONED IN FEWER HIGH-DENSITY ELECTRICAL PROGRAMABLE LOGIC DEVICES (EPLD'S).

(B) TEST:

QUALIFICATION/CERTIFICATION

CERTIFICATION TESTING AND ANALYSIS FOR THE EMEC'S ARE COMPLETED AND APPROVED. QUALIFICATION TESTING (QUAL TEST REPORT C90-682/701) INCLUDING FULL FUNCTIONAL, THERMAL, VIBRATION, SHOCK, POWER, ELECTROMAGNETIC COMPATIBILITY (EMC), THERMAL VACUUM, AND LIFE HAS BEEN PERFORMED.

CERTIFICATION TESTING FOR THE AMEC'S INCLUDED FULL FUNCTIONAL, THERMAL, VIBRATION, SHOCK, POWER, AND ELECTROMAGNETIC COMPATIBILITY (EMC). THERMAL VACUUM AND LIFE ARE CERTIFIED BY SIMILARITY AND ANALYSIS.

ACCEPTANCE AND SCREENING

EACH UNIT IS SUBJECTED TO ACCEPTANCE TEST PROCEDURE (ALO-5138) 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 REQUIREMENTS. CERTIFICATION RECORDS AND TEST REPORTS ARE MAINTAINED CERTIFYING MATERIALS AND PHYSICAL PROPERTIES.

CONTAMINATION CONTROL

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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.

(E) OPERATIONAL USE:

NONE

- APPROVALS -

| | | |
|-------------------|---------------------|-----------------------------|
| SAFETY ENGRG | : T. AI/K. RYAN | :/S/ K. E. RYAN _____ |
| SAFETY ITM | : P. STENGER-NGUYEN | :/S/ P. A. STENGER-NGUYEN__ |
| MEC/AMEC/EMEC SSM | : P. VU | :/S/ PHAT VU 11/15/01_____ |
| EPD&C SSM | : L. MINTER | :/S/ LARRY MINTER_1/11/02__ |

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|---------------------|---|-------------------------------|
| MOD | : | :/S/ JEFFREY MUSLER_1/11/02 |
| USA SAM | : | :/S/ PAUL KRAUSE_1/15/02_____ |
| USA ORBITER ELEMENT | : | :/S/ JAMES WILDER FOR1/11/02 |