FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER:05-3A-MDU -X

SUBSYSTEM NAME: MULTIFUNCTION ELECTRONIC DISPLAY SUBSYSTEM
REVISION: 1 12/05/97

PART DATA

	PART NAME **VENDOR NAME**	**PART NUMBER** **VENDOR NUMBER**
LRU	:PANEL F6 (MEDS)	VO70-730733
LRU	:PANEL F7 (MEDS)	VO70-730705
LRU	:PANEL F8 (MEDS)	VO70-730738
LRU	:PANEL R12A1	VO70-730334
LRU	:AFT MDU BRACKET ASSEMBLY	V070-732780
LRU	:DISPLAY, MULTIFUNCTION UNIT	MC409-0165-002X

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
DISPLAY, MULTIFUNCTION UNIT (MDU), 6.7 IN. X 6.7 IN., COLOR, LIQUID CRYSTAL DISPLAY (LCD), FORWARD FLIGHT DECK AND AFT FLIGHT STATION (AFT BULKHEAD & PANEL R12)

REFERENCE DESIGNATORS:
32V73A12A3
34V73A7A8
34V73A7A9
34V73A7A10
34V73A7A11
34V73A7A12
34V73A6A13
34V73A6A12
34V73A8A12
34V73A8A13
36V73A159

QUANTITY OF LIKE ITEMS: 11
ELEVEN,
NINE IN FORWARD FLIGHT DECK,
TWO IN AFT STATION

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FUNCTION:
PROVIDES GRAPHICAL DISPLAYS OF FLIGHT INSTRUMENT DATA (ADI, AVVI, AMI, HSI), GPC GENERATED SPEC., OPS. & DISPLAYS, AND SYSTEM STATUS DATA (OMS, SPI, MPS, HYD/APU). FOUR COMMANDER-DEDICATED MDU'S ARE IDENTIFIED AS CDR1, CDR2, CRT1 AND MFD1. FOUR PILOT-DEDICATED MDU'S ARE IDENTIFIED AS CRT2, MFD2, PLT1 AND PLT2 . THE CENTER MDU DRIVEN BY IDP3 CAN BE CONFIGURED AS THE COMMANDER'S OR PILOT'S MDU VIA THE CRT SELECT SWITCH. IN THE AFT STATION, FLIGHT INSTRUMENT DATA IS DISPLAYED ON THE AFD1 MDU (LOCATED ON AFT BULKHEAD), AND CRT DATA IS DISPLAYED ON THE CRT4 MDU (LOCATED ON PANEL R12A1). WHEN MANUALLY CONFIGURED, ANY MDU CAN DISPLAY FLIGHT INSTRUMENT DATA, SYSTEM STATUS DATA OR DPS DATA. SIMILARLY, AFD1 MDU CAN ALSO DISPLAY DPS DATA AND SYSTEM STATUS DATA. THERE ARE SIX SOFTWARE CONTROLLED EDGE KEYS ON THE LOWER BEZEL OF EACH MDU TO PROVIDE CREW INTERACTIVE CONTROL. EACH MDU HAS TWO DATA PORTS (PRIMARY/SECONDARY). WITH THE EXCEPTION OF CRT MDU'S, THESE DATA PORTS ARE CONNECTED TO TWO OF FOUR INDEPENDENT 1553B DATABUSES. FOR CRT MDU'S, ONLY THE PRIMARY PORTS ARE CONNECTED. THESE DATABUSES ROUTE DATA PROCESSED BY THE INTEGRATED DISPLAY PROCESSORS (IDP'S) AND ANALOG/DIGITAL CONVERTERS (ADC'S) FOR DISPLAY ONTO THE MDU'S.

FLIGHT INSTRUMENT DATA FUNCTION:

ATTITUDE DIRECTOR INDICATOR (ADI) - PROVIDES ORBITER'S ATTITUDE INFORMATION WHICH INCLUDES ATTITUDE ERRORS AND ATTITUDE RATES.

ALTITUDE VERTICAL VELOCITY INDICATOR (AVVI) - PROVIDES ALTITUDE ACCELERATION (FT/SEC/SEC), ALTITUDE RATE (FPS), ALTITUDE (FT/NM), AND RADAR ALTITUDE (FT) INFORMATION. THESE PARAMETERS ARE DERIVED FROM AIR DATA TRANSDUCERS, INERTIAL MEASUREMENT UNITS, OR RADAR ALTIMETERS.

ALPHA/MACH INDICATOR (AMI) - PROVIDES ANGLE OF ATTACK IN DEGREES, EQUIVALENT AIRSPEED (KT), MACH/VELOCITY (M/FPS), TOTAL ACCELERATION (FT/SEC/SEC) WHICH IS DERIVED FROM THE AIR DATA TRANSDUCER OR INERTIAL MEASUREMENT UNIT.

HORIZONTAL SITUATION INDICATOR (HSI) - PROVIDES VEHICLE LOCATION WITH RESPECT TO NAVIGATION WAY POINTS.

SYSTEM STATUS DATA FUNCTION:

SURFACE POSITION INDICATOR (SPI) - PROVIDES THE ACTUAL/COMMANDED POSITIONS OF THE SPEED BRAKE, AND PROVIDES THE ACTUAL POSITIONS OF THE ELEVONS, BODY FLAPS, RUDDER, AILERON.

MAIN PROPULSION SYSTEM (MPS) - LEFT/CENTER/RIGHT SSME CHAMBER PRESSURE, LO2/LH2 MPS MANIFOLD PRESSURE, AND MPS HELIUM PRESSURE (TANK SUPPLY OR REGULATOR OUTLET PRESSURE FOR PNEUMATIC/LEFT/CENTER/ RIGHT HELIUM SYSTEMS)

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ORBITAL MANEUVERING SYSTEM (OMS) - PROVIDES LEFT/RIGHT OMS CHAMBER PRESSURE, LEFT/RIGHT NITROGEN (N2) TANK PRESSURE, AND LEFT/RIGHT HELIUM (HE) TANK PRESSURE.

HYDRAULICS (HYD) - PROVIDES PRESSURE/QUANTITY FOR SYSTEMS 1, 2, AND 3.

AUXILIARY POWER UNIT (APU) - PROVIDES FUEL/H2O QUANTITY AND FUEL PRESSURE/OIL TEMPERATURE FOR SYSTEMS 1, 2, & 3.

FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE
NUMBER: 05-3A-MDU-02

REVISION#: 1 12/05/97
SUBSYSTEM NAME: MULTIFUNCTION ELECTRONIC DISPLAY SUBSYSTEM
LRU: PANEL F6, F7, F8, R12A1, AFT MDU BRACKET ASSY **CRITICALITY OF THIS**
ITEM NAME: DISPLAY, MULTIFUNCTION UNIT **FAILURE MODE:** 1R3

FAILURE MODE:
ERRONEOUS OUTPUT

MISSION PHASE:

PL	PRE-LAUNCH
LO	LIFT-OFF
OO	ON-ORBIT
DO	DE-ORBIT
LS	LANDING/SAFING

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
PIECE-PART FAILURE (MECHANICAL STRESS, VIBRATION), CONTAMINATION, RADIATION, ELECTRICAL STRESS, THERMAL STRESS, PROCESSING ANOMALY

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

REDUNDANCY SCREEN

A) PASS
B) FAIL
C) FAIL

PASS/FAIL RATIONALE:
A)

B)
FAILS SCREEN B BECAUSE TIME REQUIRED TO DETERMINE VALIDITY OF DISPLAYED DATA MAY EXCEED TIME AVAILABLE FOR CORRECTIVE ACTION.

C)
FAILS SCREEN "C" SINCE EXTERNAL LEAKAGE OF THE SINGLE MAIN CABIN RETURN AIR DUCT COULD RESULT IN LOSS OF COOLING TO ALL MDU'S.

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- FAILURE EFFECTS -

(A) SUBSYSTEM:
DISPLAYS ERRONEOUS INFORMATION ON THE MDU.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT FIRST FAILURE

(C) MISSION:
NO EFFECT FIRST FAILURE. AFTER TWO FAILURES (LOSS OF AFD1 MDU AND CRT4 MDU), POSSIBLE LOSS OF MISSION DUE TO INABILITY TO MONITOR THE VEHICLE ORIENTATION AND/OR VEHICLE STATUS AT THE AFT STATION. DEPENDING ON THE MISSION, INABILITY TO MONITOR VEHICLE ORIENTATION FROM THE AFT STATION MAY HINDER MISSION OBJECTIVE.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT FIRST FAILURE

(E) FUNCTIONAL CRITICALITY EFFECTS:
CASE 1:

FIRST FAILURE -	INCOMPLETE MPS DUMP AND VACUUM INERT, I.E. LH2 INBOARD FILL AND DRAIN VALVE (PV12) FAILS TO OPEN
SECOND FAILURE -	LH2 MANIFOLD RELIEF SYSTEM FAILS TO RELIEVE
THIRD FAILURE -	ERRONEOUS OUTPUT OF THE MDU LEADING TO INACCURATE LH2 MPS MANIFOLD PRESSURE READING

CREW USES THE DISPLAYED DATA TO DETERMINE WHICH PROPELLANT MANIFOLD REQUIRES A SECOND VACUUM INERTING. INACCURATE DISPLAY COULD DELAY OR PREVENT TIMELY CORRECTIVE ACTION. PRESSURE BUILDUP DUE TO RELIEF SYSTEM FAILURE WILL CAUSE MANIFOLD RUPTURE RESULTING IN LEAKAGE OF PROPELLANT INTO THE AFT COMPARTMENT. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYOGENIC EXPOSURE. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

FIRST FAILURE -	FA MDM FAILS. SOFTWARE CAUTION & WARNING, CRT MESSAGE, AND MCC MONITORING CAPABILITY FOR ASSOCIATED HELIUM ENGINE SYSTEM DEGRADED.
SECOND FAILURE -	LEAK IN ASSOCIATED ENGINE HELIUM SYSTEM.
THIRD FAILURE -	ERRONEOUS OUTPUT OF THE MDU PROVIDING ERRONEOUS INDICATION (SHIFTED HIGH). LOSS OF HELIUM LEAK CUES PREVENTS PNEUMATIC SYSTEM INTERCONNECT AND RESULTS IN EARLIER THAN NECESSARY ENGINE SHUTDOWN.
FOURTH FAILURE -	ONE OF THE REMAINING ENGINES EXCEEDS A REDLINE.

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CREW DOES NOT INTERCONNECT PNEUMATIC HELIUM SUPPLY TO LEAKING ENGINE AT PROPER TIME SINCE DISPLAYED METER SHIFT IS MASKING THE PROPER INTERCONNECT ACTION LEVEL. THE LEAKING ENGINE WILL SHUTDOWN EARLIER THAN NECESSARY DUE TO INTERMEDIATE SEAL PURGE REDLINE. AT THIS TIME, THE REMAINING ENGINE LIMITS WILL BE INHIBITED BY VEHICLE SOFTWARE. THE EARLY FIRST ENGINE SHUTDOWN WILL DELAY SINGLE ENGINE CAPABILITY AND THE MANUAL REENABLING OF ENGINE LIMITS. IF A SECOND ENGINE EXCEEDS A REDLINE DURING THE EXTENDED LIMIT INHIBIT PERIOD, UNCONTAINED ENGINE FAILURE WILL RESULT. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
ALL PARTS USED IN THE DESIGN AND FABRICATION OF THE MDU ARE SELECTED FROM MF0004-400 ORBITER PROJECT PARTS LIST (OPPL), EXCEPT WHERE THE USE OF NON-OPPL PARTS OR "OFF THE SHELF" HARDWARE HAD BEEN AUTHORIZED. OPPL PARTS UTILIZATION ARE BASED UPON SELECTION OF QUALIFIED PARTS, PROPER DERATING , AND MINIMIZING THE NUMBER OF PART TYPES. FOR THE USE OF PARTS WHICH ARE NOT IN THE OPPL AND DO NOT MEET THE OPPL REQUIREMENTS, A NON-OPPL PART APPROVAL REQUEST (NOPAR) FORM MUST BE SUBMITTED FOR APPROVAL ON OR BEFORE THE CRITICAL DESIGN REVIEW AND PRIOR TO PART PROCUREMENT FOR THE PROPOSED DESIGN. APPROVAL OF NOPAR PARTS ARE ALSO BASED ON CIRCUIT APPLICATION AND CRITICALITY. "OFF THE SHELF" HARDWARE ARE COMPARED, ANALYZED, OR TESTED TO MEET SPECIFIED REQUIREMENTS BEFORE BEING AUTHORIZED FOR USE. THE APPLICABLE FAULT TOLERANCES ARE BEING ACHIEVED AT THE LRU LEVEL.

THE MDU DESIGN UTILIZED ERROR DETECTION AND CORRECTION CIRCUITRY, CYCLIC PROCESSING, AND/OR RADIATION TOLERANT EEE PARTS TO PRECLUDE ADVERSE EFFECTS DUE TO RADIATION INDUCED SINGLE EVENT UPSETS OR RADIATION INDUCED LATCHUP.

THE MEDS HAVE THE CAPABILITY TO DISABLE AND ENABLE EDGE KEYS FOR USE WITHOUT AFFECTING THE OTHER EDGE KEYS.

THERE ARE VARIOUS BUILT-IN-TEST-EQUIPMENT (BITE) SELF-TEST CAPABILITY FOR THE MEDS TO DETECT AND ISOLATE FAULTS TO THE LRU LEVEL DURING FLIGHT AND GROUND OPERATIONS. OPERATIONAL BITE IN THE MDU IS PERFORMED CONTINUOUSLY WHILE THE COMPONENT IS OPERATING. COMPREHENSIVE SELF TEST IS USED TO VERIFY, AT A MINIMUM, THE PROCESSORS, MEMORIES, POWER SUPPLIES AND INTERFACES. POWER ON SELF TEST (POST) IN THE MDU, A SUBSET OF COMPREHENSIVE SELF TEST, IS USED TO VERIFY SYSTEM INTEGRITY BEFORE RESUMING OPERATION AFTER A POWER INTERRUPTION OR CYCLE.

(B) TEST:
ACCEPTANCE REQUIREMENTS INCLUDE:

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EXAMINATION OF PRODUCT
FUNCTIONAL AND PERFORMANCE
ACCEPTANCE THERMAL TEST
ACCEPTANCE VIBRATION TEST
FUNCTIONAL AND PERFORMANCE RECHECK.

AVT

20 TO 80 HZ	PLUS 3 DB/OCTAVE
80 TO 350 HZ	0.04 G^2/HZ
350 TO 2000 HZ	MINUS 3 DB/OCTAVE

ATT

THE MDU SHALL BE THERMAL CYCLED FROM 70 F TO 120 F, TO 20 F, TO PLUS 120 F, AND TO 70 F WITH CONTINUITY MONITORED THROUGHOUT. RATE OF CHANGE SHALL NOT EXCEED 240 F PER HOUR, NOR BE LESS THAN 60 F PER HOUR. DWELL AT EACH LIMIT TEMPERATURE SHALL BE A MINIMUM OF 60 MINUTES AFTER THERMAL STABILIZATION OF THE TEST ARTICLE. SELECTED PERFORMANCE TEST AT EACH HIGH TEMPERATURE EXTREME AND LOW TEMPERATURE EXTREME.

QUALIFICATION REQUIREMENTS INCLUDE:
ACCEPTANCE TEST
PERFORMANCE TESTS
POWER TEST
EMC TEST
LIGHTNING
CABIN ATMOSPHERE
HUMIDITY
SALT FOG
SAND AND DUST
ACCELERATION
OPERATING LIFE TEST
WINDOW IMPACT TEST
AUDIBLE NOISE TEST
QUALIFICATION ACCEPTANCE VIBRATION TEST
THERMAL VACUUM TEST
THERMAL CYCLE TEST
LIFE
SHOCK
POST PERFORMANCE TESTS
PACKAGE QUALIFICATION TEST

QAVT

20 TO 80	PLUS 3 DB/OCTAVE TO .067 G^2/HZ
80 TO 350 HZ	CONSTANT .067 G^2/HZ

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350 TO 2000 HZ	MINUS 3 DB/OCTAVE FROM .067 G^2/HZ
DURATION	5 TIMES AVT

ACCELERATION
ACCELERATION TEST REQUIREMENT SHALL BE MET BY ANALYSIS.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
CERTIFICATIONS & SOURCE INSPECTION TEST REPORTS ARE ON FILE. CASES AND FLATPACKS ARE SCREENED FOR LOOSE PARTICLE DETECTION IN RECEIVING INSPECTION. ALL HYBRID COMPONENTS ARE LOT SAMPLED IN RECEIVING INSPECTION.

CONTAMINATION CONTROL
LRU'S SHALL BE CLEANED TO LEVEL GC (GENERALLY CLEAN) OF MA0110-301.

ASSEMBLY/INSTALLATION
VISUAL INSPECTION IS PERFORMED AT KIT RELEASE. PRINTED WIRING BOARD MICROSECTION ANALYSIS IS PERFORMED AND MONITORED BY INSPECTION FOR EACH LOT OF PWB'S. QUALITY CONTROL VERIFIES AND WITNESSES TORQUE OPERATIONS. QUALITY CONTROL VERIFIES SOLDERED CONNECTIONS AND ASSEMBLY OF PARTS. TOOL CERTIFICATIONS ARE MAINTAINED. QUALITY CONTROL PERFORMS PRE-CAP VISUAL INSPECTION FOR CLEANLINESS. QUALITY CONTROL VERIFIES CONVEYOR FURNACE PROFILE/TEMPERATURE EVERY 90 DAYS. POPULATED PWB'S WILL BE PURGED OF IONIC CONTAMINATION PRIOR TO CONFORMAL COAT.

CRITICAL PROCESSES
INSPECTION VERIFIES CRIMPING OPERATIONS AND CERTIFICATION. SOLDERING REQUIREMENTS PER NHB5300.4(3A) AND MIL-STD-2000 ARE VERIFIED BY INSPECTION.

TESTING
ATP IS OBSERVED AND VERIFIED BY QUALITY CONTROL, INCLUDING AVT AND ATT.

HANDLING/PACKAGING
PROPER GROUNDING OF ELECTRICALLY STATIC SENSITIVE DEVICES WHEN HANDLING IS PERFORMED. PACKAGING AND PROTECTION VERIFIED BY INSPECTION.

(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 DATABASE.

(E) OPERATIONAL USE:

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1) FOR FLIGHT INSTRUMENT OR MFD MDU'S, THE SECONDARY PORT MAY BE USED. 2) INFORMATION MAY BE DISPLAYED ON ANOTHER MDU. 3) MDU POWER CYCLE MAY RECOVER MDU FUNCTION 4) ON ORBIT, ANY MDU IS AVAILABLE AS A REPLACEMENT FOR ANY FAILED MDU. 5) TO MINIMIZE THE EFFECTS OF ERRONEOUS OUTPUT ON FLIGHT INSTRUMENTS, THE CREW IS TRAINED TO CROSS-CHECK.

- APPROVALS -

PAE MANAGER	: P.A. STENGER-NGUYEN	P.A. Stenger-Nguyen 5/7/98
PRODUCT ASSURANCE ENGR	: N.D. NGUYEN	5/7/98
DPS SYSTEM	: G.L. PRICE	5/8/98
MEDS SYSTEM	: M.B. WARNER	5/8/98
MEDS HARDWARE	: R.M. SITAPARA	5/8/98
NASA SSMA	:	5/20/98
NASA SUBSYSTEM MANAGER	:	5/20/98
NASA MOD	:	5/20/98