FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 05-6PH-24800 -X

SUBSYSTEM NAME: EPD&C - GROUND COMMAND INTERFACE LOGIC (GCIL)
REVISION: 1 08/24/97

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: GCIL CONTROLLER	MC450-0051-0002

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
GCIL CONTROLLER GROUND COMMAND INTERFACE LOGIC CONTROLLER.

REFERENCE DESIGNATORS: 83V74A59

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
PROVIDES THE TRANSFER & SIGNAL CONDITIONING OF THE SIGNALS FROM THE CONTROL SWITCHES ON THE DISPLAY AND CONTROL PANELS OR THE OPERATION COMMANDS FROM THE MULTIPLEXER/DEMULTIPLEXER TO THE LRU'S OF THE COMMUNICATIONS & TRACKING SUBSYSTEM.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :EPD&C - COMM. & TRACK. FMEA NO 05-6PH-24800 -2 REV:01/05/88

ASSEMBLY :EPD&C-COMM & TRACKING
P/N RI :MC450-0051-0002
P/N VENDOR:
QUANTITY :1
:ONE
:

CRIT. FUNC: 2
CRIT. HDW: 2

VEHICLE EFFECTIVITY:	102	103	104
	X	X	X

PHASE(S): PL X LO X OO X DO X LS X

REDUNDANCY SCREEN: A- B- C-

PREPARED BY:
DES C HORNBERGER
REL M ALVAREZ
QE J COURSEN

APPROVED BY:
DES
REL
QE

APPROVED BY (NASA):
SSM
REL
QE

ITEM:
GCIL CONTROLLER GROUND COMMAND INTERFACE LOGIC CONTROLLER.

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FAILURE MODE:
LOSS OF OUTPUT - (KU BAND) NO SIGNAL AT GCIL TO LRU OUTPUT.

CAUSE(S):
VIBRATION, TEMPERATURE, MECHANICAL SHOCK, CONTAMINATION, MISHANDLING. PIECE-PART STRUCTURAL FAILURE.

EFFECT(S) ON:
(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE

(A) A FAILURE CAN RESULT IN THE LOSS OF AN OUTPUT (BOTH COMMAND AND PANEL MODES), THEREBY INHIBITING BOTH PANEL AND COMMAND CONTROL OF AN LRU.

(B) IN THE WORST CASE AFTER 4 FAILURES (1 RADAR, 1 RADAR STANDBY, 1 COMM-A, 1 COMM-A STANDBY) LOSS OF ALL KU-BAND RADAR AND COMMUNICATION AND ALSO LOSS OF ABILITY TO LOCK GIMBALS. A REAL-TIME DECISION IS REQUIRED TO PERFORM IN-FLIGHT MAINTENANCE PROCEDURE WITH EVA OR JETTISON THE DEPLOYED ASSEMBLY.

(C) AFTER ONE FAILURE, LOSS OF MISSION DUE TO LOSS OF KU-BAND RENDEZVOUS RADAR CAPABILITY OR HIGH DATA RATE TRANSMISSION CAPABILITY VIA THE KU-BAND COMM LINK (TDRS).

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(D) AFTER 5 FAILURES (4 GCIL, 1 JETTISON SYSTEM) POSSIBLE LOSS OF CREW/VEHICLE IF THE DA CANNOT BE SECURED FOR RE-ENTRY OR JETTISONED. RE-ENTRY WITH GIMBALS UNLOCKED MAY CAUSE DAMAGE TO THE RADIATOR. FAILURE OF JETTISON SYSTEM INHIBITS THE ABILITY TO CLOSE PAYLOAD BAY DOORS FOR RE-ENTRY.

DISPOSITION & RATIONALE:
(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE

(A) DESIGN
CONTROL DOCUMENT MR-450-0051-0002. TRANSISTORS AND DIODES ARE SELECTED FROM MF0004-400 (OPPL) WHICH CALLS FOR JANTXV LEVEL PARTS WITH DERATING FACTORS OF AT LEAST 25%. RESISTORS AND CAPACITORS ARE MIL TYPE, ALSO SELECTED FROM THE OPPL WITH AT LEAST 25% DERATING. ALL NON-OPPL PARTS SUCH AS HYBRIDS ARE EVALUATED FOR COMPLIANCE WITH OPPL QUALIFICATION, SCREENING, AND DERATING REQUIREMENTS.

(B) TEST
PERFORMED BY LSI, ATP REF. NO. 710348, QTR REF CC-77-02-26C. ACCEPTANCE TESTING OF ALL UNITS INCLUDE EXAMINATION OF PRODUCT. AVT - 0.04 G SQ/HZ 20-2000 HZ) INCREASING AT 3 DB/OCTAVE. ATT - 20, TO 120, DEGREES F, DWELL AT EACH LIMIT 60 MINUTES MINIMUM. INSULATION TEST IN ACCORDANCE WITH MF0004-002 AND THE RESISTANCE SHALL BE GREATER THAN 2 MEGOHMS. DIELECTRIC STRENGTH TESTED IN ACCORDANCE WITH MF0004-002 EXCEPT THE APPLIED VOLTAGE SHALL BE 200 VAC, 60 HZ, FOR A DURATION OF ONE MINUTE.

QUALIFICATION TESTING INCLUDES - QAVT - SAME AS AVT IN THE 3 ORTHO-AXES, BUT DURATION IS 5 TIMES GREATER AT .067 G SQ/HZ. FLIGHT VIBRATION .03 G SQ/HZ. EMI & EMC-PER MF0004-002 FOR CLASS ID EQUIPMENT.

THERMAL VACUUM TEST - CHAMBER AIR TEMPERATURE AT 80 DEG F. PRESSURE REDUCED FROM AMBIENT TO 8.0 PSIA AT A RATE OF 0.15 PSIA/MIN. THIS LEVEL MAINTAINED FOR 2 HRS AND RETURNED TO AMBIENT AT A RATE OF 9.0 PSIA/MIN.

THERMAL CYCLE TEST - CYCLED 6 TIMES MINIMUM FROM 70 TO 140, TO 0, TO 140, TO 70 DEG F. THERMAL RATE NOT MORE THAN (4 DEG F)/MIN AND NO LESS THAN (1 DEG F)/MIN DWELL AT TEMP PLATEAUS NO LESS THAN 60 MIN.

HIGH PRESSURE TEST-CHAMBER AIR TEMPERATURE AT 80 DEG F. FROM AMBIENT TO 36 PLUS OR MINUS 0.5 PSIA AT 0.15 PSIA/MIN MAINTAINED FOR 1 HOUR. RETURNED TO AMBIENT AT 6 PSIA/MIN.

CABIN ATMOSPHERE - SALT FOG TEST IN ACCORDANCE WITH MIL-STD-810, METHOD 509, PROCEDURE I FOR 1 HR. IMMEDIATELY UPON CONCLUSION PLACED IN HUMIDITY CHAMBER AND THERMALLY CYCLED BETWEEN 60 AND 125 DEG F FOR 5 CYCLES AT 85% HUMIDITY.

BENCH HANDLING SHOCK - PER PROCEDURE V, METHOD 516.1 OF MIL-STD-810. INTEGRATED AND SUBSYSTEM VERIFICATION IS PERFORMED AT KSC AND DURING TURNAROUND.

GROUND TURNAROUND TEST - VERIFY GCIL KU-BAND CONTROL OUTPUTS (COMMAND AND PANEL MODES) - PERFORMED EVERY FLIGHT.

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(C) INSPECTION

RECEIVING INSPECTION
CERTIFICATES OF COMPLIANCE FOR MECHANICAL PROPERTIES, CHEMICAL COMPOSITION, RADIOGRAPHIC, AND DYE PENETRANT INSPECTION OF PROCURED CASTINGS ARE MAINTAINED. CERTIFICATES OF COMPLIANCE ARE MAINTAINED FOR MULTILAYER BOARD TEST RESULTS INCLUDING MICROSECTION ANALYSIS. AGE SENSITIVE LOG MAINTAINED, EXTRUSIONS VISUALLY INSPECTED UNDER MAGNIFICATION.

CONTAMINATION CONTROL
QC VERIFIES PROPER CLEANLINESS PROCEDURES ARE MAINTAINED.

ASSEMBLY/INSTALLATION
DETAILED INSPECTION PERFORMED ON ALL PARTS PRIOR TO NEXT ASSEMBLY. SOLDERING/CRIMPING OPERATIONS VERIFIED, CONFORMAL COAT PREPARATION AND COATING VERIFIED. TORQUE VERIFIED. ALIGNMENT/DIMENSIONAL INSPECTION CHECKS DURING CARD CONNECTOR ASSEMBLY.

CRITICAL PROCESSES
SOLDERING OPERATORS ARE CERTIFIED. THE CRITICAL PROCESSES (HAND SOLDERING AND CONFORMAL COATING) ARE MONITORED AND VERIFIED BY QC. RECORDS OF INSPECTION AND CERTIFICATIONS/TEST DATA ARE KEPT ON FILE AT THE SUPPLIER.

TESTING
ALL TESTS/SET-UPS/RESULTS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING & STORAGE PROCEDURES & EQUIPMENT VERIFIED BY QC. ELECTROSTATIC DISCHARGE PREVENTION METHODS VERIFIED BY QC.

(D) FAILURE HISTORY

THERE ARE TWENTY-SIX FAILURES THAT HAVE OCCURRED DURING ACCEPTANCE TESTING, ORBITER SUBSYSTEM CHECK-OUT, DURING FLIGHT, AND DURING VERIFICATION/ TROUBLESHOOTING THAT ARE APPLICABLE TO THIS FAILURE MODE.

FOUR FAILURES (AB4210, AB4892, AB6040, AB9257) HAVE BEEN CAUSED BY HYBRID DRIVER MALFUNCTIONS DUE TO POOR WORKMANSHIP COMPOUNDED BY AN IC CHIP SHAPE DISCREPANCY. CORRECTIVE ACTIONS INCLUDED: SUBASSEMBLY DRAWING REVISION, QUALITY ASSURANCE BULLETIN ISSUED TO ALERT MANUFACTURING AND INSPECTION PERSONNEL TO THIS FAILURE AND PRODUCTION SCREENING TESTS WERE IMPLEMENTED TO DETECT THIS TYPE OF FAILURE PRIOR TO FORMAL ACCEPTANCE TESTING. THESE CORRECTIVE ACTIONS HAVE BEEN IMPLEMENTED ON ALL FLIGHT UNITS.

FAILURE AB4217 TOOK PLACE DURING TROUBLE SHOOTING FOR A PRIOR FAILURE. THE FAIL SAFE DRIVER WAS INTERMITTENT DUE TO A FAILURE INDUCED BY A SPORADIC OPEN CONDITION CAUSED BY FAULTY WORKMANSHIP. CORRECTIVE ACTION WAS TO CAUTION ASSEMBLY AND INSPECTION PERSONNEL TO EXERCISE GREATER CARE DURING FABRICATION AND INSPECTION. NO FURTHER INCIDENCES HAVE OCCURRED.

FAILURE AB4797 OCCURRED DURING ORBITER OV-102 SYSTEM CHECK-OUT; ERRONEOUS MEASUREMENTS TO THE MDM WERE CAUSED BY THE CIRCUIT DESIGN, CERTAIN SWITCH COMBINATIONS IN THE DISPLAYS AND CONTROL PANEL CREATED THIS SITUATION. CORRECTIVE ACTION INCORPORATED A DESIGN CHANGE TO PRECLUDE REOCCURRENCES. NO FURTHER INCIDENCES HAVE OCCURRED.

THREE QUALIFICATION FAILURES (AB5310, AB5692, AB5743) WERE CAUSED BY FAULTY INSTALLATION TECHNIQUES FOR CAPACITORS AND INDUCTORS. CORRECTIVE ACTION WAS TO REVISE MOUNTING TECHNIQUES FOR INDUCTORS AND CAPACITORS; THIS CORRECTIVE ACTION WAS IMPLEMENTED FOR ALL FLIGHT UNITS. NO FURTHER INCIDENCES HAVE OCCURRED.

FAILURE AB5372 TOOK PLACE DURING ACCEPTANCE THERMAL TEST. A MARGINAL SOLDER CONNECTION FOR CIRCUIT GROUND WAS CAUSED BY A WORKMANSHIP ERROR. CORRECTIVE ACTION WAS TO CAUTION MANUFACTURING AND INSPECTION PERSONNEL TO EXERCISE MORE CARE DURING ASSEMBLY; THESE CORRECTIVE ACTIONS WERE IMPLEMENTED ON ALL FLIGHT UNITS. NO FURTHER INCIDENCES HAVE TAKEN PLACE.

FAILURES AC3087 AND AC4440 OCCURRED DURING INITIAL ACCEPTANCE THERMAL TEST. THEY WERE CAUSED BY HYBRID DRIVERS WHICH FAILED DUE TO THERMAL EXPANSION. THIS PROBLEM WAS DETERMINED TO BE ACCEPTANCE TEST SCREENABLE AND NO FURTHER CORRECTIVE ACTION WAS TAKEN. NO FURTHER INCIDENCES HAVE OCCURRED.

FAILURES AC1745 AND AC4667 ARE FAILURES TO RESPOND TO COMMANDS BECAUSE TWO ADDRESS LINES WERE SHORTED TOGETHER DUE TO EXCESSIVE SOLDER FLOW. CORRECTIVE ACTION ESTABLISHED INSPECTION CRITERIA AND REMOVAL REQUIREMENTS FOR EXCESSIVE SOLDER. NO FURTHER INCIDENCES HAVE OCCURRED.

FAILURE AC9244 OCCURRED DURING TEST FOLLOWING THE REPLACEMENT OF A HYBRID DRIVER. ONE SCREW BACKED OUT OF A SELF-LOCKING NUT PLATE CAUSING THE FAILURE. THIS WAS CONSIDERED AN ISOLATED INSTANCE AND NO FURTHER INCIDENCES HAVE OCCURRED.

FAILURE 19F002 TOOK PLACE DURING MISSION 51-A; DOWNLINK DATA INDICATED THAT THE S-BAND ANTENNA ELECTRONIC SWITCH BEAM CONTROL ASSEMBLIES NUMBER 1 AND 2, AND THE S-BAND ANTENNA SWITCH ELECTRONIC PACKAGES WERE POWERED "ON" IN AN INTERMITTENT BASIS. FAILURE WAS CLASSIFIED AS UNEXPLAINED ANOMALY, A SUSPECTED DRIVER WAS REPLACED AND THE GCIL WAS RETESTED SUCCESSFULLY. NO FURTHER INCIDENCES HAVE OCCURRED.

FAILURE AD0547 TOOK PLACE DURING ACCEPTANCE THERMAL TEST. THE GCIL FAILED THE KU TO S-BAND FUNCTIONAL TEST DUE TO AN IC MULTIVIBRATOR CMOS (U4) WITH NO OUTPUT. CORRECTIVE ACTION REPLACED THE IC AND ACCEPTANCE TESTED THE BOARD; THIS WAS CLASSIFIED AS AN ISOLATED FAILURE AND NO FURTHER CORRECTIVE ACTION WAS IMPLEMENTED.

THE FOLLOWING FAILURES ARE OPEN AT THE TIME AND THE RESOLUTION IS BEING TRACKED IN THE FAILURE REPORTING SYSTEM. RESOLUTION IS PLANNED PRIOR TO THE NEXT FLIGHT.

FAILURE AD0552 OCCURRED DURING INSPECTION FUNCTIONAL TEST; FAILED TO RESPOND TO COMMAND 164 (PAYLOAD INTERROGATOR NUMBER 1) DUE TO A RESISTOR DEFECT. RESOLUTION IS IN PROGRESS.

FAILURE AD0762 TOOK PLACE DURING SYSTEM CHECK-OUT TEST; IN THE COMMAND MODE, THE GCIL S-BAND PAYLOAD INTERROGATOR NUMBER 2 SELECTION WAS AFFECTED BY THE POSITION OF THE THUMBWHEEL SELECT SWITCH DUE TO A CAPACITOR (C2) WHICH DEVELOPED A SHORT. RESOLUTION IS IN PROGRESS.

FAILURE AD0797 OCCURRED DURING INCOMING FUNCTIONAL TEST; DRIVER CIRCUIT A14-6, FM2-5 FAILED TO RESPOND TO THE UPLINK COMMAND DUE TO CAPACITOR (C2) WHICH FAILED DUE TO A THERMAL EXPANSION COEFFICIENT DIFFERENCE BETWEEN THE CAPACITOR BODY AND THE MOUNTING EPOXY. RESOLUTION IS IN PROGRESS.

FAILURE AD0836 OCCURRED WHILE PERFORMING SYSTEM CHECK-OUT; GCIL CAME UP IN A FAIL SAFE (S-BAND MODE) CONFIGURATION WHEN THE KU-COMM A PWR "ON" COMMAND WAS SENT. THIS ITEM WAS INITIALLY DIAGNOSED AS AN ELECTROSTATIC DISCHARGE (ESD) PROBLEM IN IC A2-A11. ANALYSIS IS CONTINUING TO DETERMINE THE CAUSE OF THE FAILURE AND SUBSEQUENT CORRECTIVE ACTION.

FAILURES (AD0881, AD0969, AD1960, AD1984) ARE HYBRID DRIVER FAILURES IN THE SPARE BOARDS. FOR AD0881 AND AD0969, TWO SEPARATE HYBRID DRIVERS ARE SUSPECTED AS THE CAUSE, HOWEVER, THESE TWO ITEMS ARE STILL IN AN OPEN STATUS. FOR FAILURE AD1960 HYBRID 0755, AND FOR FAILURE AD1984 HYBRID 0508 BOTH FAILED ON THE AUTOMATIC TEST SET. BOTH DRIVERS EXPERIENCED HIGH CURRENT INTO PIN 9. THIS FAILURE IS STILL OPEN AND THE RESOLUTION IS IN PROGRESS.

FAILURE AD0103 HAPPENED DURING ORBITER SUBSYSTEM CHECK-OUT TEST; DUE TO A FAILURE TO PROCESS COMMANDS TO THE NETWORK SIGNAL PROCESSOR NUMBER 1 CAUSED BY A MANUFACTURING DEFECT. CONDUCTIVE EPOXY, USED TO SECURE A TRANSISTOR, WAS MAKING CONTACT WITH THE HYBRID METALLIZATION. THIS FAILURE IS STILL OPEN, AND THE RESOLUTION IS IN PROGRESS.

(E) OPERATIONAL USE

NO CREW CORRECTIVE ACTION AVAILABLE TO REGAIN USE OF THE KU-BAND COMMUNICATIONS OR RADAR RENDEZVOUS FUNCTIONS.