

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE
NUMBER: 05-5-B11-1 -X**

SUBSYSTEM NAME: DATA PROCESSING SYSTEM (DPS)

REVISION: 8 04/26/96

PART DATA

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : GENRL PURPOSE CMPTR, AP101S LOCKHEED	MC615-0025-0202, 0203 6966000-22

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

REFERENCE DESIGNATORS: 81V72A16
82V72A17
83V72A18
81V72A19
82V72A20

QUANTITY OF LIKE ITEMS: 5
FIVE

FUNCTION:

THE GENERAL PURPOSE COMPUTERS (GPC'S) SUPERVISE, COMMAND, CONTROL AND COORDINATE ALL FLIGHT GUIDANCE FUNCTIONS, VEHICLE ATTITUDES AND FLIGHT GEOMETRY. THE GPC ALSO PROCESSES MATHEMATICAL AND LOGICAL FUNCTIONS. THE GPC READS IN COMPUTER DATA FROM THE ORBITER SUBSYSTEMS. THE DATA IS PROCESSED AND MADE AVAILABLE FOR DISPLAY, TRANSMISSION, OR COMMAND EXECUTION BY ORBITER SUBSYSTEMS. THE GPC CONTROLS TWO-WAY TRANSFER OF INFORMATION TO AND FROM THE OTHER UNITS OF THE SPACE SHUTTLE. INTERNAL BUILT IN TEST EQUIPMENT (BITE) AND COOPERATIVE SYNC BETWEEN THE REDUNDANT SET GIVE FAULT DETECTION AND ISOLATION (FDI) OF COMPUTERS DURING CRITICAL MISSION PHASES. FOUR GPC'S ARE NOMINALLY ASSIGNED TO THE PRIMARY AVIONICS SOFTWARE SYSTEMS (PASS). THE 5TH GPC IS ASSIGNED TO THE BACKUP FLIGHT SYSTEM (BFS).

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE

NUMBER: 05-5-B11-1-01

REVISION#: 8 04/02/96

SUBSYSTEM NAME: DATA PROCESSING SYSTEM (DPS)

LRU: GENRL PURPOSE CMPTR, AP101S

CRITICALITY OF THIS

ITEM NAME: GENRL PURPOSE CMPTR, AP101S

FAILURE MODE: 1R2

FAILURE MODE:
LOSS OF OUTPUTMISSION PHASE: PL PRE-LAUNCH
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT
LS LANDING/SAFINGVEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

TEMPERATURE, CONTAMINATION, PIECE-PART FAILURE, CHEMICAL REACTION,
RADIATION, VIBRATION. MANY ELECTRONIC PARTS IN THE REGISTERS, ARITHMETIC
LOGIC UNIT, MICRO PROGRAM UNIT, MAIN MEMORY, GPC CLOCKS, AND
OPEN/SHORTED SELECT LINE ARE SINGLE FAILURE POINTS FOR EACH LINE
REPLACEABLE UNIT (LRU).

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

RTLS RETURN TO LAUNCH SITE
TAL TRANS-ATLANTIC LANDINGREDUNDANCY SCREEN A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

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- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF GPC. IF GPC IS ASSIGNED AS THE BFS GPC, LOSS OF BFS FUNCTION.

(B) INTERFACING SUBSYSTEM(S):

LOSS OF STRINGS (DATA BUSES) ASSIGNED TO FAILED GPC. IF GPC IS ASSIGNED AS BFS, THEN LOSS OF ABILITY TO ENGAGE BFS.

(C) MISSION:

PASS: PER FLIGHT RULES LOSS OF ONE GPC NO EFFECT. LOSS OF TWO GPC'S RESULTS IN MINIMUM DURATION FLIGHT. LOSS OF THREE GPC'S RESULTS IN ENTRY TO NEXT PRIMARY LANDING SITE (PLS).

BFS (PRE-ENGAGE): LOSS OF SYSTEM MANAGEMENT/PAYLOAD MONITORING (NO DIRECT MISSION EFFECT). ABILITY TO ENGAGE BFS IS LOST.

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

PASS NO EFFECT FIRST FAILURE. POSSIBLE LOSS OF VEHICLE/CREW AFTER SECOND FAILURE.

BFS (PRE-ENGAGE): NO DIRECT EFFECT ON CREW/VEHICLE ABILITY TO ENGAGE BFS IS LOST.

(E) FUNCTIONAL CRITICALITY EFFECTS:

CRITICALITY 1R2 BECAUSE OF THE FOLLOWING.

FOR ASCENT/ENTRY. THIS FAILURE COUPLED WITH AN UNDETECTED FLIGHT CONTROL SYSTEM (FCS) FAILURE IN THE NULL (ZERO OUTPUT) POSITION (E.G., IN THE AEROSURFACE AMPLIFIER (ASA) OR ASCENT THRUST VECTOR CONTROLLER (ATVC)), COULD RESULT IN THE TWO HEALTHY PATHS BEING VOTED OUT. THIS COULD RESULT IN A VOTING DILEMMA IN THE FCS (E.G., "FORCE FIGHT" IN THE SERVO ACTUATORS. REFERENCE FMEA 05-1-FC6042-1 AND 05-1-FC6542-1).

FOR ASCENT: DURING INTACT ABORT (RTL, TAL) CRITICALITY 1 IF UNABLE TO PURGE AFT FUSELAGE COMPARTMENTS OF POST MECO GAS MIXTURE (BY OPENING HELIUM BLOW DOWN VALVE) VIA ((FLIGHT AFT) FA3 AND FA4 MULTIPLEXER DEMULTIPLEXER (MDM)) RESULTING IN POSSIBLE FIRE/EXPLOSION AND MAY RESULT IN LOSS OF VEHICLE AND CREW.

ALL PHASES LOSS OF A GPC ASSIGNED TO STRINGS 1, 2, OR 3 RESULTING IN A LOSS OF OUTPUT FROM ONE INERTIAL MEASUREMENT UNIT (IMU) OR A FLIGHT FORWARD ((FF) MULTIPLEXER DEMULTIPLEXER (MDM) CHANNEL PROCESSING IMU DATA, FOLLOWED BY FAILURE OF ANOTHER IMU OR FF MDM WITH ERRONEOUS OUTPUT

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SUCH THAT THE AVERAGE OF THE TWO REMAINING CHANNELS IS CORRUPTED, WILL LEAD TO INCORPORATION OF FAULTY IMU DATA BY ALL COMPUTERS AND POSSIBLE LOSS OF VEHICLE/CREW.

FOR BFS: AFTER LOSS OF PASS DUE TO GENERIC FAILURE(S), BFS ENGAGE IS REQUIRED. ANY SUBSEQUENT FAILURE IN THE BFS LEADS TO INABILITY TO CONTROL THE VEHICLE AND RESULTS IN LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

PARTS ARE DERATED 25 PERCENT TO ORBITER PROJECT PARTS LIST (OPPL) REQUIREMENTS. BASIC DESIGN IS PROVEN BY UTILIZING CIRCUITS FROM PREVIOUS GENERATIONS OF COMPUTERS. SUSCEPTIBILITY TO PROBLEMS OF GPC POLLUTION ANOMALIES HAVE BEEN MINIMIZED BY INCORPORATION OF SOFTWARE SAFEGUARDS TO THE MAXIMUM EXTENT POSSIBLE. FOR EXPOSURE TO RADIATION, ERROR CORRECTING CODE WILL CORRECT 1 BIT CHANGE PER CMOS MEMORY WORD, BUT 2 BIT CHANGES PER ONE CMOS MEMORY WORD CANNOT BE CORRECTED. DESIGN ALSO INCORPORATES RELIABILITY, MAINTAINABILITY, ENVIRONMENTAL, TRANSPORTABILITY AND THERMAL REQUIREMENTS AND OTHER DESIGN AND CONSTRUCTION CONTROLS PER SPECIFICATION MC615-0025.

(B) TEST:

ACCEPTANCE TESTING, WHICH INCLUDES AP101S (GPC) FACTORY ACCEPTANCE TEST (FAT) AND CUSTOMER ACCEPTANCE TEST (CAT) PERFORMANCE TEST PROCEDURE (TP85-357-700), AP101S CAT-THERMAL TEST PROCEDURE (TP85-387-600), AP101S CAT-VIBRATION TEST PROCEDURE (TP 85-387-500), PERFORMANCE, POWER VARIATION TEST AND EXAMINATION OF PRODUCT ARE PERFORMED IN EACH UNIT. QUALIFICATION TESTING, INCLUDING POWER, ELECTROMAGNETIC COMPATIBILITY (EMC), THERMAL CYCLE, VIBRATION, THERMAL VACUUM, LIFE, CABIN ATMOSPHERE, RADIATION, SHIPPING CONTAINER, LIGHTNING AND SHOCK HAS BEEN PERFORMED.

INTEGRATED AND SUBSYSTEM VERIFICATION PERFORMED AT JSC AND KSC. ALL COMPUTERS ARE BURNED-IN FOR 18 CYCLES MINIMUM (8 HOUR/CYCLE) +120 TO -65 F THEN 22 CYCLES OF +105 TO -5 DEGREES F, PLUS 3 AXES ACCEPTANCE VIBRATION TEST (AVT) TO .04G2/HZ LEVEL. PRIOR TO THE BURN-IN TEST, A 55 NONOPERATIONAL TEMPERATURE CYCLE (-55 DEGREES C TO +80 DEGREES C) SCREEN IS PERFORMED ON MOST PAGE ASSEMBLIES. FUNCTIONAL TESTS ARE MONITORED TO VERIFY SOFTWARE CONTROL IS WITHIN SPECIFIED LIMITS. INTEGRATED AND SUBSYSTEM VERIFICATION IS PERFORMED AT JSC AND KSC. NASA PERFORMS A MINIMUM OF 1,000 HOURS OF SYSTEM OPERATION ON EACH GPC PRIOR TO COMMITMENT TO FLIGHT.

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

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(C) INSPECTION:

RECEIVING INSPECTION CERTIFICATES OF COMPLIANCE ARE IN RECEIVING INSPECTION FILES. RECEIVING INSPECTION PERFORMS PHYSICAL AND CHEMICAL ANALYSIS OF MATERIALS.

CONTAMINATION CONTROL AIR PLENUMS ARE VISUALLY INSPECTED AND VACUUM CLEANED DURING FINAL INSPECTION AND FILTERS ARE INSTALLED TO KEEP OUT DEBRIS. KSC TURNAROUND CHECKS INCLUDE INSPECTION/CLEANING OF FILTERS AND AIR PLENUMS

ASSEMBLY/INSTALLATION TORQUE VERIFICATION TOOLS ARE USED BY INSPECTION. MULTILAYER BOARDS ARE CHECKED FOR PROPER SOLDER PENETRATION, SHORTS AND OPENS, AND MICRO-SECTION ANALYSIS 13X MAGNIFICATION AND FLUORESCENT RING ILLUMINATORS ARE USED FOR INSPECTION OF SOLDER JOINTS. 30X MAGNIFICATION IS USED FOR SUSPECTED CRACKS AND FRACTURES. CONFORMAL COATING IS CHECKED FOR CONTAMINATION, MINIMUM COVERAGE AND UNIFORMITY USING BLACKLIGHT. INSPECTION OF WIRE HARNESS IS PERFORMED DURING IN-PROCESS AND FINAL INSPECTION.

NONDESTRUCTIVE EVALUATION ALL BRAZED HOUSINGS ARE VISUALLY INSPECTED INCLUDING RADIOGRAPHIC AND SILVER NITRATE TESTING. X-RAYS ARE TAKEN OF THE BACK PANEL TO ASSURE PROPER SOLDER PENETRATION.

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

TESTING ACCEPTANCE TESTING IS OBSERVED AND VERIFIED BY ROCKWELL, DCAS, AND LOCKHEED QUALITY CONTROL INCLUDING ACCEPTANCE VIBRATION TEST AND ACCEPTANCE THERMAL TEST.

HANDLING/PACKAGING INSPECTION VERIFIES SPECIAL HANDLING OF ASSEMBLIES CONTAINING ELECTRICALLY STATIC SENSITIVE DEVICES. 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:

PRIOR TO THE LOSS OF GPC OUTPUT, FLIGHT CRITICAL STRINGS (PAIRS OF DATA BUSES) ARE DISTRIBUTED AMONG THE OPERATING GUIDANCE NAVIGATION AND CONTROL (GN&C) REDUNDANT SET IN ACCORDANCE WITH FLIGHT RULE GUIDELINES IN AN ATTEMPT TO LIMIT EXPOSURE TO A FAILURE. FOLLOWING THE LOSS OF GPC OUTPUT, THE FLIGHT CRITICAL STRINGS ARE REDISTRIBUTED ACCORDING TO FLIGHT RULE GUIDELINES IN AN ATTEMPT TO LIMIT EXPOSURE TO THE NEXT FAILURE. NO SPECIAL CREW TRAINING IS REQUIRED.

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- APPROVALS -

EDITORIALLY APPROVED
EDITORIALLY APPROVED
TECHNICAL APPROVAL

: RJ
: JSC
: VIA APPROVAL FORM

[Signature]
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: 95-CIL-013_05-5