

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE
 NUMBER:05-1-SRB -X

SUBSYSTEM NAME: GUIDANCE, NAVIGATION, & CONTROL

REVISION: 04/26/95

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:SRB - RGA	MC493-0015-0105
LRU	:SRB - RGA	MC493-0015-0106

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
 SRB RATE GYRO ASSEMBLY (RGA) NO.'S 1, 2, 3 AND 4.

REFERENCE DESIGNATORS: 131A5
 131A6
 231A5
 231A6

QUANTITY OF LIKE ITEMS: 4
 FOUR REQUIRED PER FLIGHT TWO RGA'S FOR EACH SRB

FUNCTION:
 PROVIDES ANALOG OUTPUT SIGNAL PROPORTIONAL TO THE ANGULAR RATE ABOUT
 PITCH AND YAW AXIS. PROVIDES SPIN MOTOR ROTATION DETECTOR (SMRD) TO
 INDICATE SYNC SPEED OF THE GYRO SPIN MOTOR. TWO BITE SIGNALS PROVIDE
 STATUS OF GYRO/ELECTRONICS INTEGRITY DURING GROUND TURNAROUND.

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE
NUMBER: 05-1-SRB-02

REVISION#: 1 01/22/96
SUBSYSTEM NAME: GUIDANCE, NAVIGATION, & CONTROL
LRU: SRB - RGA
ITEM NAME: SRB - RGA
CRITICALITY OF THIS
FAILURE MODE: 1R2

FAILURE MODE:
ERRONEOUS OUTPUT. THIS IS ONLY TRUE FOR SOFT FAILURES BELOW REDUNDANCY
MANAGEMENT TRIP LEVEL.

MISSION PHASE: LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
VIBRATION, TEMPERATURE, PIECE PART FAILURE, MISHANDLING/ABUSE,
CONTAMINATION, THERMAL SHOCK AND MECHANICAL SHOCK.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

A)

B)

FAILS REDUNDANCY SCREEN "B" BECAUSE THE ERRONEOUS OUTPUT SIGNAL MAY BE
BELOW THE REDUNDANCY MANAGEMENT DETECTION LEVEL.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT FOR FIRST FAILURE, REDUNDANCY MANAGEMENT (IMVS) ENABLES
CONTINUED FLIGHT CONTROL OPERATION.

(B) INTERFACING SUBSYSTEM(S):

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NO EFFECT FOR FIRST FAILURE. REDUNDANCY MANAGEMENT (IMVS) ENABLES CONTINUED FLIGHT CONTROL OPERATION.

(C) MISSION:

NO EFFECT FOR FIRST FAILURE

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

NO EFFECT FOR FIRST FAILURE

(E) FUNCTIONAL CRITICALITY EFFECTS:

NO EFFECT FOR FIRST FAILURE. SECOND FAILURE COULD RESULT IN LOSS OF CREW/VEHICLE AS A RESULT OF EXCESSIVE VEHICLE STRUCTURAL LOADING, DUE TO THE INABILITY OF SOFTWARE TO ISOLATE FAILURES DURING ASCENT. CRITICALITY 1R BECAUSE LOSS OF RATE FEEDBACK DATA MAY CAUSE LOSS OF VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

ALL ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PIECE PARTS WHICH MAKE UP THE RGA ARE CONTROLLED TO THE ORBITER PROJECT PARTS LIST (OPPL) REQUIREMENTS OF MF0004-400. PASSIVE EEE PARTS AND ELECTRICAL CONNECTORS ARE MILITARY QUALIFIED AND 100% SCREENED TO OPPL REQUIREMENTS. MICROCIRCUITS ARE QUALIFIED TO MIL-M-38510 AND SCREENED TO MIL-S-883, LEVEL B. SEMICONDUCTOR DEVICES ARE JANTXV LEVEL. CIRCUIT DESIGN LIMITS WORST CASE JUNCTION TEMPERATURES TO 95°C AND ELECTRICAL STRESSES TO 60% OF RATED CAPABILITY FOR ALL PARTS.

THE RGA AS AN ASSEMBLY WAS ORIGINALLY CERTIFIED TO MEET AN OPERATIONAL LIFE REQUIREMENT OF 8,000 HOURS, EQUIVALENT TO 20 MISSIONS. HOWEVER, THE ENVIRONMENT CERTIFICATION REQUIREMENTS OF CR17-493-0015-0102D, WHICH ARE IN COMPLIANCE WITH SPECIFICATION MC493-0015-0105 AND ICD-2-14001 ARE NO LONGER VALID. AS A RESULT OF REPEATED GYROSCOPE PIVOT FRACTURES, THE SRB'S WERE INSTRUMENTED TO RECORD BOTH THE ASCENT AND DESCENT SRB ENVIRONMENTS. FROM THESE RECORDINGS IT WAS DETERMINED THAT THE FRUSTRUM SEPARATION AND WATER IMPACT SHOCK LEVELS FAR EXCEEDED THE -0105 CERTIFICATION LEVELS. ALSO LACKING IN REQUIREMENTS IS THE SEA-TOW BACK ENVIRONMENT. THEREFORE, THE RGA CERTIFICATION PER PROGRAM DIRECTION (PRCB S40443A) IS RESTRICTED TO A MAXIMUM OF ONE FLIGHT.

HENCE, THE -0106 CONFIGURATION (COMMONLY KNOWN AS THE KRYTOX RGA UPGRADE) PER MC493-0015, APPENDIX XVI, AMENDMENT E01, WAS ESTABLISHED AS A DIRECT RESULT OF THE EARLIER STUDIES WHICH WERE DONE TO REDUCE THE HIGH COST ASSOCIATED WITH THE -0105, SINGLE FLIGHT USAGE. THESE STUDIES WHICH ALSO INCLUDED DEVELOPMENTAL TESTING, PROVED THAT THE OLD DESIGN SHORT OF THE GYRO, COULD BE CERTIFIED TO MEET A 24 MISSION LIFE CYCLE. THIS RATIONALE WAS BASED ON "FLIGHT EXPERIENCE", "TEARDOWN INSPECTION; FATIGUE EVALUATION", AND "SIMULATED WATER IMPACT AND PYRO SHOCK DEVELOPMENT TESTING USING THE RGA ENGINEERING DESIGN UNIT (EDU #2). AS A DIRECT RESULT OF THIS EARLIER EVALUATION, THE -0105 CONFIGURATION EXCLUDING THE GYRO, WAS RE-CERTIFIED FOR UP TO 24 MISSION OF RE-USE WITHOUT RESTRICTION.

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THE -0106 DESIGN IS AN UPGRADE OF THE -0105 CONFIGURATION HAVING A TOTAL LIFE CYCLE CAPABILITY, WHICH INCLUDES A NEW GYRO DESIGN, OF 24 MISSIONS WITHOUT THE NEED OF REFURBISHMENT.

THE RGA IS DESIGNED AS A HERMETICALLY SEALED UNIT TO PREVENT OR ELIMINATE THE ENVIRONMENTAL EFFECTS OF RAIN, SAND, DUST, AS WELL AS MOISTURE. FOR THE -0106 UPGRADE, ALL EXTERNAL CREVASSES ARE FILLED WITH AN EPOXY WHICH RENDERS THE RGA SAFE DOWN TO A DEPTH OF 3 METERS. ALL INTERNAL COMPONENTS ARE CONFORMAL COATED TO ELIMINATE THE ADVERSE EFFECTS OF MOISTURE, PRESSURE, AND/OR TEMPERATURE VARIATIONS IN ADDITION TO SHORT CIRCUIT PROTECTION. THE RGA INCORPORATES INTERNAL BITE TO DETERMINE CIRCUIT INTEGRITY THROUGH EXTERNAL STIMULI. A SPIN MOTOR ROTATION DETECTOR (SMRD) CIRCUIT IS ALSO PROVIDED TO INDICATE PROPER SPEED OF THE INTERNAL GYROSCOPE WHEEL MOTOR.

(B) TEST:

ACCEPTANCE TESTING, WHICH INCLUDES ACCEPTANCE THERMAL TESTING (ATT) AND ACCEPTANCE VIBRATION TESTING (AVT.), IS PERFORMED ON EACH UNIT. QUALIFICATION TESTING, INCLUDING VIBRATION, SHOCK, TEMPERATURE, HAS BEEN SUCCESSFULLY COMPLETED TO CERTIFY DESIGN. FOR THE -0106 DESIGN, PYRO SHOCK, WATER IMPACT AND IMMERSION TESTS WERE ADDED TO THE QUALIFICATION REQUIREMENTS. INTEGRATED/SUBSYSTEM VERIFICATION IS PERFORMED DURING TURNAROUND. FUNCTIONAL TEST IS MONITORED TO VERIFY STATUS SIGNALS INDICATING GYRO/ELECTRONICS INTEGRITY.

(C) INSPECTION:

RECEIVING INSPECTION

PWB EXAMINATIONS, AT 7X, BY SOURCE AND RECEIVING INSPECTION. INCOMING INSPECTION OF CASTING INCLUDES X-RAY EXAMINATIONS. QUALITY CONTROL INSPECTION OF PARTS IS CONDUCTED AT RECEIVING INSPECTION AND KITTING. INCOMING MATERIAL IS VERIFIED BY RECEIVING INSPECTION AND CERTIFICATION CONFORMANCE REVIEWED.

CONTAMINATION CONTROL

CLASS 100,000 LEVEL CLEAN ROOM AND IONIZED WORK STATIONS ARE MAINTAINED - VERIFIED 100% BY INSPECTION.

ASSEMBLY/INSTALLATION

DIMENSIONAL CHECKS ARE VERIFIED AND RECORDED BY INSPECTION. ALL ASSEMBLY BENCHES ARE EQUIPPED WITH GROUNDING STRAPS AND BENCH COVERS. ASSEMBLY AND REWORK PERFORMED IN A CLEAN ROOM.

NONDESTRUCTIVE EVALUATION

RADIOGRAPHS, TEST COUPONS, M & P CERTIFICATIONS, NON-DESTRUCTIVE TESTING CERTIFICATIONS AND CHEMICAL AND METALLURGICAL RECORDS ARE MAINTAINED.

CRITICAL PROCESSES

SOLDERING, TORQUING, POTTING AND CONFORMAL COATING IS VERIFIED BY INSPECTION.

TESTING

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ATP IS OBSERVED AND VERIFIED BY ROCKWELL AND NORTHROP QUALITY CONTROL, INCLUDING AVT, ATT, LEAK AND SHOCK TESTS.

PACKAGING

THE USE OF PLASTIC AND PADDED PWB CONTAINERS, ALONG WITH TOTAL BOXES AND ANTI-STATIC BAGS, IS VERIFIED BY INSPECTION. THE PACKING AND PACKAGING REQUIREMENTS ARE SATISFIED BY USE OF SPECIAL QUALIFIED CONTAINERS FOR IN-PLANT TRANSPORTATION AND SHIPPING.

(D) FAILURE HISTORY:

NO ERRONEOUS OUTPUT FAILURES HAVE OCCURRED DURING DEVELOPMENT, QUALIFICATION, ACCEPTANCE, FIELD TESTING AND FLIGHT OPERATIONS.

(E) OPERATIONAL USE:

CREW ACTION NONE.

- APPROVALS -

EDITORIALLY APPROVED
EDITORIALLY APPROVED
TECHNICAL APPROVAL

: RI
: JSC
: APPROVAL FORM

: Jim D. 1/25/96
: John Jensen 2-1-96
: 95-CIL-004-RI