SRB CRITICAL ITEMS LIST

SUBSYSTEM: RANGE SAFETY COMMAND DESTRUCT

ITEM NAME: IRD A, IRD B

PART NO.: 10406-0143-803, -804, -805, -806, -807, -808, -809 or 16A03344-9

FM CODE: A02

ITEM CODE: 70-17, 70-18

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 31, 2000 CN 038

CRITICAL PHASES: Boost

SUPERCEDES: March 1, 1996 CN 038

FMEA PAGE NO.: F-11

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SHEET 1 OF 7

APPROVED: S. Parvathaneni CN 038

FAILURE MODE AND CAUSES: Loss of arm or fire command output from RSS IRD A and IRD B caused by:

- O Faulty IRD A or B subassemblies
- O Open or short in wiring harness
- O Faulty IRD decoder firmware

FAILURE EFFECT SUMMARY: Loss of destruct capability of one SRB if it should break away from the cluster, leading to loss of life or injury to the public. One success path remains after the first failure. Operation is not affected until both paths are lost.

REDUNDANCY SCREENS AND MEASUREMENTS:

1. Pass- Checked at ACO, SIT, ordnance installation and final countdown by event measurements B55X1877X, B55X1878X, B55X1879X and B55X1880X.

2. Fail - Unable to detect without issuing an arm and fire command.

3. Pass- No known credible causes.

RATIONALE FOR RETENTION:

A. DESIGN:

The RSS IRDs A and B are two identical but separate boxes. The RF inputs are supplied from isolated output ports of the hybrid coupler through two redundant coaxial cables. Power is supplied from redundant batteries via redundant RSS distributor assemblies and cables. Commands from the two IRDs are furnished to the two redundant distributor sides (A and B) via redundant electrical cables.

- One of the functions of the IRD is to provide Arm and Fire commands to the RSDs upon receipt of properly encoded RF commands. These commands are implemented functionally by demodulating the RF command signals, decoding the received tone pairs, comparing the received tone pair format to the flight code stored into memory before launch, and issuing output commands as appropriate. The design of the IRD implements these functions in hardware by providing RF subassemblies, decoder subassemblies, wiring harnesses, and ROM based firmware. The specific RSS design feature that was implemented to mitigate all of the listed failure causes is true parallel redundancy.

- The IRD has one vendor source: Cincinnati Electronics. The vendor has been certified as the supplier by completing qualification testing. Cincinnati Electronics qualification is reported in Qualification Test Report RA-13, Vol. 1 through Vol. 3 and certified by USA SRBE COQs A-RSS-3101-1, A-RSS-3101-2, A-RSS-3101-3 and A-RSS-3101-4.

- All electrical and electromechanical component parts used in the IRD have traceability requirements per SE-019-033-2H. In addition, a log book is generated for each IRD assembly at the start of acceptance testing and a complete historical record is maintained for the life of the IRD.

- Faulty IRD A or B Subassemblies

  - The IRD subassemblies meet all of the requirements of USA SRBE specification 10SPC-0132, have flown on all Shuttle missions since STS-6 and are qualified to the twenty-mission level. These subassemblies have the following design features that were incorporated to mitigate the cause of failure: (BI-1610, BI-1453)

  - The two-sided printed wiring boards (PWB) were designed to MSFC STD-154 and contain plated through holes that are used as mechanical reinforcement rather than as an interconnection between two sides of the board. Electrical interconnection is by Z-wire. The receiver subassembly PWBs are mounted into isolated cavities within the top (receiver) housing. Both sides of the PWBs are conformal coated, after testing, except at the outer ground plane area where contact is made to the receiver housing for EMI/RFI shielding. The decoder subassemblies are foam potted to eliminate the possibility of shorts between components and adjacent subassemblies. (BI-1895)

  - The electrical component parts that are used in the Arm and Fire circuits are either selected from MIL-STD-975 (grade one parts) or screened up to the equivalent.

  - All components have thermal stress relief and are soldered to NHB 5300.4 (3A-1).

  - The power output transistors for Arm and Fire are designed to provide an 800 percent margin above nominal requirements.

  - A parts traceability program is implemented to respond to GIDEP Alert notices on IRD piece parts.

  - An electrostatic discharge (ESD) control program is implemented and utilized during the manufacture and inspection of all IRD subassemblies.

- Open or Short in Wiring Harness

  - The wiring harness interconnects the connectors, subassembly PWBs and the two halves of the housing. The wire, connectors and flexcircuit (flexible printed circuit material) all meet the require ments of IRD assembly specification (10SPC-0132), have been flown on all Shuttle missions since STS-6, and are qualified to the twenty mission level. The harness has the following design features that were incorporated to mitigate this cause of failure:

- o The exterior flange mounted connectors were selected from MSFC 40M39569. The selection of the pin arrangement assures that an adjacent pin short will not cause a mission failure. Different keying arrangements on these connectors preclude mismating with external harnesses. The connectors are hermetically sealed and therefore prevent contaminants from entering the case.

- o All IRD subassemblies are interconnected via a KAPTON insulated, single piece of flexible circuit material. This flex-circuit acts like a flexible mother-board.

- o Connections between receiver/decoder subassemblies and the connector interface board are also made using flexible printed circuit strips. Connection to the interface board is made at a row of feed-thru terminals and point-to-point wiring is made from these terminals to the chassis mounted connectors.

- o Connections between receiver subassemblies are made by point-to-point wires. All wires, flex-circuits and connectors are terminated per NHB 5300.4 (3A-1) which assures reliable connections.

O Faulty IRD Firmware

- o The IRD firmware is contained in read-only-memories (ROM). The firmware meets all the requirements of the IRD assembly specification (10SPC-0132), has flown on all Shuttle missions since STS-6, and is qualified for the twenty-mission level. (BI-1610, BI-1453)

- o The IRD operating program is kept under configuration control and is implemented in fusable link read-only-memories (ROM). Following programming of these memories, the parts are screened to the requirements of MIL-STD-975 (Grade one) in accordance with approved screening procedures.

- o The IRD operating program includes checksum words. Each time the IRD is powered ON, a self-test subroutine is initially executed. One of the self-tests performed is verification of the checksums. If any self-test fails, the IRD will fail to exit self-test, fail to enter signal search and fail to set the POWER-ON telemetry measurement. The last time this self-test is performed is during final countdown when the Range Safety System is powered ON and power is applied to the IRD.

B. TESTING

VENDOR RELATED TESTING

O The IRD testing is done first at the subassembly level, prior to staking, potting or conformal coating. The completed IRD is functionally and environmentally tested in accordance with Acceptance Test Procedure ES155.249. Acceptance testing establishes the absence of faulty IRD A or B subassemblies, open or short in wiring harness, and faulty IRD decoder firmware at the time of testing. (All Failure Causes)

KSC RELATED TESTING

O Each IRD received at KSC (whether new or refurbished) is bench tested as required by 10REQ-0021, Appendix E. The bench test verifies proper arm and fire command outputs. ESD protection requirements are implemented per 10REQ-0021 para 4.11 (All Failure Causes)

O The IRD arm and fire outputs are tested during ACO per 10REQ-0021, paras. 1.2.2.13.3 and 1.2.2.13.6. ESD protection requirements are implemented per 10REQ-0021 para 4.11

O Verify open loop response by all five receiver/decoder subsystems using test code for SRSS per OMRSD File II, Vol. 1, requirement number S00000.380.

O Verify operation of SRSS with flight code (closed loop) per OMRSD File II, Vol. 1, requirement number S00000.390.

O The decoder arm and decoder fire signals are monitored during flight until the separation sequence begins.

O The above referenced OMRSD testing is performed every flight.

REFURBISHMENT/RECERTIFICATION TESTING

O All IRDs are Refurbished/Recertified for flight and tested in accordance with USA SRBE 10SPC-0131. (All Failure Causes)

O All USA SRBE/TBE Florida Operations Refurbished/Recertified IRDs are acceptance tested IAW 10SPC-0131. (All Failure Causes)

C. INSPECTION

VENDOR RELATED INSPECTION

O Supplier QA performs receiving inspection and maintains traceability of all electrical parts:
  o USA SRBE PQAR SIP 1270

O Supplier Quality and USA SRBE Quality inspect the assembly, soldering, and monitor potting and conformal coating operations.
  o USA SRBE Quality - SIP 1270

O Supplier Quality and USA SRBE Quality witness/verify acceptance test.
  o USA SRBE Quality - SIP 1270

O Critical Processes/Inspections/Operations:

  o Soldering per NHB 5300.4(3A-1)
  o Staking per ES155.082
  o Encapsulating per ES155.246
  o Conformal Coating per ES155.244

KSC RELATED INSPECTION

O USA SRBE QA monitors and accepts all bench tests of IRDs. (All Failure Causes)

O Connector receptacles are inspected for damaged, bent, broken or corroded contacts per 10REQ-0021, para. 1.2.1.1.9.

O USA SRBE QA witnesses IRD isolation testing after IRD installation on SRB forward skirt equipment panel.

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O Range safety system power, network and verification testing at the SRB systems level is performed per 10REQ-0021, paras. 1.2.2.18, 1.2.2.17, and 1.2.2.15. (All Failure Causes)

o Verify open loop response by all five receiver/decoder subsystems using test code for SRSS per OMRSD File II, Vol. 1, requirement number S00000.380.

o Verify operation of SRSS with flight code (closed loop) per OMRSD File II, Vol. 1, requirement number S00000.390.

O After each flight USA SRBE QA inspects the IRD for compliance with USA SRBE 10SPC-0131.

REFURBISHMENT/RECERTIFICATION INSPECTION

O All previously flown are inspected in accordance with USA SRBE 10SPC-0131.

O Quality representatives witness, the acceptance testing of all USA SRBE/TBE Florida Operations refurbished IRDs per the design specification 10SPC-0132. (All Failure Causes)

D. FAILURE HISTORY

O Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

o Not applicable to this failure mode.

F. WAIVER/DAR

o BI-1610, 7-26-88, CCBD SB3-01-1384

- SPECIFIED REQUIREMENT:

  The EEE parts control program shall be in accordance with the specific requirements for Criticality 1 and 2 equipment of 85M03936B.

- DEPARTURE:

  Some EEE parts (diodes, opto-isolator and ICs) did not meet requirements of 85M03936B.

- JUSTIFICATION:

  There has been no failure of these parts in flight or in the field through 97 flight uses and 3,227 hours of use. The IRDs are dual redundant on each SRB and simplex on the ET. The calculated mean-time-between-failure, using MIL-HDBK-217B failure rates for the parts actually procured and installed, exceeds 10SPC-0132 specification requirement.

o BI-1453, 11-16-84, CCBD SB3-00-9398

- SPECIFIED REQUIREMENT:

  MIL-M-38510 Linear Microcircuit Products manufactured by Fairchild's Linear Division were not "cooled down under bias" after performance of the required burn-in-screen.

- DEPARTURE:

  C E P/N ITS-M-11952 (Generic 741) LDC 8301 manufactured by Fairchild and listed on Gidep Alert VV-A-84-03 (4236) is used in power supply assembly P/N 392304.

- JUSTIFICATION:

  Devices were subjected to additional testing after receipt from Fairchild. Tests included DPA, Burn-in, Parameter Measurement, etc.

o BI-1895, 1-28-91, CCBD SB3-01-3957

- SPECIFIED REQUIREMENT:

  PWBs design shall be in accordance with MSFC-STD-154. The minimum size of solder pads with component lead holes of 0.030 inch and smaller shall be determined by encircling with 0.010 inch copper, and lead holes greater than 0.030 inch shall be determined by encircling with 0.015 inch copper.

- DEPARTURE:

  IRD PWBs have component lead holes greater than .030 inch which have annular rings less than .015 inch.

- JUSTIFICATION:

  PWBs are acceptable for flight since they meet or exceed the new requirement which allows holes to have a minimum annular ring size of .005 inches.