SUBSYSTEM: RANGE SAFETY COMMAND DESTRUCT

ITEM NAME: Range Safety Distributor

PART NO.: 10406-0147

FM CODE: A17

ITEM CODE: 70-09

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 1

DATE: March 31, 2000 CN 038

CRITICAL PHASES: Boost

SUPERCEDES: March 31, 1997 CN 038

FMEA PAGE NO.: F-27A

ANALYST: S. Parvathaneni CN 038

SHEET 1 OF 9

APPROVED: S. Parvathaneni CN 038

FAILURE MODE AND CAUSES: Loss of power output to IRD A and B (requires two failures) caused by one of the following in each channel:

- o Open or short in wiring harness.
- o Open junction block.

Note: See70-09, FM Code A30 for loss of RSD Power.

FAILURE EFFECT SUMMARY: Loss of capability to destruct one SRB should it 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 during bench test ATP, ACO, SIT, ordnance installation and countdown. Monitored during flight from lift-off to separation by IRD power measurements B55X1871X and B55X1872X.

2. Pass - Monitored during flight by IRD power measurements B55X1871X and B55X1872X.

3. Pass - No known credible causes.

RATIONALE FOR RETENTION:

A. DESIGN

O The Range Safety Distributor (RSD) is redundant in its functions. The design provides one common housing with a cast aluminum wall separating the two redundant systems (System A and System B) so that no electrical failure in one system can propagate to the other. Redundant arm and fire signals are routed to systems A and B by the wiring harness and junction blocks in each unit. The specific RSD design feature that was implemented to mitigate the failure causes is true parallel redundancy.

O There is a single vendor source for RSD: Bendix, Guidance Systems Division. The RSD has completed qualification to the twenty mission level (Ref. Qual Test Report EE-QTR-91-001). The mission qualification is documented in COQ A-RSS-3113-4 and COQ A-RSS-3113-5.

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

O The design features noted and the use of high reliability parts selected from or screened to 10REQ-0036, mitigate the probability of the failure causes referenced in this failure mode.

O Open or short in Wiring Harness

- o The wiring harness interconnects the connectors, junction blocks, card connectors and terminal boards. The wire and connector pins meet all the requirements of the RSD assembly spec 10SPC-0148, have been flown on all Shuttle missions to date, 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 circuit board connectors were selected from MSFC 16A10455 and 16A10448 and are torqued to MSFC 16A10310.
- o Wires are terminated per NHB5300.4(3A-1) and JD-001, which assure reliable connections.
- o The harnesses are laced per MIL-E-45782 to prevent vibration or shock damage.
- o The connectors are located at each end of the RSD housing. The connectors meet all of the requirements of the RSD assembly spec for the SRB, 10SPC-0148, have been flown on all Shuttle missions to date and are qualified to the twenty-mission level. The connectors have the following design features that were incorporated to mitigate this cause of failure:
- o These exterior flange mount connectors were selected from MSFC 40M39569 and the pin arrangement is in accordance with 16A10300.
- o The selection of the pin arrangement assures that an adjacent pin short will not cause a mission failure.
- o Different keying arrangements on these connectors preclude airborne contaminants from entering the case.

O Open Junction Block

- o The junction blocks are judiciously located within the RSD case. The junction blocks meet all of the requirements of the RSD assembly spec, 10SPC-0148, have been flown on all Shuttle missions to date and are qualified to the twenty-mission level. These junction blocks have the following design features that were incorporated to mitigate this cause of failure:

- o The design of the junction block provides protection from contamination by use of an insulator material around the entry wire. There are no exposed electrical surfaces or points.

- o The tooling and manufacturing processes that govern the assembly of the wiring harness to the junction blocks are all controlled by MSFC specs and procedures.

B. TESTING

VENDOR RELATED TESTING

O Each RSD is acceptance tested. The acceptance test includes a complete functional and environmental test (per Bendix Acceptance Test Procedures 5135181-GTSP and 5135123-GTSP). Acceptance testing establishes the absence of listed failure modes at the time of testing. (All Failure Causes)

O A push/pull test is performed on all connectors and junction blocks after the wiring harness is installed in the chassis per Bendix Pull Test Procedure 5136632-GMS. (Open Junction Block)

KSC RELATED TESTING

O During ACO Test Operations, Electrostatic Discharge (ESD) Protection/Precauitons are implemented IAW OMRSD 10REQ-0021 Paragraph 4.11

O All OMRSD RequiredTesting listed below is performed prior to each flight.

O RSS Receiver/Decoder circuits are verified during ACO per 10REQ-0021, Paragraph 1.2.2.13.(All Failure Causes)

O RSS Receiver/Decoder circuits are verified during Cross Strap Test performed during Systems Integration performed per OMRSD File II Vol. I, Requirements S00000.200, S00000.210, S00000.220 and S00000.230. (All Failure Causes)

O RSS Receiver/Decoder circuits are verified with a response Test performed during Final Ordnance Connection on the PAD per OMRSD File II Vol. I, Requirements S00000.380 and S00000.390. (All Failure Causes)

O RSS Receiver/Decoder circuits are verified during with a response Test performed during Final Countdown on the PAD per OMRSD File II Vol. I, Requirements S00FH0.031 or S00FH0.032.(All Failure Causes)

O RSS Receiver/Decoder circuits are last verified during Final Countdown.

RECERTIFICATION/REFURBISHMENT TESTING

- O All Previously flown RSDs are refurbished and tested per USA SRBE 10SPC-0131.
- O All USA SRBE/TBE Florida Operations Recertified RSDs are acceptance tested per applicable ROD's. (All Failure Causes)
- O ESD Protection requirements are imposed per OMRS 10REQ-0021, Paragraph 4.11.

C. INSPECTION

VENDOR RELATED INSPECTION

- O Solder, flux, conformal coating, wire and copper clad board material are sample inspected upon receipt. USA SRBE PQAR verifies material certification and receiving inspection/test records per USA SRBE SIP 1091.
- O Junction blocks, card connectors and environmentally sealed connectors are sample inspected upon receipt (1 percent AQL). USA SRBE PQAR verifies material certification and receiving inspection/test records per USA SRBE SIP 1091.
- O Transistors, optical couplers, and diodes receive one hundred percent functional testing at Bendix. Capacitor and resistors are sampled at Bendix, one percent AQL. Magnetics have 100% visual, dimensional, and functional acceptance by Bendix Quality. USA SRBE PQAR verifies test data on electronic parts and screen test data per USA SRBE SIP 1091.
- O Bendix QA inspects printed wiring boards to the requirements of 50M60420.
- O USA SRBE PQAR verifies traceability records per USA SRBE SIP 1091.
- O Bendix QA inspects one hundred percent of the solder and crimp connections that go into the harness per Bendix Flow Chart 5116726. (Wiring Harness) (BI-1841)
- O Critical Processes/Inspections/Operations
    - o Soldering per NHB5300.4(3A-1)
    - o Staking per MSFC-STD-136
    - o Conformal coating per MSFC-PROC-508
    - o Crimping per Bendix-PROC-5136598

KSC RELATED INSPECTIONS

CN 038

O USA SRBE Quality monitors and accepts distributor bench testing. (All Failure Causes)

O Data from the Following OMRSD Required test is verified acceptable by a Quality representative:

- RSS Receiver/Decoder circuits verification during Cross Strap Test performed during Systems Integration Test performed per OMRSD File II Vol. I, Requirements S00000.200, S00000.210, S00000.220 and S00000.230. (All Failure Causes)

O RSS Receiver/Decoder circuit response verification Test performed during Final Ordnance Connection on the PAD per OMRSD File II Vol. I, Requirements S00000.380 and S00000.390. (All Failure Causes)

O RSS Receiver/Decoder circuit verification during response Test performed during Final Countdown on the PAD per OMRSD File II Vol. I, Requirements S00FH0.031 or S00FH0.032.(All Failure Causes)

RECERTIFICATION/REFURBISHMENT INSPECTION

O RSD's are externally inspected after each flight per 10SPC-0131 for bent or broken connector pins and visible damage.

CN 038

O RSDs are internally inspected after every third flight or five years, which ever come first in accordance with USA SRBE 10SPC-0131 for bent or broken connector pins, cracked solder joints, loose or broken components, arcing or burning of conformal coating, physical damage, torque or other items as applicable to product quality. The S&A, PIC, and controller modules are not disassembled for inspection. The RSD is cleaned and cosmetic damages repaired. If anomalies indicating damages beyond the repairable limits outlined in10SPC-0131 are noted, the RSD is returned to the vendor fror repair and acceptance Testing. (All Failure Causes)

CN 038

O USA SRBE Quality Witness acceptance testing of all USA SRBE/TBE Florida Operations Recertified RSDs per design specification 10SPC-0148. (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-1841, 6-21-90, CCBD SB3-01-3470

- SPECIFIED REQUIREMENT:

  Crimping of electrical connections shall be in accordance with JD-001.

- DEPARTURE:

  RSDs do not meet crimping requirements of JD-001 paragraph 3.1.2, 3.4.2 and 3.2.1.4.

- JUSTIFICATION:

  All crimps have undergone 100 percent visual inspection by certified operators and inspectors. No-inflight failures have occurred due to improperly crimped connections.

  Although the positioner is part of the crimp tool setup, proper positioner selection is verified by certified operators and inspectors prior to use of a tool in crimping operations.

O BI-1981, PN 10406-0147-851, SN 1000120, 01/04/96, CCBD SB3-01-5009 (BI-077 - BI-999)

- SPECIFIED REQUIREMENT:

  10CEI-0001
  Paragraph 3.2.7.2.1 - Ascent Vibration, Acoustic and Shock environments Paragraph 3.2.7.2.2 - ReentryVibration, Acoustic and Shock environments

- DEPARTURE:

  The RSD's have always been Tested with an imposed Acceleration Spectral Density Tolerance of +3/-1.5 DB. The vendor had vibration abort limits set significantly higher during Acceptance Test for repaired RSD's.

- JUSTIFICATION:

  The exceedance was within the Flight/Reentry Qualification Vibration Envelope. The Qualification Unit (IEA) has been through 20 Flight Qualification Missions. The Flight Qualification is to the maximum expected environments over the life of the RSD. This is a High Frequency narrow band spike that is separated by over 1 octave from the broad resonances.

O BI-1984, PN 10406-0147-854, SN 1000133, 1000139, 02/08/96, CCBD SB3-01-5022 (BI078-BI999)

- SPECIFIED REQUIREMENT:

  10CEI-0001
  Paragraph 3.2.7.2.1 - Ascent Vibration, Acoustic and Shock environments Paragraph 3.2.7.2.2 - ReentryVibration, Acoustic and Shock environments

- DEPARTURE:

  The RSD's have always been Tested with an imposed Acceleration Spectral Density Tolerance of +3/-1.5 DB. The vendor had vibration abort limits set significantly higher during Acceptance.

- JUSTIFICATION:

  The exceedance was within the Flight/Reentry Qualification Vibration Envelope. The Qualification Unit (RSD) has been through 20 Flight Qualification Missions. The Flight Qualification is to the maximum expected environments over the life of the RSD. This is a High Frequency narrow band spike that is separated by over 1 octave from the broad resonances.

O BI-1987, PN 10406-0147-851, SN 1000113, 1000139, 03/18/96, CCBD SB3-01-5036

O BI-1987a, PN 10406-0147-851, SN 1000112, 1000115, PN 10406-0147-854, SN 1000135, 05/07/96, CCBD SB3-01-5065

O BI-1987b, PN 10406-0147-851, SN 1000108, 1000109, 1000125, 1000126, PN 10406-0147-854, SN 1000107, 1000116, 1000123, 1000131, 1000137, 1000138, 07/11/96, CCBD SB3-01-5081

- SPECIFIED REQUIREMENT:

  10CEI-0001
  Paragraph 3.2.7.2.1 - Ascent Vibration, Acoustic and Shock environments Paragraph 3.2.7.2.2 - ReentryVibration, Acoustic and Shock environments

- DEPARTURE:

  The RSD's have always been Tested with an imposed Acceleration Spectral Density Tolerance of +3/-1.5 DB. The vendor had vibration abort limits set significantly higher during Acceptance.

- JUSTIFICATION:

  The exceedance was within the Flight/Reentry Qualification Vibration Envelope. The Qualification Unit (RSD) has been through 20 Flight Qualification Missions. The Flight Qualification is to the maximum expected environments over the life of the RSD. This is a High Frequency narrow band spike that is separated by over 1 octave from the broad resonances.