

SRB CRITICAL ITEMS LIST

SUBSYSTEM: RANGE SAFETY COMMAND DESTRUCT

ITEM NAME: Antenna A, Antenna B

PART NO.: 10406-0093-103 (20 Mission)
10406-0093-104 (Single Mission)

FM CODE: A02

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ITEM CODE: 70-01, 02

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 31, 1999

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CRITICAL PHASES: Boost

SUPERCEDES: March 1, 1996

CN 035

FMEA PAGE NO.: F-5A

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CN 035

SHEET 1 OF 5

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FAILURE MODE AND CAUSES: Loss of RF signal output from antenna A and B caused by:

- Open or shorted antenna feed
- Open or short on RF connector

- Faulty microstrip

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 during Bench Test.
2. Fail - Unable to check redundant paths during flight.
3. Pass - No credible causes

RATIONALE FOR RETENTION:

A. DESIGN:

- AFETRM/SAMTEC-127-1 requires that the Shuttle RSS antenna system provides ninety-five percent spherical coverage about the Shuttle and that the overall Range Safety System sensitivity will be at least 12 db below the RF signal level supplied by the Air Force ground transmission system at any point in the flight trajectory. Two independent antennas on each SRB and two independent antennas on the ET, plus cross-strapping, have been

implemented to satisfy this requirement. A single SRB with two operational antennas which breaks away from the cluster will also meet the requirement for ninety-five percent spherical coverage for the shuttle.

- The loss of one antenna degrades the spherical coverage to less than ninety-five percent at the specified margin of 12 db above the system threshold. Each antenna is located on opposite sides of an SRB and predominantly covers one hemisphere with significant overlap into the other hemisphere.
- The intent of the AFETRM/SAMTEC 127-1 requirement is to provide destruct capability regardless of vehicle attitude (within practical limits) at any given time. The ability to destruct a vehicle with one antenna is highly dependent on the attitude of the vehicle, the position of the operational antenna on the vehicle and the received signal level margin at the vehicle.
- The SRB receives an RF signal level that is typically 25 db above the measured threshold of any IRD at the maximum slant range. This excess margin of power compensates for reduced antenna coverage resulting from one failed antenna. Coverage is estimated to be eighty to eighty-five percent at a signal level that is 3 db above measured threshold.
- The worst-case condition for required operation of the RSS with one antenna failure is an SRB that has broken away from the cluster and has its antenna null pointed at the transmitter. This SRB can be expected to act erratically and not maintain attitude control in roll, pitch, and yaw. Under these conditions the null pointing position will follow changes in attitude of the free flying SRB and will eventually move away from the transmitter's direction. If the Arm and Fire commands are repeatedly sent by the transmitter, they will eventually be received and executed.
- In conclusion, the antennas are not redundant in the classical sense but are considered redundant in the operational systems mode.
- The antenna is designed to survive the high vibration, shock, and thermal levels encountered during the boost and descent phases of flight, and salt water immersion during the recovery phase. The antenna meets all the requirements of the Command Antenna Model 320 Spec (10SPC-0039).
- The antenna has two vendor sources: Teledyne-Lewisburg and LaBarge. Both vendors have been certified as suppliers by completing qualification testing. Teledyne-Lewisburg qualification is reported by Qualification Test Reports ET45-SRB-600 and ET45-SRB-604 and certified by USBI COQs A-RSS-3104. LaBarge qualification is reported by Qualification Test Report LBH-9600 and certified by USBI COQs A-RSS- 3106. The 10406-0093-103 is qualified to 20 missions. Due to cost effectiveness, SRB program has identified the 10406-0093-104 as single mission hardware. The 10406-0093-104 is qualified for single mission use and is not refurbished.

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O Open or Shorted Antenna Feed

The antenna feed consists of an impedance matching (and phase shifting) network (P/N 10406-0096 and -0097) and a pair of feed posts (P/N 10406-0104-104). The functional microstrip surfaces of the mirror image network boards are butted together to provide isolation for shorts and conductor redundancy at all positions along the microstrip except the electrical connection points to preclude open conductor failures. The feed posts are solid metal and are attached to the matching network boards and the radiating element microstrip boards by screws and washers. The screws are epoxied in place after torquing. All of the microstrip boards are epoxy-bonded along the edges to mitigate salt water contamination and contamination shorts or opens.

CROSS

O Open or Short on RF Connector:

This modified RF coaxial connector is attached to the matching network board with seven screws. The center conductor is attached to the matching network feed point with a screw. All screws are epoxied after torquing to mitigate opens due to loose screws.

O Faulty microstrip:

This microstrip radiating element board is procured and processed to the requirements of MSFC-SPEC-50M60233.

B. TESTING

VENDOR RELATED TESTING

- O Each antenna is subjected to acceptance testing to USBI approved test procedures, ATL-7958 for Teledyne-Lewisburg and LBH-9410 for LaBarge. Acceptance testing establishes the absence of open or shorted antenna feed, open or short of RF connector, or faulty microstrip at the time of testing. (All Failure Causes)

KSC RELATED TESTING

- o Electrical bond testing is performed per USBI STP 407.
- o After installation each antenna is tested for VSWR before cable installation per 10REQ-0021, para. 1.2.1.1.4. (All Failure Causes)
- o The antenna system is tested to the requirements of 10REQ-0021, paragraph 1.2.1.1.3 after installation. (All Failure Causes)
- o Open loop test performed per OMRSD File II, Vol. I, requirement S00000.380.

- o At approximately T-50 minutes, the range transmitter is brought up and maintains capture of the IRD until the separation sequence is started. From T-50 until separation, the signal strength measurements (B55E1100C and B55E1101C) provide an indication that the antennas are operational. There is no reliable method to assure an individual antenna is operational; however, if both antennas fail, the signal strength measurements will indicate the multiple failure from IRD capture (T-50) through separation (Reference OMRSD File II, S00FHO.031/032).
- o After each flight the antennas are refurbished and acceptance tested at the LaBarge facility per procedure MOP 477 and 52600. (All Failure Causes) (Note: This applies to 10406-0093-103 only)

CN 035

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o USBI QAR monitors receiving inspection and traceability records per SIP 1351.
- o Supplier Quality and USBI QAR perform in-process inspections to preclude errors in workmanship and materials during assembly of the antenna. The USBI QAR mandatory inspection points are listed below:
 - o Base Plate per SIP 1351
 - o Conductor Feed per SIP 1351
 - o Filler Feed per SIP 1351
 - o Filler Top per SIP 1351
 - o Support per SIP 1351
 - o Filler per SIP 1351
 - o PC Boards per SIP 1351
 - o Connector Modification per SIP 1351
 - o Cover per SIP 1351
 - o Gasket per SIP 1351
 - o Plate Cover per SIP 1351
- o USBI QAR witnesses acceptance testing per SIP 1351. (All Failure Causes)
- o Critical Processes/Inspections/Operations:
 - o None

KSC RELATED INSPECTION

- o Installation of antenna is verified by USBI QA.
- o USBI QA witnesses and accepts torquing of antenna mounting bolts.
- o USBI QA witnesses and accepts electrical bonding resistance checks between antenna and SRB Forward Skirt assembly.

- O USBI QA inspects antenna receptacles for damage and contamination during hook up of cable to antenna.
- O USBI QA witnesses VSWR test. (All Failure Causes)
- O USBI QA witnesses antenna system testing. (All Failure Causes)
- O The antenna protective covers are removed and the antennas are inspected for damage per Lockheed Procedure A5214 during roll-out preparation.

REFURBISHMENT INSPECTIONS (For 10406-0093-103 only)

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- O The antenna is inspected for scratches, nicks or surface indentations, warped base plate, distortions, O-ring groove distortion and salt water intrusion. No antenna with evidence of salt water intrusion or blemish in excess of that allowed by 10SPC-0131 shall be refurbished for flight use. The antenna is refurbished per LaBarge refurbishment procedure MOP-477 after each use. USBI QAR shall verify refurbishment per SIP 1351.

D. FAILURE HISTORY

- O Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- O Not applicable to this failure mode.