dme CORPORATION

ENGINEERING REPORT
for
QUALIFICATION TESTING
DESIGN CHANGES
MODEL SRB-406

Where used: Model SRB-406 Type S ELT
Next assembly: P3-03-0041 Series

Y3-02-0530

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FM 39229

REVISIONS

Revision	Date	Change Description	Approval
-	2/26/03	ECO # 13666	T.Cohen

1.0 PURPOSE

This report describes the design changes implemented in the Model SRB-406 Type S Emergency Locator Transmitter, PN P3-03-0041-002, and all lower tier sub-assemblies, before, during and after the performance of the FAA TSO C91a and TSO C126 qualification testing.

2.0 SCOPE

This report is applicable to test articles and specimens tested per Engineering Test Plan Y3-02-0506 and the test results documented within Engineering Test Report Y3-03-0726. The original test article and test specimen configurations are as described in Engineering Test Report Y3-03-0726.

3.0 REFERENCE DOCUMENTS

Federal Aviation Administration

Technical Standard Order TSO-C126, 406 MHz Emergency Locator Transmitter (ELT), dated December 23, 1992.

Technical Standard Order TSO-C91a, Emergency Locator Transmitter (ELT) Equipment, dated April 29, 1985.

DME Corporation

Engineering Drawing P3-03-0041, Revision (-), SRB-406 Beacon.

Engineering Test Plan, Y3-02-0506, Revision (-), Design Qualification Test Plan/Procedure for the SRB-406 ELT.

Engineering Test Report, Y3-03-0726, Revision (-), Test Report for Emergency Locator Transmitter (ELT), Survival Type – ELT (S), 121.5 MHz, 243.0 MHz and 406.028 MHz, FAA TSO C126 and TSO C91a.

4.0 DESIGN CHANGES

This section describes the design changes that were incorporated into the initial test article configuration as design improvements and difficulties were discovered before and after the start of qualification testing.

This section also describes design changes that are currently documented in the design data but have not been incorporated into the qualification test articles and test specimens. These design changes were not exposed to the environmental test conditions defined within Engineering Test Plan Y3-02-0506.

Design changes were incorporated into the transmitter housing, transmitter cover, transmitter cover gasket, transmitter assembly, membrane switch and triple frequency antenna. The design changes are described in the following paragraphs.

4.1 Antenna /Transmitter SMA Connector Sealing

Description of the Design Difficulty

The length of the SMA connector, combined with the attachment hardware dimensional stack-up and the “D” opening wall thickness exposed insufficient threads for the antenna right angle SMA connector to seal with the transmitter straight SMA connector body. The wall thickness of the transmitter housing was found to be too thick for proper sealing of the mated SMA connectors. This design difficulty was resolved by eliminating the sealing washer from the attachment hardware stack-up and sealing the opening with an RTV adhesive/sealant. All test articles started qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The transmitter straight SMA connector (w/o sealing washer, w/RTV sealant) installed in a transmitter housing with a “D” opening wall thickness of 0.125 inches (nominal) was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof test conditions without failure. A delay in the testing schedule created an opportunity to incorporate a new transmitter housing with the proper “D” opening wall thickness (0.070 inches, nominal). The initial test configuration was modified by introducing a new housing with the correct “D” opening wall thickness and the balance of the testing completed with the new housing.

Tests Performed with the New Test Configuration

The transmitter straight SMA connector (w/o sealing washer, w/RTV sealant) installed in a transmitter housing with a “D” opening wall thickness of 0.070 inches (nominal) was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion test conditions without failure.

Justification for Accepting Test Results

The change in wall thickness improves the ability of the design to withstand the environmental conditions.

Action Taken

The sealing washer has been removed from the design and the wall thickness has been defined as 0.070 inches (nominal) and incorporated into the design.

4.2 Antenna Connector Hex

Description of the Design Difficulty

The transmitter housing SMA connector "D" opening dimensions were originally defined based on the SMA connector manufacturer recommendations. When the SMA connector was installed in the "D" opening, the SMA connector would spin inside the "D" opening when the mounting hardware was tightened. The dimensions of the "D" opening were found to be larger than required in the manufacturers data sheet and this error allowed the flat edge of the SMA connector to rotate and round-off the "D" opening in the housing. Holding the SMA connector body stationary using standard hand tools was also difficult given the presence of the crimped antenna cable and the close proximity of housing features. This deficiency was resolved by eliminating the sealing washer from the attachment hardware stack-up, adding "locking" hex nuts to hold the connector stationary during tightening of the hardware and sealing the opening with an RTV adhesive/sealant. After tightening the mounting hardware, the added locking hex nuts were removed from the test article. All test articles started qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The transmitter straight SMA connector (w/o sealing washer, w/RTV sealant) in the oversized "D" opening was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure of the SMA connector or sealing media. A delay in the testing schedule created an opportunity to incorporate a new transmitter housing with the proper "D" opening shape and a recessed hex to hold the SMA connector during tightening of mounting hardware. The initial test configuration was modified by introducing a new housing with the correct "D" opening size, a recessed hex, a re-sized membrane switch "D" opening and the balance of the testing completed with the new housing/membrane switch.

Tests Performed with the New Test Configuration

The transmitter straight SMA connector (w/o sealing washer, w/RTV sealant) installed in a transmitter housing with a correct "D" shaped opening and recessed hex was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure of the SMA connector, the sealing media or the membrane switch.

Justification for Accepting Test Results

The change in "D" opening dimensions improved the ability of the design to withstand the environmental conditions.

Action Taken

The sealing washer has been removed from the design and the correct "D" opening and a recessed hex have been incorporated into the beacon design.

4.3 PEM Insert Location

Description of the Design Change

Examination of the PEM insert location indicated that there might be future difficulties with material failures (cracking) or gasket leaks adjacent to the PEM insert locations. These potential design difficulties were expected because the PEM insert was not located in the center of the housing walls or were not centered in corner radii. A decision was made to proceed with qualification testing with this potential design issue. All test articles started qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The initial test configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without material failure or gasket leaks. A delay in the testing schedule created an opportunity to incorporate a new transmitter housing with PEM inserts centered in the housing walls and corners. The balance of the testing was completed with the new housing, cover and gasket.

Tests Performed with the New Test Configuration

The transmitter housing with a correctly located PEM inserts, harmonized transmitter cover screw openings and gasket openings was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without material failure or gasket leaks.

Justification for Accepting Test Results

The change in PEM insert location, cover machine screw openings and cover gasket machine screw openings improved the ability of the design to withstand the environmental conditions.

Action Taken

The PEM insert location, cover machine screw openings and cover gasket machine screw opening changes have been incorporated into the design.

4.4 Housing Wall Thickness/Corner Radii

Description of the Design Change

Examination of the PEM insert location anticipated that there would be future difficulties with material failures (cracking). These anticipated design difficulties were expected because the PEM inserts were not located in the center of the housing walls or corner radii. A decision was made to proceed with qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure of the housing material. A delay in the testing schedule created an opportunity to incorporate a new transmitter housing with thicker walls and larger corner radii. The balance of the testing was completed with the new housing.

Tests Performed with the New Test Configuration

The transmitter housing with thicker walls and larger corner radii was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without material failure.

Justification for Accepting Test Results

The increase in wall thickness and corner radii improved the ability of this design to withstand the environmental conditions.

Action Taken

The increased wall thickness and corner radii changes have been incorporated into the design.

4.5 Wire Routing Radius

Description of the Design Change

Although there were no assembly difficulties experienced during fabrication of the test articles, subsequent reviews of the wire runs from the circuit card assembly (under the battery pack) were thought to be areas where the wires could be pinched and possibly damaged. A decision was made to proceed with qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure of the housing material or cover gasket. A delay in the testing schedule created an opportunity to incorporate a new transmitter housing with a wire run channel. Creating a wire run channel provided more room for the wires and significantly reduced the chance that the wire can be pinched or damaged. The initial test configuration was modified by introducing a new housing with a wire run channel and the balance of the testing completed with the new housing.

Tests Performed with the New Test Configuration

The transmitter housing with the wire run channel was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure.

Justification for Accepting Test Results

The incorporation of wire run channel in the housing improves the ability of the design to withstand the environmental conditions.

Action Taken

The wire run channel change has been incorporated into the beacon design.

4.6 LED Opening Sealing

Description of the Design Change

A review of the design revealed a potential leak path into the interior to the transmitter assembly through the LED-opening window on the nomenclature label. A decision was made to proceed with qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure. A delay in the testing schedule created an opportunity to incorporate a new transmitter housing and the sealing of the LED opening with a clear RTV adhesive/sealant. Sealing the LED opening eliminated a potential leak path. The balance of the testing completed was completed with the sealed LED opening.

Tests Performed with the New Test Configuration

The transmitter housing with the sealed LED opening was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure.

Justification for Accepting Test Results

Sealing the LED opening in the housing improves the ability of the design to withstand the environmental conditions.

Action Taken

The sealed LED opening change has been incorporated into the design.

4.7 Membrane Switch Assembly Sealing and Housing Bonding

Description of the Design Difficulty

Difficulties with the membrane switch were experienced after environmental tests were performed where the switch was exposed to water or the formation of condensation. The failure mode was a change in resistance between switch contacts that caused the beacon to enter and repeat the beacon self-test routine. The failure mechanism was the channeling of moisture and water between the beacon housing and the switch. Two water channels were discovered and corrected by a design change in the construction details of the switch and a change in the switch-to-housing installation process.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration and humidity and without failure of the membrane switch. The membrane switch failed during exposure to the spray proof test. A failure analysis (see Engineering Report Y3-03-0724) performed after the spray proof test failure identified the failure mechanism. The failed membrane switch was removed and replaced with modified membrane switch. The modified membrane switch was installed using the revised installation process, the spray proof testing was successfully repeated and the balance of the testing performed without further difficulties.

Tests Performed with the New Test Configuration

A modified membrane switch, installed using the revised installation process, was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure.

Justification for Accepting Test Results

The change in the membrane switch design and the bonding process improved the ability of the design to withstand the environmental conditions.

Action Taken

The membrane switch and installation process changes have been incorporated into the design.

4.8 PWA Immobilization

Description of the Design Difficulty

Minor chaffing damage was found on the transmitter housing printed wiring assembly-locating guides and on the locating radii on the printed wiring assembly after completion of the vibration testing.

Tests Performed with the Initial Test Configuration

The initial configuration (no RTV adhesive/sealant to immobilize the printed wiring assembly) was exposed to the low temperature activation, high temperature activation, altitude, decompression and overpressure without failure.

Although the performance of the beacon was unaffected by the chaffing and the damage was minor, a decision was made to immobilize the printed wiring assembly by applying a small amount of an RTV adhesive/sealant to each guide and the printed wiring assembly radius. The initial test configuration was modified after vibration testing and the balance of the testing was completed.

Tests Performed with the New Test Configuration

Test articles with immobilized printed wiring assemblies were exposed to the humidity, spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure.

Justification for Accepting Test Results

Immobilizing the printed wiring assembly in the housing improves the ability of the design to withstand the environmental conditions.

Action Taken

The immobilized printed wiring assembly has been incorporated into the design.

4.9 Transmitter Cover Thickness

Description of the Design Change

Development load tests on the transmitter cover indicated that there might be future difficulties with battery pack damage and/or PEM insert pull-out, if the design margin were exceeded. A decision was made to proceed with qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure of the housing PEM inserts or damage to the battery pack. A delay in the testing schedule created an opportunity to incorporate a new housing cover with a thicker cross section. The initial test configuration was modified by introducing a new cover with a thicker cross section and the balance of the testing completed with the new cover.

Tests Performed with the New Test Configuration

The transmitter cover with the thicker cross section was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure.

Justification for Accepting Test Results

Strengthening the transmitter cover improved the ability of the design to withstand the environmental conditions.

Action Taken

The strengthened transmitter cover has been incorporated into the design.

4.10 Transmitter Cover Gasket Lip

Description of the Design Change

Research on the transmitter cover indicated that there might be future difficulties with the cover mounting screws withstanding shear loads under extreme load conditions. A decision was made to proceed with qualification testing in this configuration.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure. A delay in the testing schedule created an opportunity to incorporate a new housing cover with a gasket lip. Incorporating a gasket lip to absorb shear loads before the cover mounting screws are loaded, reduced the chance of mounting screw failure. The initial test configuration was modified by introducing a new cover with a gasket lip and the balance of the testing completed with the new cover.

Tests Performed with the New Test Configuration

The transmitter cover with the gasket lip was exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure.

Justification for Accepting Test Results

Strengthening the transmitter cover improves the ability of the design to withstand the environmental conditions.

Action Taken

The strengthened transmitter cover has been incorporated into the design.

4.11 Membrane Switch Dome

Description of the Design Change

The sealing area surrounding the switch contacts was increased by centering the switch contact location in the membrane switch panel and reducing the diameter of the switch dome after the water leakage failure analysis revealed these areas are potential water leak paths.

Tests Performed with the Initial Test Configuration

The initial configuration was exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration and humidity without failure of the membrane switch. The membrane switch spray proof failures resulted in design changes to the switch that included centering the switch contact location and reducing the diameter of the switch dome. The modified membrane switch was incorporated into the test articles and the balance of the testing was completed in this modified configuration.

Tests Performed with the New Test Configuration

Modified membrane switches were exposed to the spray proof, salt water immersion, sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure of the modified membrane switches.

Justification for Accepting Test Results

Increasing the sealing area surrounding the switch contacts improved the ability of the design to withstand the environmental conditions.

Action Taken

The revised membrane switch has been incorporated into the design.

4.12 Antenna Right Angle SMA Connector Sealing

Description of the Design Difficulty

Water leakage was discovered in the right angle SMA connector crimped on the antenna cable after exposure to the salt-water immersion test. The right angle SMA connector that leaked is not potted and has a press fit cover.

Tests Performed with the Initial Test Configuration

The un-potted right angle SMA connector and press-fit cover configuration were exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity and spray proof tests without failure of the antenna SMA connector. Antennas were modified by removing and replacing the SMA connector after the salt-water immersion test. The new SMA connector has a threaded cover and was filled with a potting material. The balance of the testing was completed with the modified antenna configuration.

Tests Performed with the New Test Configuration

Modified antennas were exposed to the sand and dust, salt spray (corrosion), operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure of the modified SMA connector.

Justification for Accepting Test Results

Enhancing the sealing capability of the right angle SMA connector improved the ability of the design to withstand the environmental conditions.

Action Taken

The potted SMA connector with the threaded cover has been incorporated into the antenna design.

4.13 Antenna Sealing

Description of the Design Difficulty

Fluid leaked into the antenna housing during salt spray tests. The leakage was found to have come through the antenna whip and water sensor contact openings on the antenna housing. The leakage was due to the rupture of a thin bead of sealing material filling these openings. The bead of sealing material is expected to have a thicker cross-section than that found in the leaking antennas. The water leakage caused the antennas to de-tune, VSWR to change and creates a short in the water sensor such that the beacon begins transmitting immediately after the arming pin is removed.

Tests Performed with the Initial Test Configuration

The antennas with the marginal sealing material were exposed to the low temperature activation, high temperature activation, altitude, decompression, overpressure, vibration, humidity, spray proof tests, salt water immersion and, sand and dust tests without failure of the sealing material. The leaking antennas were replaced with antennas from the same production lots as the marginal antennas and the balance of the testing was completed with these units (pending implementation of sealing process and operator training improvements).

Tests Performed with the At-Risk Test Configuration

Replacement antennas from the at-risk population were exposed to the operational shock, crashworthiness, crush, flame and post-crash immersion tests without failure of the replacement antennas.

Justification for Accepting Test Results

Antennas fabricated using the refined sealing process and with better-trained operators have been exposed to a salt spray test without failure. The successful salt spray test demonstrates that the antennas can be sealed using the refined sealing process and better-trained operators.

Action Taken

The antenna supplier fabrication processes and operator training will be periodically verified through a combination of source inspection and destructive inspection of antennas.

4.14 Triple Frequency Antenna Boot Gussets

Description of the Design Change

Development tests conducted by an inflatable manufacturer revealed that the elastomeric material used to form the antenna boot was susceptible to taking a permanent set under inflatable packing forces. The permanent set resulted in the antenna whip not being held in a vertical position. Thick cross section gussets were added to the original antenna boot design in order to preserve the memory characteristics of the elastomeric material under packing forces. The inflatable manufacturer has validated performance of the gusset antenna.

Justification for Accepting Test Results

The environmental tests performed on the original (non-gusset antenna) revealed significant changes in elastomeric properties of the antenna boot. The addition of the antenna gussets improves the ability of the design to withstand the application environment.