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SPECIFICATION FOR THE PERFORMANCE DESIGN DEVELOPMENT
AND TEST REQUIREMENT.. (U) ADVANCED ENGINEERING LAB
ADELAIDE (AUSTRALIA) S J CALDECOTT ET AL. 20 NOV 84
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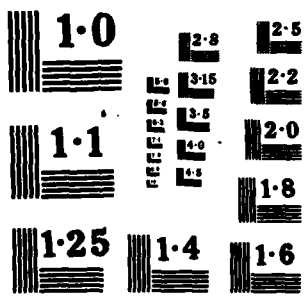
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ADVANCED ENGINEERING LABORATORY

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Airborne Structures and Instrumentation Group

 * SPECIAL DOCUMENT *
 * AEL-0125-SD *
 * SPECIFICATION FOR THE PERFORMANCE, DESIGN, *
 * DEVELOPMENT AND TEST REQUIREMENTS FOR A *
 * SEVERE ENVIRONMENT CARTRIDGE RECORDER *
 * ISSUE 4 DATE 20NOV84 *

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Prepared by S.J.Caldecott and N.J.Phillis.

SUMMARY

This specification establishes the performance, design, development and test requirements for a Severe Environment Cartridge Recorder (SECR)

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LIST OF AMENDMENTS.

This specification contains 17 sheets and is issued as a bound document. Each reissue shall be as a complete and bound document.

Issue	Date	Amendments
1	23NOV83	Original Issue.
2	23DEC83	Page i, List of Amendments - number of sheets corrected. Para 4.2.4.(g) amended. Distribution - spare copies reduced from 25 to 15.
3	23DEC83	Para 4.2.4.(a) added. Paras 4.2.4.(b) to 4.2.4.(h) renumbered. Paras 4.2.4.(b) and 4.2.4.(c) amended.
4	20NOV84	Paras 4.2.4 (c) and 4.2.4 (d) amended, lower temperature limit changed from -50° to -20°. Distribution, spare copies reduced from 15 to 5.

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1. SCOPE

1.1 This specification establishes the performance, design, development and test requirements for a Severe Environment Cartridge Recorder (SECR).

2. APPLICABLE DOCUMENTS

Reference is necessary to the latest issue of the following documents unless otherwise stated.

2.1 Advanced Engineering Laboratory

AEL-0126-SD Specification for the Performance, Design, Development and Test Requirements of a Magnetic Tape Cartridge Replay Machine

2.2 DEF(AUST)

DEF(AUST)5085 The Preparation of Drawings for Service Equipment, Specification

2.3 Standards Association of Australia

AS1103 Pt 2 Diagrams, Charts and Tables for Electrotechnology; Item Designations

AS2536 Surface Texture

2.4 American Military

MIL-STD-454 Standard General Requirements for Electronic Equipment

MIL-STD-461B Electromagnetic and Susceptibility Requirements for the Control of Electromagnetic Interference

MIL-STD-462 NOTICE 3 Electromagnetic Interference Characteristics, Measurement of

MIL-STD-810C Environmental Test Methods

2.5 Other American Organisations

IRIG 118-73 Test Methods for Telemetry Systems and Sub-systems

3. DEFINITIONS

This section is not applicable to this specification.

4. REQUIREMENTS

4.1 Item Definitions

4.1.1 Severe Environment Cartridge Recorder (SECR)

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The SECR shall consist of a magnetic tape cartridge recorder intended for recording analogue or digital data in high vibration, high acceleration and wide temperature range environments.

The SECR shall comprise a single assembly in which shall be housed an electric motor, a means of securing and driving a magnetic tape cartridge, electronic speed control circuitry and a four-track magnetic recording tape head. No signal-conditioning electronics shall be contained within the SECR.

Replay of magnetic tape cartridges shall be accomplished with the Cartridge Replay Machine (CRM), (refer AEL-0126-SD).

4.1.2 Magnetic tape cartridge

The magnetic tape cartridge shall be a commercial magnetic tape cartridge, such as the 3M DC100A Certified Data Cartridge, or equivalent.

4.2 Characteristics

4.2.1 Performance

(a) Bandwidth. The SECR shall be capable of simultaneously recording four tracks, signals on each of which may be either analogue signals of bandwidth 5Hz to 40kHz within 3dB, or digital data at up to 32Kbauds.

(b) Speed. The SECR recording speed shall be settable at 10, 20, 30 or 40 inches per second (25.4, 50.8, 76.2 or 101.6 centimetres per second), within 0.5% of the set speed, in the record direction only. Speed setting shall be accomplished by installing links or setting switches; soldering shall not be acceptable for this procedure.

(c) Wow and Flutter. Wow and flutter shall desirably be less than 1.0% RMS, with a maximum acceptable value of 3.0% RMS, at all speeds.

(d) Control. The motor shall run while a circuit closure, external to the SECR, exists between the control line and 0v. The SECR shall source a current of at least 10mA and shall operate with an external loop resistance of up to 220 ohms.

(e) Start Delay. The SECR motor shall be running at the selected speed within 400 milliseconds of the run loop being applied.

(f) End of Tape Stop. Optical detection of End-of-Tape holes provided in the magnetic tape shall cause the SECR motor to stop regardless of the state of the control line. Resetting this condition shall be achieved by removal and reconnection of power.

(g) Cartridge Restraint. The SECR shall provide a means of positively restraining the cartridge under all operating conditions, to prevent its movement relative to the tape head or drive mechanism.

(h) Endurance. The SECR shall be capable of recording for up to three minutes at any time during a four hour exposure to the environmental conditions stipulated in Sub-Section 4.2.4, during which exposure power shall be continuously applied to the SECR.

(i) Minimum Life Expectancy. The SECR shall be designed to provide a minimum total life expectancy of 1000 hours. Required mission duration shall be up to four hours, with a maximum of two missions within a 12 hour period.

(j) Supply voltage. The SECR shall operate from an external supply of 12Vdc, within 5%.

(k) Manual operation. The SECR shall allow manual operation of the tape transport mechanism by providing finger-tip access to a rotating member of this mechanism. A suitable non-slip surface for this member shall be applied to a section whose diameter is at least 10mm.

4.2.2 Physical characteristics

(a) Dimensions. The dimensions of the SECR shall be within the following limits, unless exemption is sought from and granted by AEL.

Width : 100 to 140mm

Length : 75 to 110mm

Height : 35 to 50mm

The total volume of the recorder shall not exceed 500 cubic centimetres.

(b) Weight. The weight of the SECR shall not exceed 0.80 kg.

(c) Tape inspection. There shall be provision in the SECR case for visual inspection of both tape reels within the cartridge, showing tape distribution between reels.

(d) Mounting. The SECR case shall contain tapped holes to allow mounting the SECR to a flat surface by appropriately specified bolts through clearance holes in the surface. Mounting holes shall be provided on four sides, three of which shall be mutually perpendicular. Hole spacing shall be at least 60mm between centres. The designer shall specify the material and head type of mounting bolts to be used.

(e) Projections. All fixing screws, bolts, pins, studs and other protruding components shall be recessed beneath the outline formed by extending all planar exterior surfaces to their intersection lines. The only exception allowable shall be the electrical connector (see subsection 4.2.2(g)).

(f) Protective coating. Protective coating and finish details shall be specified to provide suitable durability and corrosion resistance.

(g) Electrical connection. Power, control and signal wiring shall enter the SECR through a miniature bulkhead-mounted multi-pin connector.

(h) Tape Head Alignment. Tape head mounting in the SECR shall allow adjustment, but be preset by the manufacturer to establish uniform head alignment between different SECRs and CRMs. Special equipment needed to preset the heads shall be supplied by the manufacturer with instructions for its use.

(i) Tape Head Polarity. Signal connection to the tape head shall be such that a common polarity of signal to all channels shall produce a common magnetic flux pattern on all tracks of the tape. Drawings shall show the polarity of tape head connections required to produce this effect.

4.2.3 Reliability

The SECR shall be designed to provide a minimum MTBF of 200 hours.

4.2.4 Environmental Conditions

(a) General. The following environmental conditions are those which the SECR will experience in use. A test specification shall be drawn up to enable demonstration that the equipment will function in these conditions. Tests may be combined and levels determined to suit these requirements within the testing capability of the AEL Environmental Engineering Facility.

(b) Vibration. The SECR shall operate within the vibration environment of Fig 1. Testing shall subject the SECR to one hour of vibration in each of 3 orthogonal axes; refer to the following paragraphs of MIL-STD-810C, Method 514.2:

- (i) Test item operation, 4.1
- (ii) Mounting techniques, 4.2
- (iii) Random vibration test, 4.5.2

This test shall be combined with the Temperature test, 4.2.4(c). The SECR shall be deemed to have passed this test if the speed requirements of 4.2.1(b) are met during the test (refer 5.2.2 for speed test method).

(c) Temperature. The SECR shall operate over the range -20°C to $+70^{\circ}\text{C}$. For testing refer to the MIL-STD-810C, Methods 502.1 and 501.1. These tests shall be combined with those of 4.2.4(b). The SECR shall be deemed to have passed this test if the speed requirements of 4.2.1(b) are met during the tests (refer 5.2.2 for speed test method).

(d) Temperature shock. The SECR shall withstand temperature shock over the range -20°C to $+70^{\circ}\text{C}$. For testing refer to MIL-STD-810C, Method 503.1. The SECR shall be deemed to have passed this test, if the speed requirements of 4.2.1(b) are met following the test (refer 5.2.2 for speed test method).

(e) Altitude. The SECR shall operate within a range of altitudes from 0 to 18000 metres. For testing refer to MIL-STD-810C, Method 500.1. The SECR shall be deemed to have passed this test if the speed requirements of 4.2.1(b) are met following the test (refer 5.2.2 for speed test method).

(f) Humidity. The SECR shall operate at up to 95% R.H. (noncondensing). For testing refer MIL-STD-810C Method 507.1. The SECR shall be deemed to have passed this test if the bandwidth requirements of 4.2.1(a) are met during the test (refer to 5.2.1 for bandwidth test method).

(g) Acceleration. The SECR shall withstand acceleration of up to 80g in each of three mutually perpendicular axes in steps of 20g from 20g. For testing refer to MIL-STD-810C Method 513.2. The SECR shall be deemed to have passed this test if the bandwidth and speed requirements of 4.2.1(a) and 4.2.1(b) respectively are met during this test (refer to 5.2.1 and 5.2.2 respectively for bandwidth and speed test methods).

(h) Shock. The SECR shall withstand a shock of 100g, sawtooth profile, of 6 milliseconds duration, applied twice in each direction of three mutually perpendicular axes (12 shocks). For testing, refer MIL-STD-810C, Method 516.2, Procedure IV. The SECR shall be deemed to have passed this test if the bandwidth and speed requirements of 4.2.1(a) and 4.2.1(b) respectively are met following this test (refer 5.2.1 and 5.2.2 respectively for bandwidth and speed test methods).

Figure 1. Vibration Environment.

4.3 Design and Construction

Unless otherwise specified, equipment design and construction shall conform to the applicable requirements of MIL-STD-454.

4.3.1 Materials, processes, parts

(a) Body. The SECR body shall be manufactured by either machining it from solid blanks of aluminium alloy, or by casting it from aluminium alloy. The finished external surfaces shall be orthogonal.

(b) Surface finish. The surface finish shall not exceed

(c) N7 (63 micro inches) as defined in AS2536, for machined surfaces, or

(d) N9 (250 micro inches) as defined in AS2536, for cast surfaces.

This shall not be seen as limiting the use of finer finishes where warranted by the design.

4.3.2 Electromagnetic compatibility

The SECR shall be designed to comply with the requirements of MIL-STD-461B, Part 2, paragraphs CE01, CE03, CE07, CS01, CS02, CS06, RE01, RE02-1, RS01, RS02, RS03.

4.3.3 Markings

Each SECR body shall be permanently and legibly marked with the item descriptor, and the legend "Manufactured for AEL, Defence Research Centre, Salisbury". The item descriptor, comprising the item name, identifying drawing number and serial number, shall be located on at least two surfaces so that it shall be visible regardless of the mounting face used.

4.3.4 Workmanship

The minimum acceptable standard of workmanship shall be instrument standard.

4.3.5 Interchangeability

The SECR component parts shall be modular and interchangeable between units to shorten and simplify maintenance tasks, except where precision matching of machined parts is necessary.

4.4 Drawing and Documentation

4.4.1 Engineering Drawings

Engineering drawings shall be prepared to level 2 of DEF(AUST)5085. DRCS identifiers and AEL drawing numbers shall be used in all drawing and parts list title blocks.

Engineering drawing types to be prepared shall include parts lists, detail and assembly drawings, and installation and interface control drawings. Data lists and Build Status Records shall be required. The mono-detail drawing system shall be used. Parts lists separate from the engineering drawings shall be prepared at the sub-assembly level.

4.4.2 Documentation

The following types of documentation shall be provided.

(a) Design-supporting material which will describe alternative approaches considered, design philosophies, major design decisions, and calculations to validate the design.

(b) Technical Manual, incorporating hardware description, operation and maintenance procedures, installation interface drawings and descriptions, troubleshooting guide and relevant engineering drawings.

4.5 Logistics

4.5.1 Maintenance

Design of the SECR shall allow a level of accessibility and modularity consistent with achieving a maximum MTTR of 1 hour. Except for the head alignment jig, no special purpose equipment for assembly, disassembly or testing shall be used.

4.6 Precedence

This specification shall take precedence over all referenced documents. If a conflict arises between different requirements, it shall be resolved by AEL.

5. QUALITY ASSURANCE PROVISIONS

5.1 General

Testing shall be carried out on one unit to verify that the specified requirements of Section 4 have been satisfied. Testing to prove compliance with section 4.2.4 shall be carried out at the AEL Environmental Testing Facility, jointly by AEL and contractor personnel. Any decision required during tests on repairs or modifications shall be made by AEL. Responsibility for concessions approval shall reside with AEL.

5.2 Tests

5.2.1 Bandwidth

The contractor shall design a recording amplifier to connect to one channel of the four-track tape head. Sinusoidal signals of 1Vpp and frequencies 5, 10, 20, 100, 200Hz, 1, 2, 10, 20 and 40 kHz shall be recorded in turn for 5 seconds each at 30 inches per second (76.2 centimetres per second) onto an unrecorded tape cartridge. The resultant tape shall be replayed on a CRM via a replay amplifier of the contractor's design. The output signal shall be constant in level, to within 3db, over the bandwidth 5Hz to 40kHz. Successful completion of this test shall satisfy the bandwidth requirement of both this document and that of the CRM (AEL-0126-SD, 5.2.2).

5.2.2 Speed

A test lead shall be attached to a point in the speed control circuit where a signal whose frequency is proportional to the drive shaft speed is available. An electronic frequency counter shall be used to measure

the frequency of this signal for each of the SECR's operating speeds. In each case, it should be within the following range.

$$0.995k < f < 1.005k$$

where $k = x.s.r.C$ x = number of pulses per drive shaft revolution
 s = tape speed (in centimetres per second)
 r = ratio of drive shaft speed to cartridge drive pulley speed
 C = the reciprocal of the circumference of the cartridge drive pulley (=1/3.86 cm)

5.2.3 Wow and Flutter

The motor shall be run and the technique of 5.2.2 used to monitor speed. The digital signal so derived shall be passed to a frequency discriminator whose output shall be measured as described in Section 3-32(g) of IRIG 118-73. The measured output shall be less than 3.0% RMS at all controlled speeds.

5.2.4 Control

The motor speed switch shall be set to 30 inches per second (76.2 centimetres per second) and the techniques of 5.2.2 used to monitor speed. An ammeter, set to a range of at least 100 mA FSD shall be connected in series with the following resistances, in turn, between the control line and 0v.

- (a) 0 ohms
- (b) 82 ohms
- (c) 220 ohms

In each case, the SECR shall be observed to run at 30 inches per second, and the current reading on the ammeter shall be at least 10mA.

5.2.5 Start Delay

The technique of 5.2.2 shall be used to monitor motor speed while the output from the frequency discriminator of Section 3-32(g) of IRIG 118-73 shall be observed on an oscilloscope with a sweep time of 20 milliseconds per division. The oscilloscope display shall be triggered by the negative-going transition of the control line, and the display used to establish that the motor reaches commanded speed within 400 milliseconds of this trigger. The test shall be conducted for all speeds.

5.2.6 End Of Tape Stop

A magnetic tape cartridge shall be pre-wound to ensure that the Beginning Of Tape (BOT) hole has passed the sensing mirror, but that the End Of Tape (EOT) hole has not. The cartridge shall be loaded into the SECR and the control line shorted to the 0v rail with a switch. The SECR shall run until the EOT hole passes the sensing mirror, when the SECR shall stop. Opening and closing the switch shall no longer cause the SECR to run.

Removal and reconnection of power to the SECR shall again allow normal control to be exercised by the switch until the second EOT hole is detected. At that point the SECR shall again stop and remain stopped, regardless of the state of the control line switch.

Any failure of the SECR to carry out the above operations during ten attempts shall be deemed a failure to pass this test.

5.2.7 Supply Voltage

With a supply voltage of 11.4 Vdc, and again with 12.6 Vdc, the tests of 5.2.2 to 5.2.5 shall be repeated, for a speed of 40 inches per second (101.6 centimetres per second). The same criteria shall be met as in the previous tests.

5.3 Functional Assessment

Following completion of the tests in 5.2, an assessment of those tests shall be made by AEL, to determine the acceptability of the SECR. The contractor will be informed of the result, with instructions for any re-testing which may be required.

6. PREPARATION FOR DELIVERY

The SECR shall be prepared for delivery by ensuring that complete assembly of the unit has taken place, and that it is in an operational state i.e. all lubrication, adjustment, alignment, calibration and cleaning is complete. The speed control switches or links shall be set for 30 inches per second (76.2 centimetres per second).

The SECR shall be packaged to provide protection against damage resulting from dropping from two metres onto a concrete surface, and secured to prevent the packing coming off. The package shall be labelled with the name of the item, its serial number, a consecutive package number, date of manufacture, contract number, and the names of the maker and the consignee.

7. NOTES

7.1 Intended use

The SECR will be used to record flight test data in airborne weapons or aircraft. The general purpose design allows for adaptation to a variety of applications in high vibration, high acceleration and wide temperature range environments. The exclusion of signal processing electronics from this item provides the instrumentation engineer with greater freedom to configure the equipment to his data logging needs.

7.2 Development Background

The need for a SECR became apparent within AEL several years ago, and led to the design and construction of a prototype which forms the basis for this specification. The AEL Recorder contained most of the mechanical features described in this specification, but speed control and selection, and end-of-tape stop were not available.

Background information on the AEL Recorder will be available to enquirers through the AEL contact officer.

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