R-63-120 63-3-1

WSC E-28

CATEGORY I AND II TEST REPORT FOR RUNWAY VISUAL RANGE COMPUTING SETS AN/FMN-1

WEATHER SYSTEM CENTER
United Aircraft
EAST HARTFORD, CONNECTICUT

AF 19 (626)-16

WSC E-28
Copy No. 8

CATEGORY I AND II TEST REPORT FOR RUNWAY VISUAL RANGE COMPUTING SETS, AN/FMN-1

Weather Observing and
Forecasting System 433L
(Contract No. AF 19(626)-16)

UNITED AIRCRAFT
CORPORATE SYSTEMS CENTER
Weather System Center

Farmington, Connecticut
February 26, 1963

ABSTRACT

The results of Category I and II tests performed on the Aeronca and Olympic Runway Visual Range Computing Sets, AN/FMN-1, are provided in the text of the report. A discussion of the advantages and disadvantages of each model concept is included, as well as the results of each test specified in the Test Plan. Included also are the human factors engineering review, the reliability and maintainability study of the test operations, and test results. Recommendations are made for improvement in the AN/FMN-1 method of operation.

Prepared by: UNITED AIRCRAFT
CORPORATE SYSTEMS CENTER
Weather System Center

Approved by:

J. G. Davis
Project Leader, Test and Evaluation

Concurred in:

R. G. Bounds
Lt/Col., USAF
433L System Program Director

Concurred in:

Cornelius Callahan
433L Test Director

Publication Review

This document has been reviewed, concurred in and authorized for publication.

R. G. BOUNDS, JR.
Lt. Colonel, USAF
System Program Director
433L SPO

Report No. WSC E-28

Category I and II Test Report for
Runway Visual Range Computing Sets, AN/FMN-1

CONTENTS

CONTENTS (cont'd)

LIST OF FIGURES

1. PURPOSE

A. Category I tests were conducted on the Aeronca and Olympic (XD-3) Runway Visual Range (RVR) computers to determine:

1. The electronic and mechanical suitability of the equipment in performing its intended purpose.

2. The extent to which the equipment meets specifications.

3. Maintenance problems and supply requirements and adequacy of AGE.

4. Any engineering design deficiency and necessary corrective action.

5. Equipment reliability, availability, and maintainability.

B. Category II tests were conducted on the Aeronca and Olympic (XD-3) Runway Visual Range (RVR) computers to determine:

1. The suitability of the equipment in computing Runway Visual Range values.

2. The operational effectiveness.

3. Maintenance problems, supply requirements and adequacy of AGE.

4. Equipment reliability, maintainability and availability data.

5. Compliance with human engineering standards.

2. RESULTS, CONCLUSIONS AND RECOMMENDATIONS

2.1 Results

2.1.1 General

The analysis of data obtained indicated that the AN/FMN-1 concept of presenting a digitized data display of the runway visual range (RVR) as determined from the transmissivity of the atmosphere is feasible.

2.1.2 Comparative Results

Comparison of the Olympic RVR and the Aeronca RVR Computers against the requirements and against each other indicate that deficiencies exist in each equipment. These deficiencies are discussed further in the text.

2.2 Conclusions

2.2.1 Aeronca RVR Computer

1. The Aeronca RVR computer appears to have a high susceptibility to noise at the transmissometer input.

2. It is possible for the background and transmissivity counters of the Aeronca RVR computer to recycle when an overflow condition exists. The results will be displayed as an incorrect value of RVR.

3. The readout display has a low MTBF due to susceptibility to lamp burnout at the increased voltage necessary for display under high ambient lighting conditions.

4. A discrepancy exists between the third character encoding logic of the RVR computer and the AN/FMQ-5. The present AN/FMQ-5 cannot identify and accept the characters in the third position which may be a +, -, L or T. There is no provision for encoding a Blank in any of the three character positions.

5. The MTBF is approximately 834.1 hours (exclusive of display lamp failures) which is below the required 1600 hour as specified in MIL-C-27930.

6. With the exception of the power supplies and relays the RVR computer can easily be serviced due to the accessibility of the components and the use of indicator lamps in each binary stage of the counters.

7. The computer has a self test feature which performs the function of sequencing through the visual displays, checking the data transmission path and the computing circuitry.

2.2.2 Olympic RVR Computer

1. The background correction does not sense the background count equivalent in time duration to the transmissivity input signal period. The adjustment of background setting is ambiguous and difficult to determine during the background correction period.

2. In the event of a voltage reference failure (reference zener diode inoperative) special trimming procedures have to be followed in replacing the diode in order to ensure the correctness of displayed data.

3. The polarity of the AC input power is critical in that the unit will not operate properly if the polarity is reversed.

4. The matrix control relays are of a special type (mercury wetted) and are difficult to replace, i.e., relays are close together with about 12-14 soldered connections on each. With power on, the equipment has to be level for maintenance; otherwise, the mercury wetted relays will not operate properly.

5. The computer is difficult to maintain and work on due to the crowded and inaccessible placement of the components.

6. The MTBF is approximately 498.5 hours which is below the required 1,600 hours as specified in MIL-C-27930.

7. The Bina-View display appears to have good reliability and readability characteristics.

8. The Olympic RVR computer does not measure the true average transmissometer pulse during a one minute period. The displayed RVR value is dependent upon the variability of the transmissivity during the one minute cycle the computer samples the transmissivity pulses; i.e., the sampled value is not truly representative of the average value.

9. Under rapidly changing transmissivity conditions, either the Olympic or Aeronca RVR computer only approximates the change of transmissivity. No meaning is conveyed as to the variability or low RVR value during the sampling interval. In some instances the transmissivity has changed by a factor of 40 per cent within a one minute period.

2.3 Recommendations

1. The background correction should be performed automatically every hour and during a change in either light intensity setting or day-night setting. This could be accomplished, for example, by a motor driven cam closing a relay contact each hour. The relay contact in turn would energize the background correction circuitry. The period of time in which a background count is sampled should be equal in time to the sampling period of pulses arriving from the transmissometer.

2. The input circuitry of the RVR computer should be designed to operate on 50 to 70 per cent of the average maximum input transmissometer pulse. This would discriminate against noise signals. For further discrimination against noise, a probe pulse should be produced which strobes the transmissometer pulse in the middle of the period (see Fig. 12). The 50 to 70 per cent amplitude pulse level would energize a Schmidt trigger circuit, with a recovery time slightly less than $\frac{1}{4,000}$, or 0.25 milliseconds. The Schmidt trigger circuit would fire a One Shot Multivibrator with an output pulse delayed in time 1/2 of a transmissometer pulse width period. The One Shot output pulse (probe) would be terminated with the transmissometer pulse at an AND gate. In order for a signal to be valid, time coincidence between the probe and transmissometer pulses is necessary at the AND gate. This technique would discriminate against noise as follows:

   a. Signals (noise) lower than the 50 to 70 per cent average pulse amplitude would be rejected for they would not fire the Schmidt Trigger.

   b. Signals (noise) greater than the 50 to 70 per cent average pulse amplitude but of a duration less than 1/2 pulse period would be rejected, for they would not be coincident at the AND gate.

   c. Having the Schmidt Trigger recovery time slightly less than the maximum transmissivity pulse period to be encountered would eliminate to a degree transmissivity pulse jitter affecting RVR values.

3. The AN/FMN-1 should not only display the average RVR but it also should indicate the "low" RVR during its averaging period. For example, if the RVR average is 5,000 feet and the low during this period is 5,000 feet, an observer knows immediately that the RVR is remaining constant. However, if during the average period the "low" RVR is 1,000 feet the observer knows that the visibility is changing rapidly.

4. The AN/FMN-1 should count the number of pulses arriving from the transmissometer both in the background and normal operate mode for a period of (T), where: $T = (60 \text{ sec.} - T_1)$, T_1 being equal to the time necessary for computation. By using this technique a time average of RVR for the selected period T would be obtained.

5. The Bina-View display, if used, should be provided with a rheostat for controlling the display intensity.

3. INTRODUCTION

3.1 Scope

This report presents the results of Category I and II tests of the Aeronca and Olympic (XD-3) Runway Visual Range computers (see Figures 1 and 2). These tests were performed in accordance with report No. WSC E-15, Appendix I, Category I and II Test Plan for Visual Range Computing Set AN/FMN-1, hereinafter referred to as the Test Plan. These tests were performed at Westover Air Force Base, Chicopee Falls, Massachusetts.

3.2 Test Schedule

The equipment was in operation between 10 July 1962 and 30 October 1962 for Category I tests and from 30 July 1962 to 14 December 1962 for Category II tests. The tests were performed at Westover Air Force Base, Chicopee Falls, Massachusetts on an eight-hour day, five-day week schedule. The Aeronca Runway Visual Range computer was operated for a total of 5,004.8 hours and the Olympic (XD-3) Runway Visual Range computers were operated for a total of 997 hours during the test and evaluation periods.

3.3 Test Objectives

A. Category I tests were conducted to determine:

1. The electronic and mechanical suitability of the equipment in performing its intended purpose.

2. The extent to which the equipment meets specifications.

3. Maintenance problems and supply requirements and adequacy of AGE.

4. Any engineering design deficiency and necessary corrective action.

5. Reliability data.

B. Objectives of the Category II test program were as follows:

1. The extent to which the equipment meets military requirements.

2. Maintenance problems, supply requirements, and AGE requirements.

3. Effectiveness when used under operational conditions in an operational environment.

4. Equipment reliability, availability and maintainability.

5. Human factors requirements.

3.4 Test Authorization

The Category I and II tests of the Aeronca and Olympic (XD-3) Runway Visual Range Computer Sets were carried out in partial fulfillment of section 3.4.4 of the 433L System Program authorized by Government Contract AF 19(626)-16. Specific cognizance of this program is vested in the 433L System Program Office (SPO), 424 Trapelo Road, Waltham 54, Massachusetts.

4. DESCRIPTION OF TEST EQUIPMENT

The Runway Visual Range (RVR) computers are basically devices used to count the number of pulses arriving from a transmissometer. Through computation within the computers they display the proper RVR value in decimal format. The transmissometer is located along the runway, and the pulses originating from the transmissometer are a function of the transmission characteristics of the medium between the transmissometer projector and detector. The RVR computers have the capability of recognizing the following parameters which affect RVR reading:

1. Day or night switch setting
2. Runway light intensity setting
3. Background correction

The Aeronca RVR computer has the capability of displaying RVR values between the limits of 1,000 feet and 6,000 feet: in increments of 200 feet from 1,000 to 4,000 feet, and in increments of 500 feet from 4,000 to 6,000 feet. RVR values below 1,000 feet are indicated as 10-, from 1,000 to 6,000 feet as two characters (hundreds of feet), and values above 6,000 feet are displayed in three characters as 60+.

The Olympic (XD-3) computer has the capability of displaying RVR values in two character format only. For the range from 1,000 feet to 4,000 feet the display is in increments of 200 feet; from 4,000 feet to 9,500 feet, the display is indicated in increments of 500 feet. RVR values below 1,000 feet are indicated as "--", and values above 9,500 feet are indicated as "++".

The basic equipment complement of the Aeronca RVR Computer includes:

1. Signal Data Converter
2. Receiver Decoder
3. Power Supplies
4. Visual Display Unit
5. Time Base Generator

The basic equipment complement of the Olympic (XD-3) RVR Computer includes:

1. Pulse Rate to DC Voltage Converter
2. Programmer and Counter
3. Analog Function Generator
4. V_R Register

5. TESTS PERFORMED

All tests required under Addenda 1, 2, 3 and 4 of the test plan were completed as outlined. Specific comments on each of these tests are contained in section 6 of this report. Samples of the actual records kept during the test program are presented in Figures 3 through 7.

6. DISCUSSION OF TESTS AND INTERPRETATION OF DATA

6.1 Test Description

Throughout the Category I and Category II tests several logs were maintained to provide information that could be utilized in the evaluation of the Aeronca and Olympic (XD-3) RVR computers. These logs were:

1. Manpower Log
2. Maintenance Log
3. Daily Operational Log
4. Daily Operational Log (Comparative Tests)

6.1.1 Manpower Log

The Manpower Log (Fig. 3) is a record of man hours expended during any tests, modifications, or maintenance functions. The "REFERENCE" column shows what type of effort was expended in addition to the technical order, request, or reference document number calling for this effort. The Manpower Log also shows the time required to perform maintenance analysis, QQPRI analysis, and any other Personnel-Equipment analyses.

6.1.2 Maintenance Log

The Maintenance Log (Fig. 4) was utilized to maintain a record of all maintenance and modification effort and equipment "down" time. This log is organized to indicate an individual component record for the equipment showing the date of maintenance and modification, the time equipment went out of service, and the time equipment was returned to service. When maintenance was required for component failure or routine replacement, an "Operational Trouble and Maintenance Report (OTMR)" was completed (see Fig. 5). Since the OTMR's were numbered, this number also appeared in the "Failure Report No." column of the maintenance log. An OTMR was also required whenever modifications were made, either for special test efforts or for improved operation. The "REFERENCE" column is noted with the technical order, request or reference document number, or is used to indicate emergency maintenance, as the case may be, in addition to the type of effort (i.e., test, maintenance, modification) that is required to maintain equipment performance.

6.1.3 Daily Operational Log

The Daily Operational Log (Fig. 6) was utilized during these tests to record observations not covered by the Manpower and Maintenance Logs. Entries in the Daily Operational Log, being of an unpredetermined nature, were recorded as the events occurred and began when the equipment installation was completed. This log indicates:

1. Any installation problems and deviations from original installation layout

2. Operational peculiarities and malfunctions

3. Operational capability of equipment with respect to operational specifications

4. Electrical interference with, and from other base installation equipment

5. Any unusual requirements for personnel

6. Adequacy of safety precautions

7. Any significant deviations in primary line voltage

8. Data obtained from functional tests

6.1.4 Daily Operational Log (Comparative Tests)

The comparative test log (Fig. 7) was kept to acquire knowledge and data pertaining to the operational characteristics of the RVR computers. The displayed data obtained from the RVR's were compared with other sources capable of measuring the equivalence of RVR. The devices used in the comparison were:

1. Aeronca RVR Computer
2. Olympic RVR Computer
3. Multiple Instrument Viewing Panel (MIVP)
4. Electronic Counter

The entries in the log were made every two hours, or more frequently during periods of significant weather.

6.2 Category I Tests, Aeronca RVR Computer Set

All Category I tests are designated by a number. The Aeronca RVR computer tests begin with I-100A and end with I-111A.

6.2.1 Physical Inspection (Test I-100A)

The equipment was received from the Weather System Center uncrated and installed in a BUD cabinet.

6.2.2 Uncrating (Test I-101A)

Test procedure did not apply.

6.2.3 Visual Inspection (Test I-102A)

The Aeronca RVR computer consisted of:

1. RVR Signal Data Converter, Serial No. 808-1
2. Time Base Generator
3. Power Supply
4. BUD cabinet

The unit was received in excellent condition and the equipment functioned properly when power was applied.

6.2.4 Power Supplies (Test I-103A)

The line voltage to the RVR computer was varied between the limits of 95 volts and 125 volts. The following readings were obtained:

AC Input Volts	Power Supply Voltages - DC						
	-12	-6	+6	+12	-30	-10	-82
115	11.959	7.164	6.754	13.161	32.278	12.140	80.666
95	11.576	6.998	6.714	12.029	30.733	10.191	78.895
125	12.234	7.293	6.783	13.618	33.758	14.052	81.840
123*	12.225	7.292	6.773	13.569	33.569	13.725	81.807

*Normal Station Line Voltage

The regulation of the power supplies for the range of input line voltages from 95 volts to 125 volts was as follows:

Power Supply Under Test (Nominal Voltage)	Regulation in Per Cent from Average Voltage
-82	3.66
-30	9.25
-12	5.33
+12	12.4
-10	30.9
-6	4.13
+6	1.32

The equation for calculating regulation in per cent is given by the expression:

$$\text{Reg.} = \frac{2(V\ max - V\ min)}{V\ max + V\ min} \times 100$$

In reviewing the voltage deviation on the Aeronca RVR power supplies, in all but one case the percentage deviation values are quite high; however, the computer operates satisfactorily over the range of line variations of 95 to 125 volts. Due to the type of logic used in the RVR computer it can operate satisfactorily under the power supply voltage deviation listed above. A requirement for power supply regulation for the type of digital circuit used in the Aeronca should be ± 5 per cent.

6.2.5 Time Base Generator (Test I-104A)

The output frequency of the Time Function Generator crystal oscillator was measured at 99.9984 kc, while the required value was 100 kc. This error represents a deviation of only .0016 cycles per kilocycle.

6.2.6 Background Correction (Test I-105A)

A signal generator was connected to the Background Counter Input for accuracy of count, and the following information was obtained:

1. All indicator flip-flop lights operated with the exception of the "32" lamp.

2. The introduced background count indicated on the EPUT meter agreed with that stored in the background count circuit, except when the number of the background pulses exceeded the capacity of the background register. The register recycles and only the excess is stored and transferred.

3. The Transmissometer Ready Light illuminated within one minute after the Transmissometer Background switch was placed in the background position.

4. The Background Counter was cleared by the Reset Pulse.

5. The Background Count transferred to the Transmissivity Register after the Background count was completed; however, the Background Switch must be placed in the Transmissivity position within 15 seconds after the Transmissivity Ready Light is turned ON.

6.2.7 Light Setting Switch and Day-Night Switch (Test I-106A)

The transmissometer simulator was connected in place of the transmissometer input and 4,000 pulses per minute were applied to the RVR input. The following data was obtained:

1. All indicator lights of the transmissivity register functioned properly.

2. The relay selection of the proper matrix was checked and found to be operating correctly.

3. When 1450 pulses per 45 second period were applied to the input of the RVR computer with no Background count entered in the Background register, the following results were obtained:

INPUT	LS	D/N	THEORETICAL PULSE COUNT	MEASURED PULSE COUNT	INDICATED RVR	THEORETICAL RVR
1450	5	D	9	9	26	26
1450	4	D	6	6	20	20
1450	3	D	6	6	20	20
1450	5	N	20	37	60+	60
1450	4	N	18	18	50	50
1450	3	N	16	16	40	40

In several cases besides that indicated above the matrix pulse count and RVR solution did not agree with the theoretical value. The cause of the discrepancy is the susceptibility of the RVR computer to noise generated on the input signal line.

6.2.8 Random Reset Generator (Test I-107A)

The Random Reset Generator produced a pulse of 27.68 milliseconds duration each time the light-setting intensity switch or day-night switch was changed. All flip-flops were reset.

6.2.9 Internal Test 1 (Test I-108A)

When the test switch was placed in Test 1 position the letter T appeared in the third digit position and the display was sequenced through all values of RVR beginning with 10- and ending with the letter T being displayed simultaneously with 60+ so that the displayed third digit appeared as Ŧ. It was difficult to determine that a + was not being displayed instead of a -. The same situation existed when the 60+ value was displayed; the + was superimposed upon the T and the digit displayed appeared as 60Ŧ. Also the L was not displayed during this check; therefore, not all of the possible displays were checked.

The display intensity control on the front panel of the Signal Data Converter allowed the voltage to be controlled over a range of 2 to 11 volts, DC. Under the normal lighting in the METRO building this control must be adjusted so that the voltage applied to the lamps of the displays is approximately

10 volts in order to obtain a satisfactory display viewing level. This high voltage level resulted in a very high failure rate of the type 47 (or 1847) lamps of the display device. The unit must be installed in a location where the ambient light level is moderate in order that the lamps can be operated at about 6.5 volts, producing a satisfactory display under these lighting conditions.

Approximately 1 minute and 20 seconds are required to complete the test sequence display cycle.

6.2.10 Internal Test 2 (Test I-109A)

The computing circuitry in the signal Data Computer is checked when the test switch is placed in the Test 2 position. The Transmissivity/Background switch was placed in Background position. When the Transmissivity Ready Light was illuminated, the switch was then placed in Transmissivity position. A minimum of one minute is required for the Background count to be stored in the Background register. The RVR tables were checked by rotating the table selector switch through position 1 to 6 and the following results were obtained.

RVR Table Selector Switch	Answer
1	60+
2	60+
3	60+
4	38
5	38
6	38

If the Background test is not performed as outlined above the answers obtained in the last three cases will be erroneous.

6.2.11 Input Voltage Amplitude and Noise Test (Test I-110A)

The pulse from the transmissometer was monitored and the following results were obtained:

Pulse width	50 microseconds (at the 50 per cent voltage level)
Pulse amplitude	15 volts nominal
Pulse polarity	Negative
Rise Time	1 microsecond (from the 20 to 80 per cent voltage level)

The input pulse amplitude was reduced from 15 volts to 0.5 volts before the RVR computer ceased to function properly. This test verifies that a very high susceptibility to noise and transients exists.

A Random Noise Generator was utilized to introduce controlled noise level along with the transmissometer simulator pulse at the input of the RVR computer. The pulse from the simulator was kept at a constant 15 volts while the RMS noise voltage was varied. Various types of noise were introduced, Audio Frequency noise (AF) and "Pink" noise (Acoustical Society of America - ASA). The data obtained from the tests are shown below.

Transmissometer Simulator Pulse/45 sec.	Computer Pulse Count		RVR		Noise	
	Measured	Theoretical	Measured	Theoretical	Type	Amplitude rms
1336	4,454	666	36	24	AF	0.5
1336	3,501	666	34	24	AF	0.5
1336	8,584	666	00	24	AF	0.5
1336	5,652	666	00	24	AF	0.5
1336	287,168	666	16	24	AF	1.0
1336	284,582	666	26	24	AF	1.0
1336	283,116	666	00	24	AF	1.0
1336	279,539	666	00	24	AF	1.0
1332	666	666	24	24	ASA	0.5
1332	707	666	26	24	ASA	0.5
1332	666	666	24	24	ASA	0.5
1332	666	666	24	24	ASA	0.5
1332	4,643	666	40	24	ASA	1.0
1332	6,285	666	10-	24	ASA	1.0
1332	6,147	666	12	24	ASA	1.0
1332	5,426	666	00	24	ASA	1.0

The tests indicate that the Aeronca RVR computer is highly susceptible to random electrical noise and will produce erroneous indications of RVR in such an environment. Steps should be taken to minimize the effects of such noise by redesign of the input circuits to prevent triggering of the counters by random noise spikes.

6.2.12 Over-all Transmissometer Simulation Test (Test I-111A)

The operation of the background counter, transmissivity counter, data transmission paths, computing functions, and operation of the light setting and day-night relays were tested for errors in the RVR computer. An electronic counter was used to count the input pulses from the transmissometer simulator during the interval of 45 seconds. A known number of pulses were injected into the RVR computer. A corresponding RVR value, in feet, appeared at the visual display of the Signal Data Converter which was dependent on the setting of the day-night switch and light intensity switch. The results of this test are shown in Fig. 8 which illustrates the output in RVR as a function of Pulse Count, Light Setting, and Day-Night Setting.

Figure 9 illustrates the complementing function of the Background and Transmissivity Count. The data agrees with the exception of one situation where the RVR varied by an insignificant 200 feet.

6.3 Category I Tests, Olympic (XD-3) RVR Computer Set

All Category I tests are designated by a number. The Olympic RVR computer tests begin with I-100B and end with I-108B.

6.3.1 Physical Inspection (Test I-100B)

The shipment was inspected by Weather System Center personnel and no physical damage to the crate was found. The crating procedures were adequate.

6.3.2 Uncrating (Test I-101B)

The equipment was uncrated by Weather System Center personnel and no unusual requirements were noted.

6.3.3 Visual Inspection (Test I-102B)

The RVR computer was not operational when received at Westover AFB and required troubleshooting. It was necessary to disassemble the Function Generator Switch and clean all six switch sections in order to remove existing shorts between contacts; also, a diode had to be replaced.

The output of the AN/GMQ-10 Transmissometer at Westover AFB was +15 VDC nominal with negative going 50 microsecond pulses. These pulses when applied to the input circuit of the Olympic RVR computer were of incorrect polarity to pass the first stage emitter follower. It was necessary to modify Card AS 21309 by installing a coupling circuit consisting of a 1,500 MMFD capacitor connected in series with the input signal and a 10 K ohm resistor connected from the base of the first emitter follower to ground.

6.3.4 Line Voltage Variation (Test I-103B)

This test checked the voltage variation of the Voltage Reference supply, the frequency to level converter output voltage deviation, and the over-all RVR operation for changes in line voltage.

a. The Computer reference voltage (V) changed by a factor of .071 per cent between the limits of 108 and 132 volts line variation.

b. The frequency to level converter output voltage (V_T) changed by a factor of .033 per cent between the limits of 108 and 132 volt line variation. Since the RVR Computer performs ($V - V_T$), the maximum variation in ($V - V_T$) is 0.15 per cent for changes of line voltages between 108 and 132 volts. Using the relationship

$$\frac{d(V-V_T)}{V-V_T} = \frac{-1.46 \times 10^3}{VR} \frac{dVR}{VR}$$

This relationship represents the worst case of a change in $(V-V_T)$ effecting a change in RVR $(\frac{dVR}{VR})$. Using Contrast Law, one can solve for the errors in RVR.

$$\text{Let} \quad \frac{d(V-V_T)}{V-V_T} = .15\%$$

$$\text{and} \quad VR = 9{,}500 \text{ feet (worst case)}$$

$$\text{Therefore } \frac{dVR}{VR} = 1 \text{ per cent.}$$

The maximum variation in RVR is 1 per cent for a change in 20 per cent of line voltage. This represents a maximum of 95 feet variation in RVR at a value of 9,500 feet, and proportionately less for lower values of RVR.

The RVR computer was not affected operationally over the range of variations in line voltage between 108 and 132 volts.

6.3.5 Input Voltage Amplitude and Noise Test (Test I-104B)

The pulse from the transmissometer simulator was monitored with an oscilloscope and the results are shown below:

Pulse width	50 microseconds (at the 50 per cent voltage level)
Pulse amplitude	15 volts nominal
Pulse polarity	Negative
Pulse rise time	1 microsecond (from the 20 to 80 per cent voltage level)

RF, AF and ASA random noise was introduced on the input signal to the RVR computer. It was determined that all noise with an amplitude of 3 volts or greater produced an increased RVR reading. The increase in the RVR reading is dependent upon the amplitude and type of noise. The minimum value of input pulse voltage for reliable operation is 3 volts. This value is too low, for it only represents 20 per cent of the operational pulse amplitude of the AN/GMQ-10 at Westover AFB.

6.3.6 Power Supplies (Test I-105B)

This test checked the regulation of the +12 volt and -12 volt power supplies during the period the line voltage was varied between the limits of 108 and 132 volts. The +12 volt power supply had a regulation value of 0.935 per cent, while the -12 volt power supply regulation was 1.04 per cent. The test results are shown on the next page.

Line Voltage	+12V Supply Output	-12V Supply Output
108	11.70	11.40
112	11.74	11.40
116	11.76	11.44
120	11.78	11.47
124	11.79	11.49
128	11.81	11.52
132	11.81	11.52

6.3.7 Background Count (Test I-106B)

The background correction circuit does not sample the incoming background pulse for an interval of time equal to the sampling of the transmissometer pulses. The background circuit continuously samples the Background Count until the background switch is de-energized. The period of monitoring background correction should be of equal duration (one minute) to that in which RVR is computed.

As the background circuit has a finite time constant, the result obtained from a background correction is useless at the low background count normally present. Under this condition the background correction meter fluctuates and it is difficult to determine the null point on the meter. There is no provision for extinguishing the AN/GMQ-10 projector lamp when the background switch is energized on the Olympic RVR computer.

6.3.8 Frequency to Voltage Converter (Test I-107B)

A transfer function of input (pulses per second) versus integrator output (DC voltage) was run on the frequency-to-voltage converter (pulse rate integrator) to determine its linearity. Figure 10 illustrates the deviation of the frequency to voltage converter from a straight line function. If the transfer function were ideal the deviations would be zero. Figure 10 was corrected for "bias error" by subtracting the average deviation from each data point. Both curves have a maximum deviation of less than 0.1 per cent, which is acceptable for this type of device.

There was no measurable AC ripple present on the output of the frequency-to-voltage converter; however, random noise was present with an amplitude of 80 millivolts peak to peak.

6.3.9 Over-all Transmissometer Simulation Test (Test I-108B)

The Over-all Transmissometer Simulation Test was conducted to check the matrices, the data transmission path, readout indicators, operation of the light setting relays, and the day-night relay. A known number of pulses were inserted into the RVR computer, and the displayed readout was compared to a known value. The μ_1 through μ_6 relays were energized and the μ condition indicator lamps operated properly.

With zero input pulses to the computer the μ_1, μ_2, and μ_3 positions indicate an RVR output of 1,200, 1,000, and 1,000 feet, respectively, which is equivalent to an input signal of 70 pulses per minute (ppm). From calculations and actual measurement this value of 70 ppm is equivalent to 90 millivolts originating from the background circuit.

When a count of 3,600 ppm was introduced into the RVR computer, the μ_1, μ_2 and μ_3 positions all indicated "++", which is correct. Figure 11 illustrates the RVR answers for values of μ_1, μ_2 and μ_3 settings using a known input pulse rate. A few discrepancies exist in Fig. 11 because the input signals (frequency) fall on the boundary of two possible RVR answers. The BCD lamps located on the front panel of the RVR computer agreed with all readings of RVR displayed. The inhibit pulse from the RVR computer was -12 volts and lasted for a duration of 200 milliseconds, which is in agreement with the test plan.

6.4 Category II Tests, Aeronca RVR Computer Set

All Category II tests are designated by a number. The Aeronca RVR computer tests begin with I-200A and end with I-204A.

6.4.1 Transmissometer Lamp (Test I-200A)

The transmissometer lamp is extinguished when the Background switch is placed in the Background position on the Aeronca computer and remains out until the Background count is completed (if the equipment is modified).

6.4.2 Transmissometer Pulse (Test I-201A)

Figure 13 is a photograph of an oscilloscope display of the transmissometer pulse. Figure 13 illustrates that the transmissometer pulses ride on a DC level of approximately 17 volts. This DC level is necessary to provide power for the AN/GMQ-10 projector lamp. The transmissometer pulses originating from the AN/GMQ-10 detector are negative pulses of an amplitude of approximately 12 volts. The nominal pulse width is about 50 microseconds. In these photographs no ripple or transients were observed. However, as transients (noise) are of a random nature, the photographs represent too small a sampling in time to be a significant measure of the occurrence of noise.

6.4.3 Day-Night Photocell (Test I-202A)

Approximately 30 seconds is required for the photocell to switch from day to night. The time delay is necessary and adequate because, during periods of darkness, the photocell will not accidently cause the RVR computer to change to the Day position by high transient light levels or vice versa under daytime conditions. The test did not subject the photocell to high intensity light transients as might be encountered from lightning.

6.4.4 Operational Test Aeronca RVR (Test I-203A)

The Aeronca RVR was compared with devices capable of displaying transmissivity such as the Beckman model 7360RU electronic counter and the ID/353 transmissivity indicator. These tests were run from 30 July 1962 to 10 August 1962 with a total of 119 groups of readings. Unfortunately, the visibility during the testing period was exceptional and all the devices indicated a 60+ in 118 groups of readings out of 119. During the one instance of reduced visibility all devices indicated similar RVR values.

6.4.5 Compatibility Test (Test I-204A)

The results of Test I-204A indicated a discrepancy in the third character encoding logic of the Aeronca RVR computer. The characters which the Aeronca can display in the third position are +, -, T, L and Blank. The internal logic of the present AN/FMQ-5's is arranged so that it cannot identify these characters as a T, L or a Blank. In addition, the Blank does not cause a space in the AN/FMQ-5 message format, so the next group of weather parameters is not spaced over. A preferred situation would be that whenever the Aeronca RVR has anything except + or - in the third character position a space character would be automatically encoded and transmitted to the AN/FMQ-5. The Blanks in the first two character positions are a problem when the computer displays an L in the third character position.

6.5 Category II Tests, Olympic (XD-3) RVR Computer Set

All Category II tests are designated by a number. The Olympic (XD-3) RVR computer tests begin with I-200B and end with I-202B.

6.5.1 Transmissometer Pulse (Test I-200B)

The Transmissometer output pulse was photographed as shown in Fig. 13.

6.5.2 Compatibility Test (Test I-201B)

Using the Transmissometer Simulator, all numerical and sign readouts were displayed on the Olympic RVR computer and printed on the Meteorological Data Display Set ID-826/TMH-1. The AN/FMQ-5 printout was the same as the RVR value displayed.

6.5.3 Comparison (Test I-202B)

Under steady state conditions of transmissivity, where transmissivity index did not change by a factor of 10 per cent in a 2 minute period, the AN/FMN-1 (Olympic and Aeronca models) and the electronic counter displayed similar RVR readings. The two models of the RVR were also checked against the transmissivity meter on the MIVP. The electronic counter Beckman 7360RU counted the transmissometer pulses for a 1 minute period and the data were translated to RVR readings. The data gathered during the comparison tests, 12 November 1962 to 14 December 1962 (a total of 97 groups of readings), can be divided into three phases as follows:

I. Steady state transmissivity readings, in the range of values of 60+ on the Aeronca model or ++ on the Olympic model.

II. Steady state transmissivity values, in the range of values below 60+ on the Aeronca model or below ++ on the Olympic model.

III. Rapidly varying transmissivity values, a rate of change in transmissivity index greater than 10 per cent in a 2 minute period.

Phase I - Total Number of Readings in this Category - 77

Example:

Electronic Counter	MIVP	AN/FMN-1 Olympic	AN/FMN-1 Aeronca
RVR - feet	RVR - feet	RVR - feet	RVR - feet
Greater than 9,500	60+	++	60+
Greater than 9,500	60+	++	60+

Phase II - Total Number of Readings in this Category - 3

Example:

Electronic Counter	MIVP	AN/FMN-1 Olympic	AN/FMN-1 Aeronca
RVR - feet	RVR - feet	RVR - feet	RVR - feet
10,000	60+	95	60+
1,700	24	16	20

Phase III - Total Number of Readings in this Category - 12

Example: (see Fig. 15)

On 3 December 1962 at Westover AFB from approximately 1136 to 1236 EST the visibility changed very rapidly, as shown in (Fig. 14) the strip chart recording of the AN/GMQ-10 Transmissometer output. Figure 15 is a plot for this same period of the readings of the various devices which have the capability of recording RVR or transmissivity as a function of time. The MIVP converts the digital output of the AN/GMQ-10 to an analog plot of transmissivity with a constant damping factor. The Aeronca model and electronic counter average the transmissivity value for a time interval of 45 seconds, and 1 minute, respectively. The Olympic model samples the transmissivity during one clock phase and displays the RVR value each minute. It can be seen from Fig. 15 that under rapidly varying visibility conditions the AN/FMN-1 and electronic counter can only approximate the transmissivity curve. The greater rate of change of transmissivity, the further the AN/FMN-1 will depart from the true values of transmissivity. The curves in Fig. 15 of the AN/FMN-1 and electronic counter are only approximate for the following reasons:

1. No attempt was made to synchronize these devices to a common starting period for gating in the transmissivity pulses.

2. Readings were taken on an average of every 3 minutes.

3. Human error becomes significant in attempting to collect data under rapidly changing visibility conditions from the AN/FMN-1, the MIVP and electronic counter, and to correlate time, especially when these devices are located in different parts of the METRO buildings.

4. The Aeronca and electronic counter are digital devices which count the incoming transmissometer pulses for a fixed time duration. On the other hand the Olympic model converts the digital pulse to a voltage level and takes the instantaneous value somewhere during a 1 minute period.

Figure 15 shows that the RVR data obtained from the Aeronca model does not follow the curve contour of the Olympic RVR or electronic counter. The reason for this discrepancy lies in the high susceptibility of the Aeronca RVR to noise, which resulted in erroneous readings during this test. Basically, the Beckman model 7360 RU electronic counter is functionally identical to the Aeronca RVR with the exception that it has no decoding matrix to transform transmissivity to RVR. Both units are identical in that they count the transmissivity pulses for a time increment.

6.6 Category I and II Reliability, Maintainability and Availability Evaluation Tests

During Category I and II testing the AN/FMN-1 was evaluated from reliability and maintainability points of view. In general, both the Aeronca and Olympic units operated satisfactorily during the test period. The major difficulties uncovered were: (1) a problem of short lived lamps in the One-Plane Digital Display Unit of the Aeronca RVR Computer, and (2) various maintainability problems in regard to both units. These problem areas, as well as others of lesser importance, are discussed in detail in subsequent paragraphs.

The length of test time accumulated on the subject units was insufficient to establish with 90 per cent confidence that the MTBF requirement for the RVR computer (see MIL-C-27930) of 1,600 hours was met. However, the probable length of test time necessary to obtain 90 per cent confidence (about two years if the MTBF were actually about 1,600 hours) and the attendant costs involved are incompatible with 433L schedules and budgeting. It is felt that the data presented herein provide a reasonably good picture of RVR computer reliability and maintainability and should, therefore, be utilized to the maximum extent possible to influence future decisions regarding the procurement of a production quantity of RVR computers.

6.6.1 Data Collection

Reliability and maintainability information was accumulated over the entire Category I and II test period. Major sources of information on the Aeronca and Olympic RVR computers were the WSC Operational Trouble and Maintenance (OT&M) Reports, maintenance logs, and other test records and special reports received throughout the test period. Personal interviews with test personnel supplemented recorded data, especially in the maintainability area.

6.6.2 Definitions

The following reliability term definitions will assist in understanding subsequent reliability discussions:

a. Availability (A) - Availability is the percentage of total time (operating plus downtime) that an equipment is actually operable; or alternately, it is the probability that an equipment will be available for use at any given instant:

$$A = \frac{\bar{T}}{\bar{T} + \bar{T}_D}$$

where: $\bar{T}$ = Mean-time-between failures

$\bar{T}_D$ = Mean-downtime-between-failures

b. Downtime (D) - Downtime is defined as the number of calendar hours that the equipment is not available for use. It includes all active maintenance downtime both preventive and corrective. Repair delay time is not considered.

c. Failure Rate (F) - Failure rate is defined for a particular interval as the average number of failures occurring per unit time in that interval. It is assumed that the failure rate is constant during the useful life of the equipment and, therefore, is equal to the reciprocal of the MTBF.

d. Mean-Downtime-Between-Failures ($\bar{T}_D$) - Mean-Downtime-Between-Failures is simply the mean or average of the downtime hours during periods between successive failures. $\bar{T}_D$ may be used as a quantitative expression for maintainability.

e. Mean-Time-Between-Failures ($\bar{T}$ or MTBF) - The MTBF for a particular equipment in a given time interval is the mean value of the operating periods between all failures occurring in that equipment during that interval. It is assumed that the MTBF will remain constant during the useful life of the equipment. The mean operating time between independent failures is used as an index of the reliability of the equipment

6.6.3 Availability (A)

An estimated availability of 99.98 per cent was indicated in the preliminary Reliability Analysis of the Aeronca RVR Computer-Signal Data Converter. Analyses of test data and results indicated availabilities of 99.60 per cent and 98.43 per cent for the Aeronca and Olympic RVR computers, respectively (using C_L values for MTBF, see Fig. 16). The Aeronca result seems to compare favorably with the predicted value.

6.6.4 Mean-Time-Between-Failures

As may be seen by examination of Fig. 16, the measured MTBF's for the Aeronca and Olympic units were calculated to be 834.1 and 498.5 hours, respectively. These values are well below the MTBF requirement of 1,600 hours (see MIL-C-27930) which is expected to be imposed on the production version of this equipment. However, in consideration of the types of failures that did occur during testing (discussed below) and the probable improvements that will be effected in the production units to eliminate many of the types of failures that have occurred, the achievement of the MTBF requirement is believed to be attainable by either the Aeronca or Olympic version. This belief is further strengthened, since a preliminary reliability analysis, using standard reliability prediction techniques, performed on the Aeronca RVR has indicated an approximate MTBF of 1,360 hours for this unit. A similar study, however, could not be made in regard to the Olympic unit due to a complete lack of technical data regarding the numbers and types of parts employed. No manuals, schematics, or other descriptive material were provided with the Olympic unit.

A Chi Square distribution analysis of the data obtained indicates that we can be 90 per cent confident that the MTBF is not less than 474.4 hours for the Aeronca unit and 188.1 hours for the Olympic unit. Refer to Fig. 16 for details.

6.6.4.1 Aeronca RVR Computer

The Aeronca RVR computer, serial number 808-1, was received at the Westover test site on 26 April 1962. Category II testing of this unit was completed by 14 December 1962 at which time 5,004.8 operating hours had been accumulated. Analysis of the data obtained has revealed a total of six relevant failures of the Aeronca unit resulting in a measured mean-time-between-failures (MTBF) of 834.1 hours. Failures of indicator lamp types 47 and 1847 (summarized according to lamp assembly in Fig. 17) were not considered relevant as it was found that these type lamps were being overstressed by operating personnel in an effort to increase the brightness of the display. An operational trouble not considered as a relevant failure was caused by loss of base power. Of the six relevant failures, two were type 44 indicator lamps which were presumably not subjected to overstressing; one was a 2N414 transistor, and three OT&M reports covered dirty contacts of two relays and a switch, and two loose circuit cards. Refer to Fig. 17, which presents a summary of failures for both the Aeronca and Olympic units, for details. It should be noted that there was only one failure (other than display lamps) of the Aeronca RVR that actually required a part replacement.

During the early stages of Category I and II testing, an excessive number of indicator lamps failed in the One-Plane Digital Display Unit of the Aeronca RVR computer. The lamp type in use at the time was GE type 47 with a voltage rating of 6.3 volts. Lamp voltage in the display unit is controlled by a potentiometer over a range of 2 to 11 volts. It was determined that these lamps were being operated at approximately 6.5 volts (to provide adequate display illumination) which was above rated voltage. A more reliable lamp (GE type 1847) was initially recommended as a substitute for type 47 before the overstressing of the lamps became apparent. The problem still existed because adequate display illumination still could not be attained without increasing lamp voltage above rated level. A solution to the problem has apparently been found in the utilization of a type 44 lamp which is identical in size, voltage, and base to types 47 and 1847. Type 44 lamps emit about 80 per cent more candlepower (0.9 versus 0.52) than type 47 lamps, thus providing adequate illumination for proper display readability without necessitating an increase in lamp voltage above the rated 6.3 volts. The upper limit of illumination control, however, should be fixed and should not allow the applied voltage to exceed 6.3 volts to eliminate possible accidental damage.

6.6.4.2 Olympic RVR Computer

Category I and II Tests were performed on Olympic RVR computers, serial numbers 001 and 005, respectively. Total operating time on both units as of 14 December 1962 was 997 hours (300 hours on serial no. 001 - removal on 5 November 1962 and 697 hours on serial no. 005 as of 14 December 1962). During the period of operation two relevant failures occurred both of which were in serial number 001. All Olympic failures are also summarized in Fig. 17. In total, five OT&M reports were received concerning the Olympic units. Of these, the first two received were not considered relevant since the unit was not operational at the time the discrepancies were found. The latest report received as of 14 December 1962 was also not considered relevant since it was caused by loss of base power. The remaining two reports were both concerned with 1N752 zener diode failures in the reference voltage power supply. Based on a total operating time of 997 hours and two relevant failures, an MTBF of 498.5 hours was calculated for the Olympic RVR computer.

6.6.5 Maintainability and Maintainability Design Reviews

Maintainability is expressed herein in terms of Mean-Downtime-Between-Failures ($\bar{T}_D$). This measure includes scheduled maintenance as well as corrective maintenance time, but does not include repair delay time. Analysis of the relevant failures indicated in the test data revealed a $\bar{T}_D$ of about 1.9 hours. Based on the limited failure data received on the Olympic RVR and discussions with test personnel, the $\bar{T}_D$ for the Olympic unit has been estimated as 3.0 hours.

Maintainability design reviews were conducted at the Westover test site on both the Aeronca and Olympic RVR computers. Over 200 maintainability factors covering displays and controls, external and internal accessibility, servicing requirements, tools, test equipment, test points, manuals, cases, cables, and connectors were reviewed with test and evaluation personnel thoroughly familiar with the subject equipments.

6.6.5.1 Aeronca Maintainability Review

1. There are no identification numbers or letters in the power supply section, thus making maintainability difficult.

2. A connector should be provided on the One-Plane Digital Display to facilitate removal for repair. Each of the power supplies (7 total) should be of modular construction with plug-in capabilities.

3. Test points should be provided in a convenient location so that waveforms can be measured by maintenance personnel.

4. Guide pins on the printed circuit card connectors are too soft and bend easily when cards are inserted into the mating connector.

5. The relay "matrix tree" is very difficult to service for purposes of cleaning the relay contacts.

6.6.5.2 Olympic Maintainability Review

1. The "nor" logic cards are very difficult to service due to lack of descriptive marking.

2. Test points exist in the computer; however, they should be grouped in an accessible location.

3. The Bina-View display should be made a plug-in unit through the use of a connector.

4. The matrix control relays are of the mercury "wetted type" and should be replaced with a "dry" type of relay. In order to work on the equipment with the wetted type relays, the equipment must be perfectly level. The relays should also have plug-in capabilities.

5. The terminal boards in the computer should be replaced with plug-in circuit cards. At present the terminal boards have wiring on two sides, and makes circuit tracing nearly impossible.

6. Replacement of the lamps (total of 4) in the Background-Converter switch is difficult to accomplish. A special insert tool is needed.

7. The adjustment of the power supply requires adjustment in the bottom of the RVR chassis while the computer remains level. The adjustment screw should be placed in a position that is accessible from the top.

8. The motor driven servo switch is very difficult to disassemble for purpose of cleaning the contacts.

6.6.6 Reliability Test Review

Based on data resulting from the Category I and II Tests and realizing the nature of the relevant failures of both the Aeronca and Olympic RVR computers, it seems feasible that with some modifications of both units they would be able to meet a design requirement of 1,600 hours MTBF. This reasoning is based on the following facts. In the case of the Aeronca unit (with the exception of the digital display which presumably would be improved or replaced) only one failure required a part replacement. On the basis of one part failure in approximately 5,000 hours of operation, an MTBF of at least 1,600 hours is definitely indicated to at least a 90 per cent confidence level. Repackaging, air filtering, or use of alternate parts should eliminate premature failures due to dirty contacts. On the other hand, in the Olympic unit both relevant failures involved troubles with the reference voltage zener diode in the power supply. Minor redesign of the affected circuitry could greatly improve the MTBF of the Olympic RVR computer. Discounting the two zener diode failures, the 997 hours of operating time accumulated on the Olympic RVR would still be insufficient to indicate a minimum MTBF of 1,600 hours to a 90 per cent confidence level (thus requiring more test time).

One advantage of the Aeronca model is a self-test feature which performs the function of sequencing through the visual circuitry. The Olympic model apparently has a very good display. This display (Bina-View) has good readability and has not presented any reliability problems.

6.7 Human Factor Tests

Human factor tests were performed on the Aeronca and Olympic RVR computers. The devices were found to be adequate in tests of display readability, a static review of components, and a functional evaluation of operating and maintenance procedures.

Performance levels with these devices could be enhanced by modifications in equipment design and such recommendations for those improvements have been included in this report.

6.7.1 Test Objectives

The objective of the human factor test program was to determine whether the two equipments could be adequately used and maintained by the programmed personnel.

Specific objectives were evaluations of performance level as affected by the following equipment characteristics:

a. Readability of displays

b. Placement and labelling of controls and displays

c. Accessibility of equipment for maintenance and the adequacy of adjustment and attach points

d. Design of test devices provided with the equipment

e. Adequacy of equipment operating and test procedures

6.7.2 Deviation From Test Procedure

Some deviations from the test plan were necessary and they are described on the following page.

6.7.2.1 The Magnaline display-indicator was not functionally tested because no circuitry was available to drive it. However, a static review was accomplished and that evaluation revealed serious deficiencies which made it questionable whether a functional review would change the evaluation of that component.

6.7.2.2 It was evident from the data after ten trials that it would not be necessary to conduct the planned number of sixty trials for each display device; and thus, ten trials were accepted as an adequate basis for evaluation.

6.7.2.3 It was apparent from results of readability tests with the Aeronca display at the low and medium brightness levels that additional data by the observers at the high brightness level were unnecessary; thus, further testing on that device was discontinued.

6.7.3 Test Results (References are to Addendum 4 of the Test Plan)

6.7.3.1 Display Readability (Test I-200)

6.7.3.1.1 Procedures

a. Four observers were given the task of reading RVR values from the display of both the Olympic and Aeronca equipment and writing the data on a prepared form.

b. The test conditions were varied so that each observer made 10 to 30 trials under three ambient illumination levels and 1 to 3 display illumination levels. The distances between the observers and the display surfaces were either 5 or 7 feet; these distances cover the likely range of working conditions.

c. An item was scored as an erroneous message when any one of the 2 or 3 characters in the message written by the observer as incorrect, transposed, missing, or added. The number of erroneous messages generated by each observer are outlined in the table which follows.

6.7.3.1.2 Results (see table on page 32)

a. Display device - Erroneous messages occurred only during the use of the Aeronca, and none at all while reading the Olympic device. The most significant difference between these two indicators is the brightness and size of the message characters; these characteristics account for the better reading performance with the Olympic display. The single brightness level of the Olympic indicator is approximately the same level as the brightest output (10 v.) of the Aeronca indicator. The size of the characters is approximately

1 3/8" x 1" for the Olympic and 15/16" x 3/5" for the Aeronca device; this difference is a significant factor in readability at low brightness levels and longer reading distances. Therefore, a comparison of test results between the two displays, when conditions are comparable, indicates insignificant error occurrence in both devices.

b. Brightness level - The data in the table indicate that the variable brightness level of the Aeronca is critical for the correct reading of the display. The Macbeth Illuminometer is not accurate for the measurement of the luminance of the narrow characters on the displays (a spot photometer is required) but the 6.3 v. setting is specified by the manufacturer as approximately 27 foot lamberts. The low brightness setting (2.5 v.) is required and, from the data, appears suitable for night operations. For moderate ambient illuminations, the medium setting is found to be adequate; and for bright environmental illuminations, the high (10.0 v.) setting on the display indicator will be required. It is also evident from these data that the observer can compensate lower brightness levels on the indicators by moving closer to the displays. However, the Olympic indicator with a single high brightness level is shown to be suitable over the range of ambient illuminations and working distances that were evaluated during this testing program.

c. Magnaline display - Readability of this device was not tested under operating conditions; however, assessments of its status characteristics which might induce erroneous readings were noted:

(1) The characters in this display are set back from the face plate by a distance which charply reduces the viewing angle (left to right, or up-down).

(2) The light covers protrude from the front of the display and that feature limits the viewing angle.

(3) The cover glass on the display reflects the ambient light and interferes with the readability of the character.

(4) The height of the characters is smaller than the characters on the other two displays. This small size will make the parameters of reading distance, ambient illumination, and indicator brightness much more critical for efficient readability.

ERRORS IN READING DISPLAY DEVICES

Ambient Illumination (ft.lamberts)	Viewing Distance (feet)	Observer	DISPLAY DEVICE: AERONCA (IEE 10,000 Series) Brightness Level: Low (2.5v)	Medium (6.3v)	High (10.0v)	OLYMPIC (IEE BINA-VIEW)
1. Bright (220)	a) 5	#1	10*	1	0	0**
		#2	10	1	0	0
	b) 7	#3	10	4	0	0
		#4	10	4	1	0
2. Moderate (18)	a) 5	#1	2	0	0	0
		#2	0	0	0	0
	b) 7	#3	6	0	0	0
		#4	6	0	0	0
3. Night (0.01)	a) 5	#1	0	0	-	0
		#2	0	0	-	0
	b) 7	#3	0	0	-	0
		#4	0	0	-	0

Note: *Aeronca, 10 messages per observer
**Olympic, 30 messages per observer

6.7.4 <u>Static Review (Test I-201)</u>

6.7.4.1 Olympic RVR Computer

The examination of the Olympic RVR computer shows that the device was adequately designed. However, some improvements, which would permit better performance levels by the programmed personnel, can be noted.

a. The use of special symbols on the "μ" condition switch is not the best design for position selection when there is a failure in data input from the day-night sensor or the tower light-setting switch. Since the operator will have to set the switch according to the prevailing day-night condition and the runway light setting, it is preferable that it be set with the same symbology used by the tower operator. A better design would be to separate and label the setting according to a day or night group, and then to label the positions within each group according to the light-setting symbols used at the tower.

b. The symbols used on the "μ" condition indicator should be compatible with the symbology adapted for the light-setting condition switch. It also would be desirable to locate the indicator and switch closer together, or even into an integrated subpanel with brighter indicator lamps than presently used.

c. The 42*21 Counter Output lights which appear on the front panel will be used primarily by maintenance personnel. The lamps should be placed behind the front panel.

d. The Counter Output lights illuminate to indicate the <u>absence</u> of a bit signal and, when out, indicate the presence of a bit signal. This situation should be reversed.

6.7.4.2 Aeronca RVR Computer

The analysis of the Aeronca RVR computer demonstrated that the device was adequate in design for the use of the programmed operators. Some recommendations may be made to effect an improvement of this device:

a. The Aeronca display provides a "T" character in the third position when the computer is in the test mode; however, under test a "+" or "-" character is sometimes superimposed on the "T" character. This condition generates a display in which the "+" or "-" cannot be distinguished by the maintenance technician. The use of a white lamp marked TEST instead of the display of a "T" character would be one way to avoid this difficulty.

b. When the card extender, which is of metallic construction, is used to test circuit cards there is danger of shorting out other cards. Therefore, the card extender should be constructed of non-conductive material.

6.7.5 Functional Review (Test I-202)

6.7.5.1 Olympic RVR Computer

The operation of the Olympic RVR computer under prevailing conditions was reviewed for the adequacy and completeness of its operating and maintenance procedures. Some improvement would be effected if, during night conditions, an auxiliary light source was made available when making background corrections or changing the "u" condition switch. Otherwise, no illumination is provided for the transmissivity meter or for the "u" condition switch.

6.7.5.2 Aeronca RVR Computer

Operating procedures were found to be satisfactory but some recommendations for improvement can be made:

1. The technique for background correction requires a waiting interval for the appearance of the transmissivity Ready Light and then a switching action to the "Trans" position on the "Trans Background Switch" within a 15 second period. This procedure has the disadvantage of requiring a high degree of attention to the task.

2. The test procedure for checking the lamps does not provide a check for the L symbol.

3. The power supply test and adjustment are very difficult to accomplish. In order to gain access to the output points it is necessary to remove the bottom of the power supply drawer and make adjustments from the under side position.

4. No built-in illumination has been provided for the controls and, when they are used at night, some auxiliary source of illumination will be required.

ANNEX A

Test Support Requirements
Category I and II Test Plan for RVR Computers

1. PURPOSE

To indicate test and support equipment required to provide support for Category I and II testing of the Aeronca RVR computer and Category II testing of the Olympic RVR computer.

2. TEST EQUIPMENT

The following test equipment, or equivalent was necessary to support these tests, and was provided by the Test Agency:

Oscilloscope, AN/USM-81	1	FSN 6625-649-5279
Oscillator Hewlett-Packard Model 211AR	1	
Universal EPUT and Timer Beckman Model 7360 RU	2	
Multimeter, AN/PSM-6	1	FSN 6625-724-8582
5" Oscilloscope Camera Analab Type 3001	1	
115 Volt, 1.0 KVA Variac Superior Electric 3PN-116	1	
Random Noise Generator H. B. Scott	1	
Digital Voltmeter Electronic Associates, Inc. Model 5000	1	
Illuminometer, Macbeth	1	
Stop Watch		
Twelve Inch Rule	1	

3. REFERENCES

3.1 Handbooks

3.1.1 Instruction Manual for Runway Visual Range Computer - Aeronca Manufacturing Corporation

3.1.2 Olympic Design Study Modified AN/FMQ-5

3.2 Specifications

3.2.1 System Runway Visual Signal Data Converter Specification

No. 4519167 - United States Department of Commerce Weather Bureau, dated 1 Feb. 1962.

Exhibit AFCRC 59-6, Amended by ECT ORT 1-713-18, 19 June 1961.

3.3 Special Reports

3.3.1 System 433L Test and Evaluation Plan WSC E-15 - United Aircraft Corporation

3.3.2 System 433L Reliability Plan WSC E-14 - United Aircraft Corporation

3.4 Logistical Data

3.4.1 Cognizant Agency - Air Force Cambridge Research Laboratories

3.4.2 Development Agency - FAA and United States Weather Bureau

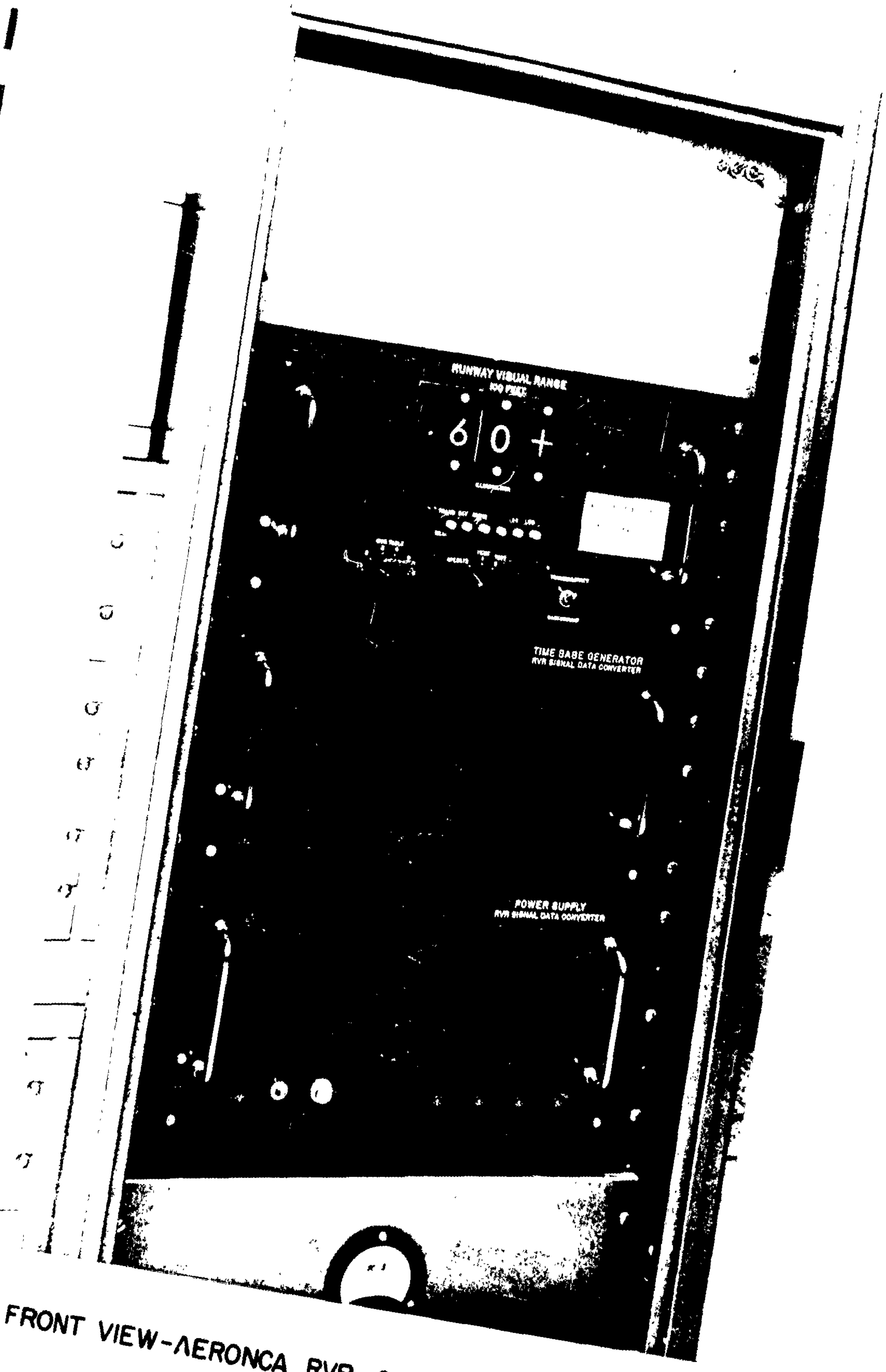


Figure 1A. FRONT VIEW-AERONCA RVR COMPUTER PANEL ASSEMBLY

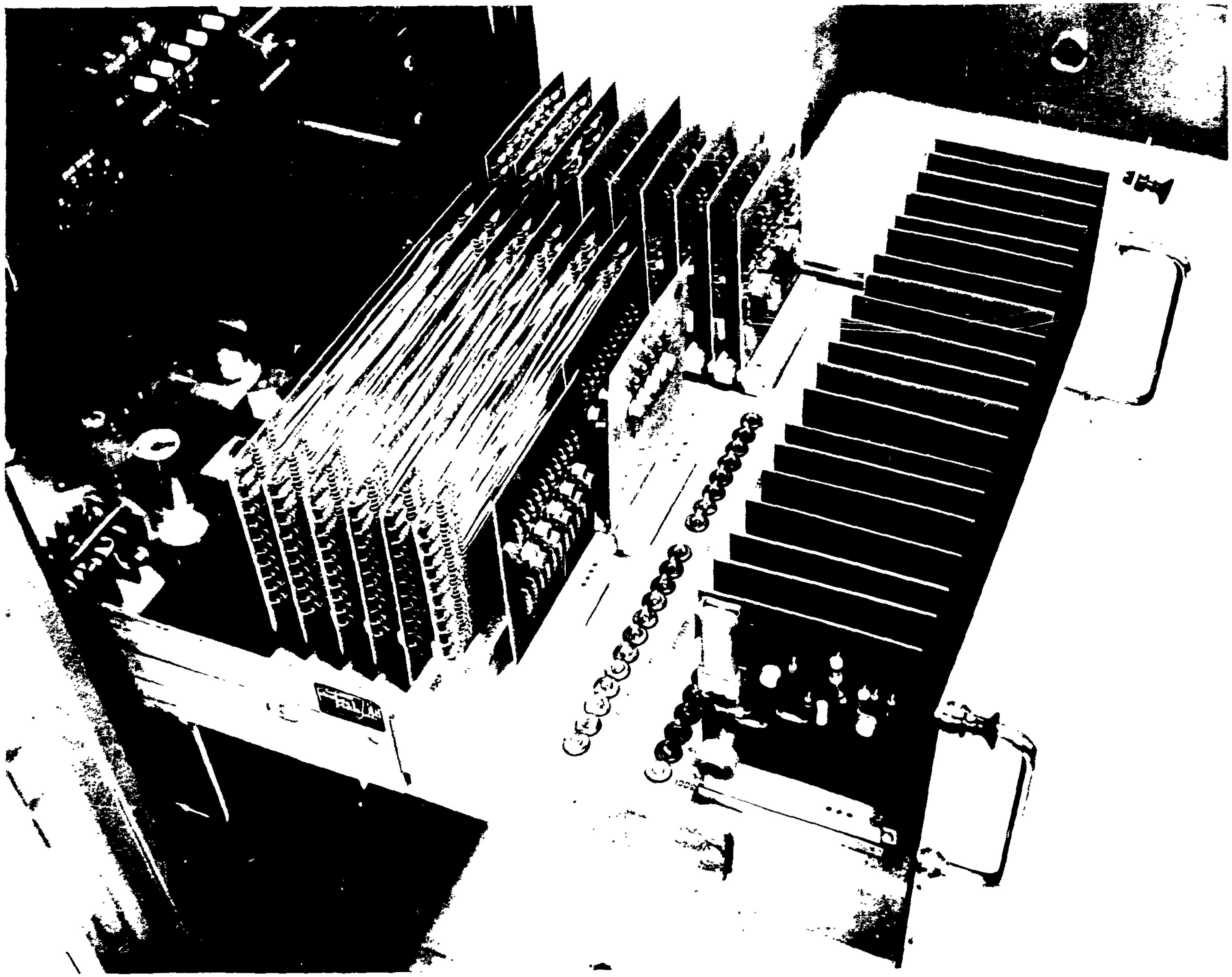


Figure IB. INTERIOR VIEW-AERONCA RVR COMPUTER PANEL ASSEMBLY

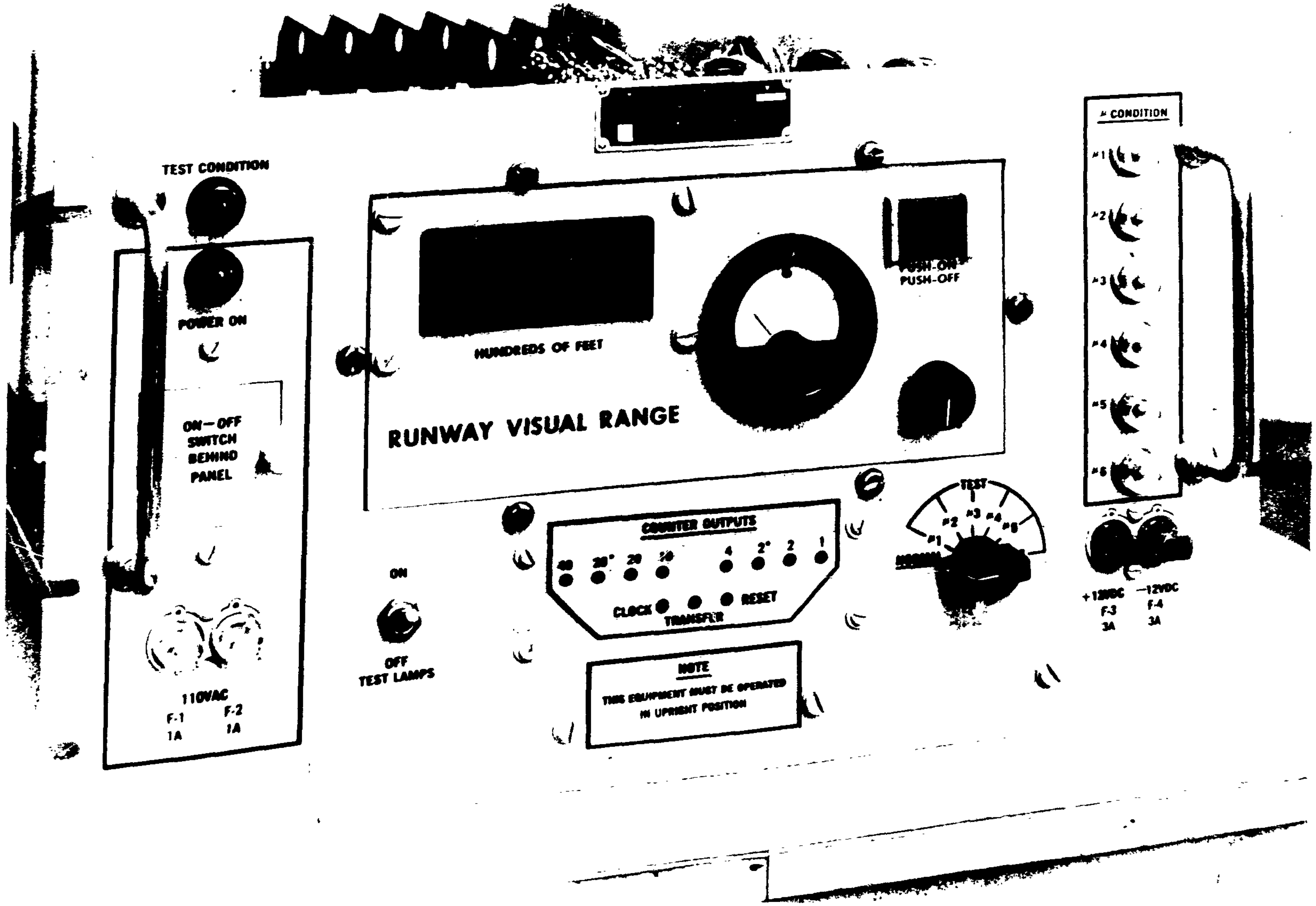


Figure 2A. FRONT VIEW - OLYMPIC (XD-3) RVR COMPUTER PANEL ASSEMBLY

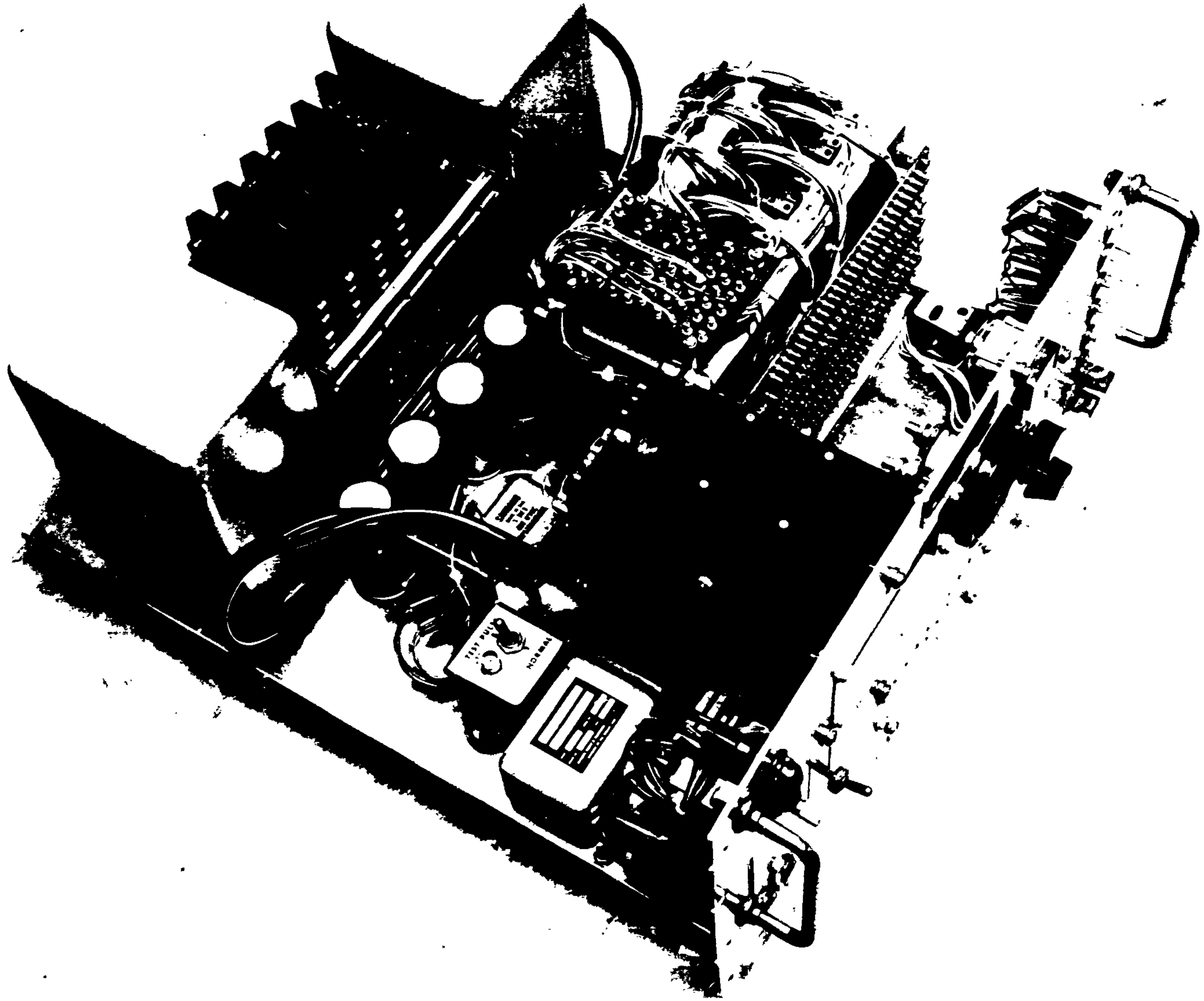


Figure 2B. INTERIOR VIEW– OLYMPIC (XD-3) RVR COMPUTER PANEL ASSEMBLY

MANPOWER LOG

STATION: Westover AFB, Chicopee Falls, Mass.

EQUIPMENT: Olympic XD-3 RVR Computer

SHEET NO. 1

DATE	TIME	MAN HOURS EXPENDED	REFERENCE	TASK SUMMARY	INITIALS
9/24/62	Not Applicable	8	Maintenance	Initial Installation	
9/25/62	Not Applicable	6	Modification and Test	Troubleshooting Revise Input Circuit and I-102B	
9/26/62	Not Applicable	1	Modification	Install Time Meter	
10/1/62	Not Applicable	3	Test	Installation Test	
10/3/62	Not Applicable	6	Maintenance	Initial Installation Troubleshooting	
10/4/62	Not Applicable	4	Maintenance	Initial Installation Troubleshooting	
10/11/62	Not Applicable	6	Modification	Fabricate and Install Reference Voltage Reg.	
10/12/62 thru 10/19/62	Not Applicable	40	Modification and Maintenance	Install Line Voltage Regulator Install DC Power Switch Troubleshooting	
10/22/62	Nct Applicable	8	Test	I-103B, I-105B and I-106B	
10/25/62	Not Applicable	8	Test	I-107B and I-104B	
10/29/62 thru 10/30/62	Not Applicable	10	Test	I-108B	

FIG. 3

MAINTENANCE LOG

LOCATION: Westover AFB, Chicopee Falls, Mass.

EQUIPMENT: Olympic XD-3 RVR Computer

COMPONENT	DATE	EQUIPMENT TIME IN - OUT	FAILURE REPORT NO.	TASK	SUMMARY AND REMARKS	INITIALS
	9/24/62	Not Applicable	238	Maintenance	Replaced CR3 Diode	
	9/24/62	Not Applicable	239	Maintenance	Disassemble, clean, align and reassemble Langevin Motor driven switch	
	9/25/62	Not Applicable	-	Modification	Revise Input Circuit	
	9/26/62	Not Applicable	-	Modification	Install Time Meter	
	10/11/62 thru 10/19/62	Not Applicable	255	Modification	Install Transistor voltage regulator for 5.6V Reference Supply	
			255	Modification	Install Line Voltage Regulator	
			255	Modification	Install DC Power Switch	

FIG. 4

UNITED AIRCRAFT CORP.
WEATHER SYSTEM CENTER

OPERATIONAL TROUBLE & MAINTENANCE REPORT

A. REPORT NO. 2 3 5

B. STATION CODE C E F

C. REPORT TYPE
- [X] OPERATIONAL TROUBLE
- 2 PREVENTIVE MAINTENANCE
- 3 UNSCHEDULED MAINTENANCE
- 4 BENCH REPAIR
- 5 MODIFICATION
- 6 STOCK DEFECTIVE
- 7 MAINTENANCE TEST

D. DATE OF TROUBLE OR MAINTENANCE MONTH 9 DAY 21 YEAR 62

E. TIME METER DESIGNATION — READING 2 8 7 5 0

F. WSC EQUIPMENT NO. / LONG LINES, CABLE, WIRE NO. 1 4 3 C

G. EQUIP. / LOWEST SUB-DIV. SERIAL NO. 0 8 1

H. PM ROUTINE / FIELD CHANGE NO.

OPERATIONAL TROUBLE DATA

I. FIRST INDICATION
- 1 ALARM
- [X] DISPLAY ERROR
- 3 INDICATOR ERROR
- 4 MONITOR ERROR
- 5 USER REPORT
- 6 INOPERATIVE
- 7 LOW PERFORMANCE
- 8 NOISE / VIBRATION
- 9 INTERMITTENT / UNSTABLE
- 0 OTHER, EXPLAIN

J. ISOLATED TO
- [X] STATION EQUIPMENT
- 2 INSIDE WIRING / CABLING
- 3 OUTSIDE WIRING / CABLING
- 4 LONG LINES
- 5 BASE POWER
- 6 COMMERCIAL POWER
- 7 OPERATOR
- 8 OTHER STATION, EXPLAIN
- 9 NOT FOUND
- 0 OTHER, EXPLAIN

K. CAUSE
- 1 EXTREME AMBIENT TEMPERATURE
- 2 SHOCK / VIBRATION
- 3 POWER SURGE / FAILURE
- 4 DESIGN DEFECT
- 5 FAULTY INSTALLATION
- 6 OPERATOR ERROR
- 7 FAULTY ASSEMBLY
- 8 HANDLING / MAINTENANCE DAMAGE
- [X] UNDETERMINED
- 0 OTHER, EXPLAIN

L. ACTION TAKEN
- [X] REPLACED PARTS
- B REPL. UNITS/MODULES
- C REPL. WIRE / CABLE
- D REPAIRED
- E ADJUSTED / CALIBRATED
- F CORRECTED OPERATOR ERROR
- G TROUBLE CLEARED, CAUSE UNKNOWN
- H SWITCHED TO ALTERNATE EQUIPMENT
- I INSTALLED FIELD CHANGE
- J PM CHECK ONLY
- O OTHER, EXPLAIN

REPLACEMENT & ADJUSTMENT DATA IF PART WAS ADJUSTED ONLY COMPLETE BLOCKS M,O,Q & R IN THIS SECTION

M. PART REFERENCE SYMBOL OR UNIT / MODULE NO.	N. SERIAL NUMBERS FAILED ITEM	N. SERIAL NUMBERS REPLACEMENT	O. DESCRIPTION	P. FEDERAL STOCK NUMBER	Q. MANUFACTURER	R. TYPE OF FAILURE	S. PRIMARY OR SECONDARY FAILURE	T. REPLACEM'T AVAILABLE LOCALLY ?
Q 2			Transistor	2N414	SYL	735	[P] S	Y [N]
							P S	Y N
							P S	Y N
							P S	Y N
							P S	Y N

U. SYSTEM FUNCTION AFFECTED

V. DOWNTIME DAYS — HOURS 3 TENTHS 0

W. REPAIR DELAY TIME DAYS — HOURS 1 TENTHS 5

X. MAINTENANCE TIME MAN-HOURS 1 TENTHS 5

Y. REPORTED BY NAME F. D. Konczal CODE 2

Z. REMARKS LIST MAINTENANCE DIFFICULTIES ENCOUNTERED, i.e., INADEQUATE TOOLS, TEST EQUIPMENT, OR TECHNICAL LITERATURE. ALSO LIST UNUSUAL CONDITIONS AND RECOMMENDATIONS. ATTACH ADDITIONAL SHEETS IF NECESSARY.

Q-2 is part of Card Assembly J-2014

FIG. 5

FIG. 6

OPERATIONAL LOG CAT. II
AERONCA RVR COMPUTER

Location: Metro Bldg. Westover AFB
Date: 23 July 1962

Sheet No. 5

	1 Background Count EPUT Meter	2 Transmissivity Count EPUT Meter	3 RVR Reading (LS-5)	4 ID/353 Reading	5 Visual Range Estimate	6 Type of Weather	7 Remarks	8 Time of Observation
1	4	2994	60+	10	7	0	Runway 23	1230Z
2	6	2947	60+	10	8	0	Runway 23	1358Z
3	8	2920	60+	7	10	0	Runway 23	1458Z
4	12	2937	60+	7	10	0	Runway 23	1557Z
5	6	2919	60+	7	8	0	Runway 23	1656Z
6	6	2753	60+	1 1/4	5	RW-H	Runway 05	1756Z
7	11	2910	60+	6	5	H	Runway 05	1856Z
8	14	2876	60+	5	3	RW-H	Runway 05	1956Z
9								
10								
11								
12								
13								
14								
15								
16								

COMPARATIVE TEST LOG CAT. II

OLYMPIC XD-3 RVR COMPUTER SER. #001

Location: Metro Bldg. Westover AFB
Date: November 12, 1962 to November 15, 1962

Sheet No. 1

	1	2	3	4	5	6	7	8	9	10	11	12
	Background Count		RVR Reading									
	Electronic Counter Pulse/Min.	MIVP Hi Sens. ma	Electronic Counter Pulse/Min.	MIVP Sensitivity Lo ma	MIVP ft.	Aeronca RVR ft.	Olympic RVR ft.	Visual Range Estimate mi.	Light Intensity Setting	Day or Night	Remarks	Zebra Time
1	4	.04	4023	1.0	60+	60+	++	15+	u5	D	Clear	1330
2	4	.02	4025	1.0	60+	60+	++	15+	u5	D	Clear	1530
3	4	.02	4030	1.0	60+	60+	++	15+	u5	D	Clear	1730
4	4	.02	3978	1.0	60+	60+	++	15+	u5	D	Cldy	1930
5	1	0	4002	1.0	60+	60+	++	15+	u5	D	Cldy	1330
6	2	0	3977	1.0	60+	60+	++	10	u5	D	Cldy	1600
7	1	0	3977	1.0	60+	60+	++	9	u5	D	Cldy	1800
8	0	0	3888	0.97	60+	60+	++	7	ul	D	R--	2000
9	0	0	3900	0.94	60+	60+	++	4	ul	D	R- H	2115
10	2	.03	3628	1.0	60+	60+	++	15	u5	D	Cldy	1300
11	2	0	4074	1.0	60+	60+	++	15	u5	D	Cldy	1500
12	2	0	3982	1.0	60+	60+	++	15	u5	D	Cldy	1700
13	3	0	3947	1.0	60+	60+	++	15	u5	D	Cldy	1900
14	2	0	3983	1.0	60+	60+	++	15	u5	D	Cldy	2100
15	2	.04	4023	1.0	60+	60+	++	15	u5	D		1300
16	5	.05	4062	1.0	60+	60+	++	15	u5	D		1500
17	8	.05	3992	1.0	60+	60+	++	15	u5	D		1700
18	0	.02	4141	1.0+	60+	60+	++	15+	u5	D	1-	1900

FIG. 7

OVER-ALL TRANSMISSOMETER SIMULATION COUNT
AERONCA RVR COMPUTER

Pulse Count per 45 Second	LS5-N		LS4-N		LS3-N		LS5-D		LS4-D		LS3-D	
	Ideal	Measured	Ideal	Measured	Ideal	Measured	Ideal	Measured	Ideal	Measured	Ideal	Measured
0	10-	10-	10-	10-	10-	10-	10-	10-	10-	10-	10-	10-
74	16	16	14	14	12	12	10-	10-	10-	10-	10-	10-
392	24	24	22	22	18	18	12	12	10	10	10-	10-
572	30	30	26	26	22	22	14	14	12	12	10-	10-
840	36	36	32	32	26	26	18	18	14	14	10	12
1390	55	55	45	45	38	38	24	24	18	18	18	18
1540	60	60	50	50	45	45	28	28	22	22	22	22
2047	60+	60+	60+	60+	60+	60+	38	38	38	38	38	38
2331	60+	60+	60+	60+	60+	60+	60	60	60	60	60	60

FIG. 8

FIG. 9

BACKGROUND COUNT

AERONCA RVR COMPUTER

Background Count Pulses/usec	Transmissivity Count Pulses/usec	Difference Count Pulses/usec	RVR x 100	
			Ideal Ft.	Measured Ft.
100	1000	900	38	38
200	2000	1800	60+	60+
50	500	450	26	28
75	750	675	32	32
150	1500	1350	55	55

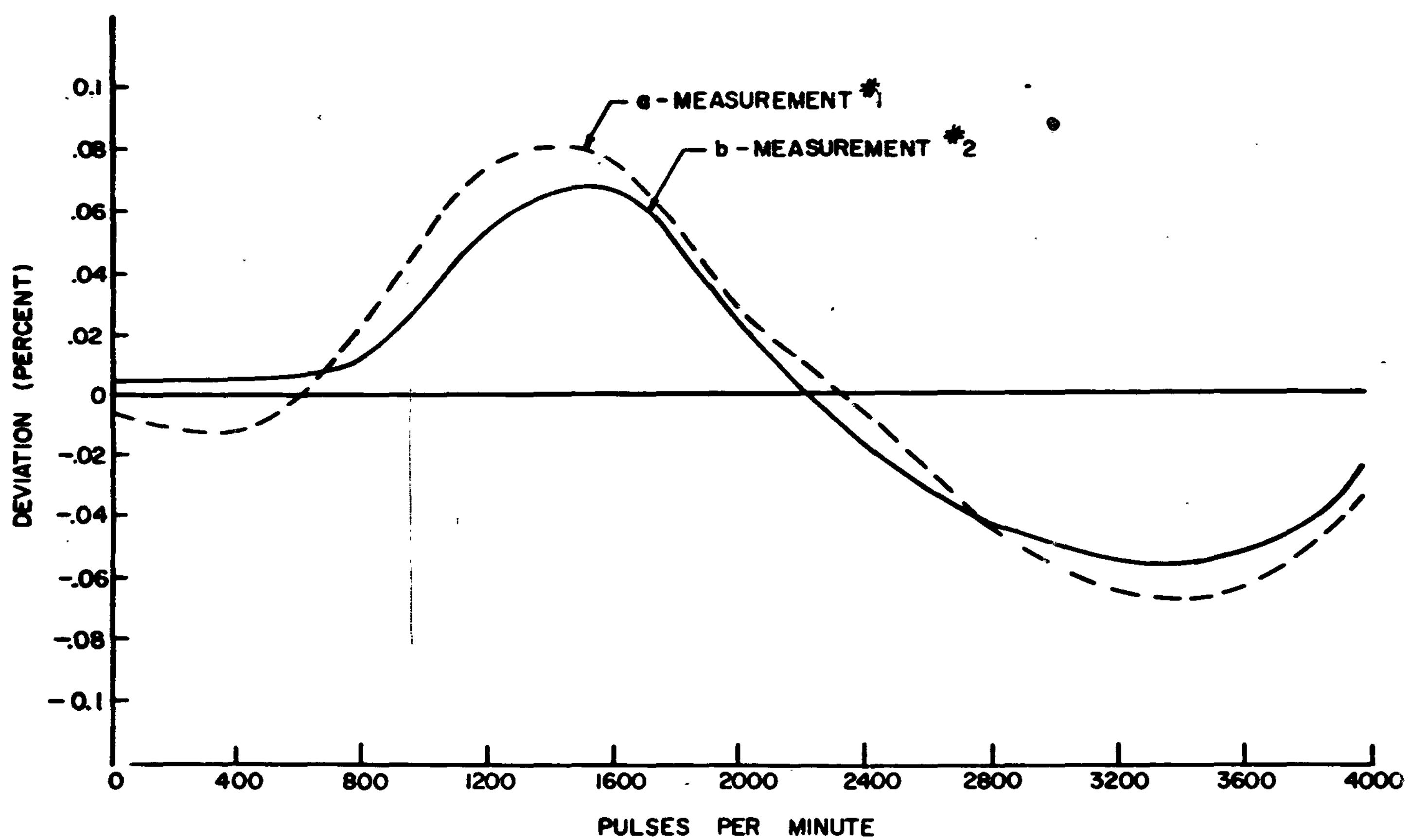


Figure 10. PERCENT OF DEVIATION - STRAIGHT LINE FUNCTION VS. THE OLYMPIC RVR PULSE RATE INTEGRATOR'S APPLIED FREQUENCY

OVER-ALL TRANSMISSOMETER SIMULATION
OLYMPIC XD-3 RVR COMPUTER

PULSES PER MIN.	PULSES PER SEC.	TRANSMISSIVITY		RVR (feet) $\mu 1$		RVR (feet) $\mu 2$		RVR (feet) $\mu 3$	
		COMPUTED	RECORDED	COMPUTED	RECORDED	COMPUTED	RECORDED	COMPUTED	RECORDED
400	6.6	0.1	0.1	2200	2200	2200	1800	1600	1600
800	13.3	0.2	0.2	3000	3000	2600	2600	2200	2200
1200	20.0	0.3	0.3	3800	3800	3400	3400	2800	2800
1600	26.6	0.4	0.4	5000	5000	4000	4000	3400	3400
2000	33.3	0.5	0.5	6000	6000	5000	5000	4000	4000
2400	40.0	0.6	0.6	7500	7500	6500	6500	5000	5500
2800	46.6	0.7	0.7	++	++	8500	8500	6500	7000
3200	53.3	0.8	0.8	++	++	++	++	9500	9500
3600	60.0	0.9	0.9	++	++	++	++	++	++
4000	66.6	1.0	1.0	++	++	++	++	++	++

FIG. 11

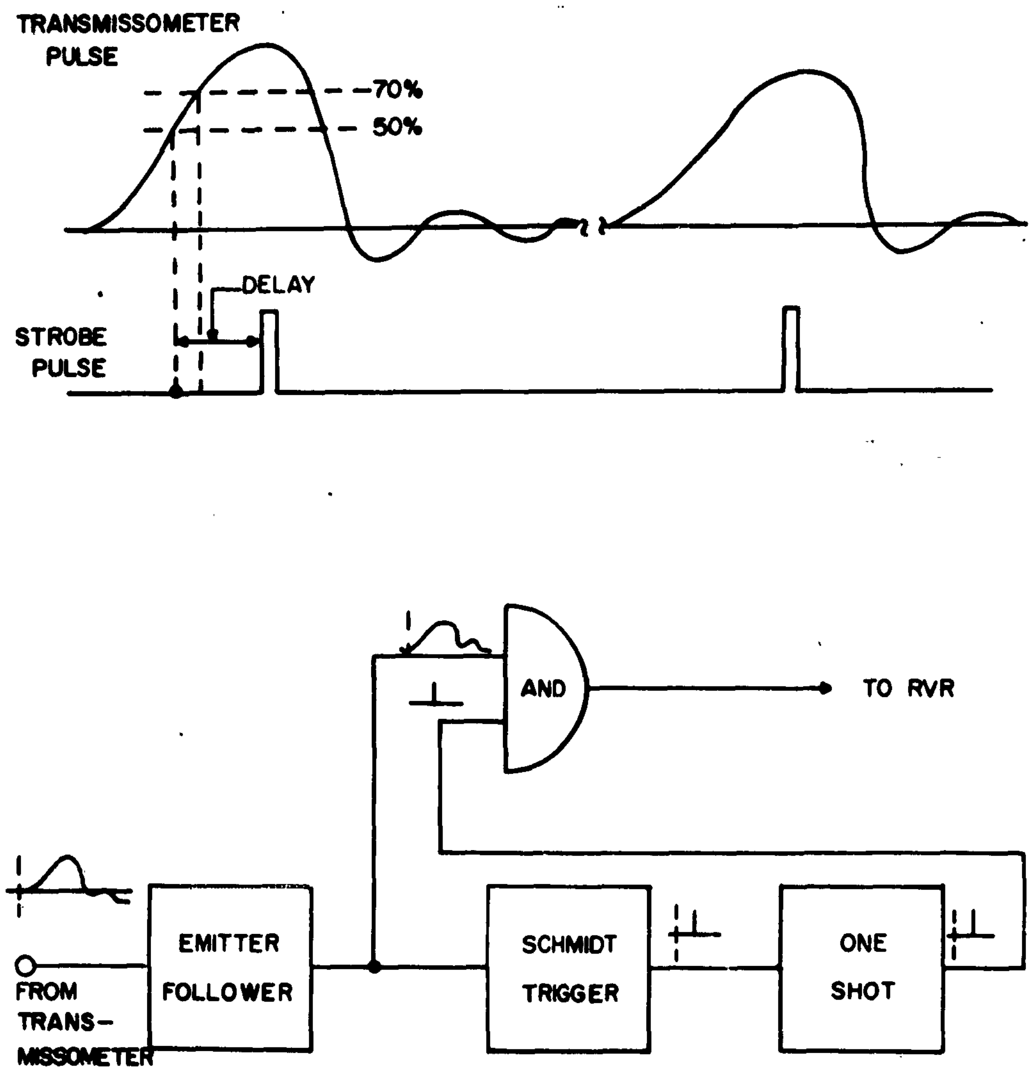
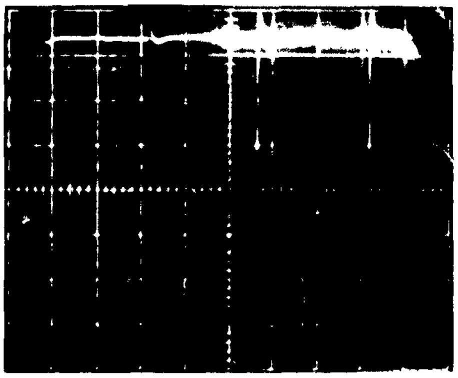


Figure 12. NOISE SUPPRESSION LOGIC DIAGRAM

1. TIME (HORIZONTAL) 5MS/CM
AMPLITUDE (VERTICAL) 5V/CM
DC INPUT



2. TIME (HORIZONTAL) 5MS/CM
AMPLITUDE (VERTICAL) 5V/CM
DC INPUT

3. TIME (HORIZONTAL) 5MS/CM
AMPLITUDE (VERTICAL) 5V/CM
AC INPUT

Figure 13. PHOTOGRAPHS OF AN/GMQ-10 TRANSMISSOMETER PULSE

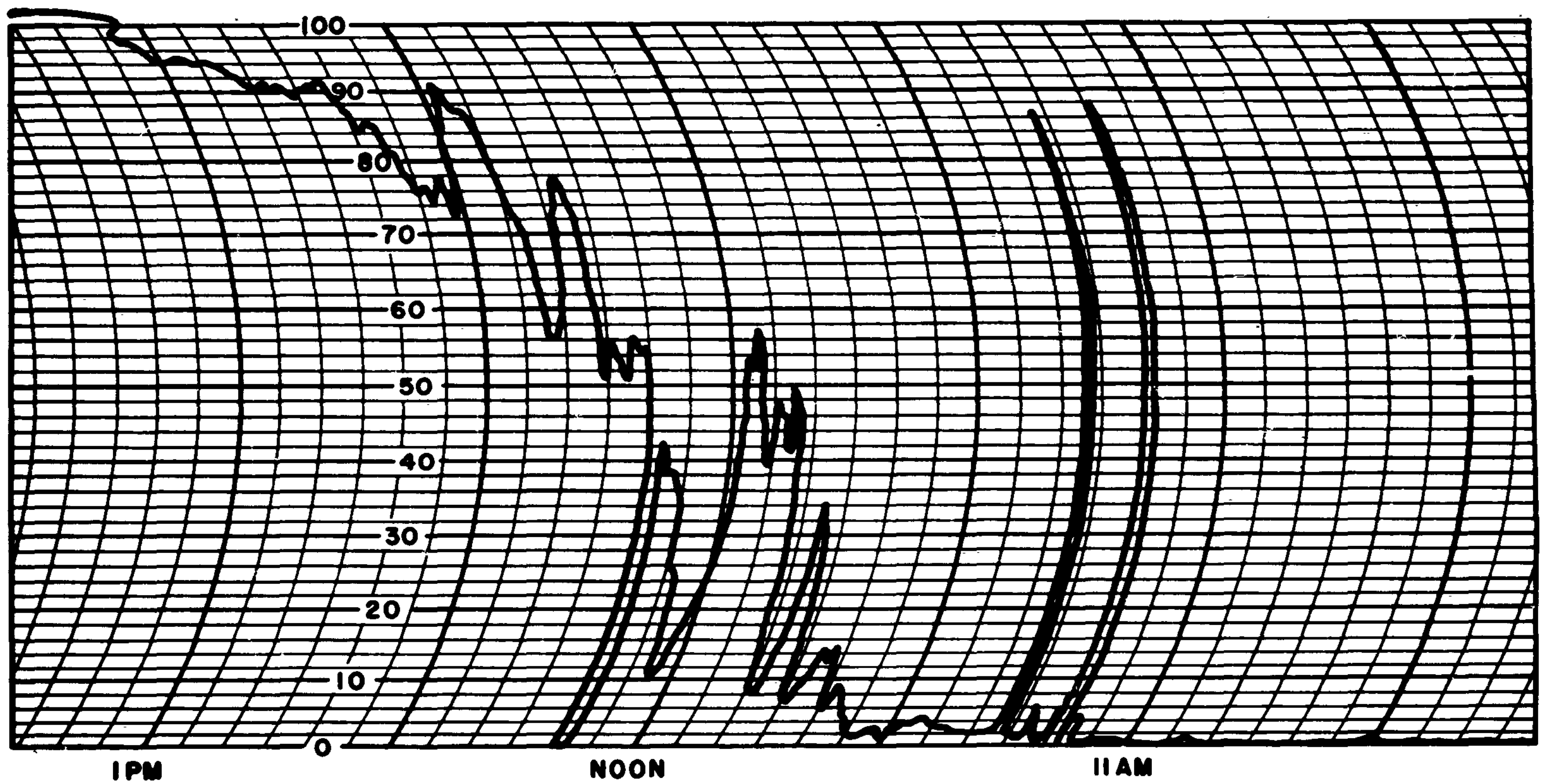


Figure 14. AN/GMQ-10 TRANSMISSIVITY RECORDING FOR DECEMBER 3, 1962

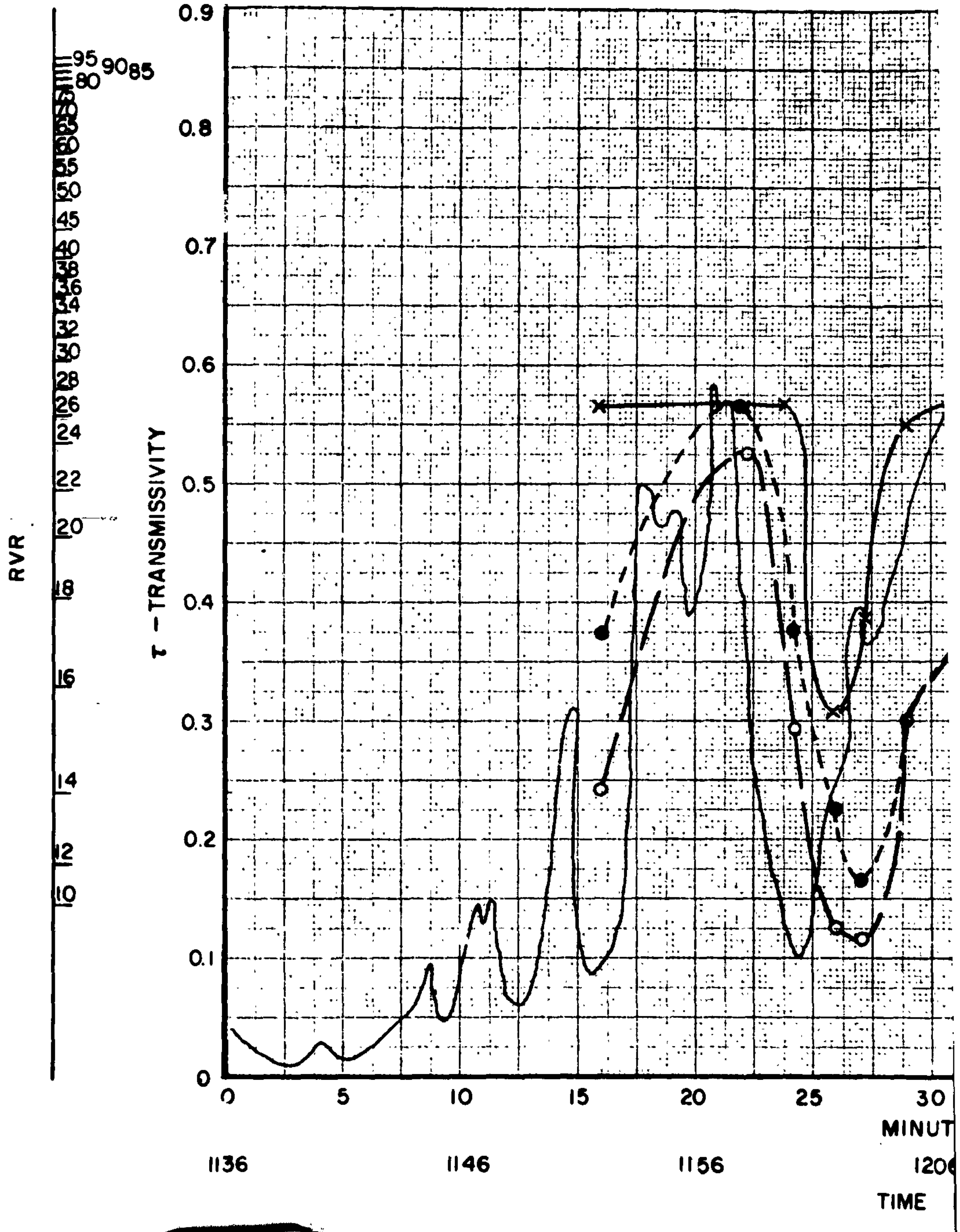


Figure 15. COMPARISON T
WESTOVER AFB, DEC. 3,
LIGHT SETTING-LS5-

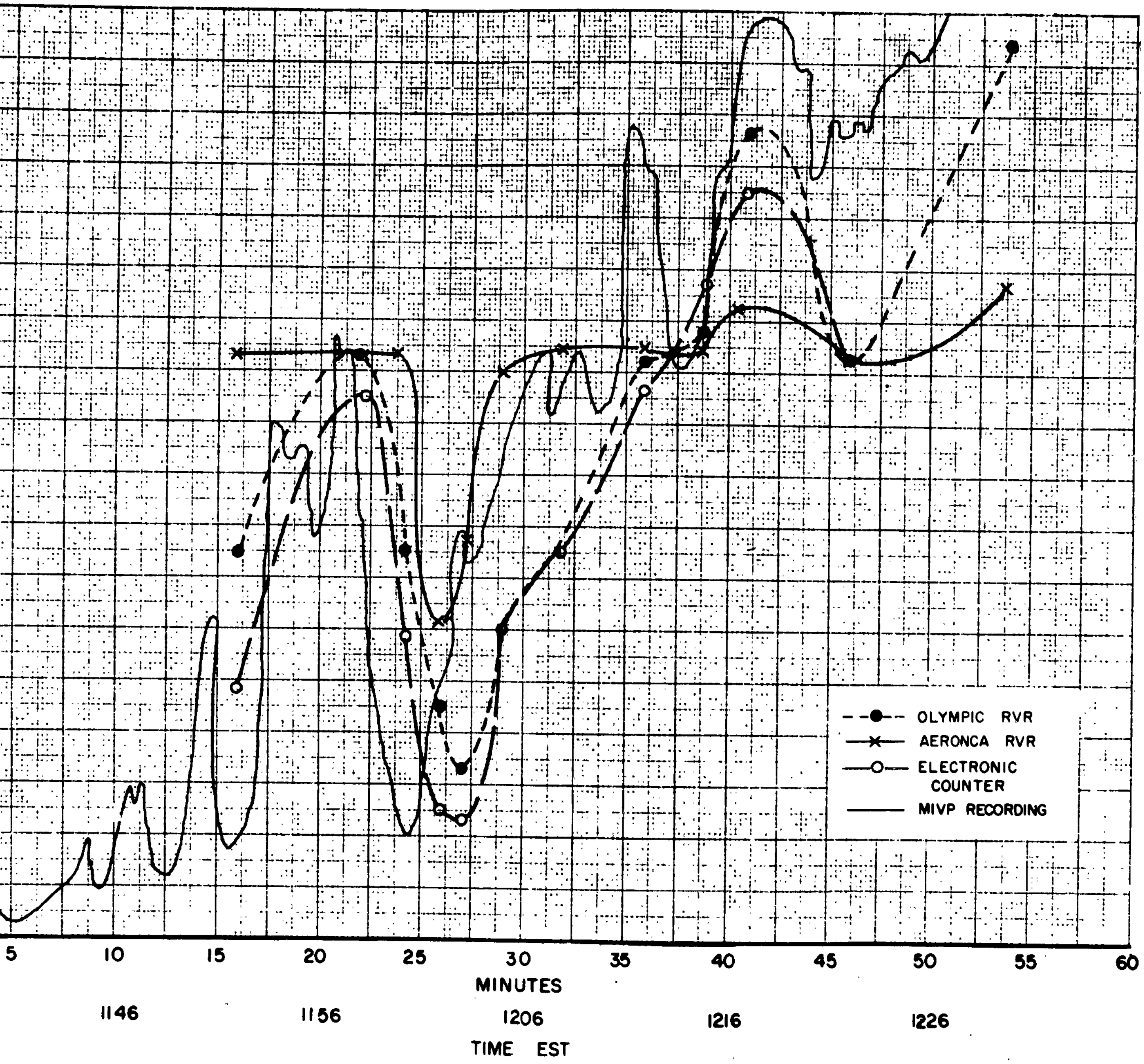


Figure 15. COMPARISON TEST
WESTOVER AFB, DEC. 3, 1962
LIGHT SETTING-LS5-D

2

FIG. 16

SUMMARY OF C_L, MEAN DOWNTIME & AVAILABILITY
RVR COMPUTERS

Equipment	Measured $\bar{T}$ (hours)	C_L Value* (for $\bar{T}$)	T_D (hours)	A (%)
Aeronca RVR	834.1	474.4	1.9	99.60
Olympic RVR	498.5	188.1	3.0	98.43

$$*C_L = \frac{2r\bar{T}}{X^2(\ ;2r+2)}$$

where:
r = number of relevant failures

$\bar{T}$ = measured MTBF in hours

X^2 = Chi Square based on 90% confidence level and 2r+2 degrees of freedom

FIG. 17

SUMMARY OF AERONCA DISPLAY LAMP FAILURE
LAMP TYPES 47 AND 1847

Date	OT&M Report No.	Time Meter Reading	Display Symbol or Number	Lamp Type
		Lamp Assembly DS 2012		
5/ 7/62	132	(none)*	+	47
5/ 7/62	134	"	+	47
5/15/62	147	"	+	47
7/11/62	203	1147.7	+	1847
7/11/62	205	1152.6	-	47
9/19/62	233	2880.0	+	47
		Lamp Assembly DS 2013		
5/ 3/62	129	(none)*	0	47
5/ 7/62	133	"	60	47
5/ 9/62	138	"	0	47
5/15/62	147	"	0	47
6/15/62	382	533.6	0	47
7/23/62	207	1436.6	0	1847
9/13/62	226	2682.5	0	1847
9/17/62	228	2775.5	0	1847
9/24/62	237	2947.0	0	1847
		Lamp Assembly DS 2014		
5/ 7/62	133	(none)*	0	47
5/11/62	145	"	60	47
5/15/62	147	"	10	47
7/11/62	203	1147.7	60	47
8/ 6/62	210	1778.7	60	47
8/16/62	214	2018.4	60	1847
8/31/62	217	2370.4	10	47
9/19/62	233	2880.0	60	1847
9/24/62	237	2947.0	60	1847

*Time Meter not installed

WSC OPERATIONAL TROUBLE AND MAINTENANCE REPORT

EQUIPMENT / SYSTEM		STATION		
NOMENCLATURE	CODE #	NAME	CODE	RE
AN/FMN-1 RVR Computer	143	Westover Air Force Base	CEF	DA

REPORT NO.	DATE MO.	DATE DAY	REPORT TYPE	EQUIPMENT / SYSTEM DATA: WSC EQUIP LL, C OR W NO.	EQUIP LOW SUB DIV. S/N	TIME METER DES.	TIME METER READING	P.M. ROUT./ F.C. NO.	FIRST IND.	ISOL. T.Q.	CAUSE	ACTION TAKEN	MAINTENANCE DATA: SYSTEM FUNCT. AFFECT.	DOWNTIME DAYS	DOWNTIME HRS & 10THS	REPAIR DELAY TIME DAYS	REPAIR DELAY TIME HRS & 10THS	MAINT. TIME MAN HRS & 10THS
				AERONCA	RELEVANT		FAILURES											
235	9	21	1	143C	08-1		2875.0		2	1	9	A			3.0		1.5	1.5
251	10	15	1	143C	08-1		3451.0		2	1	4	A			0.1			0.1
262	10	31	1	143C	08-1		3840.0		2	1	4	D			23.0		17.0	6.0
265	11	12	1	143C	08-1		4121.0		2	1	0	0			3.0			3.0
268	11	13	1	143C	08-1		4194.1		2	1	9	A			0.1			0.1
269	11	16	1	143C	08-1		4223.0		2	1	9	0			1.0		0.5	0.5
				AERONCA	NON-RELEVANT		FAILURES		(OTHER THAN TYPE 47 OR 1847 LAMPS)									
279	11	29	1	143C	08-1		4532.0		2	5	0	0			6.0			
				OLYMPIC	RELEVANT		FAILURES											
254	10	5	1	143B	001							I		15	8.0	15		8.0
255	10	5	1	143B	001							I			4.0		1.0	3.0
				OLYMPIC	NON-RELEVANT		FAILURES											
238	9	24	3	143B	001							A			0.5			0.5
239	9	24	3	143B	001							D			3.0			3.0
280	11	29	1	143B	005				2	5	0	0			6.0			

FIG. 18

ONAL TROUBLE AND MAINTENANCE REPORT SUMMARY SHEET

	STATION			FROM	TO
E #	NAME	CODE	REPORT NOS.	235	280
43	Westover Air Force Base	CEF	DATES	5/3/62	12/14/62

TA						MAINTENANCE DATA						REP'L, REPAIR AND ADJUST. DATA									REP. BY	REMARKS
	P.M. ROUT./ F.C. NO.	FIRST IND.	ISOL. TO	CAUSE	ACTION TAKEN	SYSTEM FUNCT. AFFECT.	DOWNTIME DAYS	DOWNTIME HRS & 10THS	REPAIR DELAY TIME DAYS	REPAIR DELAY TIME HRS & 10THS	MAINT. TIME MAN HRS & 10THS	PART REF, SYMBOL OR UNIT/MOD. NO.	SERIAL NOS. FAIL. ITEM	SERIAL NOS. REP'L	FEDERAL STOCK NO.	MANUF.	TYPE OF FAILURE	PRI/SEC FAILURE	REP'L AV LOCALLY			
)		2	1	9	A			3.0		1.5	1.5	Q-2			Transistor 2N414	SYL	735	P	N		2	Y
)		2	1	4	A			0.1			0.1	DS2014			Lamp 44	CMI	080	P	Y		2	Y
)		2	1	4	D			23.0		17.0	6.0	S-2001			Switch	UNK	160	P	N		2	Y
												J-3031			Card	"	730	P	N			
												J-3021			Card	"	730	P	N			
)		2	1	0	0			3.0			3.0	K-2003			Relay		567		-		2	Y
L		2	1	9	A			0.1			0.1	DS-2013			Lamp 44	CM	080	P	Y		2	Y
)		2	1	9	0			1.0		0.5	0.5	K-2014			Relay		567		-		2	Y
ES		(OTHER THAN TYPE 47 OR 1847 LAMPS)																				
)		2	5	0	0			6.0							Loss of Base Power to Transmissometer						2	Y
					I		15	8.0	15		8.0	CR3			IN752 (ZENER)	HU	450	P	N		2	Y
					I			4.0		1.0	3.0	CR3			IN752 (ZENER)	HU	450	P	Y		2	Y
ES																						
					A			0.5			0.5	CR3			Diode IN457	HU	380	P	Y		2	Y
					D			3.0			3.0	PP 21364			Motor Driven Switch	LAN	005	P			2	Y
		2	5	0	0			6.0							Loss of Base Power to Transmissometer						2	Y

2

OPERATIONAL TROUBLE & MAINTENANCE REPORT FORM CODES

C. REPORT TYPE CODES

1. Operational Trouble
2. Preventive Maintenance
3. Unscheduled Maintenance
4. Bench Repair
5. Modification
6. Stock Defective
7. Maintenance Test

I. FIRST INDICATION

1. Alarm
2. Display Error
3. Indicator Error
4. Monitor Error
5. User Report
6. Inoperative
7. Low Performance
8. Noise Vibration
9. Intermittent Unstable
0. Other, Explain

J. ISOLATED TO

1. Station Equipment
2. Inside Wiring Cabling
3. Outside Wiring Cabling
4. Long Lines
5. Base Power
6. Commercial Power
7. Operator
8. Other Station, Explain
9. Not Found
0. Other, Explain

K. CAUSE

1. Extreme Ambient Temperature
2. Shock/Vibration
3. Power Surge/Failure
4. Design Defect
5. Faulty Installation
6. Operator Error
7. Faulty Assembly
8. Handling/Maintenance Damage
9. Undetermined
0. Other, Explain

L. ACTION TAKEN CODES

A. Replaced Parts
B. Repl. Units/Modules
C. Repl. Wire/Cable
D. Repaired
E. Adjusted/Calibrated
F. Corrected Operator Error
G. Trouble Cleared, Cause Unknown
H. Switched to Alternate Equipment
I. Installed Field Change
J. PM Check Only
O. Other, Explain

Y. REPORTED BY

1. USAF
2. WSC-UAC
3. Manufacturer's Representative
4. FAA
5. USWB
6. Other

1

001
003
004
005
006
007
008
009
101
011
014
015
018
020
022
026
035
040
053
070
080
082
088
089
090
091
094
096
097
099
130
131
140
150
156
160
170
190
200
210
225
226
230
255
258
300
320
340
350
360
370
380
387

FIG. 19

Operational Trouble and Maintenance Codes

NANCE REPORT FORM CODES

NDICATION	J. ISOLATED TO
	1. Station Equipment
Error	2. Inside Wiring Cabling
r Error	3. Outside Wiring Cabling
Error	4. Long Lines
ort	5. Base Power
ive	6. Commercial Power
ormance	7. Operator
bration	8. Other Station, Explain
tent Unstable	9. Not Found
xplain	0. Other, Explain

L. ACTION TAKEN CODES

A. Replaced Parts
B. Repl. Units/Modules
C. Repl. Wire/Cable
D. Repaired
E. Adjusted/Calibrated
F. Corrected Operator Error
G. Trouble Cleared, Cause Unknown
H. Switched to Alternate Equipment
I. Installed Field Change
J. PM Check Only
O. Other, Explain

TYPE OF FAILURE CODES

001 Gassy
003 Open Filament
004 Low Gm or Emission
005 Shorted, Intermittent
006 Shorted, Permanent
007 Arcing
008 Noisy
009 Microphonic
101 Poor Focus
011 Screen Defects (Cathode Ray)
014 Broken Base
015 Broken Glass
018 Tested OK, Did Not Work
020 Worn Excessively
022 No Oscillation
026 Solder Joint Defective
035 Drifts
040 Binding, Mechanical
053 Misfires (Gas Tubes)
070 Broken
080 Burned Out
082 Open, Intermittent
088 Gain, Low
089 Modulation, Low
090 Brushes, Improper Tension
091 Sensitivity, Low
094 Gain, None
096 Modulation, None
097 Response, None
099 Other, Explain

130 Change of Value
131 Marginal Part Replacement
140 Charred
150 Chattering
156 Poor Recovery Time
160 Contacts, Connection Defective
170 Corroded
190 Cracked

200 Dented
210 Detent Action Poor
225 Manufacturer's Defect (Explain)
226 Excessive Play
230 Dirty
255 Output, None
258 Overheats

300 Grounded
320 High Voltage Breakdown
340 Installed Improperly
350 Insulation Breakdown
360 Intermittent Operation
370 Jammed
380 Leakage
387 Low Performance

400 Loss of Residual Magnetism
450 Open, Permanent
451 Open Rotor
452 Open Stator
453 Open Winding
460 Open Primary
462 Output, Low
470 Open Secondary

520 Pitted
560 Poor Regulation
567 High Contact Resistance
570 Rusty
582 Seal Leaking

600 Shorted to Case
610 Shorted to Frame
612 Shorted Rotor
613 Shorted Stator
620 Shorted Primary
630 Shorted Secondary
660 Stripped
680 Unstable
690 Vibration Excessive

710 Bearing Failure
720 Brush Failure
730 Loose
731 Shorted, Collector-to-Emitter
734 Rise Time, Excessive
735 Open, Base-to-Emitter
736 Shorted, Base-to-Emitter
737 Open, Base-to-Collector
738 Shorted, Base-to-Collector
739 Beta Low
740 Saturation Resistance High
741 Alpha Cut-Off Low
742 Ico High
743 Fall Time, Excessive
744 Back Resistance Low
745 Forward Resistance High
749 Storage Time, Excessive
770 Slip Ring or Commutator Failure
780 Bent
790 Out of Adjustment

884 Broken Lead, Terminal, Or Pin

920 Not Determined
945 Structural Failure
960 Broken Envelope
965 Tuning Drive Defective

2