



**Test and Evaluation Report  
of the  
Paravant<sup>®</sup> Ruggedized Hand Held Computer  
Model RHC-88**

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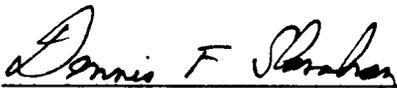
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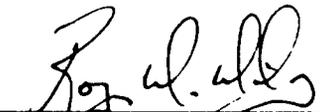
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## Section 1. Executive digest

The Army program for Test and Evaluation of Aeromedical Equipment uses existing military standards (MIL-STD) and collective professional expertise to test and evaluate selected medical equipment proposed for use aboard Army aircraft. Equipment meeting these standards ensures the safety of the crew, patients, and aircraft by eliminating risks due to: (1) Interference by the medical equipment with aircraft systems/subsystems operation, (2) by the aircraft system's interference with the operation of the medical equipment, (3) the medical equipment's susceptibility to environmental exposure, or (4) physical and/or functional incompatibility while in use on board selected rotary-wing aircraft. This program tests both developmental and nondevelopmental (off the shelf) medical equipment destined for use aboard Army medical evacuation (MEDEVAC) aircraft.

### 1.1 TEST OBJECTIVES

1.1.1 To determine if the medical equipment is complete and operational per the manufacturer's operating instructions.

1.1.2 To ensure the electrical safety of the medical equipment.

1.1.3 To ensure the equipment will function as designed throughout the rated battery operation time.

1.1.4 To ensure the safety of the operator, the patient, and the aircrew.

1.1.5 To assess design considerations which potentially could contribute to an operator error.

1.1.6 To determine if the medical equipment can function as designed in a low pressure environment.

1.1.7 To determine the ability of the medical equipment to withstand the vibrational stresses expected in a rotary-wing flight environment without degradation or malfunction.

1.1.8 To determine the ability of the medical equipment to be stored and operated in a high temperature environment.

1.1.9 To determine the ability of the medical equipment to be stored and operated in a low temperature environment.

1.1.10 To determine the ability of the medical equipment to operate satisfactorily for short periods of time during exposure to highly humid conditions.

1.1.11 To assess the levels of electromagnetic emissions produced by the medical equipment within selected frequency ranges.

1.1.12 To assess the minimum electromagnetic susceptibility levels of the medical equipment within selected frequency ranges.

1.1.13 To assess the physical and/or functional compatibility of the medical equipment while in use on board the aircraft.

1.1.14 To assess the electromagnetic interference (EMI) and electromagnetic compatibility (EMC) characteristics of the medical equipment with the host aircraft and its installed systems.

## 1.2 TESTING AUTHORITY

Research and Technology Work Unit Summary, dated 5 October 1989. Project number 3M463807D836, titled, Army Program for Testing and Evaluation of Equipment for Aeromedical Operations.

## 1.3 SCOPE

1.3.1 This test was conducted at the United States Army Aeromedical Research Laboratory (USAARL), Cairns Army Airfield (CAAF), and designated test flight areas in and around Fort Rucker, Alabama.

1.3.2 The USAARL UH-60A aircraft, serial number 88-26069, with subsystems delineated in paragraph 3.2.2, was configured with the Paravant® RHC-88\* and used as the test aircraft for the in-flight evaluation. The in-flight evaluation required 2.5 flight hours.

1.3.3 Laboratory testing was accomplished at USAARL using government furnished equipment (GFE) by Universal Energy Systems, Inc. (UES), under contract No. DAMD 17-86-C-6215.

1.3.4 Prior to flight testing, the following tests were accomplished: Acceptance inspection, equipment training, electromagnetic compatibility, human factors and safety, environmental compatibility, and in-flight compatibility.

1.3.5 An airworthiness release (AWR) dated 10 Sep 1991 was received from the U.S. Army Aviation Systems Command (AVSCOM) prior to the in-flight testing of the Paravant® RHC-88.

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\* See list of manufacturers

## 1.4 MATERIAL DESCRIPTION

The Paravant® RHC-88 is a portable ruggedized hand held computer designed for use in severe environmental conditions. It is enclosed in a sealed high impact plastic case. The display is a 5 x 3 inch liquid crystal display (LCD) located in the front panel above the keyboard. The keyboard contains 52 pushbutton keys which control 74 characters and functions. The alphabetic keys are arranged in five horizontal rows. The computer contains a 16-bit central processing unit (CPU) which is compatible with the MS-DOS operating system. The CPU is provided with 512K random access main memory (RAM) and 192K operating system read only memory (ROM). In addition, up to four 512K removable electronic disks may be installed in the computer. Connections are provided for a communication port and external power supply. A locking cover is provided to protect the connector when not in use. A leather carrying handle is provided at the top of the hand-held computer. A removable cover on the back of the unit is provided to allow access to battery cells and electronic disks.

## 1.5 SUMMARY

### 1.5.1 Laboratory testing

1.5.1.1 Battery Life Evaluation: During three battery life tests, the hand held computer was operated at room temperature with the backlight off. The computer operated an average of 10 hours and 8 minutes under these conditions. The hand held computer manual does not specify a battery service interval.

1.5.1.2 Electrical Safety Evaluation: All measurements were within acceptable limits. No unsafe qualities were found in the Paravant® RHC-88. The limits for currents and resistances were in accordance with (IAW) the National Association of Fire Prevention (NAFP) standards.

1.5.1.3 Human Factors Evaluation: The Paravant® RHC-88 was found satisfactory in each area of the evaluation except that there is no indication the battery is charging when connected to a 120 Vac power source. All other evaluation criteria were met satisfactorily. Standards referenced include MIL-STD-1472D, AAMI Human Factors Engineering Guidelines, and UL-544.

1.5.1.4 Environmental Tests: The Paravant® RHC-88 can be expected to perform in a variety of environmental conditions. Its performance was found to be satisfactory in all stages of the environmental testing. The requirements for environmental tests are established in MIL-STD-810D, Methods 500.2 (altitude), 514.3 (vibration), 501.2 (high temperature), 502.2 (low temperature) and 507.2 (humidity).

1.5.1.5 Radiated Emissions Tests (RE02): The Paravant® RHC-88 may be unsatisfactory for use in certain EMI sensitive environments. Narrowband and broadband emissions were detected in the test frequency ranges. Some narrowband and broadband emissions exceeded the test limits. Emission limits are set forth in MIL-STD-461A, Notice 4.

1.5.1.6 Radiated Susceptibility Test (RS03): The Paravant® RHC-88 was not found to be susceptible to the radiated test signals specified in MIL-STD-461A, Notice 4.

1.5.1.7 Conducted Emissions Test (CE01, CE02, and CE04): The Paravant® RHC-88 was not found to produce emissions in excess of the military standard.

1.5.1.8 Conducted Susceptibility Test (CS02 and CS06): No susceptibility to the test power line spikes or radio frequency interference test levels were noted in the Paravant® RHC-88.

## 1.5.2 In-flight testing

1.5.2.1 During the in-flight human factors evaluation, the Paravant® RHC-88 was found to be satisfactory in all but one category of the evaluation criteria. There was no indication of battery charging as noted in the laboratory human factors evaluation. The placement of alphabetic keys in a grid pattern rather than standard keyboard layout may slow operation of this device by persons familiar with the use of a standard keyboard.

1.5.2.2 The aircraft and its subsystems were not adversely affected by the operation of the Paravant® RHC-88 in any of the prescribed flight test profiles.

1.5.2.3 The Paravant® RHC-88 was not affected by the aircraft and its subsystems during the in-flight testing.

## 1.6 CONCLUSIONS

Based on the results of laboratory and in-flight testing, the Paravant® RHC-88 was found to be compatible with the U.S. Army medical evacuation UH-60A Blackhawk, with the subsystems listed in paragraph 3.2.2.

## Section 2. Subtests

### 2.1 INITIAL INSPECTION

#### 2.1.1 Objective

To determine if the Paravant® RHC-88 is complete and operational for testing per the manufacturer's operating instructions.

#### 2.1.2 Criteria

2.1.2.1 The physical inventory is conducted solely for investigation and documentation.

2.1.2.2 The Paravant® RHC-88 will successfully complete ROM and RAM checks without errors.

#### 2.1.3 Test procedure

2.1.3.1 A complete physical inventory of the Paravant® RHC-88 was completed per the manufacturer's equipment list.

2.1.3.2 An operational validation test of the Paravant® RHC-88 was conducted per the manufacturer's operating instructions.

#### 2.1.4 Test findings

2.1.4.1 The Paravant® RHC-88 was inventoried and found to be complete.

2.1.4.2 The Paravant® RHC-88 operated as prescribed in the manufacturer's operating manual. Criterion met.

### 2.2 BATTERY LIFE EVALUATION (Laboratory)

#### 2.2.1 Objective

To ensure the equipment will function as designed throughout the rated battery operation time.

#### 2.2.2 Criteria

2.2.2.1 Equipment will function as designed using battery power for continuous execution of a test program that keeps the microprocessor and display active.

2.2.2.2 Ensure battery is capable of supplying a minimum of 1.5 hours continuous use to support MEDEVAC mission.

### 2.2.3 Test procedure

2.2.3.1 Three charging and operation cycles were conducted in ambient room conditions of 23°C, 40-60 percent relative humidity (RH).

2.2.3.2 The Paravant® RHC-88 was operated continuously with backlight off from a fully charged battery until a low battery alert was displayed on the screen. After depletion, the battery was allowed 15 hours to recharge before the next test.

### 2.2.4 Test findings

The computer operated continuously for an average of 10 hours and 8 minutes before a low battery indication was displayed. The battery life is not specified by the manufacturer. This exceeds the minimum 1.5 hours continuous operation required to support MEDEVAC missions. Criterion met.

## 2.3 ELECTRICAL SAFETY EVALUATION

### 2.3.1 Objective

To ensure the electrical safety, by evaluation of case-to-ground resistance and case-to-ground current leakage, of the Paravant® RHC-88.

### 2.3.2 Criterion

The Paravant® RHC-88 shall meet the standards established in NFPA 99 for electrical safety of medical equipment.

### 2.3.3 Test procedure

Measurements in the electrical safety evaluation were made with a Neurodyne-Dempsey model 431F electrical safety analyzer\*, IAW the procedures described in Technical Bulletin (TB) Number 38-750-2. Case-to-ground resistance and various case-to-ground leakage currents were measured. Leakage currents were measured using a 10 by 20 centimeter aluminum foil sheet taped flush to the equipment case. Checks were made for safety concerns, such as case integrity, breaks in power cord insulation, and connectors.

### 2.3.4 Test findings

Grounding conductor resistance was not measured because there is no grounding conductor on the power adapter. Maximum case leakage current was 0.2 microamperes. This is IAW the value specified in TB-38-750-2. Criterion met.

## 2.4 HUMAN FACTORS EVALUATION (Laboratory)

### 2.4.1 Objectives

2.4.1.1 To assure the safety of the operator, the potential patient, and the aircrew.

2.4.1.2 To assess the design considerations which, potentially, could contribute to an operator error.

### 2.4.2 Criterion

The Paravant® RHC-88 must be rated satisfactory in all major categories of the evaluation. These include visual displays, controls, maintainability, conductors, fasteners, test points, test equipment, fuses and circuit breakers, labels and coding, and safety.

### 2.4.3 Test procedure

2.4.3.1 The evaluation was conducted in a laboratory under fluorescent lighting and ambient room conditions.

2.4.3.2 The Paravant® RHC-88 was operated according to prescribed instructions through its full range of functions.

### 2.4.4 Test finding

The Paravant® RHC-88 was found to be unsatisfactory in one of the evaluation criteria: Visual displays. There is no indication the battery is charging while the hand held computer is connected to a 120 Vac power source. In addition, the grid arrangement of the alphabetic keys on the keyboard proved awkward to persons familiar with the use of a standard keyboard layout. Criterion partially met.

## 2.5 ALTITUDE (LOW PRESSURE) TEST [IAW MIL-STD-810D, METHOD 500.2]

### 2.5.1 Objective

To determine if the Paravant® RHC-88 can function as designed in a low pressure environment.

### 2.5.2 Criterion

The Paravant® RHC-88 will run self tests and test program without errors while exposed to an altitude equivalency of 15,000 feet above sea level.

### 2.5.3 Test procedure

2.5.3.1 A pretest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

2.5.3.2 The Altitude Test was performed in a Tenney Engineering model 64S altitude chamber\*. This test is based on MIL-STD-810D, Method 500.2. The Paravant® RHC-88 was placed in operation near the center of the floor of the chamber. Chamber pressure was decreased to 420 mmHg (15,000 ft equivalent altitude) over a 15-minute period, held constant for 60 minutes, then raised, at 1500 fpm, to ambient conditions (760 mmHg) over a 10-minute period. There were no provisions for the control of temperature or humidity inside this chamber.

2.5.3.3 A posttest performance check was conducted to ensure proper operation of the Paravant® RHC-88 after the exposure to low pressure.

### 2.5.4 Test findings

2.5.4.1 The pretest performance check met criterion 2.1.2.2.

2.5.4.2 No failures in the Paravant® RHC-88's performance were noted before, during, or after the altitude test. Criterion met.

2.5.4.3 The posttest performance check met criterion 2.1.2.2.

## 2.6 VIBRATION TEST [IAW MIL-STD-810D, METHOD 514.3]

### 2.6.1 Objective

To determine the ability of the Paravant® RHC-88 to withstand the vibrational stresses expected in a rotary-wing environment without degradation or malfunction.

### 2.6.2 Criterion

While exposed to vibrational stresses, the Paravant® RHC-88 will execute self tests and test program without errors.

### 2.6.3 Test procedure

2.6.3.1 A pretest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

2.6.3.2 The vibration test was performed using an Unholtz-Dickey model TA115-40/CSTA vibration test system\*. It is a single-axis system with an electromagnetic driver unit. The test consisted of sinusoidal vibrations, superimposed on random vibrations over a frequency range of 500 Hz, as shown below. These vibrations

were derived from measurements taken on the floor under the co-pilot's seat in a UH-1 helicopter traveling at 120 knots. The reference spectrum breakpoints are from MIL-STD-810D, Method 514.3; reference spectrum levels are based on field measurements with a conservatism factor of 1.5. Independent tests were conducted in the X, Y, and Z axes.

### Z-axis

duration: 60 minutes  
broadband intensity: 0.4506  $G_{rms}$   
random vibration: initial slope : 99.00 dB/Hz  
5 Hz level: 0.00006210  $G_{sqr/Hz}$   
100 Hz level: 0.0006210  $G_{sqr/Hz}$   
300 Hz level: 0.0006210  $G_{sqr/Hz}$   
500 Hz level: 0.00006210  $G_{sqr/Hz}$   
final slope: -99.00 dB/oct  
sinusoidal vibration: .5450  $G_{pk}$  at 11.25 Hz  
.1690  $G_{pk}$  at 22.50 Hz  
.1200  $G_{pk}$  at 33.75 Hz  
.0310  $G_{pk}$  at 45.00 Hz  
.0530  $G_{pk}$  at 56.25 Hz

### X and Y axes

duration: 60 minutes each  
broadband intensity: 0.3099  $G_{rms}$   
random vibration: initial slope: 99.00 dB/oct  
5 Hz level: 0.00002920  $G_{sqr/Hz}$   
100 Hz level: 0.0002920  $G_{sqr/Hz}$   
300 Hz level: 0.0002920  $G_{sqr/Hz}$   
500 Hz level: 0.00002920  $G_{sqr/Hz}$   
final slope: -99.00 dB/oct  
sinusoidal vibration: .3200  $G_{pk}$  at 11.25 Hz  
.0670  $G_{pk}$  at 22.50 Hz  
.0950  $G_{pk}$  at 33.75 Hz  
.0350  $G_{pk}$  at 45.00 Hz  
.0770  $G_{pk}$  at 56.25 Hz

The Paravant® RHC-88 was strapped to the vibration table fixture, and its performance was evaluated before, during, and after exposure to vibration.

2.6.3.3 A posttest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

### 2.6.4 Test findings

2.6.4.1 The pretest performance check met criterion 2.1.2.2.

2.6.4.2 No failures in the Paravant® RHC-88's performance occurred before, during, or after exposure to vibration. Criterion met.

2.6.4.3 The posttest performance check met criterion 2.1.2.2.

## 2.7 HIGH TEMPERATURE TEST [IAW MIL-STD-810D, METHOD 501.2]

### 2.7.1 Objective

To determine the ability of the Paravant® RHC-88 to be stored and operated in a high temperature environment.

### 2.7.2 Criteria

2.7.2.1 During the high temperature operation check, the Paravant® RHC-88 will execute self tests and test program without errors.

2.7.2.2 After the high temperature storage cycle, the Paravant® RHC-88 must be able to execute self tests and test program without errors.

### 2.7.3 Test procedure

2.7.3.1 A pretest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

2.7.3.2 The high temperature test was conducted in a Tenney Engineering model ZWUL-10107D Walk-in Controlled Environment Chamber\*. This test is based on MIL-STD-810D, Method 501.2. For the high temperature operation test, the Paravant® RHC-88 was placed in operation on a wire test stand near the center of the environmental chamber. The chamber temperature was raised to 49°C and the humidity was stabilized at a maximum of 20 percent RH within 15 minutes. The environmental control system is capable of regulating temperature within  $\pm 2^\circ\text{C}$  and humidity within  $\pm 5$  percent RH. Temperature and humidity were held constant for 2 hours. At 30-minute intervals, the chamber door was opened briefly to minimize the change in chamber conditions during performance checks. After the operational test, the Paravant® RHC-88 was allowed to return to ambient conditions over a 30-minute period.

2.7.3.3 A posttest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

2.7.3.4 The Paravant® RHC-88 was stored (not operated) at temperatures of 63°C for 1 hour, 71°C for 4 hours, then again at 63°C for 1 hour. The chamber and Paravant® RHC-88 then were returned to ambient conditions over a 30-minute period.

2.7.3.5 A poststorage performance check was conducted to ensure proper performance of the Paravant® RHC-88.

#### 2.7.4 Test findings

2.7.4.1 The pretest performance check met criterion 2.1.2.2.

2.7.4.2 No operational failures occurred during the high temperature test. Criterion met.

2.7.4.3 The posttest performance check met criterion 2.1.2.2.

2.7.4.4 The Paravant® RHC-88 functioned properly after the high temperature storage test. Criterion met.

### 2.8 LOW TEMPERATURE TEST [IAW MIL-STD-810D, METHOD 502.2]

#### 2.8.1 Objective

To determine the ability of the Paravant® RHC-88 to be stored and operated in a low temperature environment.

#### 2.8.2 Criteria

2.8.2.1 During the low temperature operation check, the Paravant® RHC-88 must execute self tests and a test program without errors.

2.8.2.2 After the low temperature storage cycle, the Paravant® RHC-88 must execute self tests and a test program without errors.

#### 2.8.3 Test procedure

2.8.3.1 A pretest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

2.8.3.2 The Paravant® RHC-88 was placed on the floor of the environmental chamber and the temperature was lowered to 0°C within 25 minutes. The environmental control system is capable of regulating temperature within 2°C. Humidity cannot be controlled in the chamber at freezing temperatures. The temperature was held constant for 2 hours. Every 30 minutes, the chamber door was opened briefly to minimize the change in chamber conditions, and a performance check was conducted. The chamber temperature then was raised to ambient temperature within a 30-minute period.

2.8.3.3 A posttest performance check was conducted to ensure proper operation of the Paravant® RHC-88.

2.8.3.4 The Paravant® RHC-88 was "stored" in a nonoperational mode with the power cord coiled and placed on top of the

Paravant® RHC-88. The Paravant® RHC-88 was placed on the floor of the environmental test chamber and the temperature was lowered to -46°C for 6 hours. The chamber was then raised to ambient temperature over a 30-minute period.

2.8.3.5 A poststorage performance check was conducted to ensure proper operation of the Paravant® RHC-88.

#### 2.8.4 Test findings

2.8.4.1 The pretest performance check met criterion 2.1.2.2.

2.8.4.2 No operational failures occurred during the low temperature test. The display faded slightly during exposure to cold temperature, but remained readable throughout the test. Criterion met.

2.8.4.3 The posttest performance check met criterion 2.1.2.2.

2.8.4.4 The Paravant® RHC-88 functioned properly after the low temperature storage test. Criterion met.

### 2.9 HUMIDITY TEST [IAW MIL-STD-810D, METHOD 507.2]

#### 2.9.1 Objective

To determine the ability of the Paravant® RHC-88 to operate satisfactorily for short periods of time during exposure to highly humid conditions.

#### 2.9.2 Criterion

While exposed to a high humidity environment, the Paravant® RHC-88 must execute the self tests and a test program without errors.

#### 2.9.3 Test procedure

2.9.3.1 A pretest performance check was conducted to ensure the proper operation of the Paravant® RHC-88.

2.9.3.2 The humidity test was conducted in a Tenney Engineering model ZWUL-10107D Walk-in Controlled Environment Chamber\*. This test is based on MIL-STD-810D, Method 507.2. For the humidity test, the Paravant® RHC-88 was placed in operation on a wire test stand near the center of the environmental chamber. The chamber temperature was raised to a temperature of 29.5°C and a relative humidity of 95 percent within 25 minutes. Temperature and relative humidity were maintained for 4 hours. The environmental control system is capable of regulating temperature within  $\pm 2^\circ\text{C}$  and humidity within  $\pm 5$  percent RH. At 45-minute intervals the computer performance was checked. The chamber door was opened

briefly to minimize the change in chamber conditions. The chamber and the Paravant® RHC-88 were returned to ambient conditions before the posttest performance validation check was conducted.

2.9.3.3 A posttest performance check was conducted to ensure the proper operation of the Paravant® RHC-88.

#### 2.9.4 Test findings

2.9.4.1 The pretest performance check met criterion 2.1.2.2.

2.9.4.2 No operational failures occurred during the humidity test. Criterion met.

2.9.4.3 The posttest performance check met criterion 2.1.2.2.

### 2.10 ELECTROMAGNETIC CHARACTERISTICS TEST [IAW MIL-STD-461A, Notice 4, and MIL-STD-462, Notice 3]

#### 2.10.1 Objectives

2.10.1.1 To assess the maximum levels of radiated electromagnetic emissions produced by the Paravant® RHC-88 in the 14 kHz to 1.0 GHz frequency range.

2.10.1.2 To assess the tolerances of radiated electromagnetic susceptibility of the Paravant® RHC-88 within the 10 kHz to 10 GHz broadband electric field and the 14 kHz to 12.4 GHz narrow-band.

2.10.1.3 To assess the maximum levels of conducted electromagnetic emissions produced by the Paravant® RHC-88 in the 10 kHz to 50 MHz frequency ranges.

2.10.1.4 To assess the tolerances of conducted electromagnetic susceptibility of the Paravant® RHC-88 within the range of 50 kHz to 400 MHz and power spikes.

#### 2.10.2 Criteria

2.10.2.1 The Paravant® RHC-88 shall not produce emissions in excess of the limits set forth in paragraph 6.13, MIL-STD-461A, Notice 4.

2.10.2.2 The Paravant® RHC-88 shall not malfunction when it is subjected to radiated emissions as specified in paragraph 6.20, MIL-STD-461A, Notice 4.

2.10.2.3 The Paravant® RHC-88 shall not conduct emissions in excess of the limits set forth in MIL-STD-461A, Notice 4, paragraphs 6.1 and 6.2.

2.10.2.4 The Paravant® RHC-88 shall not malfunction when it is subjected to conducted emissions as specified in MIL-STD-461A, Notice 4, paragraphs 6.7 and 6.10.

### 2.10.3 Test procedure

2.10.3.1 The radiated emissions test was performed according to MIL-STD-462, Notice 3, Method RE02. The Paravant® RHC-88 was positioned on a wooden test stand 1 meter tall, 0.18 meters wide, and 0.21 meters long, inside the EMI chamber. The unit was directly in line with, and at a horizontal distance of 1 meter from the receiving antennas. The antennas were mounted for both vertical and horizontal polarities and connected to the appropriate EMI receivers. Electrometrics EMC-25 and EMC-50 receivers were used for this test. Their frequency ranges in testing were 14 kHz to 1 GHz and 1 to 12.4 GHz. Broadband and narrowband detection methods were used from 14 kHz to 1 GHz. Narrowband detection methods were used from 1 to 12.4 GHz. The computer operated continuously during this test.

2.10.3.2 The radiated susceptibility test was performed according to MIL-STD-462, Notice 3, Method RS03. The Paravant® RHC-88 was positioned inside the EMI chamber on a wooden test stand 1 meter tall, 0.18 meters wide, and 0.21 meters long. The unit was directly in line with, and at a horizontal distance of 1 meter from, the transmitting antennas. The antennas were mounted for both vertical and horizontal polarities and connected to radio frequency (RF) transmitters. The computer was exposed to fields of 10 V/m from 200 MHz to 2 GHz, and 5 V/m from 2 to 10 GHz. All RF carrier waves were 50 percent amplitude modulated with a 1000 Hz tone. The computer operated continuously during this test.

2.10.3.3 The conducted emissions tests were performed according to MIL-STD-462, Notice 3, Methods CE02 and CE04. The Paravant® RHC-88 was placed on a grounded, copper-covered workbench. The top of the workbench was 1 meter from floor level, 1.37 meters long, and 0.81 meters wide. Power was supplied via a pair of line impedance stabilization networks (LISN) and a test jig. The test jig is a wooden tray with two power receptacles and two slots to hold current probes in place around power supply conductors. While the Paravant® RHC-88 was operating, the frequency range (10 kHz to 50 MHz) was scanned for emissions conducted in the power cable from the Paravant® RHC-88.

2.10.3.4 The conducted susceptibility spike test was performed on a chemical resistant counter top according to MIL-STD-462, Notice 3, Method CS06. Power was supplied via a customized metal connection box. The connection box had two power receptacles and four banana jacks on its front panel. Connections to the individual power lines were made in series through the banana jacks. Transient spikes of 100 volts, 10 microseconds were generated with a Solar Electronics model 8282-1 transient pulse generator\*

and induced onto the power leads at the connection box banana jacks. The spikes were monitored with a Tektronix 2235 oscilloscope\* connected to a power receptacle on the connection box. The Paravant® RHC-88 was plugged into the other receptacle on the connection box and placed in operation. It was visually observed for correct operation of visual displays while it was subjected to the power line spikes.

2.10.3.5 The conducted susceptibility test was performed according to MIL-STD-462, Notice 3, Method CS02. The Paravant® RHC-88 was placed on a grounded, copper-covered workbench. Radio frequency interference was induced on the power leads and measured at the Paravant® RHC-88 power cable. The frequency of the interference was incremented over the 50 kHz to 400 MHz range while the Paravant® RHC-88 was operated. It was visually observed for correct displays while it was subjected to the radio interference on the power leads. Each frequency was held for 15 seconds.

2.10.4 Test findings

2.10.4.1 During the radiated emissions test, narrowband and broadband emissions which exceeded specification limits of MIL-STD-461A, Notice 4, were detected in the frequency ranges below.

AC operation:

| <u>Frequency</u>   | <u>Emission exceeding standard</u> |
|--------------------|------------------------------------|
| 175 - 630 kHz      | 10.9 - 26.3 dB (NB)                |
| 1.09 - 3.07 MHz    | 3.70 - 19.1 dB (NB)                |
| 6.25 - 8.08 MHz    | 4.50 - 18.1 dB (NB)                |
| 13.82 - 486.35 MHz | 0.40 - 48.4 dB (NB)                |
| 14 kHz - 1.26 MHz  | 0.20 - 24.2 dB (BB)                |
| 29.97 - 30 MHz     | 22.4 dB (BB)                       |

Battery operation:

| <u>Frequency</u>   | <u>Emission exceeding standard</u> |
|--------------------|------------------------------------|
| 150 kHz - 3.17 MHz | 3.5 - 19.3 dB (NB)                 |
| 7.82 - 497.61 MHz  | 0.1 - 25.6 dB (NB)                 |
| 35 kHz - 70 kHz    | 0.6 - 1.40 dB (BB)                 |

Criterion partially met.

2.10.4.2 The Paravant® RHC-88 was not found susceptible to radiated emissions. Criterion met.

2.10.4.3 No failure level emissions were detected during this test. Criterion met.

2.10.4.4 The Paravant® RHC-88 was not found susceptible to conducted radio frequency interference. Criterion met.

## 2.11 IN-FLIGHT HUMAN FACTORS EVALUATION

### 2.11.1 Objective

To assess the physical and/or functional compatibility of the Paravant® RHC-88 while in use on board the aircraft.

### 2.11.2 Criterion

The flight surgeon shall be able to operate the Paravant® RHC-88 without physical or functional restrictions aboard the aircraft. Major areas of concern include: Proper operation, visual displays, controls, maintainability, conductors, fasteners, test points, test equipment, fuses and circuit breakers, labels and coding, and safety.

### 2.11.3 Test procedure

2.11.3.1 A human factors evaluation was performed IAW MIL-STD-1472D, AAMI Human Factors Engineering Guidelines, and UL-544 to ensure the compatibility of the Paravant® RHC-88 and the in-flight environment. The flight surgeon conducted the test wearing a flight suit, flight gloves, and an SPH-4B flight helmet. An evaluation of the compatibility with the nuclear, biological, and chemical (NBC) protective equipment was not conducted. Due to restrictions of the AWR, testing was conducted during daylight hours only.

2.11.3.2 The Paravant® RHC-88 was hand held by the flight surgeon in the aircraft. Internal tests and a test program were used to evaluate the performance of the computer in the aircraft.

### 2.11.4 Test findings

During the in-flight human factors evaluation, the Paravant® RHC-88 was found to be satisfactory in all but one category of the evaluation criteria. First, the deficiencies noted in the laboratory evaluation (paragraph 1.5.1.3) were present in the aircraft. The display could be easily read in all except direct sunlight conditions. The keyboard could be operated while wearing flight gloves, but the grid key layout proved awkward when typewritten entries were required for the test program. Criterion partially met.

## 2.12 IN-FLIGHT EMI/EMC CHARACTERISTICS TEST

### 2.12.1 Objective

To assess the EMI/EMC characteristics of the Paravant® RHC-88 with the host aircraft and its installed systems.

### 2.12.2 Criteria

2.12.2.1 The Paravant® RHC-88 shall not radiate EMI to disrupt or interfere with other equipment or systems aboard the aircraft.

2.12.2.2 The aircraft shall not radiate EMI to disrupt or interfere with the Paravant® RHC-88's operation.

### 2.12.3 Test procedure

A qualitative EMI/EMC assessment was performed with both the Paravant® RHC-88 and the aircraft operating as source and victim. The Paravant® RHC-88 and applicable aircraft instruments and systems were monitored for unusual operation, readings, surges, or power anomalies for each checklist item (see 3.2.3 Inflight test data card).

### 2.12.4 Test findings

2.12.4.1 There were no adverse instances of EMI/EMC noted with the Paravant® RHC-88 acting as either the source or victim. Criterion met.

2.12.4.2 There were no adverse instances of EMI/EMC noted with the aircraft acting as either the source or victim. Criterion met.

## Section 3. Supporting documentation

### 3.1 DETAILED TEST INFORMATION

#### 3.1.1 General information

3.1.1.1 Paravant® RHC-88 testing is not considered a major action significantly affecting the quality of the human environment and therefore qualifies for categorical exclusion A-28, AR 200-1, Appendix A.

3.1.1.2 A safety pilot will be designated for each flight. Flight operations will be conducted IAW the aircraft operator's manual, appropriate aircrew training manuals, and test item technical data.

#### 3.1.2 Material description

3.1.2.1 The Paravant® RHC-88 is a portable ruggedized hand-held computer designed for use in severe environmental conditions. It is enclosed in a sealed high impact plastic case. The display is a 5 by 3 inch LCD mounted in the front panel above the keyboard. The keyboard contains 52 pushbutton keys which control 74 characters and functions. The alphabetic keys are arranged in five horizontal rows. A connector for a communication port and an external power supply is located on the top of the hand-held computer. A locking cover is provided to protect the connector when it is not in use. A carrying handle is also provided on the top of the hand held computer. A cover on the back of the enclosure is removable to allow access to the battery cells and electronic disks. The cover is held in place by a locking hand screw.

3.1.2.2 Method of operation: The Paravant® RHC-88 is based on a 16-bit central processing unit, which is compatible with the MS-DOS operating system. The CPU is provided with 512K RAM main memory, 192K ROM operating system memory, and up to four 512K removable electronic disks. The display has a resolution of 256 x 128 pixels in graphics mode and 16 lines x 42 characters in text mode.

3.1.2.3 Dimensions: 23.37 x 16.26 x 6.62 cm (9.2 x 6.4 x 2.6 in).

3.1.2.4 Weight: 2.04 kg (4.5 pounds) with battery pack.

3.1.2.5 Power requirements: 5 C-cell alkaline batteries; rechargeable NiCad battery pack; 120 Vac adaptor. Battery charge time is 15 hours. No battery life specification was provided in the user's guide.

### 3.2 TEST DATA

#### 3.2.1 Photographic description



### 3.2.2 Aircraft equipment list

| Item No. | Nomenclature   |
|----------|--|
| 1        | Receiver radio -- R-1496A/ARN-89<br>(automatic direction finder)                   |
| 2        | Displacement gyro -- CN-1314/A   |
| 3        | Gyro directional -- CN-998/ASN-43  |
| 4        | Signal data converter -- CV-3338/ASN-128   |
| 5        | Receiver -- R-2139/ARN-123<br>(VOR/LOC/MB/GS)                                      |
| 6        | Command instrument system processor -- 70600-01038-101                             |
| 7        | SAS amplifier -- 70901-02908-104<br>(flight control stability augmentation system) |
| 8        | Rate gyro -- TRU-2A/A  |
| 9        | Amplifier, impedance -- AM-4859A/ARN-89  |
| 10       | Cargo hook -- FE-7590-145  |
| 11       | Receiver, radar -- RT-1193/ASN-128<br>(doppler navigation receiver)                |
| 12       | Barometric altimeter -- AAU-31/A-1   |
| 13       | Barometric altimeter -- AAU-32A  |
| 14       | Receiver/transmitter -- RT-1300/ARC-186<br>(VHF-AM and/or FM radio)                |
| 15       | UHF-AM radio set -- RT-1518/ARC-164  |
| 16       | Interphone control -- C6533/ARC<br>(aircraft intercom control)                     |
| 17       | Receiver/transmitter -- RT-1115D/APN-209<br>(radar altimeter)                      |
| 18       | Indicator altimeter -- ID-1917C/APN-209<br>(radar altimeter)                       |
| 19       | Control radio set -- C-7392A/ARN-89<br>(automatic direction finder)                |
| 20       | Comparator signal data -- CM-482/ARC-186<br>(comparator for ARC-186)               |
| 21       | Receiver/transmitter -- RT-1296A/APX-100<br>(transponder with IFF)                 |
| 22       | Computer display unit -- CP-1252/ASN-128<br>(doppler navigation system)            |
| 23       | Compass set controller -- C-8021E/ASN75  |
| 24       | Magnetic compass - standby -- MS-17983-4   |

### 3.2.3 In-flight test data card

#### DATA CARD FORMAT

#### GUIDELINE FOR DATA COLLECTION

#### IN-FLIGHT SUITABILITY TEST OF MEDICAL ITEMS

| 1. Installation/removal.   | Suitable |    | Comments |
|--|----------|----|----------|
|  | Yes      | No |          |
| a. Weight and balance<br>(DD Form 365-4, Clearance<br>Form F).   | X        |    |          |
| b. Space/area allocation.  |          |    |          |
| (1) Operational<br>requirements.   | X        |    |          |
| (2) Storage requirements.  | X        |    |          |
| c. Interface connections<br>(safe, positive, secure).  | X        |    |          |
| d. Installation/removal<br>(expedient/easily achieved).  | X        |    |          |
| e. Mounting/final config-<br>uration (functional/stable).  | X        |    |          |
| 2. Operations and performance.   | Suitable |    | Comments |
|  | Yes      | No |          |
| a. Manufacturer's operating<br>instruction.  | X        |    |          |
| b. Medical item operation<br>before aircraft run-up.   | X        |    |          |
| c. System interface during<br>aircraft engine run-up and<br>medical item operation (EMI<br>switchology checklist). | X        |    |          |
| (1) Aircraft voltage<br>output.  | X        |    |          |

|  | Suitable |    | Comments |
|--|----------|----|----------|
|  | Yes      | No |          |
| (2) Flight control function (UH-60).                     | X        |    |          |
| (3) Stabilator function (UH-60).                         | X        |    |          |
| (4) Radio communication vs medical item operation.       |          |    |          |
| (a) FM   | X        |    |          |
| (b) UHF  | X        |    |          |
| (c) VHF  | X        |    |          |
| (5) Navigation equipment vs medical item operation.      |          |    |          |
| (a) Transponder  | X        |    |          |
| (b) ADF  | X        |    |          |
| (c) VOR  | X        |    |          |
| (d) Doppler  | X        |    |          |
| (6) Radar altimeter operation vs medical item operation. | X        |    |          |

d. System interface during aircraft hover and medical item operation (EMI switchology checklist).

|  |    |  |  |
|--|----|--|--|
| (1) Voltage output.                                | NA |  |  |
| (2) Radio communication vs medical item operation. |    |  |  |
| (a) FM   | X  |  |  |
| (b) UHF  | X  |  |  |
| (c) VHF  | X  |  |  |

| (3) Navigation equipment operation vs medical item operation. | Suitable |    | Comments |
|---|----------|----|----------|
|   | Yes      | No |          |

- |                 |   |  |  |
|-----------------|---|--|--|
| (a) Transponder | X |  |  |
| (b) ADF         | X |  |  |
| (c) VOR         | X |  |  |
| (d) Doppler     | X |  |  |

e. Flight mission profile vs medical item operation (EMI switchology checklist).

(1) Straight and level (1000 ft MSL for 20 minutes).

|  |   |  |  |
|--|---|--|--|
| (a) Compatibility of flight mode and medical item operation. | X |  |  |
|--|---|--|--|

(b) Radio communication vs medical item operation.

- |               |   |  |  |
|---------------|---|--|--|
| <u>a.</u> FM  | X |  |  |
| <u>b.</u> UHF | X |  |  |
| <u>c.</u> VHF | X |  |  |

|  |   |  |  |
|--|---|--|--|
| (2) NOE (20 minutes). compatibility of flight mode and medical item operation. | X |  |  |
|--|---|--|--|

|                             |   |  |  |
|-----------------------------|---|--|--|
| (3) FM homing (10 minutes). | X |  |  |
|-----------------------------|---|--|--|

(4) Doppler navigation vs medical item operation.

- |                          |   |  |  |
|--------------------------|---|--|--|
| (a) Initialize function. | X |  |  |
| (b) Fix function.        | X |  |  |
| (c) Update function.     | X |  |  |

|   | Suitable |      | Comments |
|---|----------|------|----------|
|   | Yes      | No   |          |
| (5) VOR navigation vs medical item operation.                             | X        |      |          |
| (6) ILS approach vs medical item operation.                               | X        |      |          |
| f. Medical item operation after engine shutdown (external power source).  | X        |      |          |
| g. Restrictions to the medical item's use (i.e., electrical connectors).  | X        |      |          |
| h. Deviations from the laboratory test results.                           |          |      |          |
| (1) Electrical/electronic.  |          | None |          |
| (2) Mechanical environment.   |          | None |          |
| (3) Human factors (user interface, controls, markings, lighting, egress). |          | None |          |
| (4) Safety.   |          | None |          |

3. Deviations from the in-flight test protocol.

The VOR navigation portion of the in-flight test conducted at 2000 feet MSL due to air traffic control clearance.

3.2.4 EMI switchology checklist

EMI SWITCHOLOGY CHECKLIST UH-60 AIRCRAFT

IN-FLIGHT SUITABILITY OF MEDICAL ITEMS

| ENG INSTRUMENTS/CDU       | No EMI<br>Affect | EMI Affected |     | Explanation |
|---------------------------|------------------|--------------|-----|-------------|
|                           |                  | Gnd          | Flt |             |
| Fuel quantity             | X                |              |     |             |
| Fuel indicator test       | X                |              |     |             |
| XMSN oil temperature      | X                |              |     |             |
| XMSN oil pressure         | X                |              |     |             |
| #1 engine oil temperature | X                |              |     |             |
| #2 engine oil temperature | X                |              |     |             |
| #1 engine oil pressure    | X                |              |     |             |
| #2 engine oil pressure    | X                |              |     |             |
| #1 TGT                    | X                |              |     |             |
| #2 TGT                    | X                |              |     |             |
| #1 Ng speed               | X                |              |     |             |
| #2 Ng speed               | X                |              |     |             |
| CDU digits on/off         | X                |              |     |             |
| CDU instruments dim       | X                |              |     |             |
| ENG INSTRUMENTS/PLT PDU   | No EMI<br>Affect | EMI Affected |     | Explanation |
|                           |                  | Gnd          | Flt |             |
| #1 engine RPM             | X                |              |     |             |
| #2 engine RPM             | X                |              |     |             |
| Rotor RPM                 | X                |              |     |             |
| #1 torque                 | X                |              |     |             |
| #2 torque                 | X                |              |     |             |
| ENG INSTRUMENTS/COPLT PDU | No EMI<br>Affect | EMI Affected |     | Explanation |
|                           |                  | Gnd          | Flt |             |
| #1 engine RPM             | X                |              |     |             |
| #2 engine RPM             | X                |              |     |             |
| Rotor RPM                 | X                |              |     |             |
| #1 torque                 | X                |              |     |             |
| #2 torque                 | X                |              |     |             |

| ENG CONTROLS                    | No EMI<br>Affect    | EMI Affected |     | Explanation |
|---------------------------------|---------------------|--------------|-----|-------------|
|                                 |                     | Gnd          | Flt |             |
| #1 overspeed                    | X                   |              |     |             |
| #2 overspeed                    | X                   |              |     |             |
| RPM switch                      | X                   |              |     |             |
| #1 engine anti-ice              | X                   |              |     |             |
| #2 engine anti-ice              | X                   |              |     |             |
| #1 inlet anti-ice               | X                   |              |     |             |
| #2 inlet anti-ice               | X                   |              |     |             |
| <b>RADIO EQUIPMENT</b>          |                     |              |     |             |
|                                 | No EMI<br>Affect    | EMI Affected |     | Explanation |
|                                 |                     | Gnd          | Flt |             |
| ICS, C-6533 ARC                 | X                   |              |     |             |
| VHF-FM, ARC-186/115             | X                   |              |     |             |
| VHF-AM, ARC-186/115             | X                   |              |     |             |
| UHF-AM, ARC-164(V)              | X                   |              |     |             |
| Crypto, KY-28                   | Not installed       |              |     |             |
| Radio retransmissions PLN       | Not installed       |              |     |             |
| Transponder, APX-100(V)         | X                   |              |     |             |
| KIT-1A/TSEC IFF computer        | Not keyed with code |              |     |             |
| <b>MISSION EQUIPMENT</b>        |                     |              |     |             |
|                                 | No EMI<br>Affect    | EMI Affected |     | Explanation |
|                                 |                     | Gnd          | Flt |             |
| RWR, APR-39(V)                  | Not installed       |              |     |             |
| IR CM, ALQ-144                  | Not installed       |              |     |             |
| Chaff dispenser, M-130          | Not installed       |              |     |             |
| Cargo hook system               | X                   |              |     |             |
| <b>HYDRAULIC CONTROL SYSTEM</b> |                     |              |     |             |
|                                 | No EMI<br>Affect    | EMI Affected |     | Explanation |
|                                 |                     | Gnd          | Flt |             |
| Backup hydraulic pump           | X                   |              |     |             |
| Servo off 1st stage/PLT         | X                   |              |     |             |
| Servo off 2nd stage/PLT         | X                   |              |     |             |
| Servo off 1st stage/COPLT       | X                   |              |     |             |
| Servo off 2nd stage/COPLT       | X                   |              |     |             |
| Hydraulic leak test             | X                   |              |     |             |
| Tail servo                      | X                   |              |     |             |
| Boost servos                    | X                   |              |     |             |

| FUEL SYSTEM                | No EMI<br>Affect | EMI Affected<br>Gnd Flt | Explanation |
|----------------------------|------------------|-------------------------|-------------|
| Fuel pump switch           | X                |                         |             |
| Fuel boost pump #1         | X                |                         |             |
| Fuel boost pump #2         | X                |                         |             |
| Fuel cont panel ESSS       | Not installed    |                         |             |
| WARNING SYSTEM             | No EMI<br>Affect | EMI Affected<br>Gnd Flt | Explanation |
| Low rotor RPM              | X                |                         |             |
| Master caution             | X                |                         |             |
| Caution advisory           | X                |                         |             |
| Fire warning               | X                |                         |             |
| AFCS                       | X                |                         |             |
| Stabilator                 | X                |                         |             |
| #1 engine out              | X                |                         |             |
| #2 engine out              | X                |                         |             |
| NAVIGATION INSTRUMENTS     | No EMI<br>Affect | EMI Affected<br>Gnd Flt | Explanation |
| ADF                        | X                |                         |             |
| Magnetic compass           | X                |                         |             |
| CONUS NAV, ARN-123         | X                |                         |             |
| DOPPLER, ASN-128           | X                |                         |             |
| Gyro mag compass (PLT)     | X                |                         |             |
| Gyro mag compass (COPLT)   | X                |                         |             |
| Compass cont panel, ASN-75 | X                |                         |             |
| HSI                        | X                |                         |             |
| FLIGHT INSTRUMENTS         | No EMI<br>Affect | EMI Affected<br>Gnd Flt | Explanation |
| Radar altimeter            | X                |                         |             |
| Stabilator pos indicator   | X                |                         |             |
| VSI                        | X                |                         |             |
| CIS mode select            | X                |                         |             |
| SAS 1                      | X                |                         |             |
| SAS 2                      | X                |                         |             |
| FPS                        | X                |                         |             |
| Trim                       | X                |                         |             |
| Go-around enable           | X                |                         |             |
| Cyclic trim release        | X                |                         |             |
| Cyclic stick trim          | X                |                         |             |
| ALR encoder                | X                |                         |             |

| FLIGHT INSTRUMENTS (CONT)   | No EMI<br>Affect | EMI Affected            |     | Explanation  |
|-----------------------------|------------------|-------------------------|-----|--|
|                             |                  | Gnd                     | Flt |  |
| HSI/VSI mode select (PLT)   |                  |                         |     |  |
| DPLR                        | X                |                         |     |  |
| VOR/ILS                     | X                |                         |     |  |
| BACK CRS                    | X                |                         |     |  |
| FM HOME                     | X                |                         |     |  |
| TURN RATE                   | X                |                         |     |  |
| CRS HDG                     | X                |                         |     |  |
| VERT GYRO                   | X                |                         |     |  |
| BRG 2                       | X                |                         |     |  |
| HSI/VSI Mode Select (COPLT) |                  |                         |     |  |
| DPLR                        | X                |                         |     |  |
| VOR/ILS                     | X                |                         |     |  |
| BACK CRS                    | X                |                         |     |  |
| FM HOME                     | X                |                         |     |  |
| TURN RATE                   | X                |                         |     |  |
| CRS HDG                     | X                |                         |     |  |
| VERT GYRO                   | X                |                         |     |  |
| BRG 2                       | X                |                         |     |  |
| MISCELLANEOUS EQUIPMENT     |                  |                         |     |  |
|                             | No EMI<br>Affect | EMI Affected<br>Gnd Flt |     | Explanation  |
| Blade deice                 | Not tested       |                         |     | Ambient<br>tempera-<br>ture was<br>out of<br>test lim-<br>its. |
| Windshield anti-ice         | X                |                         |     |  |
| Pitot heat                  | X                |                         |     |  |
| Vent blower                 | X                |                         |     |  |
| Windshield wiper            | X                |                         |     |  |
| Heater                      | X                |                         |     |  |
| APU                         | X                |                         |     |  |
| Generator #1                | X                |                         |     |  |
| Generator #2                | X                |                         |     |  |
| Generator APU               | X                |                         |     |  |
| Air source heat start       | X                |                         |     |  |
| Tail wheel lock             | X                |                         |     |  |
| Gyro erect                  | X                |                         |     |  |

| LIGHTING                 | No EMI<br>Affect | EMI Affected |     | Explanation |
|--------------------------|------------------|--------------|-----|-------------|
|                          |                  | Gnd          | Flt |             |
| Cockpit utility          | X                |              |     |             |
| Cockpit flood            | X                |              |     |             |
| Cabin dome               | X                |              |     |             |
| Search light             | X                |              |     |             |
| Search light control     | X                |              |     |             |
| Landing light            | X                |              |     |             |
| Flt instr lights (PLT)   | X                |              |     |             |
| Flt instr lights (COPLT) | X                |              |     |             |
| Nonflight instr lights   | X                |              |     |             |
| Console lights, upper    | X                |              |     |             |
| Console lights, lower    | X                |              |     |             |
| Position lights          | X                |              |     |             |
| Formation lights         | X                |              |     |             |
| Anticollision lights     | X                |              |     |             |
| NVG lighting             | X                |              |     |             |

3.2.5 Battery life evaluation

Battery Life Evaluation  
Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Manufacturer battery life specification: None provided.

Specified battery recharge time: 15 hours to fully charge  
depleted battery.

Specified mode of operation under battery power: Continuous  
operation with backlight off.

Overall performance: Pass

Measurements: The unit averaged 10.13 hours of operation.

Comments: None

### 3.2.6 Electrical safety test

#### Electrical Safety Test Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 5 Jun 91

#### Measurements:

Grounding conductor resistance (milliohms): NA

Leakage current - Case to ground (microamperes):

|  |     |
|--|-----|
| unit off, grounded, normal polarity    | NA  |
| unit off, ungrounded, normal polarity  | 0.1 |
| unit off, ungrounded, reverse polarity | 0.2 |
| unit on, grounded, normal polarity     | NA  |
| unit on, ungrounded, normal polarity   | 0.1 |
| unit on, ungrounded, reverse polarity  | 0.2 |

#### MAXIMUM LIMITS:

|                                    |     |
|------------------------------------|-----|
| ground resistance (milliohms):     | 150 |
| current (grounded, type A unit):   | 10  |
| current (ungrounded, type A unit): | 100 |
| current (grounded, type B unit):   | 50  |
| current (ungrounded, type B unit): | 500 |

Comments on item setup or checks: None

Comments on test run (including interruptions): No ground  
conductor on power adapter.

Comments on other data: None

3.2.7 Human factors evaluation

Human Factors Evaluation  
Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 1 Nov 88

Item configuration during test: Item prepared for operation,  
sitting on a countertop.

Checklist for HFE

RESULTS

VISUAL DISPLAYS:

Unsatisfactory

display type, format, content  
location of displays  
indicator lights  
scalar displays  
color coding  
legends and labels  
cathode ray tubes  
counters  
flags, go-no-go, center-null indicators

Comments: No "battery charging" indication

CONTROLS:

Satisfactory

location  
characteristics of controls  
labeling  
control - display relationships

Comments: Grid arrangement of keyboard awkward

TIME REQUIRED TO PREPARE FOR OPERATION (list in comment)

Comments: 15 seconds

**MAINTAINABILITY:**

**Satisfactory**

component location  
component characteristics  
rests and stands  
covers, cases, access doors  
handles  
lubrication  
component mounting  
cord storage provisions  
external accessibility  
internal accessibility  
list special tools required  
list realistic inspection requirements  
list realistic inspection intervals

Comments: 6-month check of battery pack recommended

**CONDUCTORS:**

**Satisfactory**

binding and securing  
length  
protection  
routing  
conductor coding  
fabrication  
connectors

Comments: None

**FASTENERS:**

**Satisfactory**

access through inspection panel covers  
enclosure fasteners  
device mounting bolts and fasteners

Comments: None

TEST POINTS:

NA

general  
location and mounting  
test point labeling and coding

Comments: None

TEST EQUIPMENT:

Satisfactory

general  
equipment self-test  
indicators (list in comments)  
controls  
positive indication of proper operation

Comments: None

FUSES AND CIRCUIT BREAKERS:

NA

external accessibility  
easy replacement or reset by operator

Comments: None provided.

LABELS AND CODING:

Satisfactory

placed above controls and displays  
near or on the items they identify  
not obscured by other equipment components  
describe the function of the items they identify  
readable from normal operating distance  
conspicuous placards adjacent to hazardous items

Comments: None

SAFETY:

Satisfactory

manual  
materials  
fire and explosive protection  
operator protection from mechanical hazards  
patient protection from mechanical hazards  
electrical safety (operator and patient)

Comments: None

### 3.2.8 Altitude test

#### Altitude Test Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 14 Jun 91

Item configuration during test: Item operating on dc (battery) power, sitting on chamber floor.

Performance test criteria: Successful execution of self-test and test program software.

Ambient conditions outside chamber:

|                     |        |
|---------------------|--------|
| Temperature         | 73°F   |
| Humidity            | 82% RH |
| Barometric pressure | 1 atm  |

#### PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                 |                |
|---------------------------------|----------------|
| list connections to power       | None (battery) |
| list connections to simulators  | None           |
| list connections to dummy loads | None           |
| list unconnected terminals      | Serial port    |

#### IN-TEST DATA

Time of test start: 0800

#### POSTTEST DATA

Posttest performance check (complete check of item and accessories):

Time of test end: 0924

Item functional (based on performance test criteria): Yes

**Deviation from pretest : None**

**Comments on item setup or checks: None**

**Comments on test run (including interruptions): None**

**Comments on other data: None**

### 3.2.9 Vibration test

#### Vibration Test Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 13 Jun 91

Item configuration during test: Item strapped down on vibration table fixture; ac and dc operation.

Performance test criteria: Successful execution of self-test program and software.

#### PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                 |         |
|---------------------------------|---------|
| list connections to power       | 120 Vac |
| list connections to simulators  | None    |
| list connections to dummy loads | None    |
| list unconnected terminals      | None    |

Ambient conditions

|                     |        |
|---------------------|--------|
| Temperature         | 72°F   |
| Humidity            | 83% RH |
| Barometric pressure | 1 atm  |

#### IN-TEST DATA

Data and performance checks during test:

Times of test start:

Time at first check:

X: 1511                      Y: 1405                      Z: 0747

Item functional (based on performance test criteria): Yes

Deviation from pretest: None

Time at second check:

X: 1610

Y: 1501

Z: 0840

Item functional (based on performance test criteria): Yes

Deviation from pretest: None

POSTTEST DATA

Posttest performance check (complete check of item and accessories):

Item functional (based on performance test criteria): Yes

Item intact: Yes

Deviation from pretest: None

Comments on item setup or checks:  
Times are on different days

Comments on test run (including interruptions): None

Comments on other data: None

3.2.10 High temperature test

High Temperature Test  
(Equipment Operating)  
Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 12 Jun 91

Item configuration during test: Unit was sitting on test stand.

Performance test criteria: Successful execution of self-test and test program software.

Ambient conditions outside chamber:

|                     |        |
|---------------------|--------|
| Temperature         | 24°C   |
| Humidity            | 53% RH |
| Barometric pressure | 1 atm  |

PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                   |            |
|-----------------------------------|------------|
| list connections to power         | 120 Vac    |
| list connections to simulators    | None       |
| list connections to dummy loads   | None       |
| list unconnected terminals        | Serial I/O |
| distance from north wall (meters) | 0.57       |
| distance from south wall (meters) | 0.57       |
| distance from east wall (meters)  | 1.22       |
| distance from west wall (meters)  | 1.38       |
| distance from ceiling (meters)    | 1.50       |
| distance from floor (meters)      | 0.50       |

IN-TEST DATA

Time of test start: 1340

Performance checks during test:

First check:

Time: 1410  
Temperature: 49°C  
Humidity: 15% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
Yes, all OK  
Deviation from pretest: None

Second check:

Time: 1440  
Temperature: 49°C  
Humidity: 15% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
Yes, all OK  
Deviation from pretest: None

Third check:

Time: 1510  
Temperature: 49°C  
Humidity: 15% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
Yes, all OK  
Deviation from pretest: None

POSTTEST DATA

Posttest performance check:

(complete check of item and accessories)

Time of test end: 1540  
Item functional (based on performance test criteria)  
Yes, all OK  
Deviation from pretest: None

Comments on item setup or checks: None

Comments on test run (including interruptions): None

Comments on other data: None

3.2.11 High temperature storage test

High Temperature Test  
(Equipment in Storage)  
Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 18 Jun 91

Item configuration during test: Sitting on test stand, in storage, not operating.

Performance test criteria: Successful execution of self-test and test program software.

Ambient conditions outside chamber:

|                     |          |
|---------------------|----------|
| Temperature         | 250°C    |
| Humidity            | 6043% RH |
| Barometric pressure | 1 atm    |

PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                   |      |
|-----------------------------------|------|
| list connections to power         | None |
| list connections to simulators    | None |
| list connections to dummy loads   | None |
| list unconnected terminals        | All  |
| distance from north wall (meters) | 0.57 |
| distance from south wall (meters) | 0.57 |
| distance from east wall (meters)  | 1.22 |
| distance from west wall (meters)  | 1.38 |
| distance from ceiling (meters)    | 1.50 |
| distance from floor (meters)      | 0.50 |

Time of test start: 0820

**POSTTEST DATA**

**Posttest performance check:**  
(complete check of item and accessories)

**Time of test end:** 1130  
**Item functional (based on performance test criteria):** Yes  
**Deviation from pretest:** None

**Comments on item setup or checks:** None

**Comments on test run (including interruptions):** None

**Comments on other data:** None

3.2.12 Low temperature test

Low Temperature Test  
(Equipment Operating)  
Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 14 Jun 91

Item configuration during test: Sitting on test stand, ready for operation.

Performance test criteria: Successful execution of self-test and test program software.

Ambient conditions outside chamber:

|                     |        |
|---------------------|--------|
| Temperature         | 25°C   |
| Humidity            | 53% RH |
| Barometric pressure | 1 atm  |

PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                   |            |
|-----------------------------------|------------|
| list connections to power         | 120 Vac    |
| list connections to simulators    | None       |
| list connections to dummy loads   | None       |
| list unconnected terminals        | Serial I/O |
| distance from north wall (meters) | 0.57       |
| distance from south wall (meters) | 0.57       |
| distance from east wall (meters)  | 1.22       |
| distance from west wall (meters)  | 1.38       |
| distance from ceiling (meters)    | 1.50       |
| distance from floor (meters)      | 0.50       |

Time of test start: 1200

Performance checks during test:

First check:

Time: 1035  
Temperature: 0°C  
Humidity: NA  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria): Yes  
Deviation from pretest: None

Second check:

Time: 1105  
Temperature: 0°C  
Humidity: NA  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria): Yes  
Deviation from pretest: None

Third check:

Time: 1135  
Temperature: 0°C  
Humidity: NA  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria): Yes  
Deviation from pretest: None

POSTTEST DATA

Posttest performance check:

(complete check of item and accessories)

Time of test end: 1208  
Item functional (based on performance test criteria): Yes  
Deviation from pretest: None

Comments on item setup or checks: Display not as sharp as normal while at cold temperature, but still readable.

Comments on test run (including interruptions): None

Comments on other data: None

### 3.2.13 Low temperature storage test

#### Low Temperature Test (Equipment in Storage) Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 17 Jun 91

Item configuration during test: Sitting on test stand, in storage, not operating.

Performance test criteria: Consistent and accurate displays and measurements

Ambient conditions outside chamber:

|                     |        |
|---------------------|--------|
| Temperature         | 24°C   |
| Humidity            | 57% RH |
| Barometric pressure | 1 atm  |

#### PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                   |      |
|-----------------------------------|------|
| list connections to power         | None |
| list connections to simulators    | None |
| list connections to dummy loads   | None |
| list unconnected terminals        | All  |
| distance from north wall (meters) | 0.57 |
| distance from south wall (meters) | 0.57 |
| distance from east wall (meters)  | 1.22 |
| distance from west wall (meters)  | 1.38 |
| distance from ceiling (meters)    | 1.50 |
| distance from floor (meters)      | 0.50 |

Time of test start: 0837

**POSTTEST DATA**

**Posttest performance check:**  
**(complete check of item and accessories)**

**Time of test end: 1137**  
**Item functional (based on performance test criteria): Yes**  
**Deviation from pretest: None**

**Comments on item setup or checks: None**

**Comments on test run (including interruptions): None**

**Comments on other data: The unit was allowed to return to ambient conditions overnight before final performance check.**

### 3.2.14 Humidity test

#### Humidity Test Report Form

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: None

Options installed: None

Date of test: 19 Jun 91

Item configuration during test: The unit was sitting on the test stand, ready for operation.

Performance test criteria: Successful execution of self-test and test program software.

Ambient conditions outside chamber:

|                     |        |
|---------------------|--------|
| Temperature         | 25°C   |
| Humidity            | 57% RH |
| Barometric pressure | 1 atm  |

#### PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Yes

Installation of item in test facility:

|                                   |         |
|-----------------------------------|---------|
| list connections to power         | 120 Vac |
| list connections to simulators    | None    |
| list connections to dummy loads   | None    |
| list unconnected terminals        | ALL     |
| distance from north wall (meters) | 0.57    |
| distance from south wall (meters) | 0.57    |
| distance from east wall (meters)  | 1.22    |
| distance from west wall (meters)  | 1.38    |
| distance from ceiling (meters)    | 1.50    |
| distance from floor (meters)      | 0.50    |

#### IN-TEST DATA

Time of test start: 0813

**Performance checks during test:**

**First check:**

Time: 0900  
Temperature: 29.5°C  
Humidity: 95% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
All OK  
Deviation from pretest: None

**Second check:**

Time: 0945  
Temperature: 29.5°C  
Humidity: 95% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
All OK  
Deviation from pretest: None

**Third check:**

Time: 1030  
Temperature: 29.5°C  
Humidity: 95% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
All OK  
Deviation from pretest: None

**Fourth check:**

Time: 1115  
Temperature: 29.5°C  
Humidity: 95% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
All OK  
Deviation from pretest: None

**Fifth check:**

Time: 1200  
Temperature: 29.5°C  
Humidity: 95% RH  
Barometric pressure: 1 atm  
Item functional (based on performance test criteria)  
All OK  
Deviation from pretest: None

**POSTTEST DATA**

**Posttest performance check:**

(complete check of item and accessories)

Time of test end: 1321

Item functional (based on performance test criteria): Yes

Deviation from pretest: None

Comments on item setup or checks: None

Comments on test run (including interruptions): None

Comments on other data: None

3.2.15 Electromagnetic characteristics test

\*\*\*\*\*

Electromagnetic Characteristics Testing  
Evaluation of Performance  
\*\*\*\*\*

T & E Item Number: 29

Date: 6 Jun 91

Nomenclature: Hand held computer  
Manufacturer: Paravant  
Model number: Paravant® RHC-88  
Serial number: A172.031  
Military item number: NA

\*\*\*\*\*

Conducted Emissions Tests

CE01      Testing configuration(s): NA  
            Performance (pass/fail): NA

            Comments: Unit has no external power lead  
                         adaptor.

CE02      Testing configuration(s): Operating on ac power  
            Performance (pass/fail): Pass

            Comments: None

CE04      Testing configuration(s): Operating on ac power  
            Performance (pass/fail): Pass

            Comments: None

## Conducted Susceptibility Tests

- CS02      Testing configuration(s): Operating on test bench, operating on ac power.  
Performance (pass/fail): Pass
- Comments: None
- CS06      Testing configuration(s): Operating on counter top on ac power.  
Performance (pass/fail): Pass
- Comments: Not susceptible to test spikes.

## Radiated Emissions Tests

- RE02      Testing configuration(s): Operating on wooden test stand in the EMC chamber, ac and battery power.  
Performance (pass/fail): Fail
- Comments: ac operation:

| <u>Frequency</u> |              | <u>Emission exceeding standard</u> |
|------------------|--------------|------------------------------------|
| 175              | - 630 kHz    | 10.9 - 26.3 dB (NB)                |
| 1.09             | - 3.07 MHz   | 3.70 - 19.1 dB (NB)                |
| 6.25             | - 8.08 MHz   | 4.50 - 18.1 dB (NB)                |
| 13.82            | - 486.35 MHz | 0.40 - 48.4 dB (NB)                |
| 14 kHz           | - 1.26 MHz   | 0.20 - 24.2 dB (BB)                |
| 29.97            | - 30 MHz     | 22.4 dB (BB)                       |

Battery operation:

| <u>Frequency</u> |              | <u>Emission exceeding standard</u> |
|------------------|--------------|------------------------------------|
| 150 kHz          | - 3.17 MHz   | 3.5 - 19.3 dB (NB)                 |
| 7.82             | - 497.61 MHz | 0.1 - 25.6 dB (NB)                 |
| 35 kHz           | - 70 kHz     | 0.6 - 1.40 dB (BB)                 |

## Radiated Susceptibility Tests

- RS03      Testing configuration(s): Operating on the wooden test stand in the EMC chamber.  
Performance (pass/fail): Pass
- Comments: None

### 3.3 CRITERIA, SIGNIFICANT PROBLEMS, AND SUGGESTED IMPROVEMENTS

#### 3.3.1 Criteria

| <u>Item</u> |  |                | <u>Applicable</u>   |
|-------------|--|----------------|---------------------|
| <u>No.</u>  | <u>Criteria (Source)</u>   | <u>Remarks</u> | <u>subparagraph</u> |
| 1           | The physical inventory is conducted solely for investigation and documentation.  | NA             | 2.1.2.1             |
| 2           | The Paravant® RHC-88 will display consistent and accurate measurements.  | met            | 2.1.2.2             |
| 3           | Verify battery life expectancy of at least 1.5 hours.  | met            | 2.2.2               |
| 4           | The Paravant® RHC-88 will meet the limits established in NAF 99 for electrical safety of medical equipment.  | met            | 2.3.2               |
| 5           | The Paravant® RHC-88 will be rated satisfactory in all major categories of the evaluation. These include: Visual displays, controls, maintainability, conductors, fasteners, test points, test equipment, fuses and circuit breakers, labels and coding, and safety. | partially met  | 2.4.2               |
| 6           | The Paravant® RHC-88 will display consistent and accurate measurements while exposed to an altitude equivalency of 15,000 feet above sea level.  | met            | 2.5.2               |
| 7           | The Paravant® RHC-88 will remain operational and display consistent and accurate measurements while exposed to vibrational stresses.   | met            | 2.6.2               |
| 8           | The Paravant® RHC-88 will display consistent and accurate measurements during the high temperature operation check.  | met            | 2.7.2.1             |

|    |  |               |          |
|----|--|---------------|----------|
| 9  | The Paravant® RHC-88 will display consistent and accurate measurements after the high temperature storage.   | met           | 2.7.2.2  |
| 10 | The Paravant® RHC-88 will display consistent and accurate measurements during the low temperature operation check.                                     | met           | 2.8.2.1  |
| 11 | The Paravant® RHC-88 will display consistent and accurate measurements after the low temperature storage.  | met           | 2.8.2.2  |
| 12 | The Paravant® RHC-88 will display consistent and accurate measurements while exposed to high humidity.   | partially met | 2.9.2    |
| 13 | The Paravant® RHC-88 will not produce emissions in excess of the limits set forth in MIL-STD-461A, Notice 4, paragraph 6.13.                           | partially met | 2.10.2.1 |
| 14 | The Paravant® RHC-88 will not malfunction when it is subjected to radiated fields as specified in MIL-STD-461A, Notice 4, paragraph 6.20.              | met           | 2.10.2.2 |
| 15 | The Paravant® RHC-88 will not conduct emissions in excess of the limits set forth in MIL-STD-461A, Notice 4, paragraphs 6.1 and 6.2.                   | met           | 2.10.2.3 |
| 16 | The Paravant® RHC-88 will not malfunction when it is subjected to conducted emissions as specified in MIL-STD-461A, Notice 4, paragraphs 6.7 and 6.10. | met           | 2.10.2.4 |
| 17 | The flight surgeon will be able to operate the Paravant® RHC-88 without physical or functional restrictions aboard the aircraft.                       | partially met | 2.11.2.1 |

- |    |  |     |          |
|----|--|-----|----------|
| 18 | The Paravant® RHC-88 will not radiate EMI to disrupt or interfere with the other equipment or systems aboard the aircraft. | met | 2.12.2.2 |
| 19 | The aircraft will not radiate EMI to disrupt or interfere with the Paravant® RHC-88.                                       | met | 2.12.2.3 |

3.3.2 Significant problems which require corrective action

None

3.3.3 Suggested improvements

None

### 3.4 REFERENCES

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- 3.4.7 Department of Defense. 1989. Human engineering design criteria for military systems, equipment, and facilities. Washington, DC. MIL-STD-1472D. March.
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### 3.5 ABBREVIATIONS

|         |   |
|---------|---|
| ac      | alternating current                     |
| atm     | atmosphere                              |
| AVSCOM  | U.S. Army Aviation Systems Command      |
| AWR     | airworthiness release                   |
| BB      | broadband                               |
| CAAF    | Cairns Army Airfield                    |
| CRT     | cathode ray tube                        |
| CPU     | central processing unit                 |
| dB      | decibel                                 |
| dc      | direct current                          |
| ECG     | electrocardiograph                      |
| EMC     | electromagnetic compatibility           |
| EMI     | electromagnetic interference            |
| fpm     | feet per minute                         |
| GFE     | government furnished equipment          |
| GHZ     | gigahertz                               |
| Gpk     | gravity, peak                           |
| G(rms)  | gravity (root mean square)              |
| Hz      | hertz                                   |
| IAW     | in accordance with                      |
| kHz     | kilohertz                               |
| LCD     | liquid crystal display                  |
| LISN    | line impedance stabilization networks   |
| MEDEVAC | medical evacuation                      |
| MHz     | mega hertz                              |
| MIL-STD | military standard                       |
| ml      | milliliter                              |
| mm      | millimeter                              |
| mmHg    | millimeters of Mercury                  |
| MSL     | mean sea level                          |
| NAFP    | National Association of Fire Prevention |
| NB      | narrowband                              |
| NBC     | nuclear, biological and chemical        |
| NiCad   | nickel cadmium                          |
| NVG     | night vision goggle                     |
| RAM     | random access memory                    |
| RF      | radio frequency                         |

RH  
ROM

relative humidity  
read only memory

TB  
T & E

technical bulletin  
test and evaluation

UES  
USAARL

Universal Energy Systems, Inc.  
U.S. Army Aeromedical Research Laboratory

V/m

volts per meter

### 3.6 LIST OF MANUFACTURERS

- 3.6.1 Paravant Computer Systems, Inc.  
305 East Drive  
West Melbourne, FL 32904
- 3.6.2 Sikorsy Aircraft  
6900 Main Street  
Stratford, CT 06601
- 3.6.3 Neurodyne-Dempsey, Inc.  
200 Arrowhead Drive  
Carson City, NV 89701
- 3.6.4 Tenney Engineering, Inc.  
1090 Springfield Road  
Post Office Box 3142  
Union, NJ 07083
- 3.6.5 Unholtz-Dickey Corporation  
6 Brookside Drive  
Wallingford, CT 06492
- 3.6.6 Solar Electronics Company  
901 North Highland Avenue  
Hollywood, CA 90038
- 3.6.7 Tektronix, Inc  
P.O. Box 500  
Beaverton, OR 97077