

USAARL Report No. 92-22



**Test and Evaluation Report
of the IVAC[®] Volumetric Controller
Model 280EE**

By

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**United States Army Aeromedical Research Laboratory
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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) 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 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 during exposure to high humidity 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) at Fort Rucker, Alabama.

1.3.2 The USAARL UH-60A aircraft, serial number 88-26069, with subsystems delineated in paragraph 3.2.2, was available for flight test of the IVAC® Volumetric controller*, model 280EE. The unit was not approved for flight testing.

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 The following tests were accomplished: Acceptance inspection, equipment training, electromagnetic compatibility, human factors and safety, and environmental compatibility.

1.4 MATERIAL DESCRIPTION

The IVAC® Model 200EE Volumetric controller is electrically driven and designed to regulate IV fluids on a semiautomatic basis where gravity force is sufficient to provide fluid flow. Membrane switches on the front of the controller allow the user to set the rate and volume of fluid to be administered. The rate adjustment range is from 5 to 300 mL/h. The volume to be infused may be adjusted from 0 to 9999 milliliters. When the

* See list of manufacturers

selected volume has been delivered, an audio alarm is activated and the IVAC® 280EE reverts to a "keep vein open" delivery rate of 5 mL/h. A locking clear green plastic door protects the administration set and the control mechanism. The controller is automatically shut off if the door is opened during the infusion. A pole clamp, ac power receptacle, flow sensor storage bracket, flow sensor receptacle and an ac line circuit breaker are located on the back panel. The only administration set that will function properly with the IVAC® 280EE is the IVAC® "Type S" administration set.

1.5 SUMMARY

1.5.1 Laboratory testing

1.5.1.1 Battery life evaluation: The IVAC® Model 280EE was operated on a fully-charged battery at 125 mL/h at room temperature (75 degrees F and 51% RH). The fully-charged IVAC® Model 280EE averaged 19 hours and 42 minutes of operation. The battery is rated for 12 hours of operation. This exceeds the manufacturer's specification.

1.5.1.2 Electrical safety evaluation: All measurements were within acceptable limits. No unsafe qualities were found in the IVAC® Model 280EE. The limits for currents and resistances were in accordance with (IAW) the limits specified in TB-38-750-2, April 1987.

1.5.1.3 Human factors evaluation: The IVAC® Model 280EE was found to be satisfactory in all major categories of the evaluation criteria with one exception. The red light emitting diode displays do not have an intensity control.

1.5.1.4 Environmental tests: The IVAC® Model 280EE 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 except the altitude test. The IVAC® 280EE Controller's performance was found to be unsatisfactory during the altitude test. When chamber pressure was reduced, the soft plastic vented "Type S" administration set started to expand in the low pressure environment. At altitude, a large number of air bubbles were present in the administration set and were not detected by the unit. 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 IVAC® Model 280EE may be unsatisfactory for use in certain EMI sensitive environments. Narrowband (NB) and broadband (BB) radiated 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 IVAC® Model 280EE was found to be susceptible to radio frequency interference in the testing range and magnitude.

1.5.1.7 Conducted emissions test (CE01, CE02, and CE04): Conducted emissions were measured at 38.813 and 50.449 MHz at 6.4 and 3.7 dB over specification limits.

1.5.1.8 Conducted susceptibility test (CS02 and CS06): The IVAC Model 280EE Controller was not tested for susceptibility to conducted radio frequency interference. The test signals could not be detected on the infusion pump power line due to conducted emissions from the controller.

1.5.2 In-flight testing

In-flight testing of the IVAC® Model 280EE Volumetric Controller could not be accomplished. Request for Airworthiness Release was denied by the U.S. Army Aviation Systems Command due to excess electromagnetic emissions discovered during laboratory testing.

1.6 CONCLUSIONS

Since the IVAC® Model 280EE did not perform properly in the altitude chamber and excess electromagnetic emissions make it ineligible for an airworthiness release, the unit is not considered compatible with the U.S. Army medical evacuation UH-60A Black Hawk with the subsystems listed in paragraph 3.2.2.

Section 2. Subtests

2.1 INITIAL INSPECTION

2.1.1 Objective

To determine if the IVAC® Model 280EE 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 IVAC® Model 280EE will display consistent and accurate measurements as an acceptable performance test.

2.1.3 Test procedure

2.1.3.1 A complete physical inventory of the IVAC® Model 280EE was completed per the manufacturer's equipment list.

2.1.3.2 An operational validation test of the IVAC® Model 280EE was conducted per the manufacturer's operating instructions by USAARL's medical maintenance personnel.

2.1.4 Test findings

2.1.4.1 The IVAC® Model 280EE was inventoried and found to be complete.

2.1.4.2 The IVAC® Model 280EE operated as prescribed in the manufacturer's operating manual. Criteria 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 Criterion

Verify manufacturer's specified full power internal battery life expectancy of 12 hours operation at 125 mL/h infusion rate.

2.2.3 Test procedure

2.2.3.1 Charging and operation cycles were conducted in ambient room conditions.

2.2.3.2 The IVAC® Model 280EE was operated continuously using its fully-charged internal battery at 125 mL/h infusion rate until a low battery indication occurred. The depletion time was noted and the battery was recharged. This procedure was repeated three times.

2.2.4 Test findings

The test was conducted using the fully-charged internal battery. The average operating time in testing was 19 hours and 42 minutes at room temperature. This exceeds manufacturer's specification of 12 hours. Criterion met.

2.3 ELECTRICAL SAFETY EVALUATION

2.3.1 Objective

To ensure the electrical safety of the IVAC® Model 280EE by evaluation of case-to-ground resistance and case-to-ground current leakage.

2.3.2 Criterion

The IVAC® Model 280EE shall meet the standards established in Technical Bulletin Number 38-750-2, April 1987 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 73.5 milliohms and maximum case leakage current was 0.6 microamperes. These measurements are below the limits specified in NAF 99. 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 could potentially contribute to an operator error.

2.4.2 Criterion

The IVAC® Model 280EE 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 IVAC® Model 280EE was operated according to prescribed instructions through its full range of functions.

2.4.4 Test finding

The IVAC® Model 280EE was found to be satisfactory in all of the evaluation criteria with one exception. The red LED displays do not have an intensity control. Criterion partially met.

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

2.5.1 Objective

To determine if the IVAC® Model 280EE can function as designed in a low-pressure environment.

2.5.2 Criterion

The IVAC® Model 280EE will display consistent and accurate performance 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 IVAC® Model 280EE.

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 IVAC® Model 280EE was operated at 70 mL/h and placed on 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 IVAC® Model 280EE 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 Variation in pressure caused the drip chamber of the "S" administration set to become filled with fluid and "FLO" errors were noted. Upon reaching altitude, the unit administration set became filled with air bubbles, but no error condition was detected by the unit. When the unit was returned to ambient conditions the drip chamber again became filled with fluid, causing "FLO" errors. Criterion not 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 IVAC® Model 280EE to withstand the vibrational stresses expected in a rotary-wing environment without degradation or malfunction.

2.6.2 Criterion

The IVAC® Model 280EE will remain operational and be able to display consistent and accurate measurements while exposed to vibrational stresses.

2.6.3 Test procedure

2.6.3.1 A pretest performance check was conducted to ensure proper operation of the IVAC® Model 280EE.

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 are derived from measurements taken on the floor under the copilot'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/oct
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 IVAC® Model 280EE 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 IVAC® Model 280EE.

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 performance of the IVAC® Model 280EE 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 IVAC® Model 280EE to be stored and operated in a high-temperature environment.

2.7.2 Criteria

2.7.2.1 The IVAC® Model 280EE will display consistent and accurate measurements during the high-temperature operation check.

2.7.2.2 The IVAC® Model 280EE will display consistent and accurate measurements after the high-temperature storage cycle.

2.7.3 Test procedure

2.7.3.1 A pretest performance check was conducted to ensure proper operation of the IVAC® Model 280EE.

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 IVAC® Model 280EE was turned on at 70 mL/h, with the drip chamber 36 inches above the venipuncture site, and placed on the floor 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 ± 2°C and humidity within ± 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 IVAC® Model 280EE 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 IVAC® Model 280EE.

2.7.3.4 The IVAC® Model 280EE 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 IVAC® Model 280EE 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 IVAC® Model 280EE.

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 IVAC® Model 280EE 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 IVAC® Model 280EE to be stored and operated in a low-temperature environment.

2.8.2 Criteria

2.8.2.1 The IVAC® Model 280EE will display consistent and accurate performance during the low-temperature operation check.

2.8.2.2 The IVAC® Model 280EE will display consistent and accurate performance after the low-temperature storage cycle.

2.8.3 Test procedure

2.8.3.1 A pretest performance check was conducted to ensure proper operation of the IVAC® Model 280EE.

2.8.3.2 The IVAC® Model 280EE 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 IVAC® Model 280EE.

2.8.3.4 The IVAC® Model 280EE was "stored" in a nonoperational mode. The IVAC® Model 280EE was placed on the floor of the environmental test chamber and the temperature was lowered to

-46°C for 6 hours. The chamber then was 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 IVAC® Model 280EE.

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. Criterion met.

2.8.4.3 The posttest performance check met criterion 2.1.2.2.

2.8.4.4 The IVAC® Model 280EE 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 IVAC® Model 280EE to operate satisfactorily for short periods of time during exposure to highly humid conditions.

2.9.2 Criterion

The IVAC® Model 280EE will display consistent and accurate performance while exposed to a high humidity environment.

2.9.3 Test procedure

2.9.3.1 A pretest performance check was conducted to ensure the proper operation of the IVAC® Model 280EE.

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 IVAC® Model 280EE was placed in operation on the floor of the environmental chamber. The chamber temperature was raised to a temperature of 30°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 ± 5 percent RH. At 45-minute intervals the performance of the BP monitor was checked. The chamber door was opened briefly to minimize the change in chamber conditions. The chamber and the IVAC® Model 280EE 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 IVAC® Model 280EE.

2.9.4 Test findings

2.9.4.1 The pretest performance check met criterion 2.1.2.2.

2.9.4.2 No failures were noted in the IVAC® Model 280EE performance checks conducted during the exposure to the high humidity environment. 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 IVAC® Model 280EE in the 14 kHz to 12.4 GHz frequency range.

2.10.1.2 To assess the tolerances of radiated electromagnetic susceptibility of the IVAC® Model 280EE within the 10 kHz to 10 GHz electric field.

2.10.1.3 To assess the maximum levels of conducted electromagnetic emissions produced by the IVAC® Model 280EE in the 10 kHz to 50 MHz frequency ranges.

2.10.1.4 To assess the tolerances of conducted electromagnetic susceptibility of the IVAC® Model 280EE within the range of 50 kHz to 400 MHz and power spikes.

2.10.2 Criteria

2.10.2.1 The IVAC® Model 280EE will not produce emissions in excess of the limits set forth in MIL-STD-461A, Notice 4, paragraph 6.13.

2.10.2.2 The IVAC® Model 280EE will not malfunction when it is subjected to radiated emissions as specified in MIL-STD-461A, Notice 4, paragraph 6.20.

2.10.2.3 The IVAC® Model 280EE 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 IVAC® Model 280EE 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 IVAC® Model 280EE was positioned on a wooden test stand inside the EMI chamber, 1 meter away from the receiving antennas. The antennas were mounted for both vertical and horizontal polarities and connected to EMI receivers. While the IVAC® Model 280EE was operating, the frequency spectrum (14 kHz to 12.4 GHz) was scanned for emissions. The IVAC® Model 280EE was operated with both ac and battery power.

2.10.3.2 The radiated susceptibility test was performed according to MIL-STD-462, Notice 3, Method RS03. The IVAC® Model 280EE was positioned on a wooden test stand inside the EMI chamber 1 meter away from the transmitting antennas. The antennas were mounted for both vertical and horizontal polarities and connected to radio frequency (RF) transmitters. While the IVAC® Model 280EE was operating, it was monitored for faulty operation during exposures to fields of 1 V/m from 10 kHz to 2 MHz, and 5 V/m from 2 to 30 MHz, 10 V/m from 30 MHz to 2 GHz, and 5V/m from 2 to 10 GHz. The IVAC® Model 280EE was operated with ac and battery power.

2.10.3.3 The conducted emissions tests were performed according to MIL-STD-462, Notice 3, Methods CE02 and CE04. The IVAC® Model 280EE 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 IVAC® Model 280EE was operating, the frequency range (10 kHz to 50 MHz) was scanned for emissions conducted in the power cable.

2.10.3.4 The conducted susceptibility spike test was performed according to MIL-STD-462, Notice 3, Method CS06, on a chemical resistant counter top. Power was supplied via a customized metal connection box. The connection box has two power receptacles and four banana jacks on its front panel. Connections to the individual power lines are 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 IVAC® Model 280EE was plugged into the other receptacle on the connection box and placed in operation. It was observed for correct operation and 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 IVAC® Model 280EE was placed on a grounded, copper covered workbench. Radio frequency interference was induced on the power leads and measured at the power cable. The frequency of the interference was incremented over the 50 kHz to 400 MHz range while the IVAC® Model 280EE was operated. It was observed for correct operation and visual 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, emissions which exceeded specification limits of MIL-STD-461A, Notice 4, were detected. These included:

<u>Power</u>	<u>Frequency range</u>	<u>Emission exceeding standard</u>
ac:	0.746 - 374.782 MHz	0.2 - 45.2 dB (NB)
	0.014 - 100 MHz	0.7 - 23.5 dB (BB)
dc:	0.183 - 383.771 MHz	0.4 - 42.6 dB (NB)
	0.044 MHz	0.4 dB (BB)
	100 MHz	0.4 dB (BB)

Criterion not met.

2.10.4.2 The IVAC® Model 280EE was found to be susceptible to radio frequency interference in the testing range and magnitude.

<u>Frequency range</u>	<u>Maximum field strength without susceptibility</u>
22 - 24.4 MHz	2.31 - 5.00 V/m
30 - 200 MHz	0.48 - 9.44 V/m
204 - 388 MHz	1.80 - 8.71 V/m
508 - 868 MHz	3.94 - 7.94 V/m

Criterion partially met.

2.10.4.3 Narrowband emissions of 6.4 and 3.7 dB over specification were detected at 38.813 and 50.449 MHz. Criterion not met.

2.10.4.4 The test signals were not detectable on the power lines due to conducted emissions from the IVAC® Model 280EE. Criterion not met.

2.11 IN-FLIGHT HUMAN FACTORS EVALUATION

2.11.1 Objective

To assess the physical and/or functional compatibility of the IVAC® Model 280EE while in use on board the aircraft.

2.11.2 Criterion

The flight surgeon will be able to operate the IVAC® Model 280EE 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

Not applicable since unit not available for in-flight testing.

2.11.4 Test findings

Not available since unit not available for in-flight testing. Criterion not evaluated.

Section 3. Supporting documentation

3.1 DETAILED TEST INFORMATION

3.1.1 General information

3.1.1.1 IVAC® Model 280EE testing is not considered a major action significantly affecting the quality of the human environment and, therefore, qualifies for categorical exclusion A-28, appendix A, AR 200-1.

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 IVAC® Model 280EE Volumetric controller is electrically driven and designed to regulate IV fluids on a semiautomatic basis where gravity force is sufficient to provide fluid flow. Membrane switches on the front of the controller allow the user to set the rate and volume of fluid to be administered. The rate adjustment range is from 5 to 300 mL/h. The volume to be infused may be adjusted from 0 to 9999 milliliters. When the selected volume has been delivered, an audio alarm is activated and the IVAC® 280EE reverts to a "keep vein open" delivery rate of 5 mL/h. A locking clear green plastic door protects the administration set and the control mechanism. The controller is automatically shut off if the door is opened during the infusion. A pole clamp, ac power receptacle, flow sensor storage bracket, flow sensor receptacle and an ac line circuit breaker are located on the back panel. The only administration set that will function properly with the IVAC® 280EE is the IVAC® "Type S" administration set.

3.1.2.2 Method of operation: The IVAC® Model 280EE is an electrically driven volumetric controller. The microprocessor-based controller uses a pulsatile mechanism to regulate the volume of fluid being infused. The locking clear blue plastic door covers the pulsatile mechanism and the "Type S" administration set. The drip chamber must be approximately 36 inches above the venipuncture site to insure accurate delivery of the fluid. The flow sensor unit is attached to the drip chamber of the IV administration set and is able to detect erratic drops, which activate an error message and an audio alarm. The controller automatically shuts down in this event. A flow status indicator on the front panel shows green for proper fluid flow, yellow for borderline flow, or red for incorrect fluid flow. The errors displayed on the unit are "Flo" or "Flo" followed by a

number, "Err" followed by a number or letter, "door," "hold," and "batt."

3.1.2.3 Dimensions: 5.1 x 7.67 x 7.5 in. (13 x 19.5 x 19.3 cm).

3.1.2.4 Weight: 6 lb (2.7 kg).

3.1.2.5 Power requirements: 90 to 125 Vac, 50 or 60 Hz, 0.15 amp, 3-wire grounded system. Internal rechargable battery provides 12 hours of rated operation with the controller set at a rate of 125 mL/h. Charge time for a low battery to 70% of a full charge approximately 6 hours with the unit off. Power cord is 18-3, type SJT, PE CO, of approximately 119 inches in length.

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 (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 (VOR/LOC/MB/GS)
6	Command instrument system processor -- 70600-01038-101
7	SAS amplifier -- 70901-02908-104 (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 (doppler navigation receiver)
12	Barometric altimeter -- AAU-31/A-1
13	Barometric altimeter -- AAU-32A
14	Receiver/transmitter -- RT-1300/ARC-186 (VHF-AM and/or FM radio)
15	UHF-AM radio set -- RT-1518/ARC-164
16	Interphone control -- C6533/ARC (aircraft intercom control)
17	Receiver/transmitter -- RT-1115D/APN-209 (radar altimeter)
18	Indicator altimeter -- ID-1917C/APN-209 (radar altimeter)
19	Control radio set -- C-7392A/ARN-89 (automatic direction finder)
20	Comparator signal data -- CM-482/ARC-186 (comparator for ARC-186)
21	Receiver/transmitter -- RT-1296A/APX-100 (transponder with IFF)
22	Computer display unit -- CP-1252/ASN-128 (doppler navigation system)
23	Compass set controller -- C-8021E/ASN75
24	Magnetic compass - standby -- MS-17983-4

3.2.3 Battery life evaluation

Battery Life Evaluation Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Manufacturer battery life specification: 12 hours

Specified battery recharge time: 6 hours (70% charge).

Specified mode of operation under battery power: 125 mL/h
infusion rate.

Overall performance: Pass

Measurements: The unit averaged 19 hours and 42 minutes of
operation.

Comments: The drip chamber was placed 36 inches above the
venipuncture site.

3.2.4 Electrical safety test

Electrical Safety Test
Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC[®] Inc.
Model number: IVAC[®] Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 5 Apr 89

Measurements:

Grounding conductor resistance (millionohms): 73.5

Leakage current - Case to ground (microamperes):

unit off, grounded, normal polarity	0.3
unit off, ungrounded, normal polarity	0.6
unit off, ungrounded, reverse polarity	0.5
unit on, grounded, normal polarity	0.2
unit on, ungrounded, normal polarity	0.5
unit on, ungrounded, reverse polarity	0.5

MAXIMUM LIMITS:

ground resistance (millionohms):	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): None

Comments on other data: None

3.2.5 Human factors evaluation

Human Factors Evaluation Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 6 Apr 89

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

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: Scalar displays and cathode ray tubes (CRT)
are not applicable. The LED's are red in
color and have no brightness controls.
Controls are not illuminated for low light
conditions.

CONTROLS:

Satisfactory

location
characteristics of controls
labeling
control - display relationships

Comments: It may be necessary to brace the controller
when pressing the membrane switches.

TIME REQUIRED TO PREPARE FOR OPERATION (list in comment)

Comments: 2.5 to 3 minutes required to prepare for operation.

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: There is an internal self-test with each power-up. A six month inspection list is found in the operators manual. There is no lubrication or need for internal accessibility. The enclosure is made entirely of plastic.

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: There is no inspection panel covers and the IV pole clamp is built in on the rear panel.

TEST POINTS:

Satisfactory

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: An internal self-test outputs codes for normal status and for failures.

FUSES AND CIRCUIT BREAKERS:

Satisfactory

external accessibility
easy replacement or reset by operator

Comments: A circuit breaker reset switch is located on the rear panel.

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: The unit is enclosed in a nonconducting
plastic case.

3.2.6 Altitude test

Altitude Test Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 10 Apr 89

Item configuration during test: Item operating at 70 mL/h on battery power, sitting on chamber floor.

Performance test criteria: Consistent and accurate displays and measurements

Ambient conditions outside chamber:

Temperature	59°F
Humidity	58% 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	ac

IN-TEST DATA

Time of test start: 1400

POSTTEST DATA

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

Time of test end: 1535

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): First attempt was aborted due to a "FLO.2" error. Several restarts were aborted due to "FLO" errors.

Comments on other data: Variations in pressure caused the drip chamber to become filled, thus causing "FLO" errors when drops could not be detected. Once the unit reached a stable altitude, the drip chamber was not forceable filled, but bubbles were apparent throughout the administration set for the remainder of the test. The drip chamber again filled while returning to ambient conditions which caused "FLO" errors.

3.2.7 Vibration test

Vibration Test Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 10 Apr 89

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

Performance test criteria: Consistent and accurate measurements and displays.

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	68°F
Humidity	62% RH
Barometric pressure	1 atm

IN-TEST DATA

Data and performance checks during test:

Time at first check:

X: 0825 (4-10-89) Y: 0945 (4-10-89) Z: 0910 (4-11-89)

Item functional (based on performance test criteria): Yes

Deviation from pretest: None

Time at second check:

X: 0915 Y: 1030 Z: 1000

Item functional (based on performance test criteria): Yes

Deviation from pretest: None

POSTTEST DATA

Time at test end:

X: 0920

Y: 1035

Z: 1005

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:

The drip chamber was located 36 inches above the venipuncture site.

Comments on test run (including interruptions): None

Comments on other data: A Dynatech Nevada infusion pump analyzer and volumetric chamber were used to measure the infusion rate of the unit.

3.2.8 High temperature test

High Temperature Test (Equipment Operating) Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 10 May 89

Item configuration during test: Unit was sitting on chamber floor, operated on ac and battery power at a rate of 70 mL/h. The drip chamber was located 36 inches above the venipuncture site.

Performance test criteria: Consistent and accurate displays and measurements.

Ambient conditions outside chamber:
Temperature 24°C
Humidity 61% 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	None
distance from north wall (meters)	0.6223
distance from south wall (meters)	0.5334
distance from east wall (meters)	1.4986
distance from west wall (meters)	1.2446
distance from ceiling (meters)	1.3208
distance from floor (meters)	0.4826

IN-TEST DATA

Time of test start: 0815

Performance checks during test:

First check:

Time: 0845
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: 0915
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: 0945
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: 1040
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

3.2.9 High temperature storage test

High Temperature Test (Equipment in Storage) Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 11 May 89

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

Performance test criteria: Consistent and accurate displays and measurements.

Ambient conditions outside chamber:

Temperature	23°C
Humidity	50% 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)	0.6223
distance from south wall (meters)	0.5334
distance from east wall (meters)	1.4986
distance from west wall (meters)	1.2446
distance from ceiling (meters)	1.3208
distance from floor (meters)	0.4826

Time of test start: 0745

POSTTEST DATA

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

Time of test end: 1445
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Comments on item setup or checks:
The unit was allowed to cool overnight, before the posttest performance check was completed.

Comments on test run (including interruptions): None

Comments on other data: None

3.2.10 Low temperature test

Low Temperature Test
(Equipment Operating)
Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 10 May 89

Item configuration during test: Sitting on test stand, operating on ac and battery power at 70 mL/h. The drip chamber was locate 36 inches from the venipuncture site.

Performance test criteria: Consistent and accurate displays and measurements.

Ambient conditions outside chamber:

Temperature	23°C
Humidity	not available
Barometric pressure	1 atm

PRETEST DATA

Pretest performance check:

Item functional (based on performance test criteria): Pass

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
distance from north wall (meters)	0.6223
distance from south wall (meters)	0.5334
distance from east wall (meters)	1.4986
distance from west wall (meters)	1.2446
distance from ceiling (meters)	1.3208
distance from floor (meters)	0.4826

Time of test start: 1100

Performance checks during test:

First check:

Time: 1130
Temperature: 0°C
Humidity: NA
Barometric pressure: 1 atm
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Second check:

Time: 1200
Temperature: 0°C
Humidity: NA
Barometric pressure: 1 atm
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Third check:

Time: 1230
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: 1315
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Comments on item setup or checks:

While returning to ambient conditions, condensation formed on the drip chamber and caused the unit to alarm.

Comments on test run (including interruptions): None

Comments on other data: None

3.2.11 Low temperature storage test

Low Temperature Test
(Equipment in Storage)
Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 12 May 89

Item configuration during test: The unit is in storage,
not operating.

Performance test criteria: Consistent and accurate displays and
measurements

Ambient conditions outside chamber:

Temperature	23°C
Humidity	50% 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)	0.6223
distance from south wall (meters)	0.5334
distance from east wall (meters)	1.4986
distance from west wall (meters)	1.2446
distance from ceiling (meters)	1.3208
distance from floor (meters)	0.4826

Time of test start:	0800
Midtest time:	1130
Midtest temperature:	-46°C

POSTTEST DATA

Posttest performance check:

(complete check of item and accessories)

Time of test end: 1500

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.

3.2.12 Humidity test

Humidity Test
Report Form

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: None

Options installed: None

Date of test: 15 May 89

Item configuration during test: The unit was sitting on a test stand, operating at 70 mL/h.

Performance test criteria: Consistent and accurate displays and measurements.

Ambient conditions outside chamber:

Temperature	24°C
Humidity	62% 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	None
distance from north wall (meters)	0.6223
distance from south wall (meters)	0.5334
distance from east wall (meters)	1.4986
distance from west wall (meters)	1.2446
distance from ceiling (meters)	1.3208
distance from floor (meters)	0.4826

IN-TEST DATA

Time of test start: 0845

Performance checks during test:

First check:

Time: 0930
Temperature: 29.5°C
Humidity: 95% RH
Barometric pressure: 1 atm
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Second check:

Time: 1015
Temperature: 29.5°C
Humidity: 95% RH
Barometric pressure: 1 atm
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Third check:

Time: 1100
Temperature: 29.5°C
Humidity: 95% RH
Barometric pressure: 1 atm
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Fourth check:

Time: 1145
Temperature: 29.5°C
Humidity: 95% RH
Barometric pressure: 1 atm
Item functional (based on performance test criteria): Yes
Deviation from pretest: None

Fifth check:

Time: 1230
Temperature: 29.5°C
Humidity: 95% RH
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: 1400

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

3.2.13 Electromagnetic characteristics test

Electromagnetic Characteristics Testing
Evaluation of Performance

T & E Item Number: 14

Date: 12 Apr 89

Nomenclature: Volumetric controller
Manufacturer: IVAC® Inc.
Model number: IVAC® Model 280EE
Serial number: 28-5328 / 210608-8629
Military item number: NA

Conducted Emissions Tests

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

Comments: NA

CE02 Testing configuration(s): Operating on copper work
bench at 70 mL/h.
Performance (pass/fail): Pass

Comments: No signal failures.

CE04 Testing configuration(s): Operating on copper work
bench.
Performance (pass/fail): Fail

Comments: NB failure 6.4 and 3.7 dB over speci-
fications at 38.813 and 50.449 MHz.

Conducted Susceptibility Tests

CS02 Testing configuration(s): Operating on test bench,
connected to test jig.
Performance (pass/fail): NA

Comments: Unable to test because noise generated
by the unit is greater than the test signal
(unable to measure test signal).

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 IVAC® Model 280EE will display consistent and accurate measurements.	met	2.1.2.2
3	Verify manufacturer's specified full power internal battery life expectancy of 2.5 hours or 150 blood pressure measurements.	met	2.2.2
4	The IVAC® Model 280EE will meet the limits established in TB 38-750-2 for electrical safety of medical equipment.	met	2.3.2
5	The IVAC® Model 280EE 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 IVAC® Model 280EE will display consistent and accurate measurements while exposed to an altitude equivalency of 15,000 feet above sea level.	not met	2.5.2
7	The IVAC® Model 280EE will remain operational and display consistent and accurate measurements while exposed to vibrational stresses.	met	2.6.2

8	The IVAC® Model 280EE will display consistent and accurate measurements during the high temperature operation check.	met	2.7.2.1
9	The IVAC® Model 280EE will display consistent and accurate measurements after the high temperature storage.	met	2.7.2.2
10	The IVAC® Model 280EE will display consistent and accurate measurements during the low temperature operation check.	met	2.8.2.1
11	The IVAC® Model 280EE will display consistent and accurate measurements after the low temperature storage.	met	2.8.2.2
12	The IVAC® Model 280EE will display consistent and accurate measurements while exposed to a high humidity.	met	2.9.2
13	The IVAC® Model 280EE will not produce emissions in excess of the limits set forth in MIL-STD-461A, Notice 4, paragraph 6.13.	not met	2.10.2.1
14	The IVAC® Model 280EE will not malfunction when it is subjected to radiated fields as specified in MIL-STD-461A, Notice 4, paragraph 6.20.	partially met	2.10.2.2
15	The IVAC® Model 280EE will not conduct emissions in excess of the limits set forth in MIL-STD-461A, Notice 4, paragraphs 6.1 and 6.2.	not met	2.10.2.3
16	The IVAC® Model 280EE will not malfunction when it is subjected to conducted emissions as specified in MIL-STD-461A, Notice 4, paragraphs 6.7 and 6.10.	not met	2.10.2.4

3.3.2 Significant problems which require corrective action

3.3.2.1 Problems associated with filling of the drip chamber during ascent to altitude and bubble formation in administration set should be corrected. The unit should be able to detect the presence of bubbles in the administration set.

3.3.2.2 Additional shielding will be needed to reduce the electromagnetic emissions produced by the unit. This shielding may also reduce the susceptibility of the device to electromagnetic emissions.

3.4 REFERENCES

- 3.4.1 Department of Defense. 1971. EMI characteristics, requirements for equipment. Washington, DC. MIL-STD-461A, Notice 4. February.
- 3.4.2 Department of Defense. 1971. EMI characteristics, measurement of. Washington, DC. MIL-STD-462, Notice 3. February.
- 3.4.3 Department of Defense. 1983. Environmental test methods and engineering guidelines. Washington, DC. MIL-STD-810D. July.
- 3.4.4 Department of the Army. 1987. Maintenance management procedures for medical equipment. Washington, DC. TB 38-750-2. April.
- 3.4.5 Department of the Army. 1982. Environmental protection and enhancement. Washington, DC. AR 200-1. June.
- 3.4.6 IVAC® Corporation. Operator's manual, Volumetric Controller, Model 280EE. San Diego, CA: IVAC® Corporation.
- 3.4.7 Department of Defense. 1989. Human engineering design criteria for military systems, equipment, and facilities. Washington, DC. MIL-STD-1472D. March.
- 3.4.8 Department of the Army. 1978. Operator's manual, UH-60 and EH-60 helicopter, with changes 1-5. Washington, DC. TM 55-1520-237-10. January.
- 3.4.9 Department of the Army. 1987. Maintenance management procedures for medical equipment. Washington, DC. TB 38-750-2. April.
- 3.4.10 National Fire Protection Association. 1987. Standard for health care facilities. Quincy, Massachusetts. February. NAFP 99.
- 3.4.11 Mitchell, G. W., and Adams, J. E. 1988. Technical test and evaluation of aeromedical equipment. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Letter Report LR-88-16-1-2.

3.5 ABBREVIATIONS

ac	alternating current
AEST	aeromedical equipment suitability test
AVSCOM	U.S. Army Aviation Systems Command
AWR	airworthiness release
BB	broadband
BP	blood pressure
BPM	beats per minute
CAAF	Cairns Army Airfield
CRT	cathode ray tube
dB	decibel
dc	direct current
ECG	electrocardiograph
EMC	electromagnetic compatibility
EMI	electromagnetic interference
fpm	feet per minute
GFE	government furnished equipment
Gpk	gravity, peak
G(rms)	gravity (root mean square)
Hz	hertz
IAW	in accordance with
ITOP	in-flight test operating procedure
IGE	in-ground effect
IVAC® 280EE	IVAC® Inc. volumetric controller
kg	kilogram
KHz	kilohertz
KIAS	knots indicated airspeed
lb	pound
LCD	liquid crystal display
LED	light emitting diode
LISN	line impedance stabilization network
MAP	mean arterial pressure
MEDEVAC	medical evacuation
MHz	megahertz
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
NOE	nap-of-the-earth
NVG	night vision goggle
RAM	random access memory
RF	radio frequency
RH	relative humidity
ROM	read only memory
TB	technical bulletin
TFT	technical feasibility testing
T & E	test and evaluation
UES	Universal Energy Systems, Inc.
USAARL	U.S. Army Aeromedical Research Laboratory
V/m	volts per meter

3.6 MANUFACTURERS' LIST

- 3.6.1 IVAC® Corporation
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- 3.6.3 Neurodyne-Dempsey, Inc.
200 Arrowhead Drive
Carson City, NV 89701
- 3.6.4 Tenney Engineering, Inc.
1090 Springfield Road
P.O. 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.
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