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CHECK TEST OF HELICOPTER PERFORMANCE AND LOAD COMPUTERS AND AER--ETC(U)
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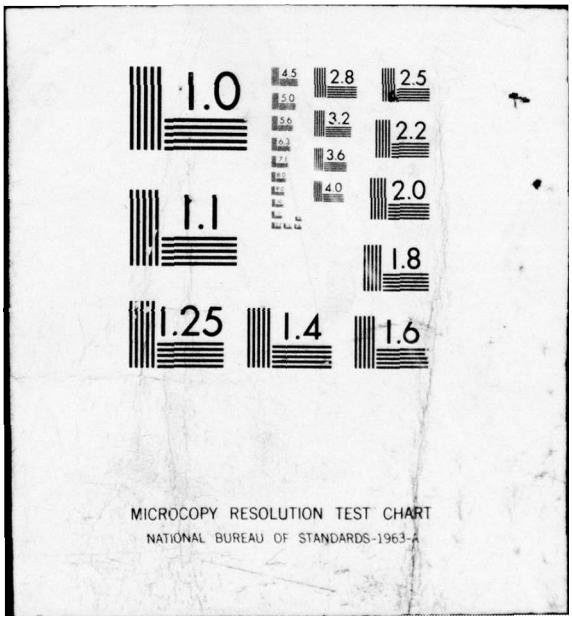
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NATIONAL BUREAU OF STANDARDS-1963-A

UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

STEBG-AAAB-4D-3510-03

12 APR 1963

SUBJECT: Report of Test, USATECOM Project No. 4D-3510-03, Check Test of Helicopter Performance and Load Computers and Aerology Kit.

12 Apr 63

19 p.

TO: Commanding General
US Army Test and Evaluation Command
ATTN: AMSTE-BG
Aberdeen Proving Ground, Maryland

1. AUTHORITY.

a. Directive. Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 21 December 1962, "Check Test of Helicopter Performance and Load Computers and Aerology Kit."

b. Purpose. To conduct a check test of the Helicopter Performance and Load Computers and Aerology Kit to determine the extent to which previously reported deficiencies and shortcomings have been corrected.

2. BACKGROUND.

a. In the operation of cargo helicopters, a quick and accurate determination of the maximum load possible under various density altitude conditions and the center-of-gravity location is required. At present, this information is obtained from the performance data charts in the Operator's Manual and from computations using a weight and balance handbook. This method is cumbersome, time consuming, and subject to numerous errors. A faster, more accurate method of computation was envisioned in the slide-rule type computer. Data for performance computations could be furnished by an aerology kit. Center-of-gravity location could be computed on the reverse side of the slide rule.

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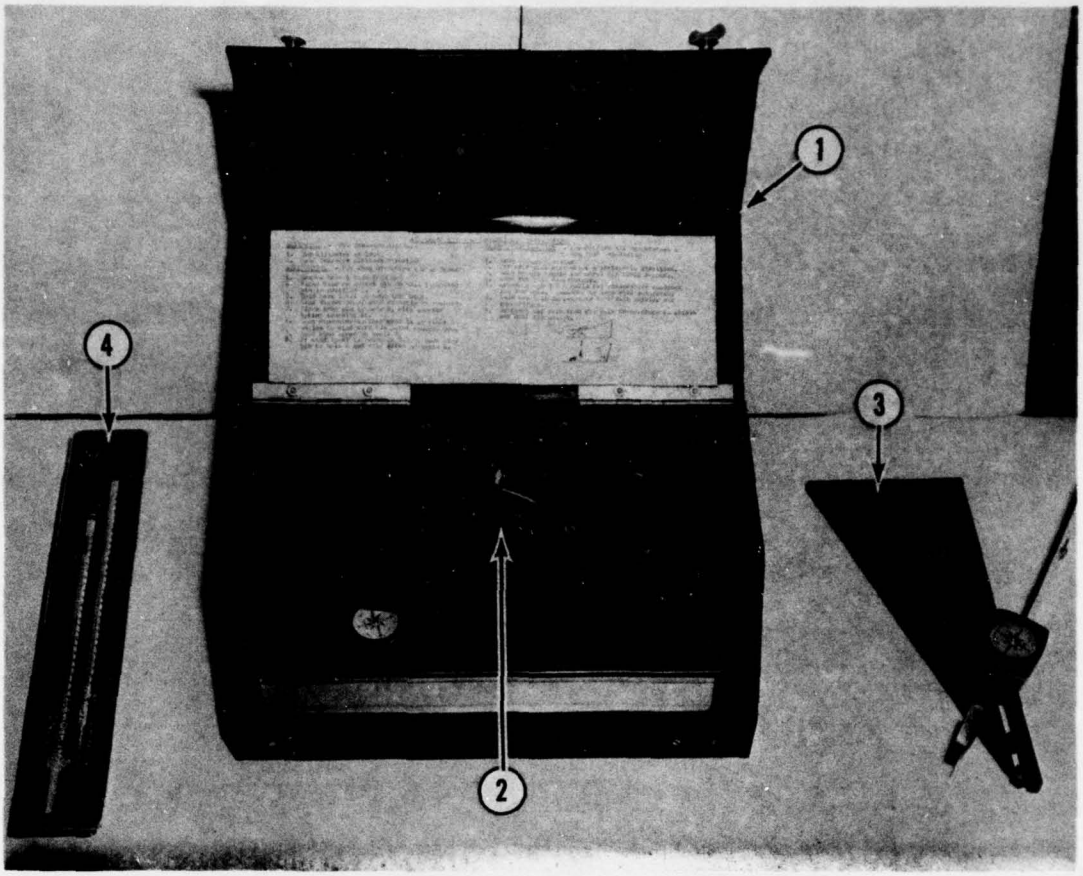

Figure 1. The aerology kit consists of a plastic-carrying case (1), a sensitive altimeter (2), a wind-velocity gauge (3), and a sling psychrometer (4)

b. A prototype aerology kit and prototype linear helicopter performance and load computers specifically designated for the H-37B (CH-37B), H-34A (CH-34A), H-21C (CH-21C), and HU-1B (UH-1B) Helicopters were evaluated by this Board in conjunction with desert and high elevation tests during the summer of 1961 and reported under Project No. AVN 1862 (reference 2). As a result of these tests, certain deficiencies and shortcomings were reported, and it was recommended that the kit and the computers be provided for check test after correction of the deficiencies and shortcomings.

c. Two improved prototype computers for the HU-1D (UH-1D) Helicopter and one improved prototype aerology kit were received for test on 15 July 1962, and were evaluated during desert and high elevation tests. Improved prototype computers and aerology kits were received for test 12 October 1962; these computers were specifically designated for the CH-21C (H-21C), CH-34A (H-34A), UH-1A (HU-1A), UH-1B (HU-1B), CH-37B (H-37B), CH-47B (HC-1B), and CH-19D (H-19D) Helicopters and were circulated to various interested agencies for their comments following evaluation by this Board. The computers and kits are manufactured by the Weir Development Company, Dayton, Ohio.

3. DESCRIPTION OF MATERIEL.

a. The aerology kit (figure 1) consists of a plastic carrying case, a sensitive altimeter, a wind-velocity gauge, and a sling psychrometer for measuring wet and dry-bulb temperature. The wind gauge measures wind direction by means of a magnetic compass mounted on a centrally pivoted vane. Wind velocity is measured by aligning the vane perpendicularly to the wind and reading the calibrated indication of the spring-restrained pointer on the other end of the vane. The dimensions of the kit and carrying case are 13 1/4" x 8" x 5 1/2" and the total weight is approximately 9.5 pounds.

b. The computer (figure 2) is a linear, slide-rule type of device with two operating sides. One side is used to compute the center-of-gravity location and the other to determine the maximum gross weight allowable to hover in or out of ground effect under various atmospheric

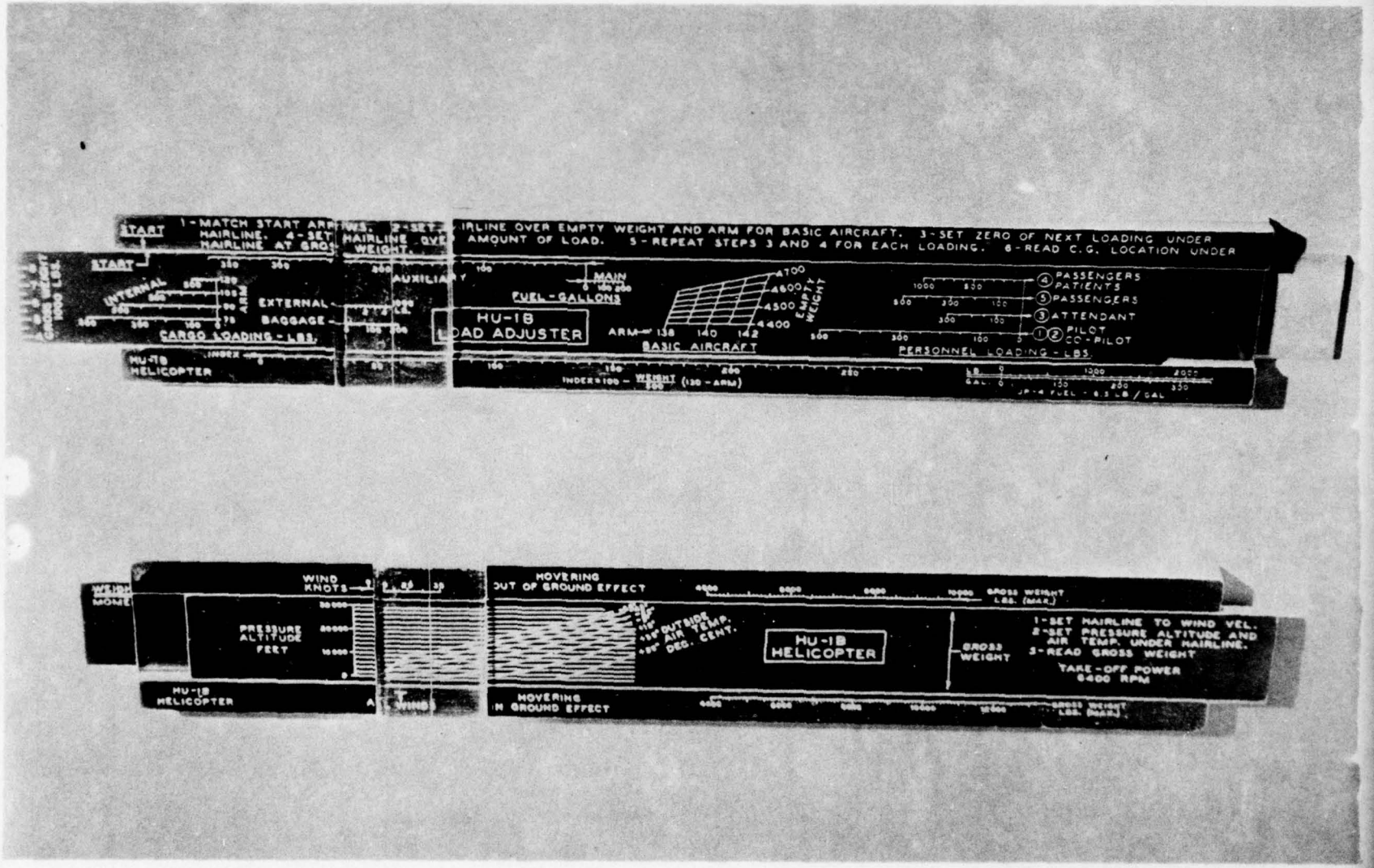

Figure 2. View of both sides of the linear computer

conditions. Each side of the computer has a slide which may be removed, turned over, and reinserted to use the information on that side. Information is presented in the form of scales, charts and graphs. A transparent cursor with hairline assists in reading. The information on the computer is derived from data appearing in the appropriate aircraft technical publications. Brief step-by-step instructions for use are presented on the computer. In addition, separate instruction pamphlets containing more detailed operating instructions are provided. The computer is constructed of aluminum alloy, is contained in a leather carrying case, and weighs approximately 0.9 pound. One computer was constructed with black letters on a white background; the remainder, with white letters on a black background.

c. The following modifications were made as a result of deficiencies and shortcomings reported from the previous tests.

(1) The carrying case of the aerology kit was constructed of plastic instead of metal.

(2) The windmeter design was changed. The original windmeter consisted of a plastic contrivance in which wind pressure caused a very light pea-sized ball to raise in a calibrated tube to a height dependent upon wind velocity. No means of determining wind direction was provided. The modified windmeter is described in paragraph 3a.

(3) Instructions for the use of the aerology kit were printed on the inside of the carrying case lid.

(4) The fastener of the computer carrying case was changed from a tongue-under-strap configuration to a plain-snap-fastener.

(5) The computer was made from extruded aluminum stock instead of being assembled from flat stock. A 20-percent reduction in weight was accomplished by reducing the thickness of the computer and slides.

(6) Stops were provided to prevent the cursor from sliding completely free from the computer.

(7) Adjustable plastic screws were set into each end of the computer for the purpose of tightening or loosening friction against the slides so that the force needed to move the slides could be regulated.

(8) The method of beginning the center-of-gravity computation (obtaining the Empty Aircraft Index) was modified to eliminate confusion and complication.

(9) The method of final determination of center-of-gravity position was changed to provide simplification and increased accuracy.

(10) The printing on the computer was changed from "Load Adjuster" to "Performance and Load Computer."

(11) The need for lubricating oil was eliminated by improved workmanship in fitting the slides.

(12) Some scales and graphs were changed on the various computers to provide more suitable content and clarity.

4. TESTS. The computers and the aerology kit were tested under desert, high-elevation and temperate conditions during the period 15 July 1962 through 31 December 1962 by personnel of the US Army Aviation Board. The US Army Aviation School, the US Army Board for Aviation Accident Research, and the US Army Combat Developments Agency at Fort Rucker, Alabama, participated in the evaluation. The computers and the aerology kit were sent to the US Army Concept Team in Vietnam (ACTIV), the 45th Transportation Battalion, and the 57th Transportation Company for comments. The last comments were received from these agencies 15 March 1963.

a. Aerology Kit.

(1) Suitability of Modifications. Modifications incorporated were found to be suitable with the exception of the following:

(a) The plastic material, which was substituted for the metal of the prototype kit carrying case, was unsatisfactory. Of three

kits shipped by mail, two suffered damage. In addition, the fasteners on the plastic case were difficult to fasten.

(b) Two of the four altimeters (one spare) supplied with the three kits were unreliable.

(c) The windmeter lacked the ruggedness to withstand normal field usage.

(2) Accuracy of Data. Data obtained from use of the sling psychrometer and windmeter were consistent with that of weather station observation, except for wind velocity determinations in gusty wind conditions.

b. Computers.

(1) Accuracy of Computations. Each of the computers furnished for test was used to calculate hovering performance and the center-of-gravity position for various climatic and helicopter load conditions. Results were compared with those derived from technical publications and were found to agree within satisfactory limits with the exceptions noted in paragraph c(2)(b) below. The accuracy of the computers was dependent upon the ability of the operator to read and interpret properly the instructions, graphs, and scales. Computations of comparable accuracy could be made in less time on the computers than when the technical publications were used to determine the same data.

(2) Suitability of Modifications. Modifications incorporated in the computers were determined to be satisfactory, with the following exceptions:

(a) The adjustable plastic screws, which could be tightened or loosened to increase or decrease the force necessary to move the slide, did not allow satisfactory fine adjustment of the slide tension. It was found, however, that, by a slight bending of the slide ends, satisfactory control of the ease of the slide movement could be obtained, and the plastic screws were no longer used.

(b) The corners of the improved prototype computer (including the slides) were not rounded off for increased handling comfort as were the prototype models.

(c) The letters and figures on the computer were not etched into the metal as they were on the prototype model but, for expedience in manufacture, were printed on a very thin metal sheet which was attached with adhesive to the computer blank. This configuration was not satisfactory due to weakness in the bonding material.

(d) The method of beginning the center-of-gravity computation (obtaining the Empty Aircraft Index) was simplified, and while one area of confusion was satisfactorily eliminated, another was created in that the printed instructions on the face of the computer did not include the first two steps of the new process.

(3) Black-on-White Versus White-on-Black Lettering. The white-on-black lettering was found to be more satisfactory than the black-on-white lettering for the reason of better readability.

c. Deficiencies and Shortcomings.

(1) Aerology Kit.

(a) The status of the deficiency and shortcomings previously reported was determined to be as follows:

Deficiency	Findings This Test
The windmeter of the Aerology Kit was over-sensitive to fluctuations in wind velocity.	The different type of windmeter used for wind measurement was satisfactory except in gusty wind conditions.

Shortcoming	Findings This Test
The indication of the windmeter was affected by sand and dust which entered the system while in use.	A different type of instrument was used for wind measurement and the deficiency did not occur.

(b) The following deficiencies and shortcomings were noted during this test:

1. Deficiencies. The deficiencies require elimination before the item will be suitable for Army use.

Deficiency	Suggested Corrective Action	Remarks
a) The carrying case for the aerology kit was too fragile.	Construct the carrying case of a light weight, durable and unbreakable material.	Light weight metal, Fiberglas, or material with similar characteristics may be suitable.
b) The Dzus fasteners on the carrying case were difficult to close.	Use suitable fasteners.	
c) The construction of the windmeter lacked ruggedness to withstand normal field use.	Strengthen the construction of the windmeter.	The weight attached to the vane needs a more secure method of attachment. The wind vane separated from the rest of the unit.

2. Shortcomings. The following shortcomings should be corrected as practical:

Shortcoming	Corrective Action
a) There were no reference marks on the compass case to facilitate reading wind direction and orientation 90 degrees to wind direction.	Provide suitable reference marks at 0 and 270 degrees on the compass case.

Shortcoming	Corrective Action
b) There were no reference marks to indicate the proper location of the receptacles in which the stop pins of the wind indicator should be positioned.	Provide suitable reference marks when the indicator is calibrated for accuracy.

(2) Computers.

(a) The status of deficiencies and shortcomings previously reported (reference 2) was determined to be as follows:

1. Deficiencies.

Deficiency	Findings This Test
a) UH-1B (HU-1B) Computer: The Empty Aircraft Index cannot be determined by following the directions on the computer.	Redesign of computation method eliminated this problem.
b) UH-1B (HU-1B) Computer: The passengers-patients scale on the Load Adjuster side of the slide does not read beyond 1000 pounds.	Satisfactorily corrected.
c) UH-1B (HU-1B) Computer: The gross weight scale on the end of the moving section of the computer only reads to a maximum of 8000 pounds.	Satisfactorily corrected.
d) UH-1B (HU-1B) and CH-21C (H-21C) Computers: The gross weight scale does not align with the similar scale on the static section of the computer.	UH-1B: Satisfactorily corrected through redesign of the computer. CH-21C: Satisfactorily corrected through redesign of the computer.

Deficiency	Findings This Test
e) UH-1B (HU-1B) and CH-21C (H-21C) Computers: The graph plotting pressure altitude against outside air temperature, used in computing hover capability, is difficult to read.	UH-1B: Satisfactorily improved. CH-21C: Minimally satisfactory improvement by adding horizontal reference line (see paragraph d5 below).
f) CH-21C (H-21C) Computer: Station L-1 (Litter No. 1) is not included in the loading zone chart.	Satisfactorily corrected.
g) CH-37A (H-37A), CH-34A (H-34A), and CH-21C (H-21C) Computers: The instructions (Step 4) for computation of Empty Aircraft Index lack clarity.	CH-37A (B), CH-34A, and CH-21C: Redesign of computers eliminated the deficiency and created another.

2. Shortcomings. The following shortcomings existed on the UH-1B, CH-21C, CH-34A, and CH-37B Computers:

Shortcomings	Findings This Test
a) The designation printed on the front of the computer reads, incorrectly, "Load Adjuster."	Satisfactorily corrected on all computers.
b) The computers are heavy when compared to other types of computers of comparable size.	Satisfactorily corrected on all computers.
c) 1. The sliding sections of the computer stuck tightly after usage, and required oil before they could be manipulated.	1. Satisfactorily corrected on all computers.

Shortcomings	Findings This Test
2. The oiled slides often slide free of the computer, collected dirt rapidly, and soiled hands and clothing during use.	2. All computers: Modifications provided were unsatisfactory; however, a slight bend at the ends of the slide would satisfactorily correct the shortcoming. Shortcoming still exists at present time.
d) It is possible for the cursor to fall free from the computer.	Satisfactorily corrected on all computers.
e) The hairline of the cursor was difficult to see under red illumination in the helicopter at night.	Satisfactorily corrected.
f) The means of securing the flap of the computer case is inadequate.	Satisfactorily corrected.

(b) This paragraph contains deficiencies and shortcomings discovered during this test and considered significant enough to warrant corrective action.

1. Deficiencies. The following deficiencies require elimination before the items will be suitable for Army use.

Deficiencies	Suggested Corrective Action	Remarks
a) All computers: The printed instructions on the computer for locating center-of-gravity position are not complete.	Change steps 2 and 3 on the slide to read: "2. Set zero line of Empty Helicopter graph under hairline.	The instruction books were adequate in this respect.

Deficiencies	Suggested Corrected Action	Remarks
	"3. Move hairline to intersection of helicopter empty weight and c.g. location." Then renumber succeeding steps as necessary.	
b) All computers: The helicopter designations are obsolete.	Correct all helicopter designations to the current designations.	For example, the HU-1B is now designated the UH-1B.
c) All computers: The plastic screws added for the purpose of preventing the slide from falling free from the computer were unsuitable.	Eliminate the screws. Provide slight bends in each end of the slide so that a light pressure is required to move the slide. Provide printed instructions in the book for lubrication (solid petroleum product) and adjustment of slide by bending if needed.	
d) All computers: The corners of the computer and slides are sharp, causing inconvenience in handling and creating a potential hazard.	Round off corners of computer and slides.	Corners of prototypes were rounded.

Deficiencies	Suggested Corrective Action	Remarks
e) CH-34A and CH-19D Computers: There is no "Hover-in-Ground-Effect" portion of the computer.	Provide the required scales using "Power Required to Hover" charts in the H-34 and UH-19D Operator's Manual.	The prototype computer had the "Hover-in-Ground-Effect" data. The latest H-34 and H-19D Operator's Manual does not have a "Power Required to Hover" chart.
f) UH-1D, UH-1B, and UH-1A Computers: The graph plotting empty weight versus c.g., used to begin c.g. location computation, stops short of the actual empty weight c.g. of the helicopter.	Revise the c.g. scale to include a practical range of empty c.g. positions.	For example, the HU-1B c.g. scale goes from 124 to 138. Average empty weight c.g. is 141. A practical scale would read from 135 to 145.
g) UH-1A Computer: There is an excessive inaccuracy in hover performance calculations when using temperatures of +35° C. and above.	Relocate the +35° C. and +55° C. lines on the graph to provide accurate computations.	
h) All computers: The method of lettering was unsatisfactory.	Etch all lettering into computer surface.	Prototype computers were so etched.

2. Shortcoming. The following shortcoming should be corrected as practical:

Shortcoming	Suggested Corrective Action	Remarks
CH-47A Computer: The scale for "personnel" on the load computer slide is graduated in 260-pound increments.	Graduate the scale in 200-pound increments for easier interpretation.	

d. Suggested Improvements. The following additional suggestions for improvement were generated through test and study of the computers.

(1) Provide a Centigrade-Fahrenheit temperature conversion scale on the computer.

(2) Provide a parenthetical explanation of "Depression of Wet Bulb" (Dry Bulb Temp. minus Wet Bulb Temp.) at the appropriate location on each side of the performance slide.

(3) Provide an erasable surface on the flap of the computer case where the helicopter serial number, empty weight, and center-of-gravity position may be recorded.

(4) On the pressure-altitude-versus-outside-air-temperature graphs, align the zero on the wind velocity scale for "Hovering Out of Ground Effect" vertically with the zero (or "all Winds," as applicable) on the "Hovering In Ground Effect" wind scale, so that one setting of the hairline at zero wind will give the gross weight which can be carried both in and out of ground effect under the prevailing conditions.

(5) Emphasize each alternate temperature line in the pressure-altitude-versus-outside-air-temperature graph by widening the line or changing its color for easier reference.

(6) The printed instruction pamphlets accompanying each computer should be brought up to date, incorporating instructions appropriate to recommendations of this report, and the construction of the pamphlet should be improved to provide greater durability.

(7) Change the "Fuel" scale to read in pounds instead of gallons on the load computer side.

(8) The "Gross Wt. Lb. (MAX.)" scale on the performance side of the computer should be moved to a position adjacent to the "Gross Weight Indicator" arrow on the movable slide so that direct reading of gross weight may be accomplished.

5. DISCUSSION. At present, there is no standard performance and load computer for use in Army airplanes. For example, load computers in use for the U-1A and the CV-2( ) airplanes are of two different types, linear slide-rule type and tubular type respectively. The development of a linear-type performance load computer for all Army airplanes would materially contribute to standardization and efficiency of load and performance computation.

6. CONCLUSIONS.

a. The Aerology Kit, when modified to correct the deficiencies noted in paragraph 4c above, will be suitable for Army use.

b. The Helicopter Performance and Load Computers, when modified to correct the deficiencies listed in paragraph 4c above, will be suitable for Army use.

c. Modifications necessary to correct the current deficiencies and shortcomings are technically feasible and minor in nature.

7. RECOMMENDATIONS. It is recommended that:

a. The Aerology Kit modified to correct deficiencies outlined in paragraph 4c above be type classified Standard A.

STEBG-AAAB 4D-3510-03
SUBJECT: Report of Test, USATECOM Project No. 4D-3510-03, "Check Test of Helicopter Performance and Load Computers and Aerology Kit"

b. The Helicopter Performance and Load Computers modified to correct the deficiencies in paragraph 4c above be type classified Standard A.

c. Shortcomings of the Helicopter Performance and Load Computers and the Aerology Kit be corrected and suggested improvements be incorporated.

d. Arctic test be conducted on the computers and the aerology kit.

e. Consideration be given to the development of a linear-type performance and load computer for all Army airplanes.

A. J. RANKIN
Colonel, Armor
President

2 Incl
1 as
2 Recommended distribution

LIST OF REFERENCES

1. Report of Project No. AVN 4060, "Comparative Evaluation of Helicopter Weight and Load Computers," US Army Aviation Board, 21 June 1960.

2. Letter, ATBG-ACAB AVN 1862, US Army Aviation Board, 2 February 1962, subject: "Report of Test, Project No. AVN 1862, 'Evaluation of Helicopter Performance and Load Computers and Aerology Kit.' "

3. Letter, ACTIV-CHC, US Army Concept Team in Vietnam, 11 March 1963, subject: "Helicopter Performance and Load Computers."

UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

REPORT OF TEST

USATECOM PROJECT NO. 4D-3510-03

CHECK TEST OF HELICOPTER PERFORMANCE

AND LOAD COMPUTERS AND AEROLOGY KIT

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