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ARMY AVIATION TEST BOARD FORT RUCKER ALA
PRODUCT-IMPROVEMENT TEST OF THE OH-6A HELICOPTER WINTERIZATION --ETC(U)
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RDT&E Project No. _____

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USATECOM Project No. 4-6-0251-15

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PRODUCT-IMPROVEMENT TEST

OF THE

OH-6A HELICOPTER WINTERIZATION KIT.

9

Final Report of Test
by

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Major Gerald W. Orr
Mr. Vernon R. Stork

JUL 11 1968

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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36360

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RDT&E PROJECT NO. _____

USATECOM PROJECT NO. 4-6-0251-15

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OF THE
OH-6A HELICOPTER WINTERIZATION KIT

Final Report of Test
by
Major Gerald W. Orr
Mr. Vernon R. Stork

DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36360

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ABSTRACT

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The US Army Aviation Test Board (USAAVNTBD) conducted the product-improvement test of the OH-6A Helicopter Winterization Kit to determine the suitability of the helicopter and winterization kit for arctic testing. The test was conducted in a simulated Arctic environment at the Climatic Laboratory, Eglin Air Force Base, Florida. Testing included 30.5 hours' helicopter operating time and some firing of 7.62mm weapons. Operation of the OH-6A was found to be limited by four design deficiencies. It was concluded that the OH-6A Helicopter and its winterization kit are not suitable for arctic test because of existing deficiencies and unreliable starting characteristics at ambient temperatures of -25°F . and below. It was recommended that the design deficiencies be corrected, that further testing be accomplished in the actual arctic environment utilizing the "Py-derichment" fuel control, that the validity of the MC's in long-duration mission performance evaluation with crew-area temperatures between 0°F . and 10°F . be investigated, that further testing of the effects of cold weather on the sliding Teflon bearing surface be conducted, and that suitable equipment be developed to permit a reliable aircraft starting capability down to -65°F .
↙

FOREWORD

The Commanding General, US Army Test and Evaluation Command (USATECOM), directed the product-improvement test of the OH-6A Helicopter Winterization Kit by letter, AMSTE-BG, Headquarters, USATECOM, 15 March 1968, subject: "Test Directive, Product Improvement Test, OH-6A Winterization Kit."

The US Army Aviation Test Board was responsible for planning and conducting the test and for reporting the test results.

The US Army Aeromedical Research Unit monitored the test to collect aviation medicine data.

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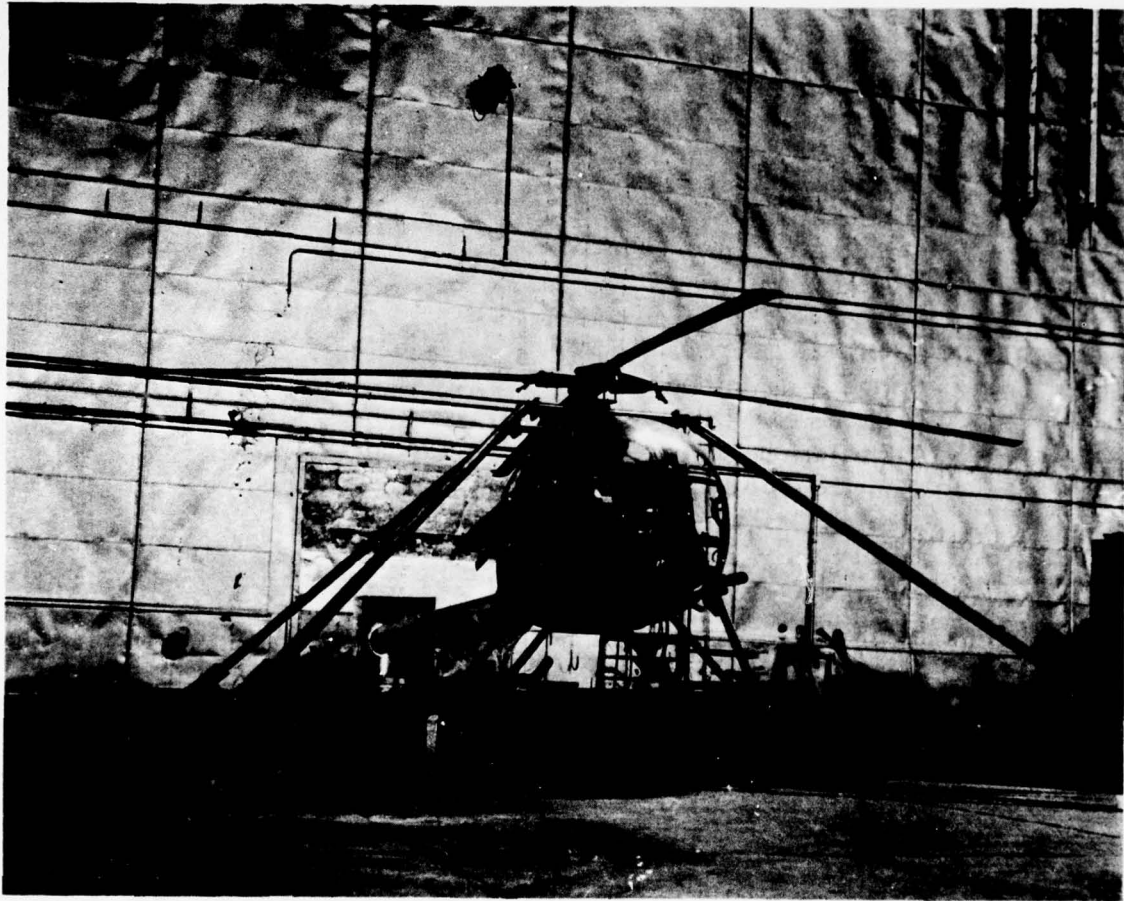


Figure 1

SECTION 1 - INTRODUCTION

1.1. BACKGROUND

USCONARC Military Characteristics (MC's) for an LOH state that it must have:

"(1) The capability of operation in a temperature environment ranging from -25°F to 115°F without modification.

"(3) A heater to provide an inside temperature of $+40^{\circ}\text{F}$. with an outside temperature of -25°F . This condition need only be met with the engine operating...

"(4) Appropriate provision for installation, without modification to the airframe, of a kit to allow operation and provide inside temperature (crew area) of 0°F with an outside temperature down to -65°F . This condition need only be met in flight, though the heater should be operable while the aircraft is on the ground. "

1.1.2. The Cayuse Project Manager requested that the Hughes Tool Company, Aircraft Division, develop a winterization kit which would be installed in time for scheduled arctic testing. The Project Manager further requested that, prior to scheduled arctic testing, the USAAVNTBD conduct a functional suitability evaluation of the kit and the production airframe and subsystems when exposed to a cold environment.

1.1.3. OH-6A Helicopter, S/N 65-12921, entered the Air Proving Ground Center Climatic Laboratory at Eglin Air Force Base, Florida, on 19 March 1968 and was secured and instrumented. (See figure 1.)

1.2. DESCRIPTION OF MATERIEL

The winterization equipment provided by the contractor is a two-part kit. The first part consists of a special aircraft nickel-cadmium battery pack designed to facilitate aircraft starting at ambient temperatures below -25°F . The second part of the kit is a cabin heater modification which uses recirculated cabin air to maintain a desired crew

area temperature. In addition, the engine manufacturer requested that an improved design "Py-derichment" fuel control be utilized during portions of the test. This fuel control is designed to provide reduced fuel flow during the start cycle.

1.3. TEST OBJECTIVE

To determine by test in a simulated arctic environment the suitability of the OH-6A Helicopter and its winterization kit for arctic testing.

1.4. SUMMARY OF RESULTS

1.4.1. The OH-6A standard production model helicopter does not meet the Military Characteristics (MC's) for engine starting at -25°F . The helicopter with the winterized starting capability does not meet the MC's at -65°F . The helicopter can be started at ambient temperatures down to -65°F . with an auxiliary power unit (APU).

1.4.2. The engine oil pressure gauge is inaccurate at temperatures below 0°F . The direct current (d.c.) overvoltage relay is unreliable at temperatures below 0°F .

1.4.3. The standard heater/defroster generally meets the MC's for ambient temperatures down to -25°F . The recirculating heater/defroster generally meets the MC's for ambient temperatures down to -65°F .

1.4.4. Pressure required to cycle the collective pitch control system below 0°F . exposes the control stick to excessive stress and increases the possibility of failure.

1.4.5. Ten minutes of ground operation at flight idle power settings are the minimum required to free the tail-rotor control sufficiently for safe hovering flight.

1.4.6. The "Py-derichment" fuel control lowers minimum starting N_1 speeds from 12 percent to 8 percent. However, internal fuel control linkages freeze below -25°F . and restrict the pilot's throttle twist grip movement.

1.4.7. Frost accumulating on the inside of the windshield must be removed before safe flight can begin.

1.4.8. Although the MC's call for a 0°F. crew-area temperature in a -65°F. environment, the ability of the pilot to perform a mission of more than 90 minutes' duration in a 0°F. to 10°F. crew-area environment is questionable.

1.5. DISCUSSION

Personnel from the US Army Aeromedical Research Unit (USAARU) who monitored the entire test program questioned the ability of aviation personnel to accomplish a military mission with crew-area temperatures between 0°F. and 10°F. Appendix II is a complete report of these findings including recommendations for evaluation of the MC's provision for a 0°F. crew area with an outside temperature down to -65°F.

1.6. CONCLUSION

The OH-6A Helicopter and its winterization kit are not suitable for Arctic test because of existing deficiencies and unreliable starting characteristics at ambient temperatures of -25°F. and below.

1.7. RECOMMENDATIONS

It is recommended that:

- 1.7.1. The design deficiencies be corrected prior to arctic testing.
- 1.7.2. Further testing be accomplished in the actual arctic environment utilizing the "Py-derichment" fuel control.
- 1.7.3. The validity of the MC's in long-duration mission performance evaluation with crew-area temperatures between 0°F. and 10°F. be investigated (appendix II).
- 1.7.4. Further testing of the effects of cold weather on the sliding Teflon bearing surfaces be conducted.
- 1.7.5. Suitable equipment be developed to permit a reliable aircraft starting capability down to -65°F.

SECTION 2 - SUMMARY OF TEST

2.1. SCOPE AND METHOD

2.1.1. The USAAVNTBD conducted the product-improvement test of the OH-6A Helicopter Winterization Kit at the Climatic Laboratory, Eglin Air Force Base, Florida. Actual cold-weather environmental testing began on 1 April and ended 10 May 1968. The aircraft operated 30.5 hours and 23,800 rounds of 7.62mm ammunition were fired during the test.

2.1.2. Test procedures were designed to examine the functional suitability of the aircraft at two ambient temperatures (-25°F. and -65°F.) specified in the MC's. In addition, tests were performed at 70°F. (baseline), 0°F., and -45°F. to permit the development of trends. Wherever possible, the aircraft was allowed to remain static (soak) for a minimum of 24 hours between test runs to insure that external and internal aircraft temperatures had stabilized.

2.1.3. Each test run was designed to simulate as closely as possible profiles normally performed in a tactical or combat environment. The aircraft was operated at predetermined power settings of specified duration with all subsystems including armament operating.

2.1.4. Personnel from USAARU monitored pilot body temperatures to determine individual tolerances and physical abilities to perform a lengthy military mission in a cold-weather environment.

2.2. WEIGHTS AND DIMENSIONS

Weights and dimensions were:

	<u>Length</u> <u>(inches)</u>	<u>Width</u> <u>(inches)</u>	<u>Height</u> <u>(inches)</u>	<u>Weight</u> <u>(pounds)</u>
Battery pack	16	8	5	35 3/4
Recirculating heater	9 3/4	7 3/4	1	3 1/4

2.3. INSTALLATION REQUIREMENTS

A detailed description of winterization kit installation requirements is not practical at this time because the equipment provided by the manufacturer was attached to the aircraft in such a manner as to allow an evaluation of kit operation only. The production kit configuration may not be the same as that of the test item. Further testing of the equipment in an actual arctic environment should consider the airframe modifications necessary for production kits.

2.4. FUNCTIONAL SUITABILITY

2.4.1. Airframe and Subsystems.

In general, the OH-6A operating at various ambient temperatures between 0°F. and -65°F. performed acceptably within the artificial environment of the Climatic Laboratory. However, during the course of the test, several problem areas appeared that required maintenance action or deviation from procedures established in applicable technical manuals. The more significant occurrences are discussed in the following paragraphs:

2.4.1.1. "Py-derichment" Fuel Control. During portions of the test, an improved design "Py-derichment" fuel control was installed in the aircraft and evaluated primarily for its effect on engine starting at reduced temperatures. Part C, appendix I, lists the changes in stabilized gas-producer speeds as a function of temperature. Acceptable engine starts that maintained turbine outlet temperature (TOT) within limits (less than 927°C.) were obtained with N_1 speeds as low as 10 percent on record runs. Detailed investigation of this condition indicated that 8.0 percent was the minimum N_1 speed for engine starts using this test fuel control. However, with this fuel control installed, the pilot's throttle twist grip became increasingly stiff with decreasing ambient temperatures. As a result, at -45°F. and below, it became necessary to preheat the fuel control before each run to allow sufficient twist grip throttle operation. The standard fuel control configuration permitted more acceptable throttle twist grip rotation even at -65°F.

2.4.1.2. Electrical System. As the ambient temperature decreased below 0°F. during the initial test runs, the time required for the d. c. generator to activate increased. Troubleshooting revealed a malfunctioning overvoltage relay which would operate properly only after

it had been preheated externally or had been warmed by internal cabin heat. As the temperature was reduced, the time required for the relay to operate increased to the extent that at -65°F. , the relay had to be bypassed to obtain proper generator operation. Only one relay was evaluated as a replacement was not immediately available.

2.4.1.3. Flight Control System. As the ambient temperature decreased, the amount of force required to cycle the collective pitch stick through its full travel increased. The rubber dust boot covering the mast had been previously removed as a precaution against cracking at the lower temperatures. At one point (-45°F.), after moisture had condensed and frozen on the uniball bearing sliding surface, the collective pitch control could not be moved. The uniball assembly had to be preheated and carefully wiped dry. As the test program continued, the collective pitch stick became so weakened that during prestart cycling, it broke off in the pilot's hand and had to be replaced. Investigation of the frozen uniball bearing surface indicated that a cold-weather-compatible dust boot would possibly have kept the uniball bearing surface relatively dry. However, the ability of the Teflon bearing to withstand the repeated abuse of an extreme cold-weather environment must also be investigated further.

2.4.1.4. Antitorque System. As the ambient temperature decreased, the antitorque reaction to pedal pressure decreased. Minimum antitorque control for hovering flight could be obtained only after operating the aircraft at flight idle N_1 speeds (minimum collective pitch and 101 percent N_2) for 10 minutes and then slowly and carefully cycling the pedals through full travel. It is anticipated that longer periods of operation at flight idle will be required for aircraft operating in the actual cold-weather environment to preclude unsafe antitorque control linkage failure.

2.4.1.5. Throttle Control. At ambient temperatures of -45°F. and below, it became necessary to disconnect the copilot's throttle twist grip linkage so that the fuel schedule position on the fuel control would correspond to the throttle twist grip position set by the pilot. Prior to disconnecting the copilot's throttle linkage, the fuel control position lagged significantly in the direction of throttle movement; at ground idle position (DETENT) on the throttle, the fuel control position was approximately between the CUT-OFF and DETENT positions. Although the exact cause of the linkage drag could not be determined, disconnecting the copilot's twist grip reduced the overall linkage drag sufficiently to alleviate the problem.

2.4.1.6. Windshield Defrosting. The heater ducts in the crew compartment of the OH-6A are designed to defrost the windshield as well as provide cabin heating. In the Climatic Laboratory, a light layer of frost began to accumulate on the inside of the windshield as soon as the pilot was seated in position and the crew doors were closed. When the engine was started and the heater/defroster was activated, at least 10 minutes of operation at flight idle N_1 speeds were necessary to clear the windshield of frost sufficiently to allow safe hovering flight. To completely clear the upper windshield panels of internal frost required as much as 20 minutes of hover power equivalents; the lower windshield and door panels were never completely cleared.

2.4.1.7. Aircraft and Engine Instruments. All stabilized aircraft and engine instrument readings except engine oil temperature and pressure correlated closely with values obtained from calibrated instrumentation attached to the aircraft. Part D, appendix I, lists both measured and aircraft instrument readings with changes in ambient temperature and power settings. At temperatures below -25°F ., the engine oil pressure gauge was generally valid only to indicate the presence of adequate oil pressure. The amount of instrument error was clearly beyond limits. The engine oil temperature gauge readings were within tolerance in the -25°F . temperature range, but were generally too high in the -65°F . range.

2.4.2. Winterization Kit.

The twin-battery installation and the recirculating heater assembly were evaluated with strict adherence to the conditions prescribed in the MC's. In all cases, the battery and heater kits performed as intended and required only normal preventive maintenance.

2.4.2.1. Starting Technique. The starter was usually engaged for a maximum of 30 seconds before a "lite off" was attempted or the starter button was released. In a few cases, the 30-second period was extended to 60 seconds if it appeared that maximum start N_1 speeds had not been achieved. However, the N_1 increase in the second 30-second period was minimal compared with the first 30-second period. If a successful "lite off" was accomplished (maximum TOT peaks less than 927°C .), the starter button remained depressed until 58 percent N_1 was achieved.

2.4.2.2. Starter Engagement at and above -25°F . (Standard Battery Power Source). At each temperature in this range, modification of

the approved technical manual starting technique was required to obtain the maximum benefits of the standard battery installation. To insure test procedure validity, battery voltage was carefully monitored. A minimum of three and a maximum of five 30-second starter engagements could be attempted before the voltage became depleted. Three- to five-minute intervals between successive starter engagements permitted the battery internal temperature to increase and voltage to be regained. At -25°F . using the standard battery configuration, only nine percent N_1 could be obtained after the third starter engagement and before the battery became depleted (part C, appendix I). This gas-producer speed was not sufficient for effective starts with the standard fuel control. Further testing at this temperature using the winterized battery installation and a "Py-derichment" fuel control resulted in a 780°C . TOT start on the third attempt and starter disengagement (58 percent N_1) in 80 seconds. The technique of aborting low N_1 start attempts discussed in paragraph 2.1.1.4.1 of reference 2 was attempted but was discontinued after obtaining inconclusive results due to the throttle linkage difficulties described above.

2.4.2.3. Starter Engagement Below -25°F . Reference 1 permits the use of a winterization kit for operation of the aircraft below -25°F . provided no major modification is required. Utilizing the winterized battery kit and the "Py-derichment" fuel control, a satisfactory start could be obtained on the first or second attempt after starter engagement at -45°F . (part C, appendix I). However, 2.5 minutes were required to reach 58 percent N_1 speed which is minimum for starter disengagement. The engine manufacturer has limited starter engagement time on production engines to two minutes. This is an igniter limitation. Engine start attempts after a 24-hour cold soak at -65°F . using a standard fuel control and the winterization battery kit were not successful. A maximum of 5.5 percent N_1 was obtained on the fourth starter engagement. Results of attempted starts using the "Py-derichment" fuel control at this temperature were inconclusive because preheating of several engine and airframe components was required. The aborted start method discussed in reference 2 was also attempted, but again only inconclusive results were obtained.

2.4.2.4. APU Starts. APU starts were successful at all test temperatures. No modification to the accepted starting technique was made because the minimum N_1 required could be obtained in each case.

2.4.2.5. Crew-Area Temperature. During all test runs, only the right front crew seat was occupied; however, it was apparent from

the data obtained that the presence of the crewmember increased the temperature in that zone.

2.4.2.6. Standard Heater/Defroster Operations at and above -25°C . The standard heater/defroster was operated continuously on each test run after an acceptable start had been accomplished until shut down. Part A, appendix I, is a table of crew and cargo-area temperatures taken at various times during the test run. These temperatures were obtained with the standard production heater installed and operating in the FULL OPEN position. At elapsed test run time of 17.5 minutes during the climb power portion, the temperatures at the pilot's head and knee positions surpassed 40°F ., but the foot temperatures did not reach 40°F . until 73.5 minutes' elapsed test run time. The pilot's comfort level in the -25°F . range was higher with the standard heater because the recirculating heater blew more cold air on the pilot's face.

2.4.2.7. Recirculating Heater Operation Below -25°C . Part B, appendix I, is a table listing crew and cargo-area temperatures taken at various times during the -65°F . test run using the recirculating air heater/defroster provided for the test by the manufacturer. At an elapsed test run time of 25 minutes, the pilot's head and knee area temperatures had exceeded 0°F . However, the foot temperature did not exceed 0°F . until 35 minutes' elapsed time. During a loiter power setting (45 p. s. i. torque), the pilot's head area temperature dropped below 0°F . for a short time to -1°F ., but increased again when the engine power setting was increased to 60 p. s. i. torque.

2.5. DESIGN DEFICIENCIES

Operation of the OH-6A in a cold-weather environment is limited by the following design deficiencies:

2.5.1. Operation of the collective flight control linkage system below -25°F . is limited by the increased stiffness in the control. (See paragraph 2.4.1.3.) Repeated operations of the stiff control stick at temperatures below -25°F . will eventually cause it to fail.

2.5.2. Throttle control below -25°F . is limited by the copilot's throttle twist grip drag on the fuel control. (See paragraph 2.4.1.5.) This design deficiency limits the pilot's ability to determine the actual fuel control reaction to a given throttle setting.

2.5.3. The engine oil pressure gauge is not an accurate reflection of the actual engine oil pressure maintained in the oil system below 0°F.

2.5.4. Normal operation of the OH-6A d.c. electrical system in a cold-weather environment (below 0°F.) requires preheating of the overvoltage relay.

2.6. SAFETY

The requirement to operate the aircraft for 10 minutes at flight idle power settings (paragraph 2.4.1.4) could restrict safe ground operation of the aircraft in an arctic environment. Furthermore, the marginal windshield defrosting capabilities (paragraph 2.4.1.6) limit the pilot's visibility.

2.7. COMPARISON WITH MC'S

2.7.1. Aircraft operation down to temperatures of -25°F. was in accordance with the MC's with the following exceptions:

- a. Unreliable overvoltage relay (paragraph 2.4.1.2).
- b. Unreliable engine oil pressure gauge (paragraph 2.4.1.7).

2.7.2. Attempts to start the engine in accordance with the conditions prescribed in the MC's were unsuccessful at both -25°F. and -65°F.

2.7.3. Cabin-area temperatures at an ambient temperature of -25°F. met the MC's after the heater/defroster had been operating for 12 minutes (17.5 minutes' elapsed test run time) although pilot area foot temperatures were below 40°F. for considerably longer. Pilots dressed in standard arctic clothing expressed no particular discomfort operating at the crew-area temperatures provided by the production heater/defroster.

2.7.4. Cabin heating at an ambient temperature of -65°F. met the MC's after the heater had been operating for 13 minutes (25 minutes' elapsed test run time) although foot temperatures were below 0°F. for considerably longer. The pilot dressed in standard arctic clothing was able to operate the aircraft for approximately 45 minutes, after which time, he expressed increased discomfort in both his feet and hands. In operations below -25°F., the pilot had to use specially designed, electrically (16-volts d.c.) heated gloves which allowed a continuation of the test run.

SECTION 3 - APPENDICES

APPENDIX I - TEST DATA

Part A

OH-6A Helicopter Cabin Temperatures at -25°F.

Standard Heater/Defroster Installation

Ambient Temperature (°F.)	Elapsed Time From Heater On (min.)	Elapsed Time From Start (min.)	Engine Torque (p. s. i.)	Flight Equivalent	Pilot Area			Copilot Area			Right Cargo Area			Left Cargo Area		
					Head	Knee	Foot	Head	Knee	Foot	Head	Knee	Foot	Head	Knee	Foot
-31	0:00	0:00	0	Start	-12	-26	-24	-17	-24	-25	-20	-21	-24	-19	-22	-24
-32	5:37	5:37	15	Ground idle	-15	-22	-25	-19	-24	-25	-22	-22	-24	-10	-23	-26
-31	10:37	5:00	25	Flight idle	16	16	-17	-1	-4	-19	-11	-22	-23	-3	-23	-26
-29	15:37	10:00	59	Hover	38	42	10	25	11	-10	+2	-20	-24	-4	-21	-25
-28	17:37	12:00	75	Climb	47	53	24	32	13	-5	6	-19	-23	0	-20	-25
-25	28:37	23:00	61	Vne	51	59	27	31	26	-1	5	-15	-20	7	-16	-22
-25	48:37	43:00	43	Loiter	47	55	-2	34	20	-3	5	-12	-18	8	-14	-20
-23	68:37	63:00	58	Fast cruise	59	69	32	39	32	7	17	-9	-15	12	-11	-17
-22	73:37	68:00	73	Climb	65	78	55	56	37	14	20	-8	-14	16	-10	-15
-23	83:37	78:00	61	Hover	63	76	42	44	37	13	18	-8	-13	14	-10	-16
-26	91:57	86:20	0	Shut down	30	22	-3	20	12	-6	-1	-11	-16	7	-13	-16

Part B

OH-6A Helicopter Cabin Temperatures at -65°F.

Ambient Temperature (°F.)	Elapsed Time From Start (min.)	Elapsed Time From Heater On (min.)	Engine Torque (p. s. i.)	Flight Equivalent	Pilot Area		Copilot Area		Right Cargo Area		Left Cargo Area					
					Head	Knee	Foot	Head	Knee	Foot	Head	Knee	Foot	Head	Knee	Foot
-68	0:00	0:00	0	Start	-41	-65	-62	-47	-59	-61	-44	-46	-61	-44	-49	-57
-69	12:00	0:00	17	Ground idle	-52	-58	-64	-55	-59	-58	-32	-55	-60	-52	-58	-61
-68	19:20	7:20	28	Flight idle	-4	-12	-60	-16	-38	-52	-34	-53	-58	-44	-57	-59
-66	25:00	13:00	62	Hover	19	15	-51	5	-1	-43	-32	-54	-55	-37	-55	-60
-66	27:00	15:00	75	Climb	10	11	-12	2	-2	-28	-7	-20	-35	-6	-14	-35
-67	38:00	26:00	64	Vne	9	14	2	6	1	-20	6	-3	-24	-6	-11	-15
-70	58:00	46:00	45	Loiter	-1	5	0	-3	-5	-15	-12	-45	-50	-15	-36	-37
-69	73:00	61:00	60	Fast cruise	6	13	9	3	-3	-12	-5	-40	-45	-14	-24	-25
-67	75:00	63:00	0	Shut down	-8	-15	-26	-20	-15	-23	-28	-42	-45	-41	-48	-50

Part C

Stabilized Gas-Producer Speeds (N_1) in Percent
with
Varying Electrical Sources and Ambient Temperatures
(12 Percent N_1 Minimum for Standard Fuel Control Starts)
(8.5 Percent N_1 Minimum for "Py-derichment" Fuel Control Starts)

<u>Ambient Temperature (°F.)</u>	<u>Fully Charged Single Battery Cold Soaked (percent)</u>	<u>Fully Charged Winterization Kit Batteries Cold Soaked (percent)</u>	<u>APU (percent)</u>
70	15.0	N/A	N/A
0	13.0	No data	12
-25	9.0(1)(2)	10.0(3)	12
-45	7.5(1)(4)	10.0(3)	12(3)
-65	No data	5.5(1)(2)	12

(1)Start not obtained.

(2)Standard fuel control.

(3)Start obtained with "Py-derichment" fuel control only.

(4)"Py-derichment" fuel control.

Part D

Comparison of Engine Instrument Readings
Against
Measured Values in the -25°F. and -65°F. Temperature Ranges

<u>Temperature</u> <u>(°F.)</u>	<u>Engine</u> <u>Torque</u> <u>(p. s. i.)</u>	<u>Engine Oil</u> <u>Temperature</u> <u>(°F.)</u>		<u>Engine Oil</u> <u>Pressure</u> <u>(p. s. i.)</u>	
		<u>Aircraft</u>	<u>Measured</u>	<u>Aircraft</u>	<u>Measured</u>
-31	60	140	145	150+	116
-29	74	158	151	150+	116
-25	43	149	151	150+	116
-65	60	167	151	150+	109
-66	63	176	157	150+	109
-67	45	176	156	150+	109

APPENDIX II - USAARU REPORT



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FORT RUCKER, ALABAMA 36360

USAARU-CO

21 June 1968

SUBJECT: Mean Body Temperatures of OH-6A Pilots During Cold Tests

The President
US Army Aviation Test Board
Fort Rucker, Alabama 36360

Attached is Letter Report entitled Mean Body Temperatures of OH-6A Pilots During Cold Tests, forwarded as requested.

FOR THE COMMANDER:

A handwritten signature in cursive script, reading "Sammy E. Brownlee", is positioned to the right of the "FOR THE COMMANDER:" text.

1 Incl
as (dupe)

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Asst Adjutant

MEAN BODY TEMPERATURES OF OH-6A PILOTS DURING COLD TESTS

Letter Report

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JUNE 1968

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INTRODUCTION

The US Army Aviation Test Board requested the US Army Aeromedical Research Unit to investigate the cold stress on pilots during the environmental testing of the OH-6A helicopter in the climatic hangar at Eglin AFB. The test period extended from 3 April to 7 May 1968, with chamber temperatures of 30°F, 0°F, -25°F, -45°F and -65°F.

PROCEDURE

Mean body temperatures were computed from mean skin temperatures and rectal temperatures. The skin temperatures were measured by Yellow Springs Instrument Company (YSI) model 409 thermistors attached to the forehead, upper arm, chest, inner thigh and calf of the leg. The rectal temperatures were measured by a model 401 YSI thermistor. During a majority of the test runs at -65°F, the finger and toe skin temperatures were monitored by model 409 YSI thermistors.

The mean skin temperature was computed from the following formula:

$$T_{SM} = 0.08 T_F + 0.13 T_A + 0.31 T_C + 0.33 T_T + 0.15 T_L$$

T_{SM} = Mean Skin Temperature

T_F = Forehead Skin Temperature

T_A = Upper Arm Skin Temperature

T_C = Chest Skin Temperature

T_T = Thigh Skin Temperature

T_L = Calf Skin Temperature

The mean body temperature was computer as follows:

$$T_{BM} = 1/3 T_{SM} + 2/3 T_R$$

T_{BM} = Mean Body Temperature

T_R = Rectal Temperature

A time series line was then fit to the data by the method of "Least Squares" calculated on a model 1130 IBM computer.

RESULTS

During a majority of the test runs, the pilots wore electrically heated gloves. These gloves are not standard issue for use by Army aviators in this aircraft. Unless a source of additional heat (electrically heated gloves) is available for the pilot's hands, the cockpit temperature must be maintained above 40°F for flights in excess of one hour. 1, 2

A detailed analysis of the data revealed no significant cold stress on the pilot during the test runs with chamber temperatures of 30°F, 0°F and -25°F.

In spite of the fact that the pilots wore as much clothing as the mission would permit (4 CLO Units), there was significant cold stress on the pilot at the chamber temperature of -45°F. (See Figure 1 and 2)

At the end of each test run at -45°F and -65°F the pilots experienced an average heat loss of over 100 Kilocalories. This heat loss could be expected to produce a

significant decrement in pilot performance. A continued loss of heat at the rates measured during the -45°F and -65°F test runs would definitely result in a significant morbidity, i. e. frostbite of the extremities, or incapacitation by the end of a three hour flight.

CONCLUSIONS

1. Without heated gloves for the pilot, the present winterization kit does not provide adequate heat for operation of the OH-6A in environments below 0°F .
2. With heated gloves for the pilot, the present winterization kit provides adequate heat for normal operation in environments as cold as -25°F .
3. Even with heated gloves, the present winterization kit does not provide adequate heat for flights in excess of 2 hours at a temperature of -45°F , or 1 1/2 hours at -65°F .

RECOMMENDATION

It is recommended that winterization kit specifications for Army aircraft require that the cockpit temperature reach 40°F within one hour after the start of the flight, if no heated gloves are provided. If heated gloves are provided, the cockpit temperature must reach a minimum of 20°F within two hours after the start of the flight.

FIG. 1
CHAMBER TEMPERATURE -45°F

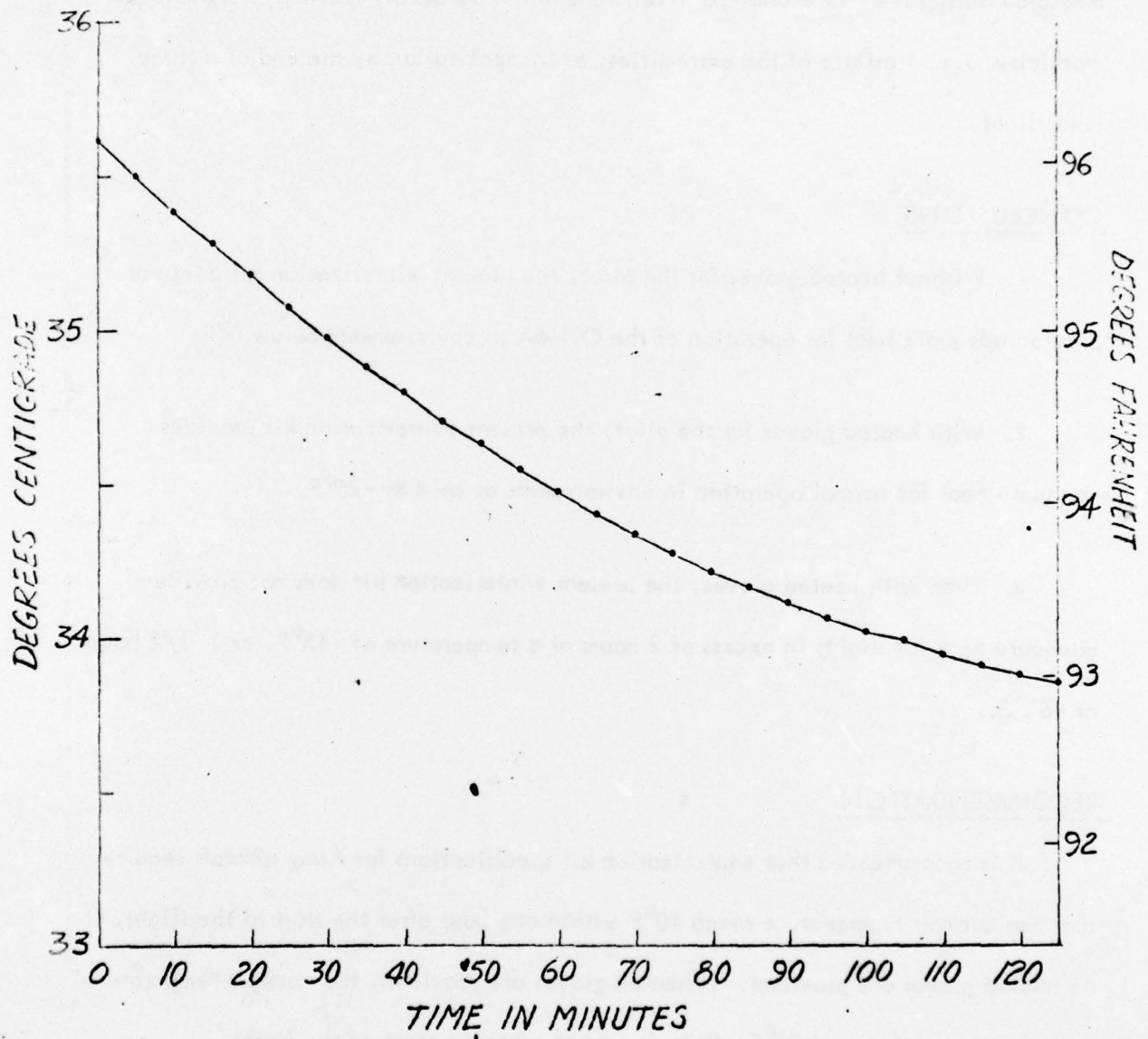
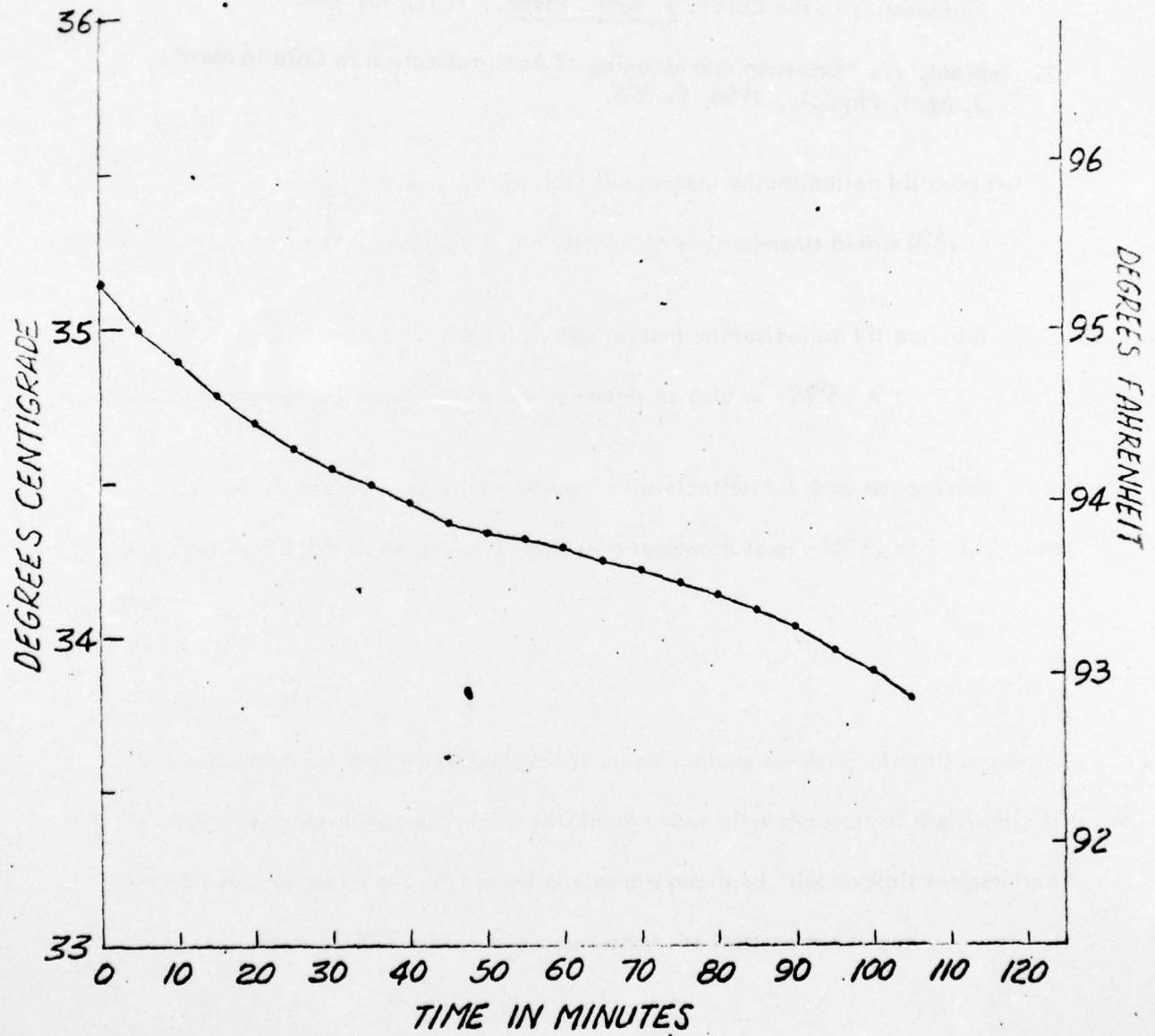


FIG. 2
CHAMBER TEMPERATURE - 65°F



REFERENCES

1. Clark, E., "The Limiting Hand Skin Temperature for Unaffected Manual Performance in the Cold", J. Appl. Psych., 1961, 45: 193.
2. LeBlans, J., "Evidence and Meaning of Acclimatization to Cold in Man", J. Appl. Physiol., 1956, 9: 395.

APPENDIX III - REFERENCES

1. Letter, ATDEV-6, Headquarters, US Continental Army Command, 30 March 1960, subject: "USCONARC-Approved Military Characteristics for a Light Observation Aircraft," with 1st Indorsement, AJAAV, Headquarters, Third United States Army, 18 April 1960.

2. Final Report of Test, "Climatic Hangar Test of the OH-6A Light Observation Helicopter," USATECOM Project No. 4-3-0200-72/80, US Army Aviation Test Activity, July 1965.

3. Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 15 March 1968, subject: "Test Directive, Product Improvement Test, OH-6A Winterization Kit."

APPENDIX IV - DISTRIBUTION

Agency

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