UNCLASSIFIED

AD NUMBER
AD902264
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; JUN 1972. Other requests shall be referred to Aeronautical Systems Division, Attn SDQH, Wright-Patterson AFB, OH 45433. This document contains export-controlled technical data.**
AUTHORITY
ASD ltr, 17 Apr 1974

THIS PAGE IS UNCLASSIFIED

FTC-TR-72-29

FTC-TR-72-29

AD INEXPLORATA

AFFTC

UH-1N CATEGORY II TEST PROGRAM SUMMARY

JOHN R. SOMSEL
UH-1N Category II
Project Manager

TECHNICAL REPORT No. 72-29

JULY 1972

Distribution limited to U.S. Government agencies only (Test and Evaluation), June 1972. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

AFSC-EDWARDS AFB, MUROC CAL

FTC-TR-72-29

UH-1N CATEGORY II TEST PROGRAM SUMMARY

JOHN R. SOMSEL
UH-1N Category II
Project Manager

FOREWORD

UH-1N Category II testing was conducted from 14 October 1970 through 16 February 1972. Testing was authorized under Air Force Regulation 80-14, 24 February 1967, AFSC/ASD Program Introduction Document, 1 April 1970, and AFFTC Project Directive 69-49, as revised.

The author expresses his appreciation to the engineers and pilots assigned to this test program. Their professionalism was the primary reason the Category II test objectives were met.

Foreign announcement and dissemination by the Defense Documentation Center are not authorized because of technology restrictions of the U.S. Export Control Acts as implemented by AFR 400-10.

Prepared by:

JOHN R. SOMSEL
UH-1N Category II
Project Manager

Reviewed and approved by:
26 JUNE 1972

JAMES W. WOOD
Colonel, USAF
Commander, 6510th Test Wing

ROBERT M. WHITE
Brigadier General, USAF
Commander

ABSTRACT

As tested, the UH-1N helicopter was considered adequate to fulfill its mission as an attack and utility helicopter. Operations in climatic extremes were satisfactory; however, the lack of anti-ice systems reduced the all-weather capability. The airframe, fuselage compartment, flight controls, electric utility system and armament system were generally satisfactory. Although the T400 engine delivered adequate power, a low mean time between failures and discrepancies in the power indicating systems degraded the overall performance. Good single-engine performance enhanced the satisfactory dual-engine performance capabilities of the helicopter. Flying qualities were satisfactory throughout most of the flight envelope; however, they deteriorated near the extremes of the flight envelope.

table of contents

list of illustrations

list of abbreviations and symbols

Item	Definition	Units
AFPE	Air Force Preliminary Evaluation	- - -
ASD	Aeronautical Systems Division	- - -
CPO	complete provisions only	- - -
ECP	engineering change proposal	- - -
ICAO	International Civil Aeronautics Organization	- - -
IFR	instrument flight rules	- - -
ITT	inter-turbine temperature	deg C
KIAS	knots indicated airspeed (corrected for instrument error)	kt
MTBF	mean time between failures	hrs
NAMPP	nautical air miles per pound of fuel	- - -
N_f	power turbine speed	rpm
N_g	gas producer speed	rpm
OGE	out of ground effect	- - -
RUMR	routine unsatisfactory materiel report	- - -
SEP	Systems Evaluation Test Program	- - -
SOF	Special Operational Forces	- - -
tacan	tactical air navigation	- - -
TCTO	time compliance technical order	- - -
V_{NE}	indicated airspeed never to exceed	kt
VOR	VHF omnidirectional range	- - -
W_f	fuel flow	lb per hr
WRAMA	Warner Robins Air Materiel Area	- - -

INTRODUCTION

GENERAL

An Air Force requirement for a new helicopter in the light-to-medium class with twin-engine reliability and increased altitude/temperature capability was approved by the Department of Defense in October 1967. The UH-1N was the aircraft selected. It was developed from the Bell Helicopter Company UH-1 series helicopter and contained sufficient changes that a comprehensive test program was necessary. Under the management jurisdiction of ASD, the aircraft manufacturer, Bell Helicopter Company, conducted the Category I tests; the AFFTC, Category II tests; and the Tactical Air Command, the Category III tests.

The testing phase of the Category II test program began on 14 October 1970 with the acceptance of three helicopters. UH-1N S/N 68-10776 was especially instrumented for performance and flying qualities tests, and UH-1N S/N 68-10774 for environmental systems tests. UH-1N S/N 69-6610, the subsystems test aircraft, had no special instrumentation except for onboard cameras to document the armament tests.

The Category II test effort was divided into four major test programs; Systems Evaluation (SEP), Performance, Flying Qualities and Instrument (figure 2). Due to the scope of the SEP, it was subdivided into six test phases: specific subsystems, arctic, tropic, desert icing, and climatic laboratory.

Figure 1 shows the cumulative monthly flying rate attained by the three Category II aircraft, along with the start and completion dates of the various test programs and test phases. A total of 809 hours was flown in 16 months, which averages to 50.9 hours per month. Figure 2 shows the productive flying hours required to complete the various Category II test programs (549.6 hours). The difference between the total and productive flying time (259.4 hours) was due to the extra hours required for ferry, functional check flights, and other nonproductive flying in direct support of the test program.

Each of the four test programs required some testing away from the primary test site, Edwards AFB, California. Performance testing was conducted at the alternate sites of Bishop and Bakersfield, California, and Canadian Forces Base, Cold Lake, Alberta, Canada. Flying qualities testing was conducted at Bishop, California. Systems environmental testing was conducted at Howard AFB, Panama Canal Zone, Eglin AFB, Florida, El Centro NAF, California, Eielson AFB, Alaska, and Malmstrom AFB, Montana. Instrument flying was conducted at Howard and Malmstrom Air Force Bases in conjunction with the environmental tests being conducted at that time.

Reporting the progress and findings of the Category II evaluation was accomplished through Monthly Progress Reports and Technical Reports. The Technical Reports are listed in appendix I. Major materiel deficiencies were also reported through the procedures outlined in Air Force Technical Order, T.O. 00-35D-54, USAF Materiel Deficiency Reporting System (reference 1).

A Category II follow-on test program to evaluate the effects of operating the UH-1N in a salt-water environment has also been accomplished. The results of that evaluation will appear in a separate AFFTC technical report.

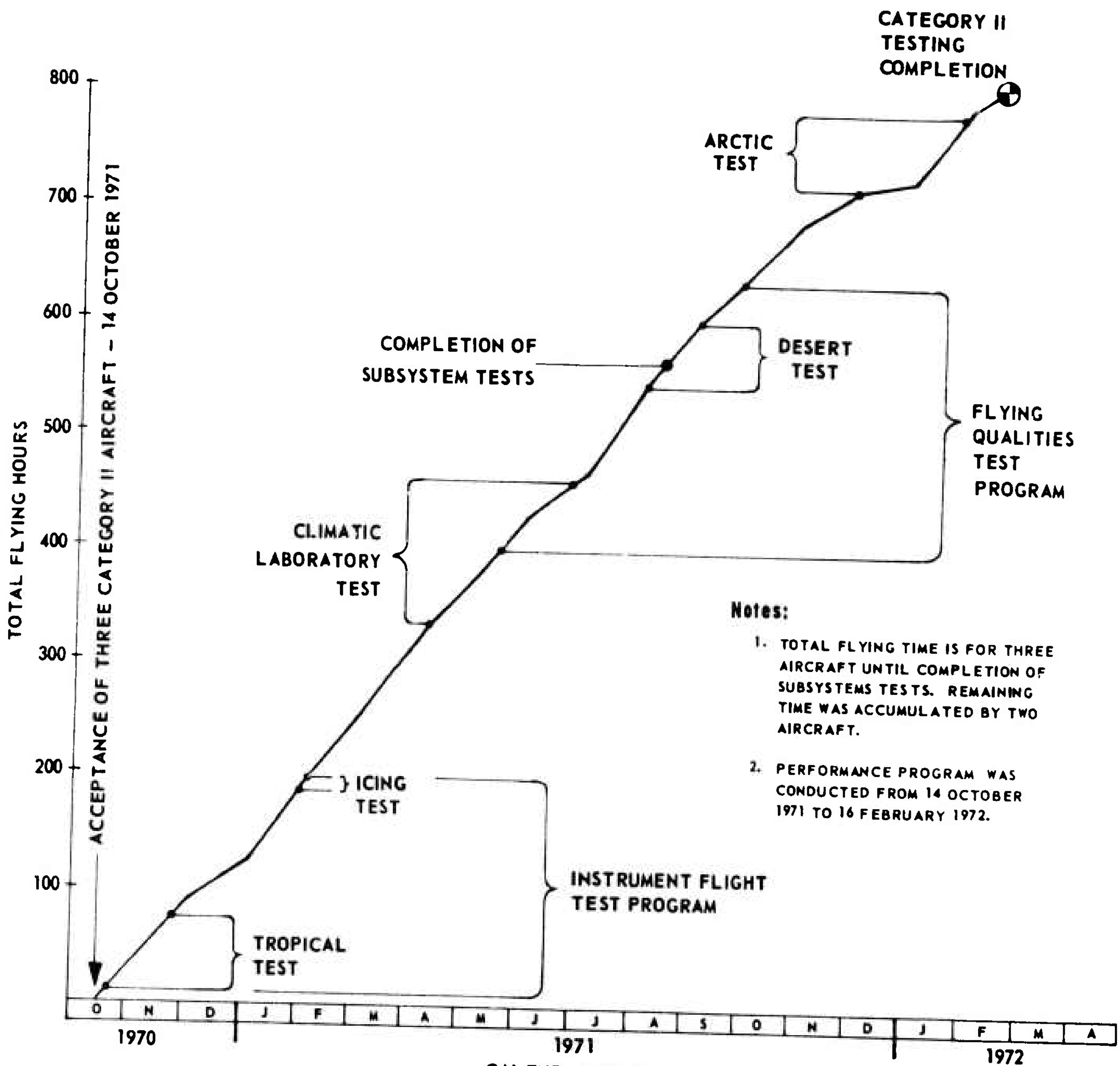

Figure 1 Category II Flight Test Schedule

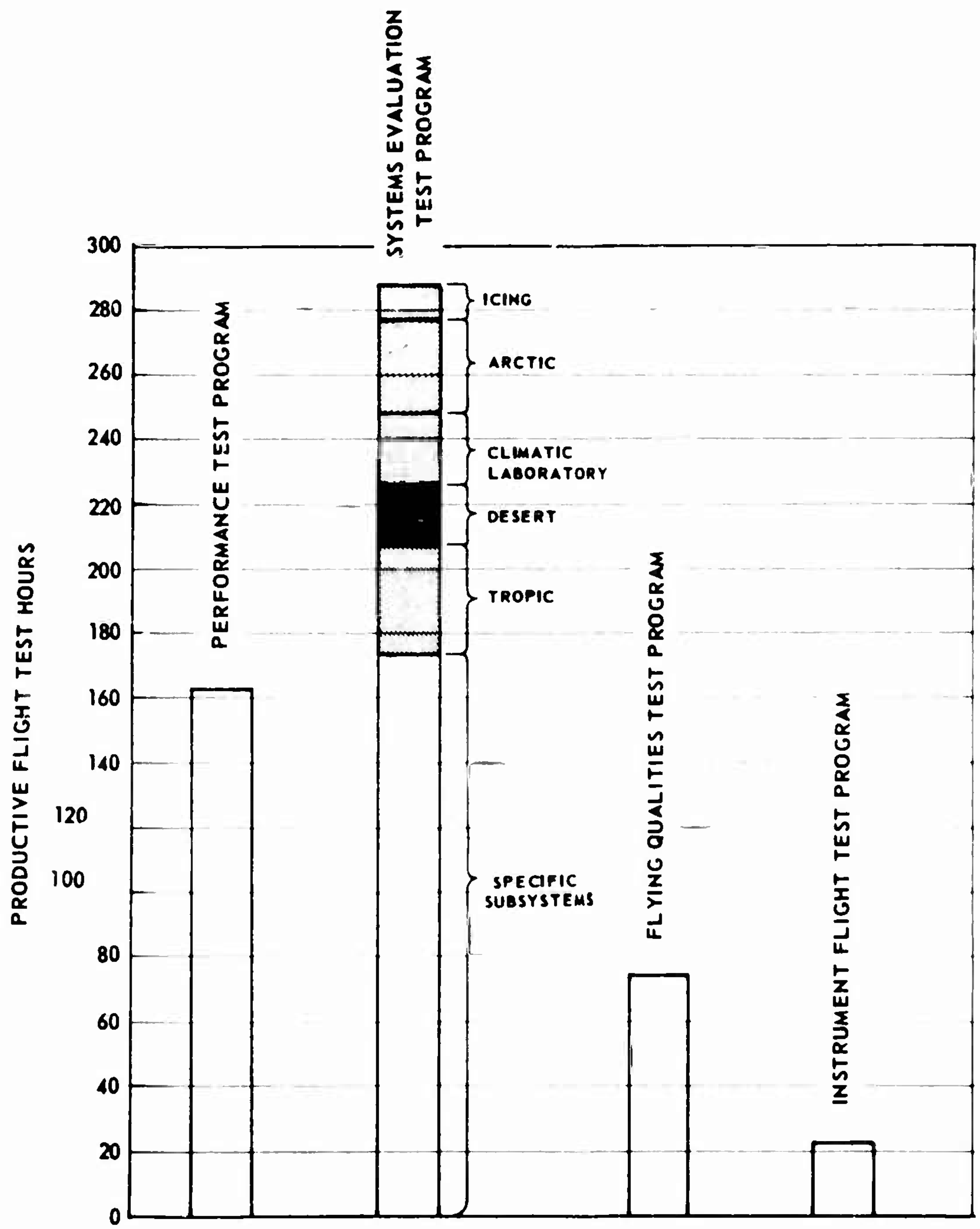

Figure 2 Program Productive Test Hours

AIRCRAFT DESCRIPTION

The UH-1N helicopter is the military version of the Bell Model 212, which is a modified UH-1H helicopter. Figure 3 shows the various features of the UH-1N. The missions for which the UH-1N was procured are counter-insurgency, unconventional warfare, psychological operations, transport of personnel and equipment, and the delivery of protective fire by the installation of appropriate weapons. To satisfy these varied missions the UH-1N was purchased in essentially two configurations. Forty-two aircraft were purchased in the Special Operational Forces (SOF) configuration, and 37 aircraft were purchased in the Alternate configuration. The differences between the two configurations lie in the choice of kits and avionics. For all 79 aircraft, however, internal provisions (CPO) exist so that any one aircraft can be quickly changed to the other configuration. A detailed list of the kits and avionics is shown in appendix II.

The UH-1N has a single two-bladed main lifting rotor and a tractor tail rotor instead of the more common pusher tail rotor. The UH-1N utilizes the basic UH-1H fuselage and is equipped with thin tip main and tail rotor blades. The aircraft is powered by a United Aircraft of Canada Limited T400-CP-400 power package consisting of two PT6T-4 free turbine turboshaft engines coupled to a combining gearbox having a single output shaft. Each engine has an uninstalled rating of 900 shaft horsepower at sea level standard day conditions. Overrunning clutches in the combining gearbox allows engine torque to be transmitted in one direction only, thus providing for both single-engine operation and two-engine out autorotation. Load sharing between the two engines is equalized by an automatic torque matching device. During the test program the maximum allowable forward speed was 130 knots indicated airspeed (KIAS), and the maximum operational/internal gross weight was 10,000 pounds. However, testing to 10,500 pounds internal gross weight was approved for Category II. In the standard configuration the difference between maximum gross weight and empty gross weight was approximately 4,000 pounds. This was approximately 300 pounds less than the equivalent weight difference for the UH-1F helicopter currently in the Air Force inventory.

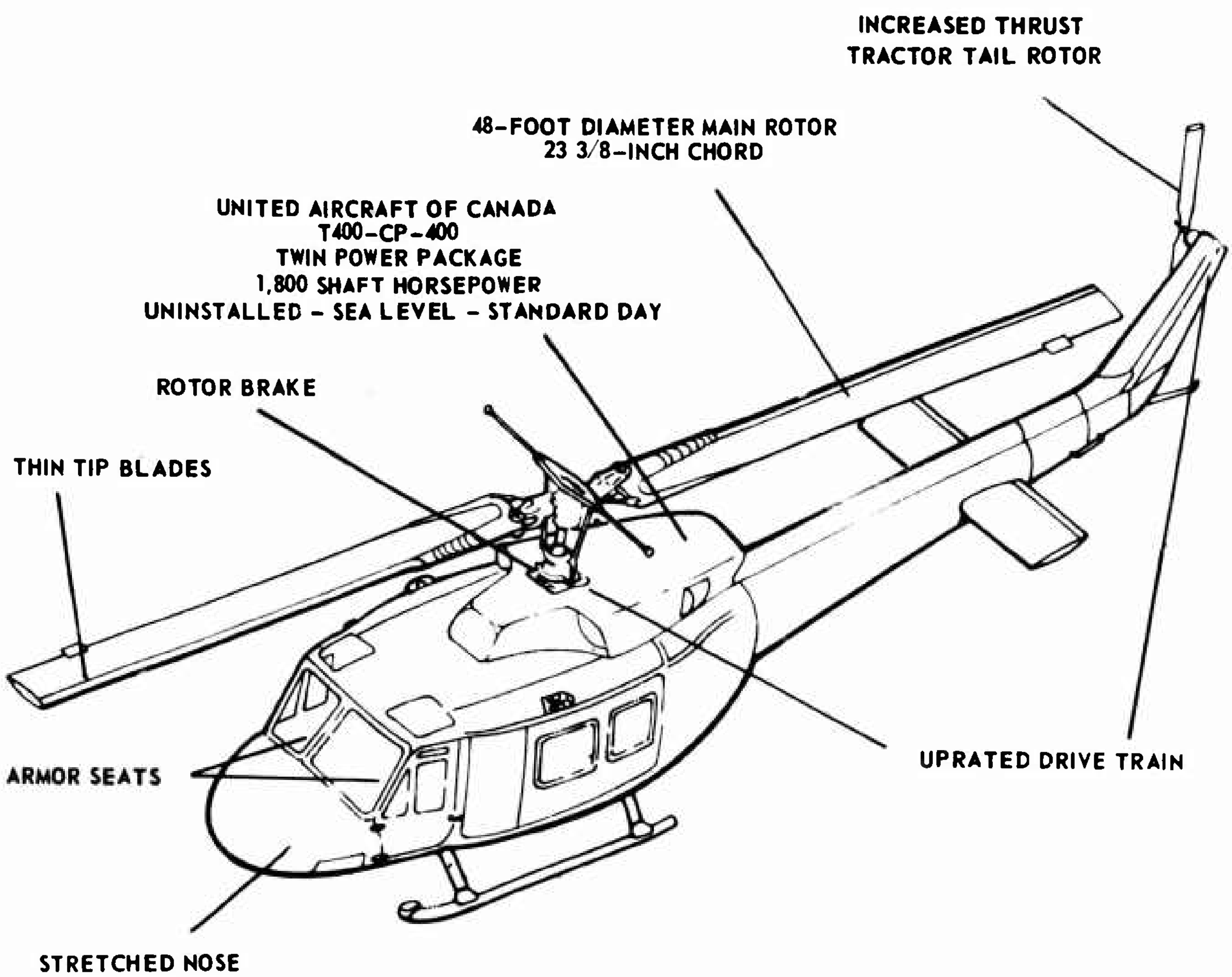

Figure 3 UH-1N Features

TEST AND EVALUATION

GENERAL

The substance of this report has been prepared from the AFFTC technical reports presented in appendix I. Details on a referenced subject can be found by referring to the appropriate technical report. Major findings, conclusions, and certain recommendations of those reports are repeated in this document for further emphasis.

OPERATIONAL ANALYSIS

Entry into and egress from the cockpit were awkward, especially when the seats were equipped with fixed side armor panels. In this configuration simulated emergency egress from the left seat while wearing a standard backpack parachute was difficult and required an average of 25 seconds. Difficulty was also experienced gaining access to the pedestal console, collective levers, and overhead circuit breakers. Modification of the seats with hinged side panels as a possible solution was recommended in reference 2.

Once stationed in the cockpit, the seat cushions were found to be hard, and as a result they became very uncomfortable after more than 30 minutes of flight. Engineering change proposal (ECP) 550 provided prototype foam filler seat cushions to alleviate the problem. In general, this cushion did not provide sufficient additional comfort, and a recommendation was made in reference 3 to provide thicker seat cushions.

Visibility from the cockpit and the placement of controls, switches, and instruments was acceptable except for the AQU-5A standby magnetic compass. In its present position, it could be seen only with difficulty by the pilot and not at all by the copilot. With the XM-60 gunsight installed and in the stowed position, the compass was completely hidden. Relocation of the compass to a more suitable location was recommended in references 2 and 4.

Night cockpit lighting was adequate and flying at night presented no problems.

Hover and takeoff characteristics were good and received flying qualities ratings of 2A and 3A, respectively. (The rating scale is shown in figure 12.) Ratings for typical flying tasks are shown in figure 11, and a further discussion of the aircraft's handling is given in the Flying Qualities Analysis section of this report.

Operations in rain from preflight through postflight were satisfactory except for the effects of operating the windscreen wipers. Although the wipers cleared the windscreen, they scratched it after only brief periods of operation (references 5 and 6 addressed this problem). Flying in rain produced no noticeable effects on either the performance or flying qualities of the aircraft.

The aircraft can be safely flown under Instrument Flight Rules (IFR) for limited periods of time. The Flying Qualities Analysis section of this report identifies certain undesirable flying quality characteristics that make prolonged IFR flight a disconcerting task. Due to the increased workload and vertigo inducing vibrations, two pilots were recommended for planned IFR flight in reference 6.

Radar identification of the UH-1N for all weather conditions without a transponder was marginal and at times unsatisfactory. A transponder should be installed on all UH-1N's and procured for all future helicopter systems. This action was recommended in references 5 and 7. **(R 1)**[1]

Operations in the desert environment where dust and fine sand are the prevalent surface condition required special cockpit procedures for takeoffs and landings. A maximum performance takeoff was found most suitable as the helicopter could be airborne and away before the sand and dust cloud formed and started to recirculate. The most satisfactory approach and landing technique into a desert area of unknown surface condition was a slow descent from a high hover. As the helicopter slowly descended the downwash effectively cleared the area beneath the helicopter, allowing the pilot to maintain visual contact with the ground at all times.

Operations into areas of powdery surface snow or ice fog were similar to operations in the sandy environment. Maximum performance takeoffs were found to be most suitable. The best approach and landing technique was to fly an approach to a high out-of-ground effect (OGE) hover (when power available permitted), remaining over the area in a hover until the snow dispersed, effecting a go-around, then after repeating the above procedure, effecting a slow descent into the landing area.

Flight into natural and artificial icing conditions up to clear-trace ice presented no degradation in flying qualities, although aircraft vibration increased as the ice accreted. Due to the lack of anti-ice systems, flight into greater than clear-trace icing conditions could not be safely effected (reference 6).

[1]**Boldface numerals preceded by an R correspond to the recommendation numbers tabulated in the Conclusions and Recommendations section of this report.**

Figure 4 Artificial Icing Tests Near Malmstrom AFB, Montana

SYSTEMS ANALYSIS

Propulsion System

Both external (auxiliary power) and self-contained (battery) ground starting was acceptable although at low temperatures the battery starts were marginal. It was recommended in reference 8 that self-contained (battery cold) battery starts in temperatures at or below 0 degrees F should not be made except in case of an emergency.

Engine airstarts were performed throughout the flight envelope and in medium, hot, tropical, and arctic environments. All airstarts were performed in a satisfactory manner.

Throttle stiffness and interaction between the No. 1 and No. 2 engine throttles was noticed throughout the Category II effort, particularly at cold temperatures. Initially this was identified during the UH-1N AFPE (reference 9). This problem was also identified in Monthly Progress Reports No. 1, 2, and 3, Technical Report FTC-TR-71-36, UH-1N Category II Climatic Laboratory Tests, and FTC-TR-72-10, UH-1N Category II Arctic Tests. Correction of the problem was recommended in these technical reports. This problem could be very serious if, during an emergency when one engine was required to be shut down, the second engine reduced in power through throttle interaction. The stiffness and interaction between the No. 1 and No. 2 throttles should be eliminated. **(R 2)**

Single- and dual-engine static droop characteristics were acceptable. Engine acceleration and rotor droop characteristics during dual- and single-engine transients induced by collective application were also satisfactory.

Rotor speed compensation characteristics were inadequate to maintain rotor speed within power-on limits when the collective pitch control was lowered even when minimum beep was applied. Improvement of the rotor speed compensation system to prevent rotor overspeed during engine transients induced the lowering the collective pitch control was recommended in reference 10.

Power available (topping power) was adequate throughout the flight envelope. Topping power determinations were found to be essentially independent of flight mode, but stabilized flight conditions were found to be best for gathering the power available data. Average single-engine installation losses were 88 shaft-horsepower (approximately 10 percent) at topping power for sea level standard day conditions. This value compares favorably with the computed installation loss of 85 shp presented at a 1 December 1971, T400 engine meeting. The following observations concerning topping power determinations were made in reference 11:

1. The No. 1 (left) power sections topped only on gas generator speed (N_g), except at cold temperatures when they topped on fuel flow (W_f). The No. 1 power sections were never observed to top on inter-turbine temperature (ITT).

2. The No. 2 (right) power sections generally topped on ITT, except at colder temperatures when they topped on N_g and W_f.

Other observations not previously reported concerning engine behavior at maximum rated power may have relevance and warrant further investigation. After relatively new T400 power packages were installed, several of the No. 2 engines produced as much or more power than the No. 1 engine until about 75 hours operating time had accumulated. After that period of time, however, either power available deteriorated rapidly or the topping power indications were low. When the indications were low, much difficulty was experienced in bringing the indicated power back to an acceptable level. Indicating discrepancies of the magnitudes encountered could cause the replacement of an otherwise satisfactory engine. No explanation for the different behavior of the No. 1 and No. 2 engines was found, but often the problems were related to the ITT indicating system. The reasons for the different behavioral characteristics of the No. 1 and No. 2 engines should be determined, and if a problem is identified, corrective action should be taken. **(R 3)**

The T400 turboshaft power plant exhibited a mean time between failures (MTBF) of 37.6 hours. Failures of fuel controls, engine instruments and two power sections were the main problems. The transmission system exhibited an MTBF of 97.8 hours. Blown transmission oil filter gaskets and false indications of high transmission oil temperatures were the major problems. Of particular note were the high pressures recorded in these systems during cold weather testing in the Climatic Laboratory (-55 to -65 degrees F). Both the transmission and engine oil systems were observed to reach transient values of 500 psi. The engine pressure system twice developed massive leaks when starting at a temperature of -65 degrees F. Correction of this problem was recommended in reference 8.

The only serious maintainability problem was the lengthy time required to change an engine. Although the total time varied depending on the proficiency of the crew (approximately 100 to 190 man-hours), at least one-third of the time was required to gain access to, and re-enclose the basic power plant.

Communication Systems

The UH-1N was equipped with three receiver-transmitter (RT) radio sets as standard equipment on the SOF-configured aircraft (appendix II). These were the AN/ARC-116 ultra-high frequency (UHF-AM), AN/ARC-115 very high frequency (VHF-AM), and the AN/ARC-114 very high frequency modulation (VHF-FM) radios. The AN/ARC-102 high frequency (HF) radio set was available as a special kit.

The AN/ARC-115 and -116 systems originally exhibited unsatisfactory performance. Bell ECP 568E was approved for resolution of the problem and was incorporated for evaluation. Except as noted in the following paragraph, post-ECP performance of the AN/ARC-115 and -116 was satisfactory. The AN/ARC-114 performance was satisfactory throughout the Category II test program.

All the radios performed adequately during environmental testing except when exposed to extreme heat. The affected radios were the AN/ARC-115 and -116. The deficiency was identified as being insufficient cooling air provided to the center console causing high temperatures in the console. Bell ECP 616 was approved by ASD to correct the problem, and incorporation will be by TCTO 1H-1 (U)N-532 from WRAMA.

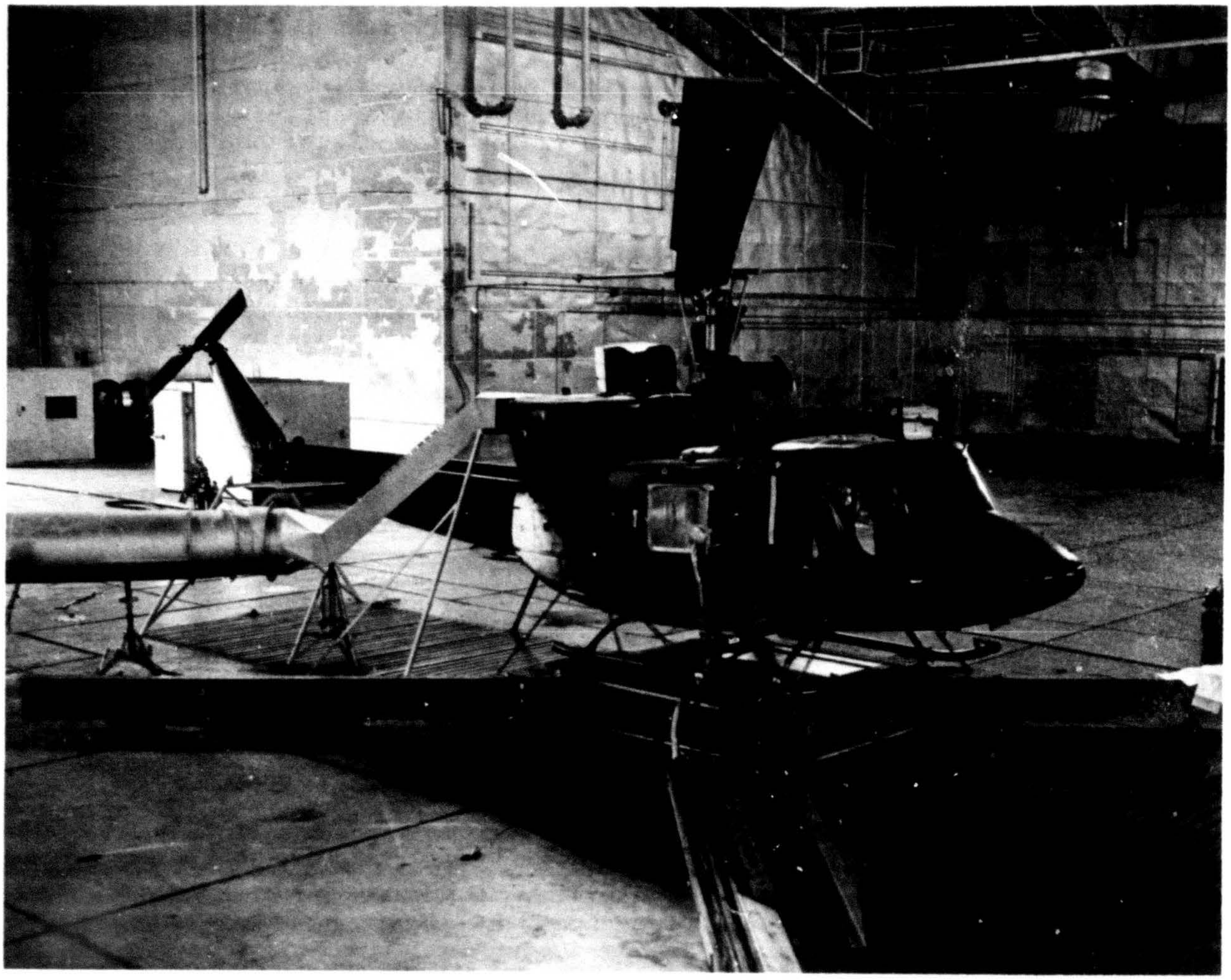

Figure 5 Testing in the Climatic Laboratory at Eglin AFB, Florida

The HF radio (AN/ARC-102) operation was satisfactory, as was the inter-communication radio system (C-6533/ARC).

Navigation Systems

The UH-1N was equipped with a full complement of navigational aids, including those required for IFR flight (appendix II). Standard equipment was the AN/ASN-43 gyromagnetic compass, the AN/ARA-50 UHF direction finder system, the AN/ARN-65 tacan, the AN/ARN-82 VOR radio receiver set, and the AQU-5A magnetic compass. The AN/ARN-89 automatic direction finder was available as a special kit.

Operation of this equipment was acceptable during all testing (including environmental extremes) although the Military Specifications for the equipment frequently were not met.

A major discrepancy was experienced with the placement of the AQU-5A standby magnetic compass and is discussed in the Operational Analysis section of this report.

Armament System

The UH-1N armament is listed in appendix II. The M-23 machine gun was not tested during Category II and only the XM-94 grenade launcher was tested in environments other than that which existed at Edwards AFB.

The armament system (XM-94 grenade launcher, XM-93 minigun, and 2.75-inch folding-fin rocket system) functioned in a reliable and satisfactory manner and was found to be compatible with the helicopter.

The operation of the grenade launcher was not adversely affected by extremes in the environment ranging from +100 to -65 degrees F.

Internal cabin noise levels during grenade launcher operations exceeded 150 decibels. Air Force Regulation 160-3 states that this is clearly above the threshold of pain and should be avoided. In references 2 and 12 it was recommended that emphasis be placed on wearing the proper protective hearing gear and that an effort should be made to reduce the noise levels emitted by the grenade launcher.

Accuracy of fire of the three weapon subsystems was unsatisfactory when fired from a hover. These systems became effective, however, in the pilot- and/or gunner-fired modes at airspeeds above 30 KIAS. (The XM-93 and XM-94 could be fired by the pilot or copilot in the fixed forward position or by a gunner in the flexed position. Rockets could only be launched by the pilot or copilot.) Inability to predict exact impact of the 40mm grenade projectiles precludes the XM-94's use as a close support weapon in the gunner-fired mode. The XM-60 gunsight was considered to be a poor target sighting device.

General Airframe and Miscellaneous Kits

The airframe, fuselage compartment, flight controls, and electric utility systems were acceptable. Many minor deficiencies existed which kept the overall system from being completely satisfactory. As recommended in the appropriate technical reports, these deficiencies should be eliminated, especially on aircraft procured in the future. Some of these airframe deficiencies are repeated in the following paragraphs.

As has been a problem with prior UH-1 aircraft, the windscreen proved to be highly susceptible to scratching. In references 5 and 6 it was recommended that this problem be corrected on the UH-1N and that all future helicopters should be equipped with scratch-resistant windshields.

During flight in rain, numerous leaks developed in the cabin ceiling, around the pilot and copilot doors, through the air vent and around the nose compartment electrical and electronic door. Routine Unsatisfactory

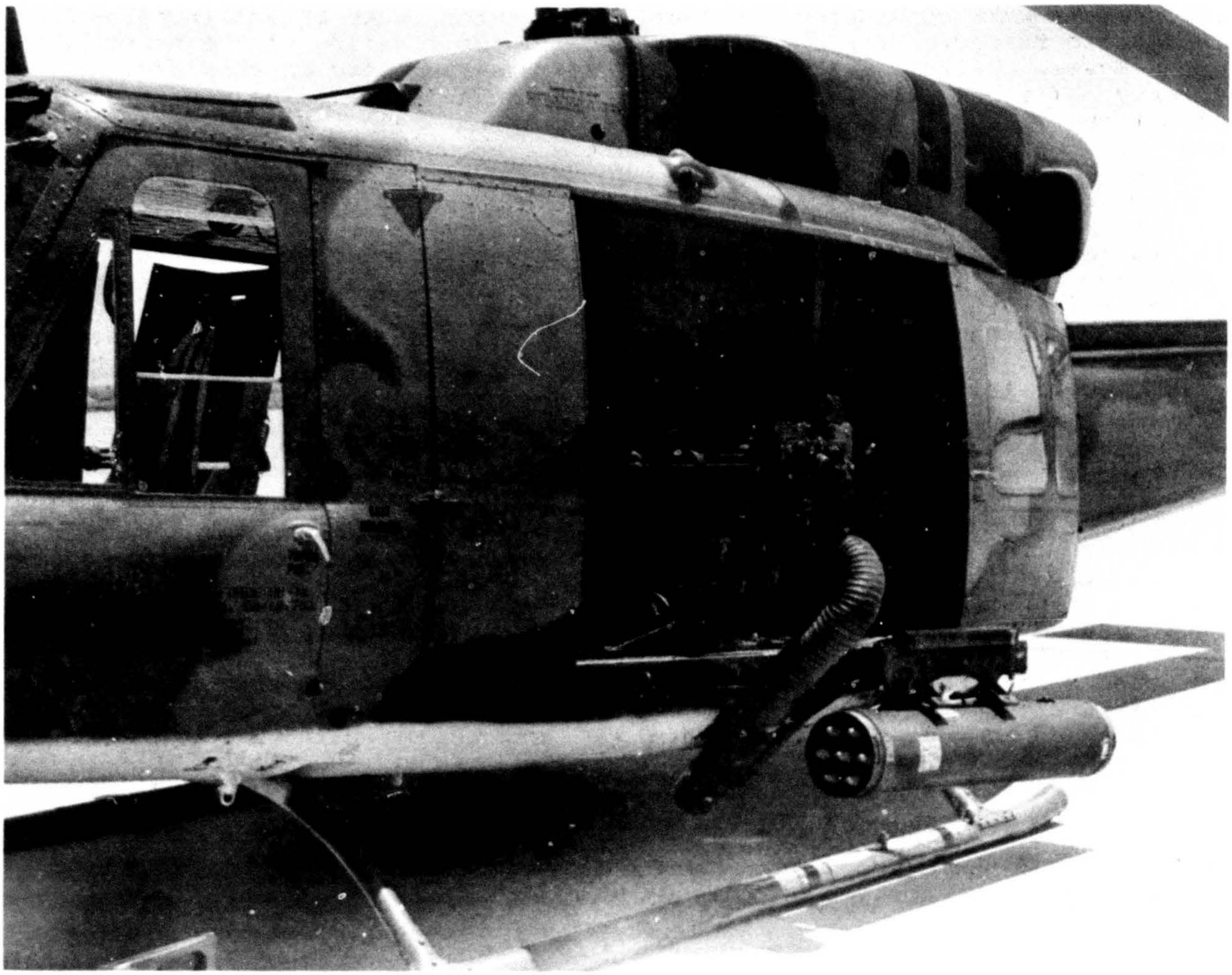

Figure 6 XM–93 Minigun and 2.75-inch Folding-Fin Rocket System

Materiel Reports (RUMR's) were submitted to cover the leaks that compromised safety of flight. Also, in the tropical environment, corrosion developed on several exposed engine and flight control components. Current approved maintenance practices should keep this corrosion at a minimum.

The general airframe was acceptable for operation in a hot, dusty, desert environment although several areas were recommended for improvement. Leaks developed around the main rotor hub grip reservoir seals when they were exposed to blowing sand. The nylon clamps used to secure the ignition wire bundles in the engine hot section compartment deteriorated in the heat.

With few exceptions, the general airframe was found to be adequate for operation in the arctic environment. The hydraulic and flight control systems were considered excellent. The rotor brake became inoperative due to suspected condensation and subsequent freezing of the moisture in the master cylinder. AFFTC RUMR R71-344 was submitted on this deficiency. The heater was adequate only when on full HOT. The windshield defrost system was inadequate because it could not keep the windshield clear of ice for most of the icing conditions encountered.

Two primary accessories available to the UH-1N were the BL-8300 internal rescue hoist and the SA-1800C loudspeaker system kit. The BL-8300 hoist functioned in an acceptable manner; however, the forest penetrator released from the hoist hood and exposed hoist motor surfaces reached temperatures that could cause severe burns if inadvertently touched. (ASD has procured an ECP that provides positive closure of the rescue hook hoist.) The SA-1800C loudspeaker system was considered to be of limited usefulness due to the UH-1N flight noise and noise feedback through the hand-held microphone.

PERFORMANCE ANALYSIS

Hover, climb, level flight, and takeoff performance was good and in general equalled or exceeded that estimated in the Flight Manual (T.O. 1H-1(U)N-1). Figures 7 and 8 present calculated hover and level flight performance characteristics. Figure 9 shows the airspeed limit envelope. Single-engine performance was also good and enhanced the operational capability of the helicopter. Specifically, single-engine operation increased maximum specific range more than 25 percent over dual-engine operation, allowed a fly-away from a single-engine failure situation for a good portion of the flight envelope, and minimized the AVOID area of the single-engine height-velocity curves. When equipped with full armament (two LAU-59/A rocket launchers, two XM-93 miniguns extended fixed to fire forward, mid cg, and cargo doors open), the specific range reduction averaged 10 percent. When equipped with only the rocket launchers, and the cargo doors closed, the specific range reduction was approximately 5 percent.

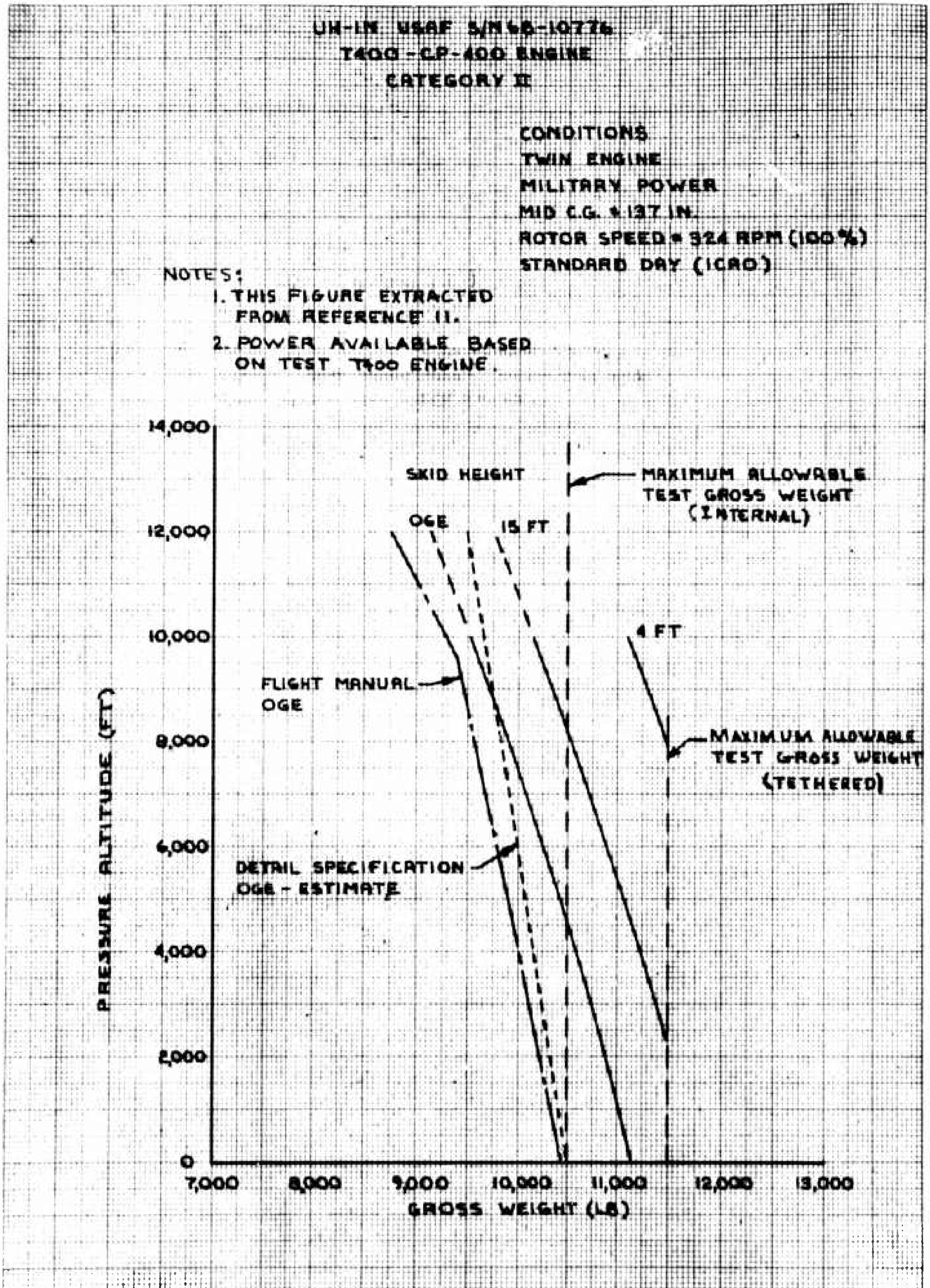

FIGURE 1. HOVER CEILING SUMMARY - STANDARD DAY

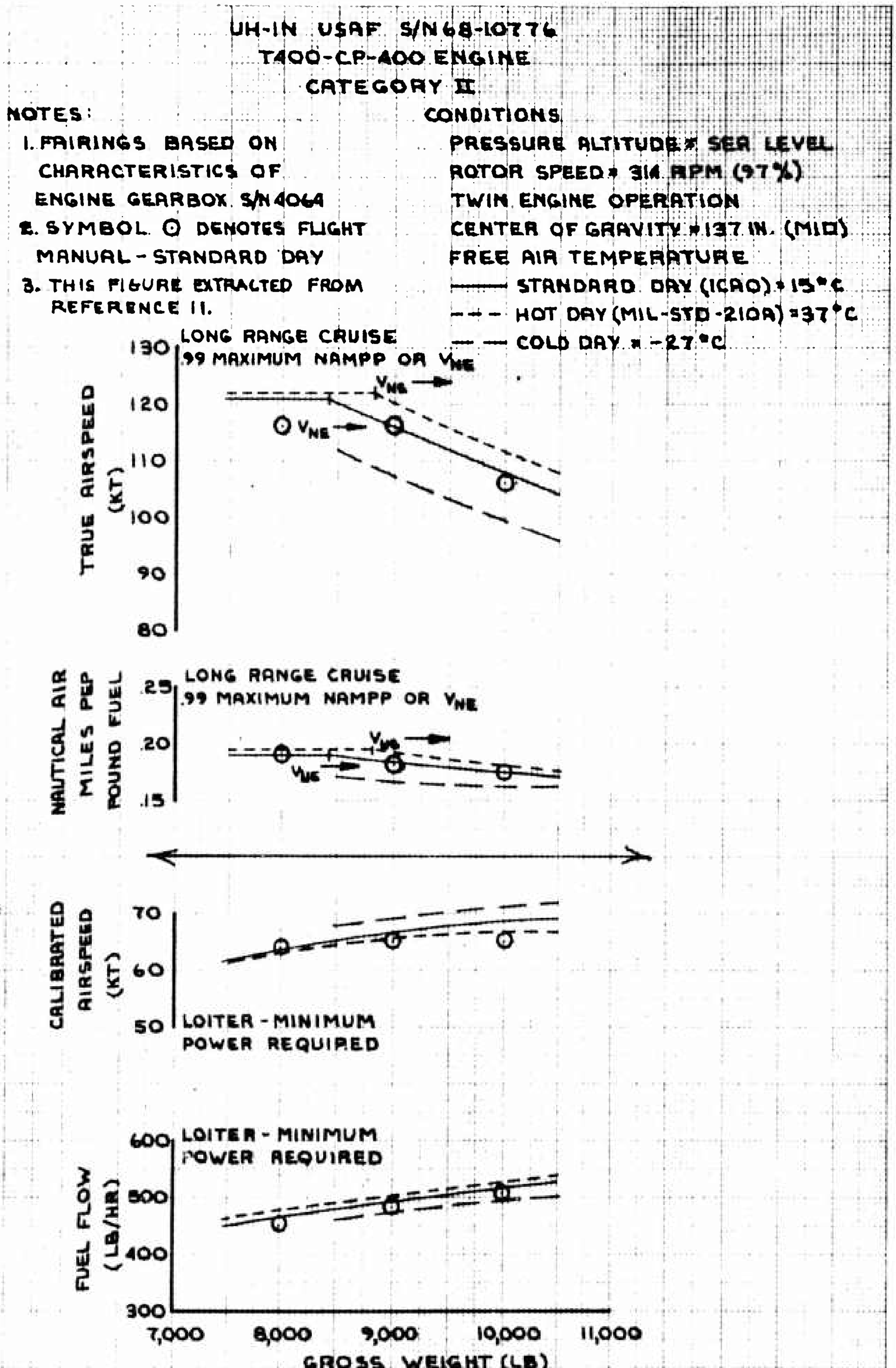

FIGURE 8. LEVEL FLIGHT PERFORMANCE SUMMARY - TWIN ENGINE

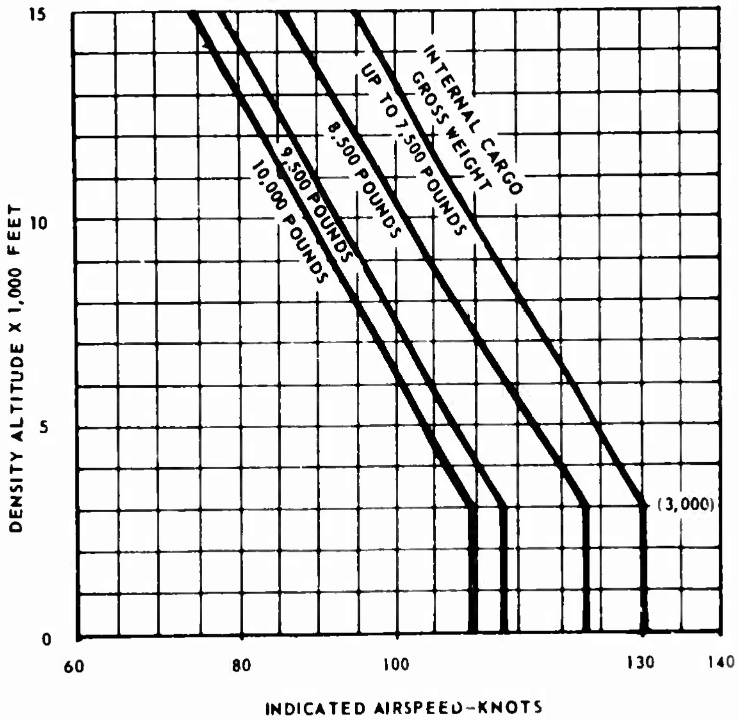

Figure 9 Airspeed Limit Envelope

Figure 10 Tethered Hover Testing at Canadian Forces Base, Cold Lake, Alberta, Canada

FLYING QUALITIES ANALYSIS

The flying qualities of the UH-1N were generally satisfactory within the normal operational flight envelope (figures 11 and 12). No unpredictable or dangerous flight characteristics were encountered. The larger tractor tail rotor enhanced the directional control characteristics. (Earlier the UH-1 helicopters were equipped with smaller "pusher" type tail rotors.) At the extremes of the flight envelope; however, that is at heavy gross weights, forward and aft cg locations, and high density altitudes, the flying qualities were degraded but acceptable.

Due to the low directional control breakout forces, and a nearly continuous yaw oscillation of ±2 degrees, the mission effectiveness for IFR flight or accurate weapons delivery was considered degraded (reference 13).

As mentioned in the Operational Analysis section of this report, no deterioration in flying qualities was noted during flight in environmental extremes.

Flight Task	Handling Qualities Rating[1]	Comments
Hover[2]	A2	Satisfactory controllability and stability.
Takeoff	A3	Slight degradation due to longitudinal trim reversal in the 10- to 20-knot speed range.
Climb	A4	Degradation due to difficulty in maintaining trim airspeed and a longitudinal dynamic instability (readily controllable).
Level Flight	A3	Slight degradation resulting from nearly continuous hunting in yaw attitude (±2 deg).
Maneuvering Flight	A3	Degradation due primarily to yaw oscillation.
Weapons Delivery	A4	Effects of yaw oscillation more critical during precision tasks.
Autorotation	A3	Slight degradation due primarily to low positive speed stability and a residual yaw oscillation.
Landing	A3	Slight degradation due to longitudinal trim reversal in 10- to 20-knot speed range.

[1]Rating numbers derived from handling qualities rating scale presented in figure 12.

[2]Rating presented is for hover in calm winds with a mid c.g. at less than maximum gross weight. As wind speed and gross weight increased and the wind azimuth varied, the ratings varied from A3 through U7. The requirement for large, frequent longitudinal and directional control inputs was responsible for the poorer ratings.

Figure 11 Flying Qualities Ratings

CONTROLLABLE CAPABLE OF BEING CONTROLLED OR MANAGED IN CONTEXT OF MISSION, WITH AVAILABLE PILOT ATTENTION	ACCEPTABLE MAY HAVE DEFICIENCIES WHICH WARRENT IMPROVEMENT, BUT ADEQUATE FOR MISSION. PILOT COMPENSATION, IF REQUIRED TO ACHIEVE ACCEPTABLE PERFORMANCE, IS FEASIBLE.	SATISFACTORY MEETS ALL REQUIREMENTS AND EXPECTATIONS. GOOD ENOUGH WITHOUT IMPROVEMENT CLEARLY ADEQUATE FOR MISSION	EXCELLENT, HIGHLY DESIRABLE	A1
			GOOD, PLEASANT, WELL BEHAVED	A2
			FAIR, SOME MILDY UNPLEASANT CHARACTERISTICS GOOD ENOUGH FOR MISSION WITHOUT IMPROVEMENT	A3
		UNSATISFACTORY RELUCTANTLY ACCEPTABLE DEFICIENCIES WHICH WARRANT IMPROVEMENT. PERFORMANCE ADEQUATE FOR MISSION WITH FEASIBLE PILOT COMPENSATION	SOME MINOR BUT ANNOYING DEFICIENCIES. IMPROVEMENT IS REQUESTED. EFFECT ON PERFORMANCE IS EASILY COMPENSATED FOR BY THE PILOT.	A4
			MODERATELY OBJECTIONABLE DEFICIENCIES. IMPROVEMENTS IS REQUESTED, EFFECT ON PERFORMANCE REQUIRES CONSIDERABLE PILOT COMPENSATION.	A5
			VERY OBJECTIONABLE DEFICIENCIES. MAJOR IMPROVEMENTS ARE NEEDED. REQUIRES BEST AVAILABLE PILOT COMPENSATION TO ACHIEVE ACCEPTABLE PERFORMANCE.	A6
	UNACCEPTABLE DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT. INADEQUATE PERFORMANCE FOR MISSION EVEN WITH MAXIMUM FEASIBLE PILOT COMPENSATION		MAJOR DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT FOR ACCEPTANCE. CONTROLLABLE. PERFORMANCE INADEQUATE FOR MISSION. OR PILOT COMPENSATION FOR MINIMUM ACCEPTABLE PERFORMANCE IN MISSION IS TOO HIGH.	U7
			CONTROLLABLE WITH DIFFICULTY. REQUIRES SUBSTANTIAL PILOT SKILL AND ATTENTION TO RETAIN CONTROL AND CONTINUE MISSION.	U8
			MARGINALLY CONTROLLABLE IN MISSION. REQUIRES MAXIMUM AVAILABLE PILOT SKILL AND ATTENTION TO RETAIN CONTROL.	U9
UNCONTROLLABLE CONTROL WILL BE LOST DURING SOME PORTION OF MISSION			UNCONTROLLABLE IN MISSION.	U10

Figure 12 Fiying Qualities Rating Scale

Figure 13 In-Ground-Effect Flying Qualities Testing at the High Altitude Test Site Near Bishop, California

CONCLUSIONS AND RECOMMENDATIONS

The operational characteristics, major systems, performance, and flying qualities, of the UH-1N were, in general, either satisfactory or acceptable. Recommendations 1 and 2, which were made in previous AFFTC technical reports, are restated here for further emphasis and immediate action.

Radar identification of the UH-1N without a transponder was marginal and at times unsatisfactory. This condition existed independently of environmental conditions.

1. A transponder should be installed on all UH-1N's and procured for all future helicopter systems (page 7).

Throttle stiffness and interaction between the No. 1 and No. 2 engine throttles was noticed throughout the Category II effort, particularly at cold temperatures. This problem could be very serious if, during an emergency when one engine was required to be shut down, the second engine reduced in power through throttle interaction.

2. The stiffness and interaction between the No. 1 and No. 2 throttles should be eliminated (page 9).

A difference in the behavior of the No. 1 and No. 2 engines was observed, i.e., the No. 1 engine generally topped on N_g and the No. 2 engine generally topped on ITT. The No. 2 engine generally appeared to deteriorate more rapidly than the No. 1 engine. No reasons for the behavioral difference could be determined.

3. The reasons for the different behavioral characteristics of the No. 1 and No. 2 engines should be determined, and if a problem is identified, corrective action should be taken (page 10).

APPENDIX I
UH-1N CATEGORY II TEST REPORTS

Technical Reports and Substantiating Documents

Report No.	Title	Date
FTC-TR-71-1*	UH-1N Category II Tropical Weather Tests	February 1971
FTC-TR-71-9	UH-1N Instrument Flight, Turbulence, and Icing Tests	March 1971
FTC-TR-71-36*	UH-1N Category II Climatic Laboratory Tests	August 1971
FTC-TR-71-37	UH-1N Category II Airframe and Subsystems Evaluation	November 1971
FTC-TR-71-38	UH-1N Category II Armament Evaluation	September 1971
FTC-TR-71-39	UH-1N Category II Propulsion System Evaluation	August 1971
FTC-TR-71-48*	UH-1N Category II Desert Tests	November 1971
FTC-TR-71-50	UH-1N Category II Flying Qualities Evaluation	November 1971
FTC-SD-71-50	UH-1N Category II Flying Qualities Evaluation	January 1972
FTC-TR-72-10*	UH-1N Category II Arctic Tests	March 1972
FTC-TR-72-17	Category II Performance Test of the UH-1N Helicopter (Volumes I and II)	May 1972

*Quantitative substantiating data are available as tabularized data in appendices to these reports.

APPENDIX II
UH-1N AVIONICS AND SPECIAL KITS

Avionics Equipment for UH-1N	Quantity per Acft	SOF(42)	Alt(37)
AN/ARC-114 VHF-FM Radio Set	1	Install	CPO*
AN/ARC-115 VHF-AM Radio Set	1	Install	CPO
AN/ARC-116 UHF-AM Radio Set	1	Install	Install
C-6533/ARC Communication System	6	Install	Install
AN/ASN-43( ) Gyromagnetic Compass Set	1	Install	Install
AN/ARA-50 UHF Direction Finder System	1	Install	Install
AN/ARN-65 TACAN, Navigational Set	1	Install	Install
AN/ARN-82 VOR Radio Receiver Set	1	Install	Install
TSEC/KY-28 Communication Security Set	1	CPO	CPO
AN/ARC-102 HF Radio Set[1]	1	CPO	CPO
AN/ARN-89 Automatic Direction Finder[1]	1	CPO	CPO
AN/APN-171 Radar Altimeter	1	CPO	CPO
R-1041( )/ARN Receiver, Marker Beacon	1	CPO	CPO
AN/APX-72 Transponder Set	1	CPO	CPO
TS-1843( )/APX Transponder Test Set	1	CPO	CPO
Mark XII Computer Kit-1A/TSEG	1	CPO	CPO
AAU-21/A Altimeter Encoder	1	CPO	CPO

Kit Equipment for UH-1N	Quantity Procured (ASD)	SOF(42)	Alt(37)
Misc. Kits			
Ferry Tank Kit (300-gallon internal)	1	CPO	CPO
Additional Covers Kit	0	CPO	CPO
Air Transportability Kit	0	CPO	CPO
Loudspeaker System Kit	9	CPO	CPO
Blackout Curtain Kit	0	CPO	CPO
Cargo Net Kit	0	CPO	CPO
Litter Kit	20	CPO	CPO
Ground Handling Sets (2 assy per set)	29	CPO	CPO
Internal Rescue Hoist Kit	9	CPO	CPO
External Cargo Kit	79	Install	Install
Formation Lights Kit	0	CPO	CPO
AN/ARC-102 HF Antiprecipitation Antenna[2]	8	CPO	CPO
Passive Armor Kit (chin-bubble armor)	42	Install	CPO
Winterization Kit	1	CPO	CPO
Armament			
M-23 Armament Subsystem	0	CPO	CPO
XM-93 System, 7.62mm Minigun[3]	12 sets	CPO	CPO
XM-94 System, 40mm Grenade Launcher[3]	12 sets	CPO	CPO
LAU-59A/B Seven-Tube Rocket Pod[4,5]	0	CPO	CPO
Collins Radio Rocket Support Assy[4]	42 sets	CPO	CPO
XM-60 Roof Mtd. Stowable Sight	42	CPO	CPO
LAU-68A/A Seven Tube Rocket Pod[4,5]	0	CPO	CPO
Armor Seats (pilot/copilot)**	42	Install	CPO
Non-armor Seats (pilot/copilot)	37	---	Install

*CPO - Complete Provisions Only, i.e., internal aircraft provisions exist so the system can be readily installed in the aircraft.

**The non-armor and armor seats are interchangeable.

[1]Eight procured for United States Air Force Southern Command (USAFSO) aircraft only.

[2]Procured for USAFSO aircraft only.

[3]Two guns with pintle mount per set.

[4]Two required per aircraft set.

[5]None procured by ASD. This is an USAF inventory item.

REFERENCES

1. USAF Materiel Deficiency Reporting System, T.O. 00-35D-54, 1 May 1970.

2. Russell, Edward B., Major USAF, and Helmick Hugh M., Captain USAF, UH-1N Category II Airframe and Subsystems Evaluation, FTC-TR-71-37, Air Force Flight Test Center, Edwards AFB, California, November 1971.

3. Somsel, John R., Category II Weapon System 443N (UH-1N Helicopter) Progress Report, Report No. 15, Air Force Flight Test Center, Edwards AFB, California.

4. Dawson, Robert H., Captain USAF, and Russell, Edward B., Major USAF, UH-1N Category II Armament Evaluation, FTC-TR-71-38, Air Force Flight Test Center, Edwards AFB, California, September 1971.

5. Angle, Theodore E., Major USAF, and Ford, James A., UH-1N Category II Tropical Weather Tests, FTC-TR-71-1, Air Force Flight Test Center, Edwards AFB, California, February 1971.

6. Dowden, Donald J., and Angle, Theodore E., Major USAF, UH-1N Instrument Flight Turbulence and Icing Tests, FTC-TR-71-9, Air Force Flight Test Center, Edwards AFB, California, March 1971.

7. Somsel, John R., Category II Weapon System 443N (UH-1N Helicopter) Progress Report, Report No. 1, Air Force Flight Test Center, Edwards AFB, California.

8. Nelsen, Gary L., Major USAF, and Ford, James A., UH-1N Category II Climatic Laboratory Tests, FTC-TR-71-36, Air Force Flight Test Center, Edwards AFB, California, August 1971.

9. Springer, Robert H., Nasal, Timothy P., Grawi, Franklin L., Captain USAF, Flanigen, Edwin G., Lieutenant Colonel USAF, Angle Theodore G., Major USAF, Air Force Preliminary Evaluation of the UH-1N Helicopter, FTC-TR-70-22, Air Force Flight Test Center, Edwards AFB, California, August 1970.

10. Brandt, Jerome C., and Russell, Edward B., Major USAF, UH-1N Category II Propulsion System Evaluation, FTC-TR-71-39, Air Force Flight Test Center, Edwards AFB, California, August 1971.

11. Springer, Robert H., and Berger, Donald, Lieutenant Colonel USAF, Category II Performance Test of the UH-1N Helicopter, Air Force Flight Test Center, Edwards AFB, California, May 1972.

12. Somsel, John R., Category II Weapon System 443N (UH-1N Helicopter) Progress Report, Report No. 5, Air Force Flight Test Center, Edwards AFB, California.

13. Nasal, Timothy P., and Berger, Donald, Lieutenant Colonel USAF, UH-1N Category II Flying Qualities Evaluation, FTC-TR-71-50, Air Force Flight Test Center, Edwards AFB, California, November 1971.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Air Force Flight Test Center Edwards Air Force Base, California	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP N/A

3. REPORT TITLE

UH-1N Category II Test Program Summary

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final

5. AUTHOR(S) (First name, middle initial, last name)
John R. Somsel

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1972	24	13

8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. AFFTC Project Directive 69-49, as revised. d.	9a. ORIGINATOR'S REPORT NUMBER(S) FTC-TR-72-29 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) N/A

10. DISTRIBUTION STATEMENT Distribution limited to U.S. Government agencies only (test and evaluation), June 1972. Other requests for this document must be referred to ASD (SDQH), Wright-Patterson AFB, Ohio 45433.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
N/A	6510 Test Wing Edwards AFB, California

13. ABSTRACT

As tested, the UH-1N helicopter was considered adequate to fulfill its mission as an attack and utility helicopter. Operations in climatic extremes were satisfactory; however, the lack of anti-ice systems reduced the all-weather capability. The airframe, fuselage compartment, flight controls, electric utility system and armament system were generally satisfactory. Although the T400 engine delivered adequate power, a low mean time between failures and discrepancies in the power indicating systems degraded the overall performance. Good single-engine performance enhanced the satisfactory dual-engine performance capabilities of the helicopter. Flying qualities were satisfactory throughout most of the flight envelope; however, they deteriorated near the extremes of the flight envelope.

DD FORM 1 NOV 65 1473

UNCLASSIFIED
Security Classification

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
UH-1N helicopter test summary attack helicopter utility helicopter performance flying qualities						

UNCLASSIFIED
Security Classification

SUPPLEMENTARY

INFORMATION

RUECDQA/NADC/AOL JOHNSVILLE WARMISTER PA
RUWTAFA/DEPT OF ARMY USABPA FT WORTH TE
ZEN/FTO/ENDI/ENTE WPAFB OHIO
ZEN/AFFDL/FGC WPAFB OH
RUCLBMA/ADTC/DLOSL/DDGZ/DLYE/ELGIN AFB FLA
RUVKRIF/DIR MAT MGT/MMLO KELLY AFB TE
RUKLAAA/TAC/DRLS/DMML/DOSO
RUCIMAA/ARRS/ARXRD SCOTT AFB ILL
BT
UNCLAS SDQH 619
SUBJECT: ASD SUPPLEMENTAL COMMENT TO AFFTC REPORT AFFTC-TR-72-29
1. REFERENCE AS/SDQH LETTER 8-5, SUBJECT, 'ASD ADDENDUM REPORT

AD-902 264L

TO FTC-TR-72-29', DTD 4 AUG 1972.
2. THE PURPOSE OF THIS MSG IS TO REPLACE PARAGRAPH 3 OF THE REFERENCE LETTER WITH THE FOLLOWING:
CONCUR WITH INTENTM PROBLEMS ASSOCIATED WITH ENGINE TOPPING HAVE BEEN MINIMIZED. TO 1H-1(U)N6CF-1 TOPPING INSTRUCTIONS WERE ERRONEOUS WHEN CATEGORY II TESTING WAS PERFORMED. SINCE THEN THE TOPPEING TROUBLE SHOOTING PROCEDURES HAVE BEEN EPANDED TO REQUIRE CALIBRATION OF THE ENGINE GAS GENERATOR AND INTERTURBINE TEMPERATURE (ITT) INSTRUMENTS. ALSO, SINCE THE ITT THERMOCOUPLE BOSS IS LOCATED ON THE LEFT SIDE OF EACH ENGINE, IT IS SUBJECTED TO A DIFFERENCE ENVIRONMENTAL TEMPERATURE. ON THE NO. 2 ENGINE THE BOSS IS LOCATED INBOARD NEXT TO THE CENTER FIREWALL. THIS LOCATION APPARENTLY RESULTS IN LOCALIZED HEATING WHICH INCREASES THE ITT SIGNAL FROM 10-20 DEGREES C AS COMPARED TO THE NO. 1 ENGINE. THIS EXPLAINS THE DIFFERENCE IN BEHAVIOR EPERIENCED BETWEEN THE TWO ENGINES.
BT
#3044

NNNN#