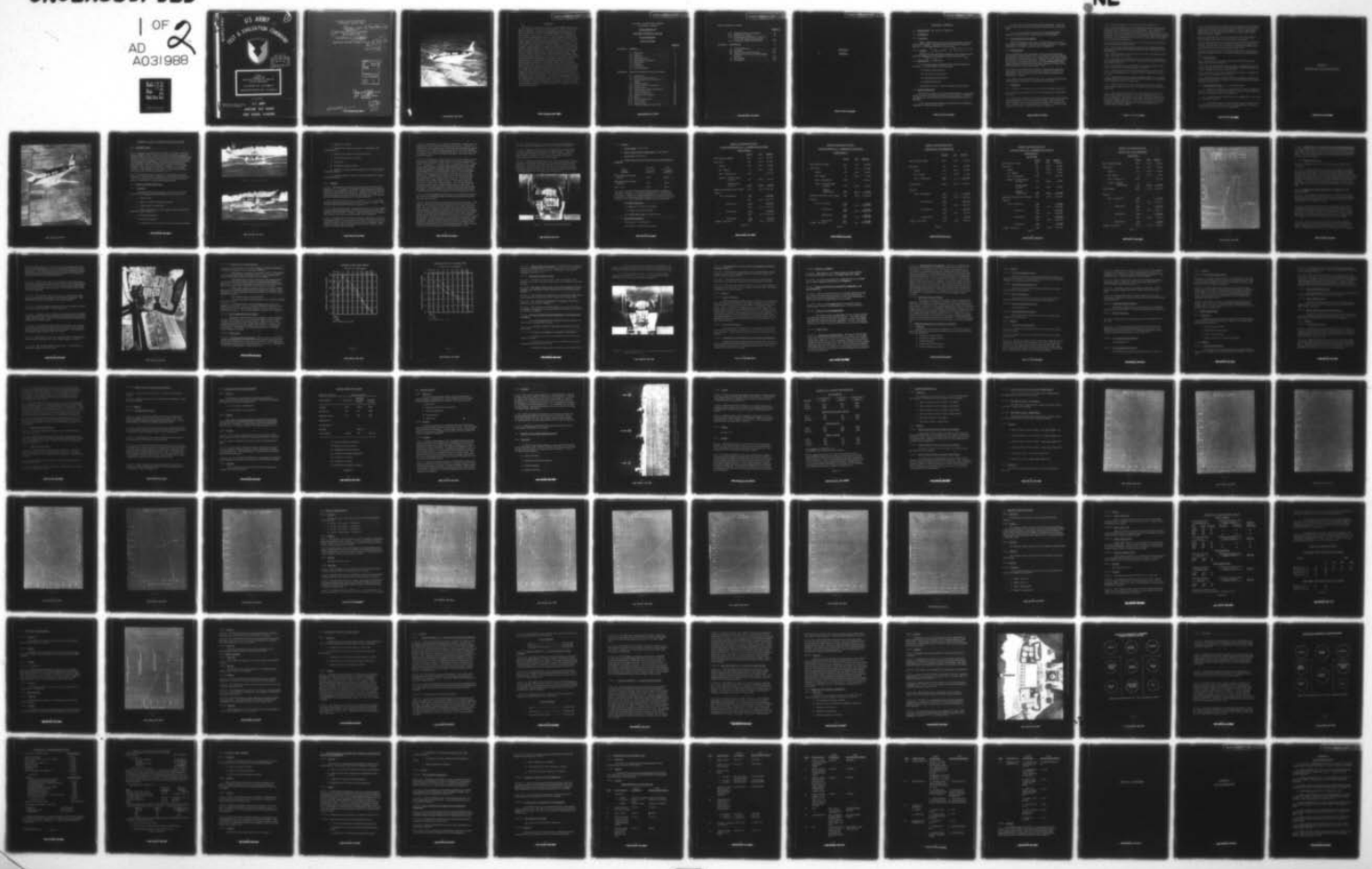
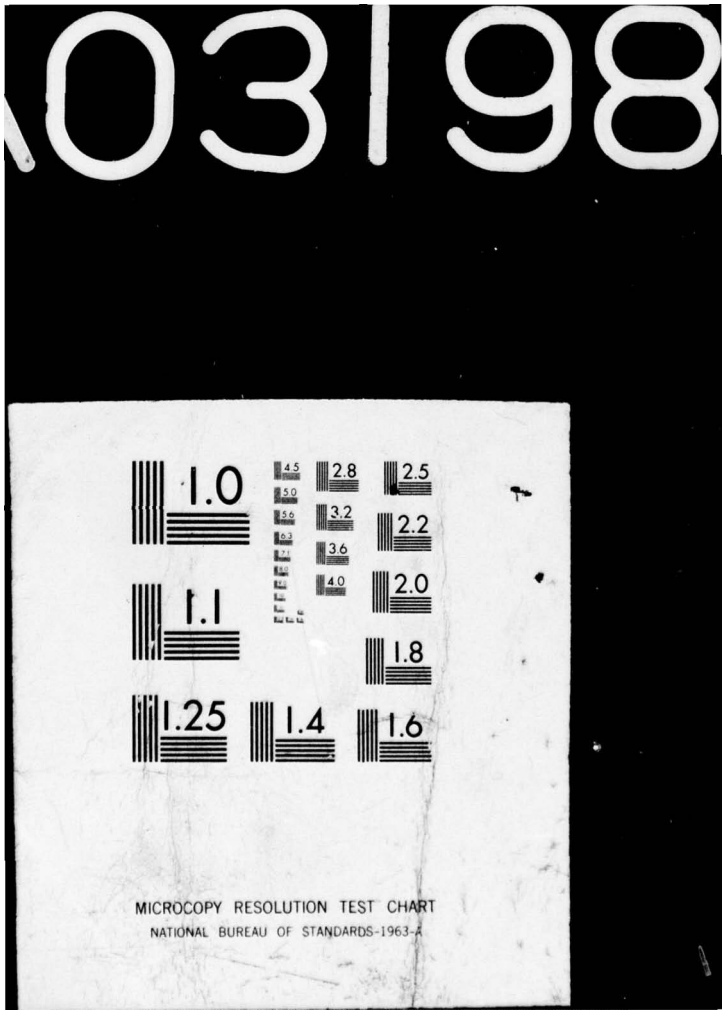
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FINAL
REPORT OF
MILITARY POTENTIAL TEST OF
NU-8F AIRPLANE

DA PROJECT NO. 1X141809D179

USATECOM PROJECT NO. 4-4-1005-01

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FORT RUCKER, ALABAMA

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ABSTRACT

The US Army Aviation Test Board (USAAVNTBD) conducted the Military Potential Test of the NU-8F Airplane in the vicinities of Fort Rucker, Alabama, and Minot, North Dakota, during the period 16 March 1964 to 3 June 1964. The USAAVNTBD was responsible for the execution of the test and submission of the report. Inputs were received from participating agencies.. It was found that the NU-8F carried a greater payload, had a nine-decibel lower noise level, had simpler ground operations and better takeoff performance, a faster climb, higher service ceiling with both engines or one engine, a faster normal cruise speed with a greater range, was considered safer in flight, and was easier to maintain than the U-8F. The c.g. limits posed no unusual problems to loading for safe operation except in two specific loading configurations. The heater system was not reliable above 20,000 feet and the oxygen system was not acceptable. The deicing and anti-icing systems operated satisfactorily with the exception of the engine alcohol anti-ice system. The available cabin seating arrangement and configuration were adequate and the location and operation of avionic equipment controls and displays were satisfactory with the exception of two shortcomings. It was concluded that when the deficiencies are corrected, the NU-8F will be more suitable for Army use than the U-8F, that correction of the shortcomings will enhance the suitability of the NU-8F, that environmental testing and a 1000-hour logistical evaluation of the airplane with the PT6A-6 engines are required to determine the engine suitability for Army use, and that the lack of pressurization seriously restricts the practical utilization of the NU-8F Airplane. It was recommended that the NU-8F be considered more suitable for Army use than the U-8F after correction of the deficiencies, that the shortcomings be corrected as economically feasible, and that the NU-8F with the PT6A-6 engines undergo environmental testing and a 1000-hour logistical evaluation after correction of the deficiencies.

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US ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

FINAL REPORT OF

MILITARY POTENTIAL TEST OF

NU-8F AIRPLANE

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SECTION 1

GENERAL

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SECTION 1 - GENERAL

1.1. REFERENCES. See section 3, appendix I.

1.2. AUTHORITY.

1.2.1. Directive.

Letter, AMSTE-BG, US Army Test and Evaluation Command, 31 May 1963, subject: "Evaluation of the U-8F (L-23F) Turbinized Aircraft," with 1st Indorsement, 18 October 1963.

1.2.2. Purpose. The purpose of the test was to

To determine the operational suitability of the turbine powered U-8F (NU-8F) during a one-hundred-hour flight test program. for Army use

1.3. OBJECTIVES. To determine:

a. The mission support suitability of the NU-8F Airplane for Army use, to include adequacy of the following:

(1) Physical characteristics

(2) The PT6A-6 turbine engine

(3) Operational characteristics

(4) Stability and control

b. Maintenance, service, and ground support requirements.

1.4. RESPONSIBILITIES.

The US Army Aviation Test Board (USAAVNTBD) was responsible for the execution of the test and submission of the report. Inputs for the report were received from the following participating agencies as indicated:

a. US Army Board for Aviation Accident Research (USABAAR): Comments on safety characteristics.

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b. US Army Aeromedical Research Unit (USAARU): Comments on noise levels and investigation of carbon monoxide in the cockpit and cabin.

c. US Army Aviation Human Research Unit (USAAHUMRU): Comments on human factors in operating the NU-8F Airplane.

1.5. DESCRIPTION OF MATERIEL.

The NU-8F Airplane represents a product improvement of the U-8F with the installation of two PT6A-6 turboprop engines. A detailed description is contained in section 3, part I, appendix II.

1.6. BACKGROUND.

1.6.1. In December 1962, the Office of the Chief of Research and Development, requested that the US Army Materiel Command (USAMC) let a contract for the purchase of one U-8F Airplane with turbine engines from the Beech Aircraft Corporation. USAMC, in turn, requested that the US Army Transporation Research Command (USATRECOM) negotiate a contract for this program with Beech calling for delivery of the NU-8F (modified U-8F) by 31 December 1963.

1.6.2. After correcting minor problems in trim control, stall characteristics, and forward center-of-gravity location, the NU-8F was delivered on 13 March 1964 to the US Army Aviation Test Board at Fort Rucker, Alabama.

1.6.3. Prior plans and reports of tests were researched and pertinent information was considered in writing this report of test.

1.7. FINDINGS.

1.7.1. The overall configuration of the NU-8F is similar to the U-8F.

1.7.2. The NU-8F Airplane carried a 453-pound greater payload than the U-8F.

1.7.3. The center-of-gravity (c.g.) limits posed no problems to loading for safe operation, except in two specific loading configurations (two pilots, full fuel and oil or maximum gross weight at the maximum aft c.g.). In these cases it was possible to exceed the c.g. limits in flight as fuel was consumed. (Reference section 2, figure 9.)

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1.7.4. The heater system was not reliable above 20,000 feet.

1.7.5. The oxygen system was not acceptable because the oxygen supply did not permit prolonged operation at high altitudes. For example, at 15,000 feet, the duration of the oxygen supply is 2.3 hours when six individuals (all seats occupied) are using the system whereas the airplane's endurance at this altitude at normal cruise (220 knots TAS) is approximately 5.5 hours. Use of the oxygen masks created discomfort for the occupants and restricted their movements.

1.7.6. The overall internal noise level of the NU-8F was nine decibels lower than that of the U-8F Airplane.

1.7.7. The available cabin seating arrangement and configuration were adequate for command/staff transport missions and limited utility transport missions.

1.7.8. Ground operations, such as starts, run-ups, and shutdowns, were simpler than those of the U-8F.

1.7.9. Air starts, with and without the use of a starter, were successfully accomplished below 20,000 feet. Consistent air starts above 20,000 feet cannot be assured.

1.7.10. Acceleration time of the PT6A-6 engine from ground or flight idle to takeoff power was approximately five seconds.

1.7.11. Takeoff performance of the NU-8F was better than that of the U-8F. The landing ground roll of the NU-8F was comparable to that of the U-8F.

1.7.12. The NU-8F could climb faster and had a higher service ceiling with both engines or one engine than the U-8F with maximum continuous power settings and similar configurations.

1.7.13. The normal cruise speed of the NU-8F was 30 percent faster with a greater range than that of the U-8F Airplane. (See paragraph 11, figure 36.)

1.7.14. The location and operation of avionic equipment controls and displays were satisfactory except for the shortcomings listed in section 3, appendix III. The capacity of the generators was insufficient for minimum essential equipment operation under emergency single-engine conditions in night icing weather. The capacity of the inverters would not permit simultaneous installation of an integrated flight system, weather radar, and an autopilot.

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1.7.15. The NU-8F was considered safer in flight than the U-8F because of the fuel system that automatically transferred fuel from the auxiliary tanks to the main tanks which fed the engines, superior single-engine performance, and increased time available for performing a single-engine emergency shutdown.

1.7.16. The NU-8F was easier to maintain than the U-8F Airplane. Ground-support equipment for both airplanes was identical.

1.7.17. The deicing and anti-icing systems of the NU-8F operated satisfactorily with the exception of the engine alcohol anti-ice system (see section 3, appendix III). The electrically-heated windshield was an improvement over the alcohol spray system of the U-8F.

1.7.18. It was not possible to determine adequately the suitability of the PT6A-6 engine for Army use during the 100-hour military potential test.

1.8. CONCLUSIONS.

1.8.1. The lack of pressurization seriously restricts the practical utilization of the NU-8F Airplane.

1.8.2. When the deficiencies listed in section 3, appendix III, are corrected, a pressurized version of the NU-8F (the King Air Airplane) will be more suitable for Army use than the U-8F.

1.8.3. Correction of the shortcomings listed in section 3, appendix III, will enhance the suitability of the NU-8F.

1.8.4. Environmental testing and a 1000-hour logistical evaluation of the NU-8F with the PT6A-6 engines are required to determine the engine suitability for Army use.

1.9. RECOMMENDATIONS. It is recommended that:

a. The NU-8F Airplane be considered more suitable for Army use than the U-8F when the deficiencies listed in section 3, appendix III, are corrected and pressurization is incorporated.

b. The shortcomings listed in section 3, appendix III, be corrected as economically feasible.

c. The NU-8F Airplane with the PT6A-6 engines undergo environmental testing and a 1000-hour logistical evaluation after correction of the deficiencies listed in section 3, appendix III.

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SECTION 2

DETAILS AND RESULTS OF SUB-TESTS

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SECTION 2 - DETAILS AND RESULTS OF SUB-TESTS

2.0. INTRODUCTION.

2.0.1. During the period 16 March 1964 to 3 June 1964, the NU-8F Airplane (figures 1 and 2) underwent a 100-hour military potential flight test program by the US Army Aviation Test Board (USAAVNTBD). Pertinent comments were provided by the US Army Board for Aviation Accident Research (USABAAR), the US Army Aeromedical Research Unit (USAARU), and the US Army Aviation Human Research Unit (USAAHUMRU). Most of the testing was conducted at Fort Rucker, Alabama. The icing weather phase was conducted in the vicinity of Dallas, Texas and Minot, North Dakota. Flight demonstrations were given in the vicinity of Washington, D. C.

2.0.2. The general technical approach to the individual tests was qualitative. The professional judgement of individual pilots was solicited to correlate previous Army flying experience with the flying qualities of the NU-8F. All data were hand recorded.

2.1. PHYSICAL CHARACTERISTICS.

2.1.1. Objective.

To determine the mission support suitability of the NU-8F Airplane by investigating the following physical characteristics:

a. Empty weight.

b. Basic or military configuration weight.

c. Useful load for military use.

d. Center of gravity (c.g.) and weight of ballast and position required to obtain desired c.g.

e. Principal dimensions.

f. Fuel and oil capacity.

g. Compatibility with standard fueling and defueling equipment.

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Figure 1. Front view of NU-8F



Figure 2. Side view of NU-8F showing air-stair door open

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h. Adequacy of lighting.

i. Adequacy of cockpit arrangement, configuration, and instrumentation.

j. Adequacy of ventilation and heating system.

k. Ground-handling characteristics.

l. Noise level.

m. Suitability of oxygen system.

n. Adequacy of cabin seating arrangement for command/staff transport missions.

o. Limited suitability testing of cabin arrangement for utility transport missions.

2.1.2. Method.

2.1.2.1. Investigation of the physical characteristics listed in paragraphs 2.2.1., a. through e. was made by measuring the airplane and weighing it with trapped fuel and full oil. Weight and balance computations were made of those configurations required for the flight tests to determine whether the center of gravity remained within limits during each of the mission profiles; that is, as fuel burned off.

2.1.2.2. The fuel capacity listed in paragraph 2.1.1.f. was verified by measuring the quantity required to refill the empty fuel tanks. Manufacturer's data were accepted for the oil capacity.

2.1.2.3. Determination of the compatibility of the aircraft with standard fueling and defueling equipment was made during fueling and defueling operations at Fort Rucker, Alabama, using standard military equipment and at several non-military airports using vendor equipment.

2.1.2.4. The adequacy of internal and external lighting was evaluated during night flights. The convenience and ease of manipulating the light switches as well as the amount of light available to all gauges, instruments, map lights, and to passengers were observed from the pilot's, copilot's, and passenger's positions.

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2.1.2.5. The adequacy of the cockpit arrangement, configuration, and instrumentation was evaluated during actual missions. Factors considered were pilot comfort, ease of reaching and manipulating controls, conformance of the pilot's flight instruments with the Army standard "T" panel in accordance with USAAVNBD Report AVN 1557.5/58, dated 19 December 1958, ease of reading instruments, and safety features within the cockpit.

2.1.2.6. The adequacy of the ventilation and heating system was evaluated during taxiing and in flight where the outside air temperatures varied from minus 12° C. to plus 40° C. and from plus 40° C. to minus 39° C., respectively. Tests for carbon monoxide fumes were made to determine compliance with the criteria of paragraph 3.393, Civil Aeronautics Manual 3, dated May 1962, which states, "Ventilation. All passengers and crew compartments shall be suitably ventilated. Carbon monoxide concentration shall not exceed 1 part in 20,000 parts of air." Samples were collected while taxiing and at ground idle with propellers feathered, heater blower on, and the aircraft positioned cross wind. Samples were collected at the centerline cabin and at seat number three positions. The method employed was to force a 250 cc air sample through a vial of carbon monoxide sensitive crystals using a manually operated piston type pump. In the presence of carbon monoxide, the pale yellow indicating crystals turn green. The concentration of carbon monoxide was determined by comparing the color of the exposed vial to a standard color chart.

2.1.2.7. Ground-handling characteristics were evaluated by moving the NU-8F on a hardtop pavement with the standard Army vehicular tugs and with manpower.

2.1.2.8. The noise levels were measured with a noise analyzer. The analyzer indicated directly the sound pressure level in any of its 12 bands, for levels between 44 and 150 decibels (db.) (RE 0.0002 dyne/cm^2). Prior to utilization, the analyzer was calibrated electrically and acoustically. External sound level measurements were completed with the microphone placed approximately 50 inches above the ground during a power check and a propeller check; since both sides of the airplane were basically the same, measurements were recorded around the left side at a 50-foot distance from the airplane parked on a hardtop surface. Internal measurements were made at normal head level positions, centerline cockpit, and each of the four passenger seats. Cockpit measurements were made during takeoff and at normal cruise. The seat position readings were taken during normal cruise.

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2.1.2.9. The suitability of the oxygen system was evaluated by flying at altitude and by consumption charts shown in TM 55-1510-201-10.

2.1.2.10. Adequacy of cabin seating arrangement for command/staff transport missions was evaluated during actual missions. The cabin was examined for passenger comfort, access to oxygen equipment, safety features, adequacy of the baggage compartment, and ease of entrance and exit from the airplane on the ground.

2.1.2.11. Limited suitability testing of the cabin arrangement for utility transport was made by examining the space within the cabin for cargo limitations. In one case, the cabin seating was rearranged by placing three seats on the right side of the cabin instead of the normal two and modifying a standard medical litter by removing its handles and affixing it with bolts to the left seat rails of the cabin (figure 3).

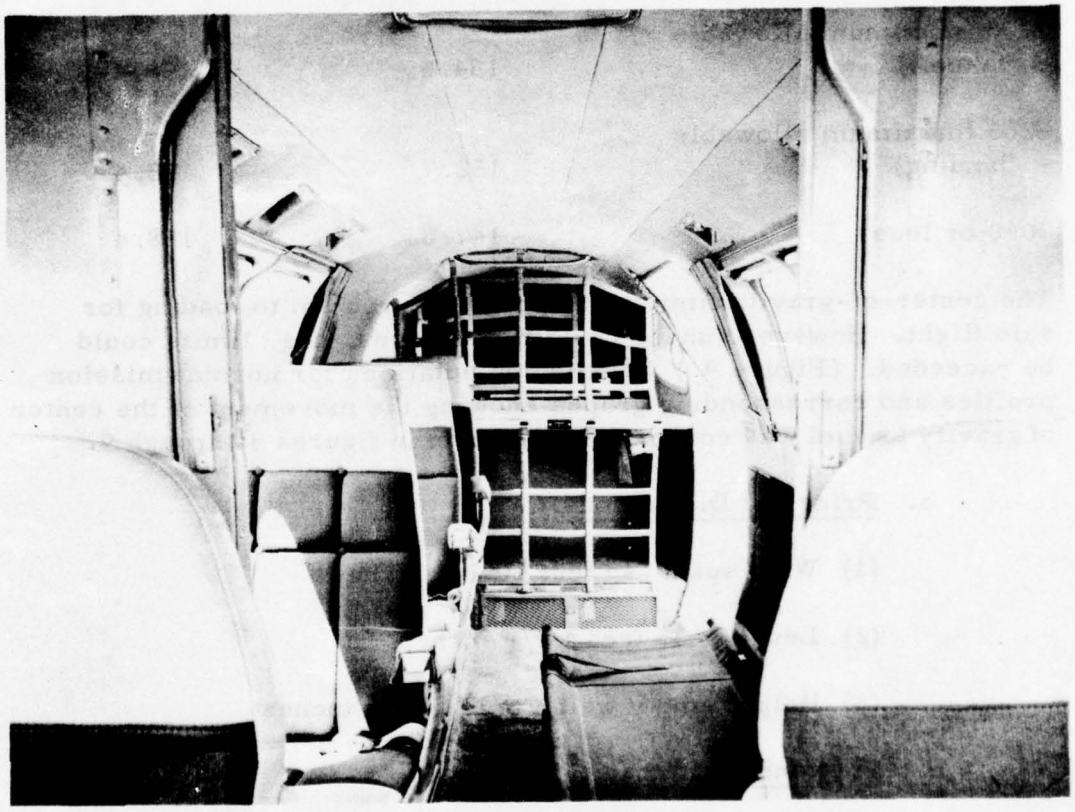


Figure 3. NU-8F cabin with litter installed

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2.1.3. Results.

a. Empty weight: 5066 pounds.

b. Basic weight (military configuration): 5081 pounds.

c. Useful load: 3619 pounds.

d. Center-of-gravity limits (extracted from manufacturer's handbook):

Weight (pounds)	Forward C.G. Limit (inches)	Aft C.G. Limit (inches)
8700 (maximum allowable *takeoff*)	154.6	158.4
8265 (maximum allowable landing)	152.7	158.4
7060 or less	147.6	158.4

The center-of-gravity limitations posed no problem to loading for safe flight. However, under certain conditions, c.g. limits could be exceeded. (Figure 9.) Sample computations for normal mission profiles and corresponding graphs showing the movement of the center of gravity as fuel was consumed are shown in figures 4 through 9.

e. Principal Dimensions.

(1) Wing span: 45 feet 10 1/2 inches

(2) Length: 35 feet 4 1/4 inches

(3) Height empty weight: 14 feet 8 inches

f. Fuel and Oil Capacity.

Fuel capacity: 368 US gallons

Oil capacity: 9 US quarts per engine

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WEIGHT AND BALANCE DATA

MAXIMUM FORWARD C.G. - MAXIMUM ALLOWABLE GROSS WEIGHT

	Weight	Arm	Moment
Basic Airplane Weight	5081	150.7	765,829
Add: Pilot	200	129.0	25,800
Copilot	200	129.0	25,800
Oil - Engine	34	100.0	3,400
Fuel - (360 gallons)	2340		363,100
Ballast - Fwd Passenger Location	397	168.0	66,696
Aft Passenger Location	448	210.0	94,080
Maximum Allowable Gross Weight	8700	154.6	1,344,705
Remove:			
Fuel - (60 gallons)	390		63,200
	8310	154.2	1,281,505
(100 gallons)	650		106,700
	7660	153.4	1,174,805
(100 gallons)	650		108,200
	7010	152.2	1,066,605
(100 gallons)	650		85,000
Weight - Zero Fuel	6360	154.3	981,605

Figure 4

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WEIGHT AND BALANCE DATA

MAXIMUM REAR C.G. - MAXIMUM ALLOWABLE GROSS WEIGHT

	Weight	Arm	Moment
Basic Airplane Weight	5081	150.7	765,829
Add: Pilot	200	129.0	25,800
Copilot	200	129.0	25,800
Oil - Engine	34	100.0	3,400
Fuel - (360 gallons)	2340		363,100
Ballast - Aft Passenger Location	545	210.0	114,450
Baggage Compartment	300	267.0	80,100
Maximum Allowable Gross Weight	8700	158.4	1,378,479
Remove:			
Fuel - (60 gallons)	390		63,200
	8310	158.3	1,315,279
(100 gallons)	650		106,700
	7660	157.8	1,208,579
(100 gallons)	650		108,200
	7010	157.0	1,100,379
(100 gallons)	650		85,000
Weight - Zero Fuel	6360	159.7	1,015,413

Figure 5

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WEIGHT AND BALANCE DATA

TWO PILOTS - NO PASSENGERS

	Weight	Arm	Moment
Basic Airplane Weight	5081	150.7	765,829
Add: Pilot	200	129.0	25,800
Copilot	200	129.0	25,800
Oil - Engine	34	100.0	3,400
Fuel - (360 gallons)	2340		363,100
Gross Weight	7855	150.7	1,183,929
Remove:			
Fuel - (60 gallons)	390		63,200
	7465	150.1	1,120,729
(100 gallons)	650		106,700
	6815	148.8	1,014,029
(100 gallons)	650		108,200
	6165	146.9	905,829
(100 gallons)	650		85,000
Weight - Zero Fuel	5515	148.8	820,829

Figure 6

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WEIGHT AND BALANCE DATA

MAXIMUM REAR C.G. - MAXIMUM ALLOWABLE GROSS WEIGHT

RECTIFIED

	Weight	Arm	Moment
Basic Airplane Weight	5081	150.7	765,829
Add: Pilot	200	129.0	25,800
Copilot	200	129.0	25,800
Oil - Engine	34	100.0	3,400
Fuel - (360 gallons)	2340		363,100
Ballast - Fwd Passenger Location	195	168.0	32,760
Aft Passenger Location	350	210.0	74,500
Baggage Compartment	300	267.0	80,100
Maximum Allowable Gross Weight	8700	157.5	1,370,289
Remove:			
Fuel - (60 gallons)	390		63,200
	8310	157.3	1,307,089
(100 gallons)	650		106,700
	7660	156.7	1,200,389
(100 gallons)	650		108,200
	7010	155.8	1,092,189
(100 gallons)	650		85,000
Weight - Zero Fuel	6360	158.4	1,007,189

Figure 7

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WEIGHT AND BALANCE DATA

TWO PILOTS - NO PASSENGERS

RECTIFIED

	Weight	Arm	Moment
Basic Airplane Weight	5081	150.7	765,829
Add: Pilot	200	129.0	25,800
Copilot	200	129.0	25,800
Oil - Engine	34	100.0	3,400
Fuel - (360 gallons)	2340		363,100
Ballast - Baggage Compartment	32	267.0	8,544
Gross Weight	7887	151.2	1,192,473
Remove:			
Fuel - (60 gallons)	390		63,200
	7497	150.6	1,129,273
(100 gallons)	650		106,700
	6847	149.3	1,022,573
(100 gallons)	650		108,200
	6197	147.6	914,373
(100 gallons)	650		85,000
Weight - Zero Fuel	5547	149.5	829,373

Figure 8

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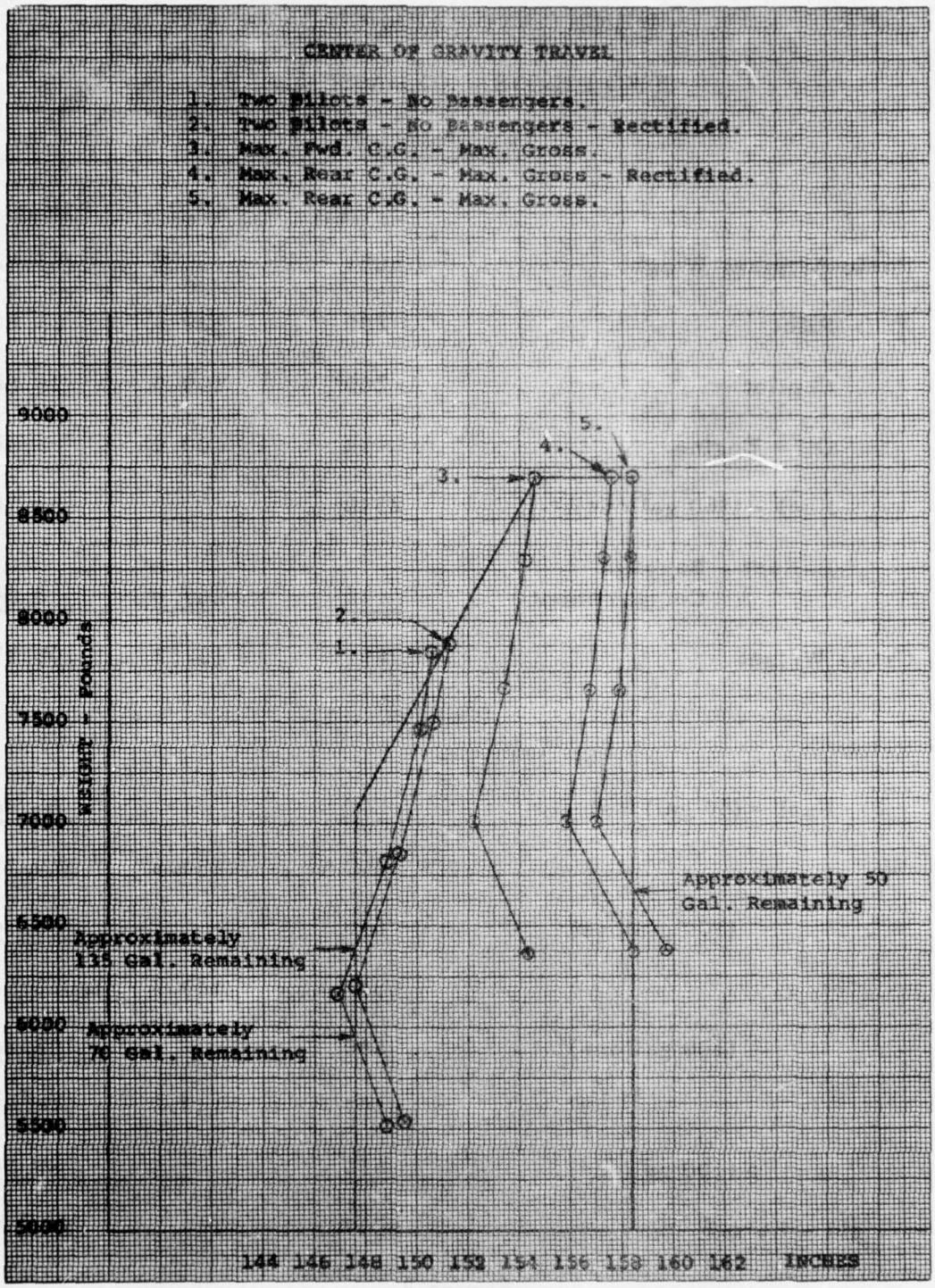


Figure 9

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2.1.3.1. Compatibility with Standard Fueling and Defueling Equipment. No difficulties were encountered during fueling and defueling operations providing a ladder was used to gain access to the fuel caps and oil filler caps. These caps were too high above the ground for the average man to service. The refueling procedure required filling the main tanks first and then the auxiliary tanks.

2.1.3.2. Adequacy of Lighting.

2.1.3.2.1. All light switches were conveniently located and easy to manipulate.

2.1.3.2.2. All exterior and interior lights were adequate except those interior lights illuminating the pilot's and copilot's flight instruments. All flight instrument lights except those for the pilot's RMI and artifical horizon instruments, which have their own integral lighting system, were too dim even at maximum intensity. With the exception of the pilot's RMI, the flight instruments could not be illuminated unless the inverter was operating. The flight instrument lights were of the 6-volt type. The pilot's RMI and all other gauge and instrument lights were of the 28-volt type.

2.1.3.3. Adequacy of Cockpit Arrangement, Configuration, and Instrumentation.

2.1.3.3.1. The cockpit arrangement provided excellent accessiblity to controls and switches. Pilot and copilot seats incorporated up-and-down and fore-and-aft adjustments which facilitated access to controls and enhanced crew comfort and safety.

2.1.3.3.2. The fuel was contained in two independent fuel systems. A common cross-feed valve mounted on a fuel control panel on the left side of the cockpit permitted cross-feeding from the left or right fuel system. When the cross-feed switch was used, a green warning light came on indicating the ON position of this switch. Operation of both engines was satisfactorily maintained when cross-feeding.

2.1.3.3.3. The fuel control panel and the fuel system simplified cockpit procedures by eliminating some of the manual functions previously required of the pilot for fuel management on the U-8( ) airplanes. The manual fuel-selector valve found on the U-8( ) airplanes

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has been eliminated in favor of a fuel system that automatically transfers fuel from the auxiliary tanks to the main tanks keeping them near full capacity. The necessity of turning the fuel boost pump on manually before each takeoff and landing has been eliminated by the design of a boost pump that remains on during operation.

2.1.3.3.4. The fire-wall fuel-valve switch and the fuel-boost pump switch were identical and adjacent to each other on the fuel panel (figure 10). On three different occasions, three different pilots inadvertently turned off the fire-wall switch instead of the boost pump switch during cross-feed operation.

2.1.3.3.5. The fuel flow meter was found to be calibrated in pounds per hour while the fuel tank gauges were calibrated in gallons. This made rapid in-flight fuel endurance computations difficult.

2.1.3.3.6. The pilot's flight instruments were not arranged in accordance with the Army standard "T" panel (figure 33).

2.1.3.3.7. The pilot's vent air handle and parking brake were identical in appearance and feel and were positioned one above the other approximately six inches apart. This increased the probability of inadvertently landing with the brakes locked.

2.1.3.3.8. Two outside air temperature (OAT) gauges were installed in the airplane, one on the cockpit ceiling in front of the pilot, and the other on the lower left of the flight instrument panel. The readings of these gauges always differed from 2°C. to 5°C.

2.1.3.3.9. Operation of the electric windshield heater caused approximately 5 degree heading errors in the standby magnetic compass.

2.1.3.3.10. The standby magnetic compass has no provisions for a disposable compass correction card.

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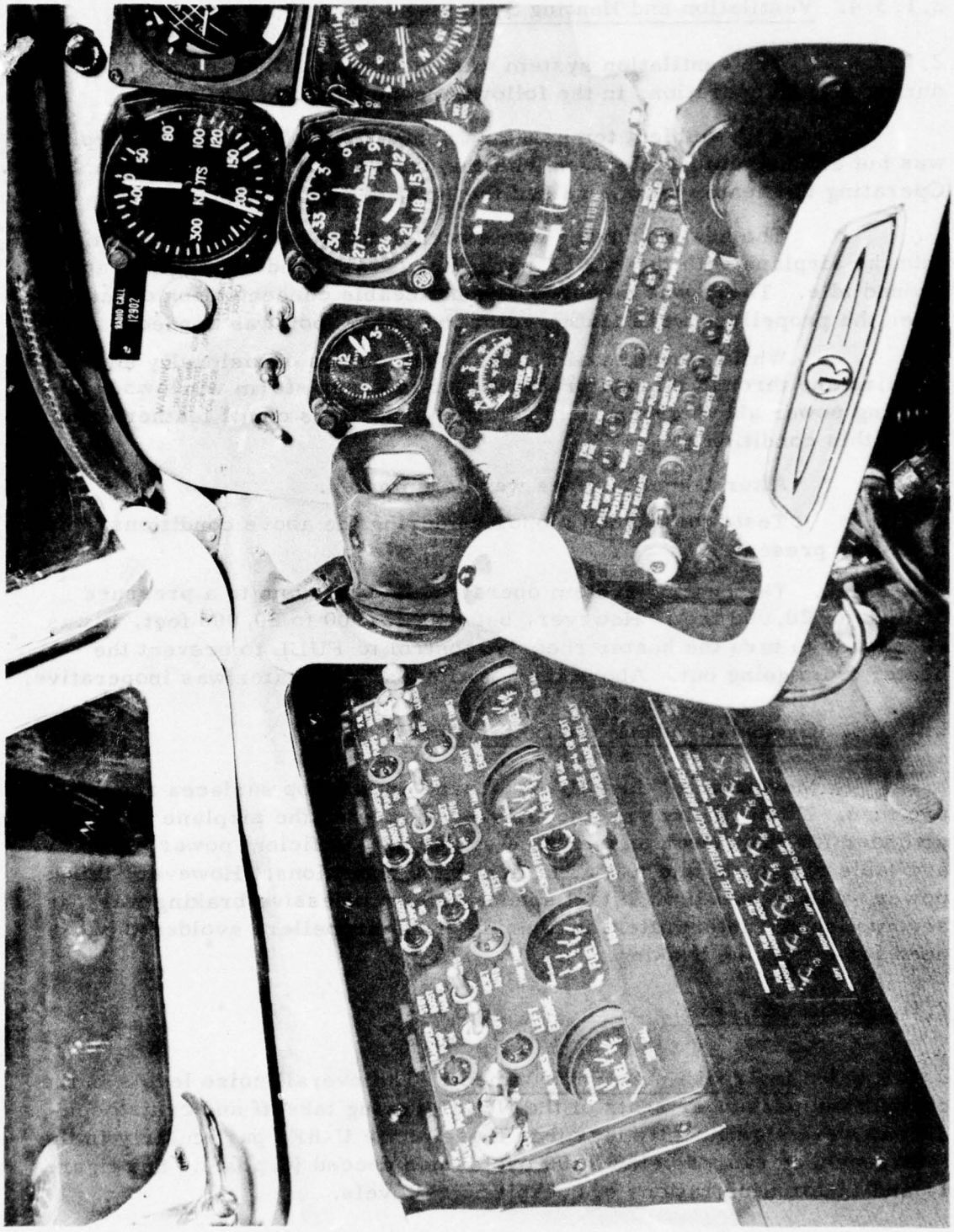


Figure 10. NU-8F Fuel panel.

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2.1.3.4. Ventilation and Heating Systems.

2.1.3.4.1. The ventilation system was adequate in flight but inadequate during ground operations in the following conditions:

With ambient temperature above 25°C. (77°F.), the airplane was hot and uncomfortable even with the crew's storm windows open. Operating the heater blower raised the level of comfort.

The heater-blower would occasionally pump exhaust fumes into the airplane with the NU-8F parked crosswind and the engines at ground idle. There was an especially noticeable concentration of fumes when the propellers were feathered or the cabin door was opened.

While slowly taxiing crosswind, fumes occasionally entered the airplane through the heater-blower or the open storm windows. Advancing power above ground idle with the propellers out of feather eliminated this condition.

After takeoff, fumes were eliminated.

Tests for carbon monoxide during the above conditions showed none was present.

2.1.3.4.2. The heating system operated adequately up to a pressure altitude of 20,000 feet. However, between 15,000 to 20,000 feet, it was necessary to turn the heater rheostat control to FULL to prevent the heater from going out. Above these altitudes, the heater was inoperative.

2.1.3.5. Ground-Handling Characteristics.

Movement of the NU-8F by hand on hardtop surfaces required two men. No difficulty was encountered in moving the airplane by tug or under its own power on the same surfaces. Sufficient power was available at ground idle to taxi in light wind conditions. However, this power would result in high taxi speeds unless excessive braking was accomplished. Intermittent feathering of the propellers avoided the need for excessive braking.

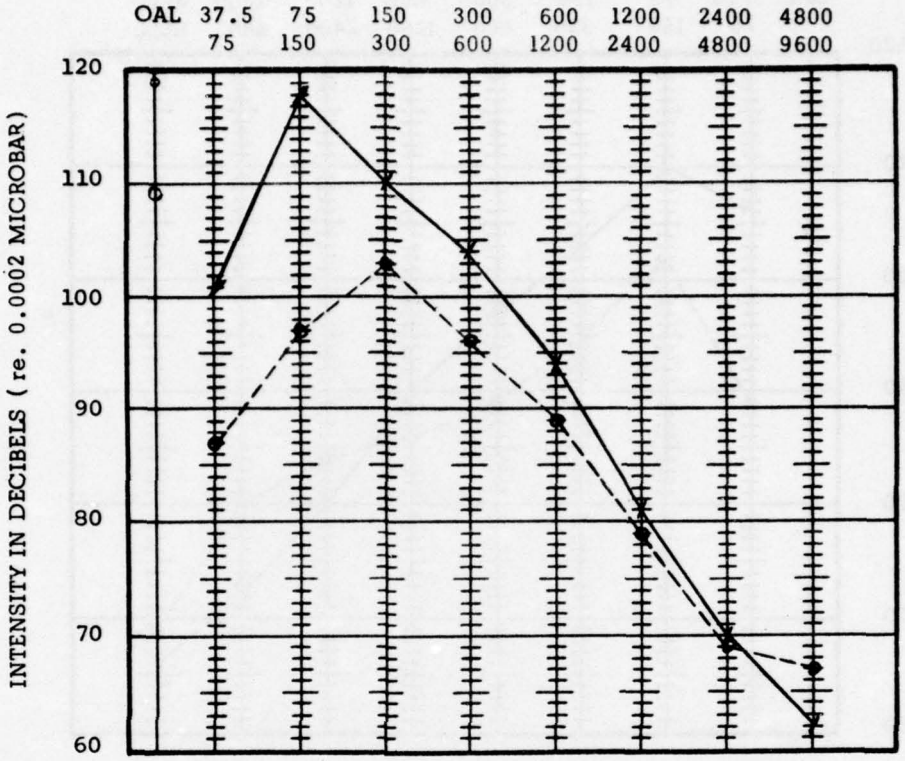
2.1.3.6. Noise Level.

2.1.3.6.1. Internal Noise Environment. The overall noise levels in the cockpit and passenger seats of the NU-8F during takeoff and cruise conditions were significantly less than those of the U-8F, particularly in the low frequency ranges below 1200 cycles per second (c.p.s.). See figures 11 and 12 for illustrations of cockpit noise levels.

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CENTERLINE COCKPIT DURING TAKE-OFF

FREQUENCY BY OCTAVE-BANDS



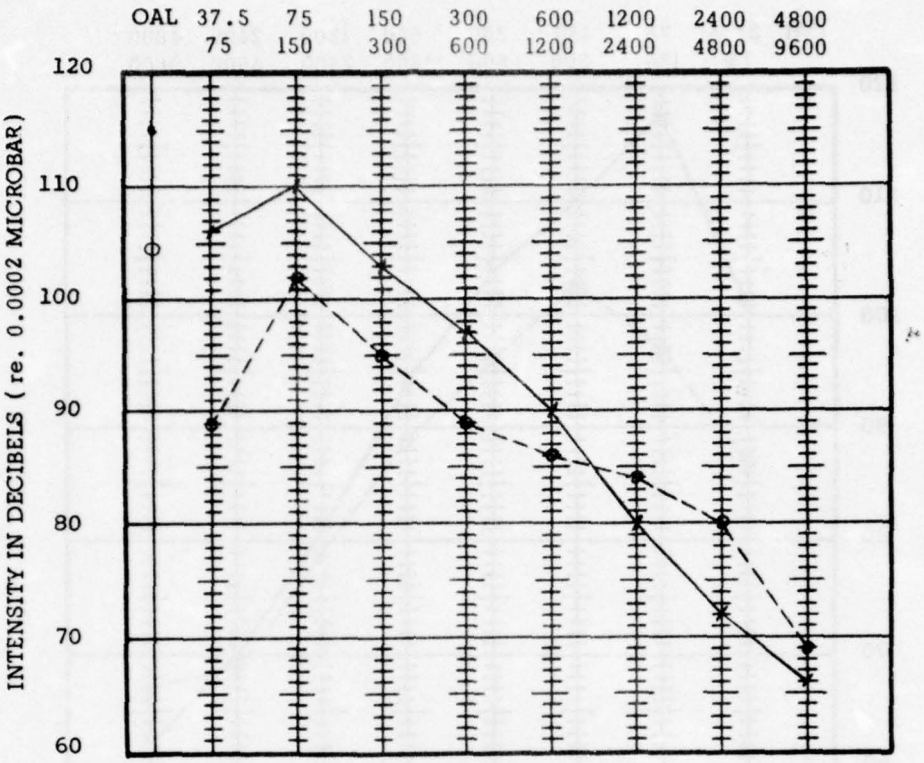
Legend:
• U-8F
○ NU-8F
OAL - Overall noise level

Figure 11

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CENTERLINE COCKPIT DURING NORMAL CRUISE

FREQUENCY BY OCTAVE-BANDS



Legend:
- • U-8F
- o NU-8F

OAL - Overall noise level

Figure 12

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2.1.3.6.2. External Noise Environment. The NU-8F had a substantial reduction in sound pressure levels over the U-8F at a 50-foot distance during ground power check conditions. Elaboration is provided in Analysis, paragraph 2.1.4.7.

2.1.3.7. Suitability of Oxygen System.

2.1.3.7.1. The NU-8F oxygen system, which is identical to that installed in the U-8F, operated satisfactorily up to 28,000 feet pressure altitude.

2.1.3.7.2. The oxygen supply of this system was insufficient to permit extended range operation at high altitudes where the NU-8F was most efficient.

2.1.3.7.3. The location and configuration of the installed oxygen bottle did not permit air crew access to the "on-off" valve during flight.

2.1.3.7.4. The oxygen pressure gauge in the baggage compartment could not be read from the cockpit.

2.1.3.7.5. The access cover to the oxygen on-off valve at the rear of the baggage compartment could not be readily opened and closed without the use of a screwdriver.

2.1.3.8. Adequacy of Cabin Seating Arrangement for Command/Staff Transport.

The cabin configuration and seating arrangement (figure 13) were excellent based on the following:

a. Location, simplicity, and ease of operation of the "air-stair" door.

b. In-flight accessibility to the baggage compartment.

c. Recessed center aisle permitting freedom of movement within the aircraft.

d. Comfort of passengers by use of individually adjustable seats that could be faced fore or aft.

e. Individual reading lights, ventilators, and oxygen outlets.

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f. Cabin temperature controllable by the passengers. (A master temperature control switch is located in the cockpit allowing the pilot to switch temperature control from the cockpit to the cabin.)

g. Three panoramic windows on each side of the cabin equipped with sunshades and curtains providing excellent visibility and ample control of natural lighting to passengers.

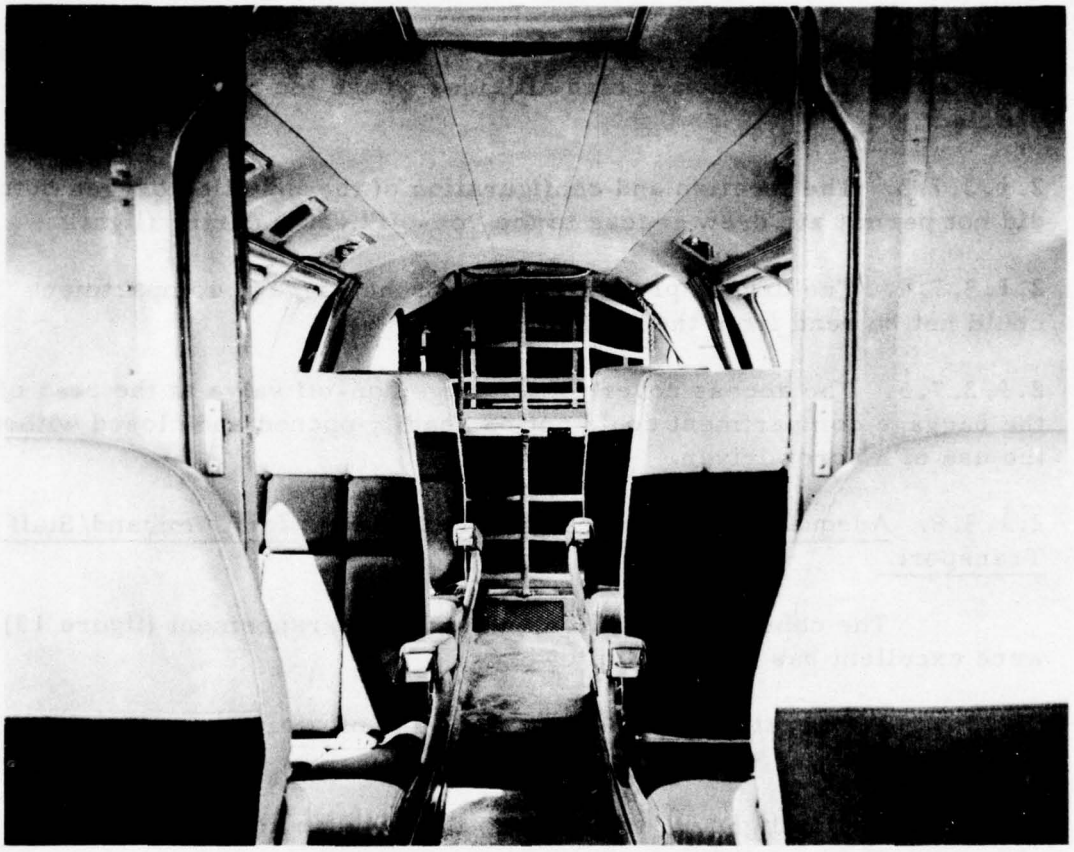


Figure 13. Cabin configuration and seating arrangement looking aft to baggage compartment.

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2.1.3.9. Limited Suitability Testing of Cabin Arrangement for Utility Transport Missions.

2.1.3.9.1. The seats were removable to permit cargo loading. Cargo tie-down rings were not standard equipment and had to be fabricated locally and were easily installed.

2.1.3.9.2. A standard medical litter was easily secured to the left side of the cabin floor after making minor modifications of the litter.

2.1.3.9.3. The size of the cabin door and the interior cabin width did not permit carrying a litter into the airplane unless the litter was rotated longitudinally at least 45 degrees.

2.1.4. Analysis.

2.1.4.1. Center of Gravity.

Although loading within the center-of-gravity (c.g.) limitations of the NU-8F posed no problem to safe flight, cognizance must be taken of the movement of c.g. as fuel is consumed to preclude exceeding c.g. limits. This is especially true with a rear c.g. at maximum gross weight loading, two pilots, no passengers and fuel fuel. Figure 9 shows that as fuel is expended, the c.g. moves forward at a rate less than the forward limit line until a point where the c.g. then moves rearward. The fuel system pumps fuel from the wing tanks (auxiliary) into the nacelle tanks (main tanks) and causes a forward c.g. movement. When the wing tanks are empty and fuel is consumed from the nacelle tanks, the c.g. then moves rearward.

2.1.4.2. Fuel and Oil Capacity.

The extra measured 8-gallon fuel capacity above the manufacturer's data of 360 gallons is attributed to in-use stretching of the neoprene fuel tanks. Three hundred sixty gallons should remain the official capacity.

2.1.4.3. Compatibility with Standard Fueling and Defueling Equipment.

Because fuel gravity feeds from the auxiliary tanks to the main tanks, the caution note "Refill Main Tank First" should be stenciled next to the auxiliary fuel filler cap. Filling the auxiliary tanks first would result in a less than full fuel supply.

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2.1.4.4. Adequacy of Lighting.

2.1.4.4.1. The intensity of the flight instrument lights should be increased to the same intensity as the engine instrument lights.

2.1.4.4.2. All instrument light bulbs should be of the same 28-volt type to reduce logistical and maintenance complexity.

2.1.4.5. Adequacy of Cockpit Arrangement, Configuration, and Instrumentation.

2.1.4.5.1. The fire-wall fuel valve switch and the fuel boost switch are identical and adjacent to each other on the fuel control panel. A guard cover should be placed over the fire-wall fuel valve switch to avoid inadvertently shutting off this switch in flight.

2.1.4.5.2. The two OAT gauges should be replaced by a more legible gauge located on the instrument panel in front of the pilot.

2.1.4.6. Ventilation and Heating Systems.

The heater system was unreliable between 15,000 to 20,000 feet unless the rheostat was in the full position. The heater system was inoperative above 20,000 feet. In its present state, the airplane should be placarded showing these limitations. However, the system should be corrected to operate up to the service ceiling of the airplane.

2.1.4.7. Noise Levels.

2.1.4.7.1. Internal Noise Environment. The overall internal noise levels of the NU-8F during takeoff and cruise conditions were significantly lower than those of the U-8F, particularly in the low-frequency ranges below 1200 c.p.s. This is especially important because Army standard headsets and APH-5 ear muffs offer greater protection against high frequency noise components. The overall levels still exceed the 90 decibels (db) criteria established by the Surgeon General, US Army, to facilitate speech communication and prevent temporary hearing loss for non-protected ears.

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2.1.4.7.2. External Noise Environment. There was a substantial reduction in sound pressure levels between the NU-8F and U-8F at a 50-foot distance during ground power checks since low-frequency noise components are propagated through any medium more easily and with less loss of intensity. (A thorough explanation of reciprocating and gas turbine noise characteristics can be found in US Army Aeromedical Research Unit Report 63-1.) There is no clear advantage for the NU-8F during propeller check conditions because the propeller is the dominating noise generator during this condition. (The turbine engine has more intense noise in front quadrants while the reciprocating engine has more intense noise in the rear quadrants.) Unfortunately, there are no published damage-risk criteria for near-field external noise environments. The primary consideration is a reduction of external noise to decrease the vulnerability of the airplane in a combat environment. This can only be achieved by reducing the noise generated by the propeller during operation.

2.1.4.8. Suitability of Oxygen System.

The oxygen system was not acceptable in the turboprop NU-8F Airplane. At altitudes of 15,000 feet, or above, where the PT6A-6 engines were most efficient and where flight over most weather phenomenon was possible, the duration of the oxygen supply was too short for long range flights for this airplane. For example, at 15,000 feet, the duration of the oxygen supply is 2.3 hours when six persons (all seats occupied) are using the system whereas the airplane's endurance at this altitude at normal cruise (220 knots TAS) is approximately 5.5 hours. The present oxygen system, which requires that a mask be worn, greatly reduced passenger comfort by restricting movement and conversation. A pressurized system would rectify this deficiency (reference paragraph 1d, section 3, appendix III.)

2.2. GROUND OPERATION OF THE PT6A-6 ENGINE

2.2.1. Objective.

To determine the operational suitability of the PT6A-6 engine in the NU-8F Airplane during ambient conditions by investigating the following ground operations:

a. Ground-starting procedures.

b. Ground-idle characteristics.

c. Power transients.

d. Acceleration characteristics.

e. Ground shutdown procedures.

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2.2.2. Method.

2.2.2.1. Ground-Starting Procedure.

The manufacturer's recommended starting procedure was observed to determine any complexities or difficulties in starting with a battery or an auxiliary power unit (APU).

2.2.2.2. Ground-Idle Characteristics.

The engines were observed during ground-idle operation for any unusual manifestations.

2.2.2.3. Power Transients.

Run-up checks of the engines were observed for ease of checking and determining proper functioning of the engines.

2.2.2.4. Acceleration Characteristics.

See paragraph 2.4.

2.2.2.5. Ground Shutdown Procedure.

The shutdown procedure was observed to determine any complexities or difficulties.

2.2.3. Results.

2.2.3.1. Ground-Starting Procedure.

2.2.3.1.1. The ground-starting procedure was simpler than that of the U-8F Airplane.

2.2.3.1.2. Engine starts with an APU produced cooler starts than battery starts.

2.2.3.1.3. Ground crew personnel were exposed to engine hot exhaust gases while securing the APU receptacle cover with a screwdriver. This cover was located inboard and underneath the right wing. The ground crew could withstand exposure to these gases for only a short time. Feathering the propellers increased this exposure time because the propeller blast no longer blew these gases rearward.

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2.2.3.1.4. Battery starts for the first 85 hours of test time resulted in turbine-inlet temperatures (TIT) averaging 880°C. Most of the subsequent starts resulted in higher turbine-inlet temperatures, 90°C. to 40°C below the starting temperature limit of 1038°C.

2.2.3.1.5. Starts of the second engine, after recharging the battery with the generator, resulted in lower turbine-inlet temperatures similar to those obtained with an APU.

2.2.3.1.6. The battery open circuit voltage was 24 volts. The airplane's voltmeter reading of the battery under starting load was 17 volts.

2.2.3.1.7. The generator power terminal voltage is 28.75 volts. The airplane's voltmeter reading of the generator system under starting load was 22 volts.

2.2.3.2. Ground-Idle Characteristics.

No unusual manifestations of the engines were noted during ground operation at idle power. Ground-idle operation was satisfactory.

2.2.3.3. Power Transients.

2.2.3.3.1. Run-up checks of the engines were simpler than those of the U-8F.

2.2.3.3.2. It was not always possible to make a check of the overspeed governor on the ground without going over the red line of the turbine-inlet temperature gauge. The limiting atmospheric condition could not be determined during the period of this test.

2.2.3.4. Acceleration Characteristics.

See paragraph 2.4.

2.2.3.5. Ground Shutdown Procedure.

The shutdown procedure was simple and easy to perform.

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2.2.4. Analysis.

2.2.4.1. Ground Starting Procedure.

2.2.4.1.1. The higher starting turbine-inlet temperatures, after the first 85 hours of testing, were first observed subsequent to the installation of modified combustion chambers in the PT6A-6 engines. Battery starts were considered satisfactory.

2.2.4.1.2. The burn hazard to ground personnel from the engine exhaust gases at the APU receptacle could be alleviated by relocating the receptacle or reduced by installing a spring-loaded receptacle cover. (The cover should be of a spring-loaded hinged type so that it will not open against the slipstream and will close unaided after withdrawal of the APU cable.)

2.2.4.2. The inability to make an overspeed governor check in hot weather was a restriction to ground operation and should be appropriately noted in any future operator's manual. This restriction does not preclude an in-flight check.

2.3. FLIGHT OPERATION.

2.3.1. Objective.

To determine the operational suitability of the PT6A-6 engine in the NU-8F Airplane during ambient conditions by investigating the following flight operations:

a. Air-starting procedure.

b. Flight-idle characteristics.

c. Effect of maneuvering.

d. Engine controls and instrument operation.

2.3.2. Method.

2.3.2.1. Air-Starting Procedure.

The ability to start the engines in the air with and without a starter was investigated at various altitudes from 4,000 feet to 28,000 feet.

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2.3.2.1.1. Air starts with starter were attempted using manufacturer's recommended techniques. (This will be subsequently referred to as a normal air start.)

2.3.2.1.2. Air starts without starter were attempted after diving the airplane to cause the ram air to bring the N_1 speed to at least 8 to 10 percent. The ignition switch was then activated. Fuel was then added by bringing the throttles to the idle position. Ram-air starts were attempted with and without the propellers windmilling with the propeller lever out of the feathered position just forward of the detent.

2.3.2.2. Flight-Idle Characteristics.

The engine instruments were observed for any unusual operation after placing the throttles at the flight-idle position.

2.3.2.3. Effect of Maneuvering.

The effects of different attitudes of the NU-8F Airplane on engine operation were observed during changes of airpseed in level flight, banks, and stalls.

2.3.2.4. Engine Controls and Instrument Operation.

The ease of manipulating and convenience of the engine controls were evaluated during ground and flight operations. The engine instruments were evaluated for convenience and readability.

2.3.3. Results.

2.3.3.1. Air Starting Procedure.

2.3.3.1.1. Air starts were simple and easy when using manufacturer's recommended techniques provided the airplane was trimmed. When the controls were released, an untrimmed airplane produced a change in attitude during air starts which disconcerted some pilots and caused them to abort the start.

2.3.3.1.2. Approximately 90 percent of the air starts with starter were significantly cooler than the average ground start with battery power. Although the remaining 10 percent of the starts were hotter, they were still well below the TIT red line except for two starts at 28,000 feet and 23,500 feet, which are discussed below.

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2.3.3.1.3. Numerous normal air starts were successfully accomplished below 20,000 feet. One normal air start was accomplished at 23,500 feet and one at 28,000 feet. The TIT's on these two air starts were approximately 30°C. and 20°C. below the starting TIT limit, respectively. (The maximum starting TIT of 1038°C. is limited to two seconds.) One normal air start attempt at 22,000 feet and at 20,000 feet was unsuccessful.

2.3.3.1.4. Ram-air starts (without the use of a starter) were successfully completed in eight out of eight attempts as follows: One at 15,000 feet, one at 13,000 feet, four at 7,000 feet and two at 4,000 feet. In each attempt, the propeller was windmilling before actuating the igniter and placing the power lever from the fuel-off to flight-idle position. Four ram-air starts at 7,000 feet with a fully-feathered propeller and not windmilling were aborted to prevent excessive turbine-inlet temperatures.

2.3.3.1.5. The in-flight single engine emergency shutdown procedure was found to be less critical on the NU-8F than on the U-8F because more time was available to determine the inoperative engine and feather its propeller.

2.3.3.2. Flight-Idle Characteristics.

2.3.3.2.1. No unusual engine characteristics were observed during flight-idle operation.

2.3.3.2.2. It takes several minutes for the engine compressor to decelerate to approximately 51-percent compressor speed with the throttle levers at the flight-idle position. (Flight-idle throttle setting was the same as ground idle.)

2.3.3.3. Effect of Maneuvering.

2.3.3.3.1. A large increase in airspeed at a given throttle setting produced a small increase of engine torque. Conversely, a large decrease in airspeed at a given throttle setting produced a small decrease of torque.

2.3.3.3.2. The effect of accelerating to takeoff will be discussed in paragraph 2.4. below.

2.3.3.3.3. With the exception of the above, normal maneuvering had no effect on engine performance.

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2.3.3.4. Engine Controls and Instrument Operation.

2.3.3.4.1. Engine controls were easy to operate and conveniently located.

2.3.3.4.2. Engine instruments were legible and conveniently located for cross checking.

2.3.4. Analysis.

2.3.4.1. Air Starting Procedure.

2.3.4.1.1. Test results revealed that of the three methods of air starts investigated, normal starts and ram-air starts with a windmilling propeller could be accomplished below 20,000 feet. Ram-air starts without a windmilling propeller caused hot starts.

2.3.4.1.2. The success of ram-air starts with a windmilling propeller is attributed to unloading of the power turbine and the improvement of pre-start air flow through the engine in this configuration.

2.3.4.1.3. Additional air starts above 20,000 feet must be accomplished before any reliability can be ascertained.

2.3.4.1.4. The increased time available to determine which engine was inoperative in order to feather its propeller was due to the reduced drag of the free-turbine propeller on the NU-8F as compared to the propeller of the reciprocating engine on the U-8F. The relative wind must act against greater engine frictional forces transmitted to the U-8F propeller than that of the NU-8F. The resultant is an increase in drag and a faster decrease in airspeed for the U-8F.

2.3.4.1.5. Future operator's manual should alert the pilot to the sudden yaw of the airplane that is experienced when the propeller of an inoperative engine is unfeathered.

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2.4. ACCELERATION CHARACTERISTICS

2.4.1. Objective.

To determine the operational suitability of the PT6A-6 engine in the NU-8F Airplane during ambient conditions by evaluating the following acceleration characteristics:

a. Acceleration to takeoff power.

b. Acceleration to normal power.

2.4.2. Method.

The engines were observed during acceleration from ground-idle and flight-idle to takeoff and normal rated power for limitations and speed of acceleration. (Takeoff power and normal rated power were the same on the PT6A-6 engine; 500 shaft horsepower (s.hp.).)

2.4.3. Results.

2.4.3.1. The average acceleration time from ground idle or flight idle to takeoff or normal rated power was approximately five seconds.

2.4.3.2. Engine limitations are shown in figure 14 (manufacturer's data).

2.4.3.3. In more than ten attempts in flight, high ambient temperatures precluded the ability to develop normal rated power as stated by the manufacturer. The limiting factor was the maximum allowable turbine inlet temperature.

2.4.3.4. The acceleration to takeoff power was adequate to accomplish balked landings (go-arounds) with landing gear and full flaps extended.

2.4.4. Analysis.

The acceleration characteristics of the PT6A-6 engine are suitable in the NU-8F airplane.

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ENGINE OPERATING LIMITS

Operating Condition	Operating Limits		
Power Setting	Torque ft/lb	Maximum Allowable TIT °C.	Propeller R.P.M.
Takeoff	1192	994 (5)	2200
Normal (1)	1192	935	2200
Maximum cruise	1122	905	2200
Flight idle (2)			
Ground idle (3)			
Starting		1038 (6)	
Acceleration	1500 (4)	965	2420 (7)

(1) Same as maximum continuous.

(2) Minimum of 51 percent N_1.

(3) Approximately 51 percent N_1.

(4) Limited to momentary operation.

(5) Limited to 5 minutes.

(6) Limited to 2 seconds.

(7) Limited to momentary operation.

FIGURE 14

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2.5. GROUND TESTS.

2.5.1. Objective.

To investigate the ground cooling characteristics of the PT6A-6 engine as installed on the NU-8F Airplane by observing the engine during the following power settings in the sequence shown:

a. Idle power.

b. Eighty-percent normal rated power.

c. Normal rated power.

d. Takeoff power.

e. Idle power.

2.5.2. Method.

Ground cooling tests were attempted with the airplane positioned crosswind with a velocity of less than ten knots. The test engine was downwind of the fuselage. The test engine was run consecutively for five minutes at power settings shown above and observed for any engine or propeller limitations.

2.5.3. Results.

2.5.3.1. Results of ground tests were incomplete because of intermittent violent surges in engine power at settings above 80-percent normal rated power on the left engine and at settings near normal rated power on the right engine. In addition to the apparent "feel" of engine power surges, there were comparable fluctuations in the fuel flow and torquemeters. The surging of the left engine was greater, more violent, and more frequent than that of the right engine. The left engine fuel-flow meter fluctuated from a reading of 310 pounds per hour to 250 pounds per hour and then back to 310 pounds per hour at an 80-percent power setting.

2.5.3.2. Routine ground run-up checks revealed that, at low elevations, the engines were torque limited on cool days and turbine-inlet temperature limited on hot days. At high elevations, routine ground run-up checks indicated that the engines were turbine-inlet temperature limited. However, the checks accomplished were too few to be conclusive or definitive.

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2.5.4. Analysis.

2.5.4.1. The engine surges at high power settings were first noticed in flight with settings above 65 percent normal rated power. Although the "feel" of the engine power was smooth and constant, occasional fluctuations were evidenced by minute deviations in the fuel flow and torquemeters. At 128:40 hours of engine life, modified fuel regulators were installed to rectify the deficiency. The installation did not eliminate the surging. Subsequent ground run-up tests revealed an increase in surging on the right engine.

2.5.4.2. When accomplishing a maximum performance takeoff, the surging quickly dampened out as the airplane accelerated. During three such takeoffs, however, the surging continued intermittently for approximately 30 seconds after takeoff but at a reduced magnitude.

2.5.4.3. Additional ground tests on the engines should be accomplished after this deficiency is corrected.

2.6. TAKEOFF AND LANDING PERFORMANCE.

2.6.1. Objective.

To make a side-by-side comparison of the takeoff and landing performance of the U-8F, NU-8F, and Model 90 King Air (pressurized NU-8F) Airplanes (figure 15) under identical atmospheric, no-wind conditions by investigating:

a. Normal takeoffs.

b. Maximum performance takeoffs.

c. Normal landings.

d. Obstacle landings.

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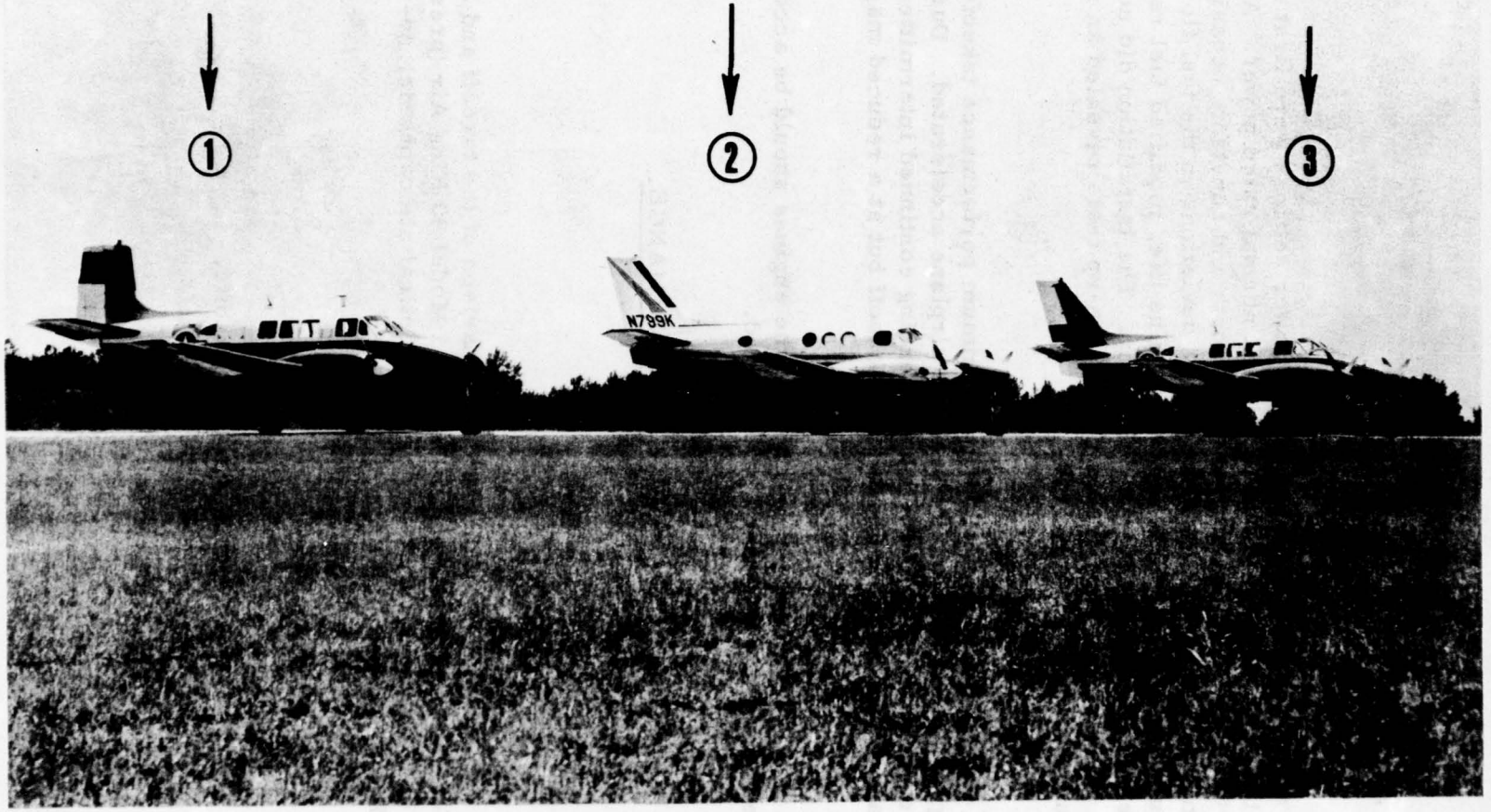


Figure 15. Side-by-side comparison of the U-8F, NU-8F, and Model 90 King Air. Arrow 1: U-8F Arrow 2: King Air Arrow 3: NU-8F

2.6.2. Method.

2.6.2.1. Normal and maximum performance takeoffs were performed with each airplane using the flap setting, takeoff power, maximum forward center of gravity, maximum gross weight, and lift-off speed recommended by the manufacturer.

2.6.2.2. Normal and obstacle landings were performed with each airplane using the flap setting, technique, and landing weight recommended by the manufacturer while at a maximum forward center of gravity.

2.6.2.3. Distances over a 50-foot obstacle and ground rolls were measured with a flight analyzer at Fort Rucker, Alabama, where the field elevation is 305 feet above mean sea level. The average OAT during the test runs was +23° C. (+73 °F.).

2.6.3. Results.

See figure 16.

2.6.4. Analysis.

2.6.4.1. The ground runs on normal and maximum performance takeoffs on the NU-8F Airplane may have been shortened had there been no surging in power at the beginning of the ground runs. See paragraph 2.5.4. for discussion of power surging.

2.6.4.2. With the propellers in the normal position after landing (low pitch) and the engines at ground idle, the propellers produced a small amount of thrust, henceforth referred to as residual thrust, which prolonged the ground run. Reverse pitch propellers would have reduced this ground run. Reverse pitch propellers should be installed to enhance the mission support capability of the NU-8F at short tactical airfields. In the present configuration of the NU-8F, the landing ground roll may be shortened by feathering the propellers after touch down.

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TAKEOFF AND LANDING PERFORMANCE

Normal Takeoff

Aircraft	Ground Distance (feet)	Air Distance (feet)	Total Distance (feet)
U-8F	1313	1542	2855
NU-8F	1441*	477	1918
King Air	1388	776	2164

Maximum Performance Takeoff

U-8F	968	711	1679
NU-8F	871*	443	1314
King Air	749	564	1313

Normal Landing

U-8F	1369	1203	2572
NU-8F	1489	1803	3292
King Air	1318	2080	3398

Obstacle Landing

U-8F	882	697	1579
NU-8F	1019	937	1956
King Air	992	787	1779
NU-8F	881**	937	1748

*See Analysis, paragraph 2.6.4.1.
**Propellers were feathered after touchdown.

NOTE: During these tests, the U-8F and NU-8F were flown by USAAVNTBD personnel while the King Air was flown by the manufacturer's pilot. Aviators were assigned to the same airplane for all of the test runs. Test results indicated that pilot technique was a factor in the preciseness of the data obtained. Additional tests are required to improve the degree of preciseness of the test data. The data should be used for comparison purposes only.

Figure 16

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2.7. CLIMB PERFORMANCE.

2.7.1. Objective.

To investigate the climb performance of the NU-8F Airplane and compare it with that of the U-8F Airplane by investigating:

a. Rate of climb to service ceiling - two engines.

b. Time to climb to service ceiling - two engines.

c. Rate of climb to service ceiling - single engine.

d. Time to climb to service ceiling - single engine.

e. Best rate of climb - two engines.

f. Best rate of climb - single engine.

2.7.2. Method.

2.7.2.1. Rate of Climb to Service Ceiling - Two Engines.

A two-engine climb to service ceiling was performed with the NU-8F Airplane in a clean configuration, the engines at maximum continuous power, maximum allowable forward center of gravity while at maximum gross weight, and the best rate of climb speeds recommended by the manufacturer.

2.7.2.2. Time to Climb to Service Ceiling - Two Engines.

The time to climb to service ceiling was recorded during the climb to service ceiling.

2.7.2.3. Rate of Climb to Service Ceiling - Single Engine.

A climb to service ceiling with the critical engine (left) inoperative was performed with the NU-8F Airplane in a clean configuration, the inoperative engine feathered, the remaining engine at maximum continuous power, at maximum allowable forward center of gravity while at maximum gross weight using the best rate of climb speeds recommended by the manufacturer.

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2.7.2.4. Time to Climb to Service Ceiling - Single Engine.

The time to climb to service ceiling was recorded during the single-engine climb to service ceiling.

2.7.2.5. Best Rate of Climb - Two Engines.

The best rate of climb was spot checked by sawtooth climbs at 10,000, 15,000, and 20,000 feet.

2.7.2.6. Best Rate of Climb - Single Engine.

The best rate of climb was spot checked by sawtooth climbs at 4,000 and 8,000 feet with the critical engine inoperative.

2.7.3. Results.

a. Rate of climb to service ceiling - two engines (figure 17).

b. Time to climb to service ceiling - two engines (figure 18).

c. Rate of climb to service ceiling - single engine (figure 19).

d. Time to climb to service ceiling - single engine (figure 20).

e. Best rate of climb - two engines (figure 21).

f. Best rate of climb - single engine (figure 22).

2.7.4. Analysis.

The NU-8F was significantly better in all areas tested than the U-8F.

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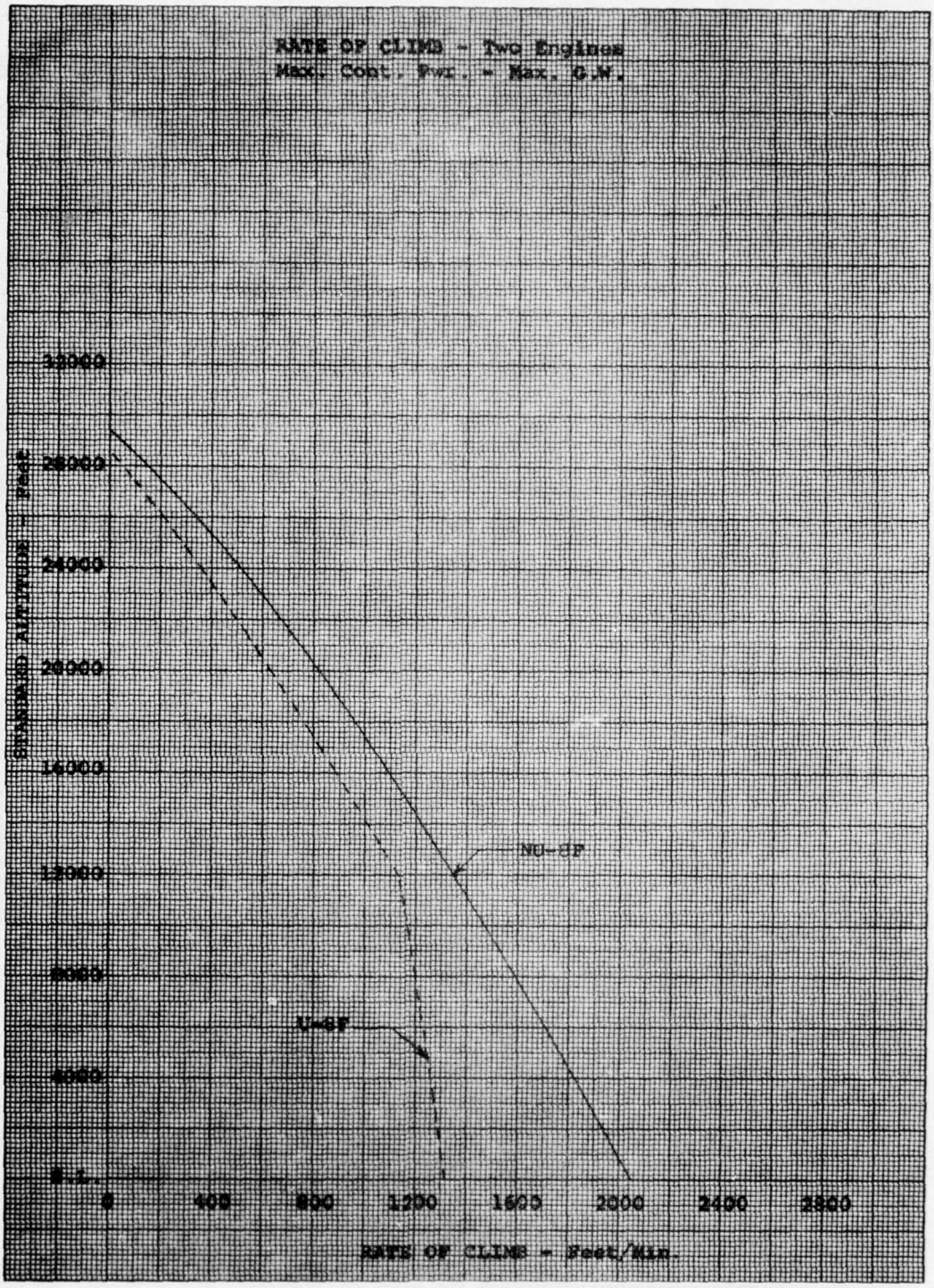


Figure 17

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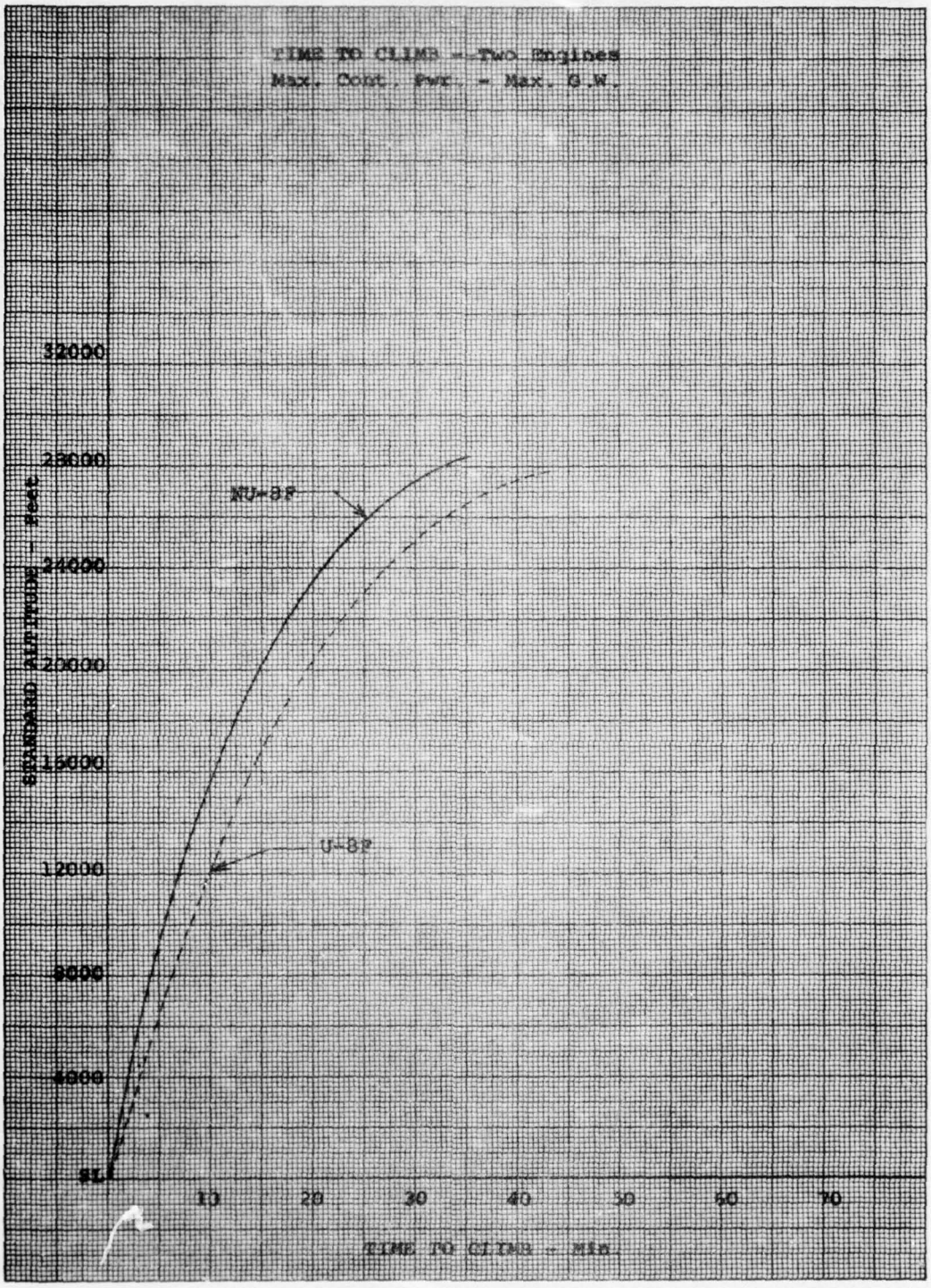


Figure 18

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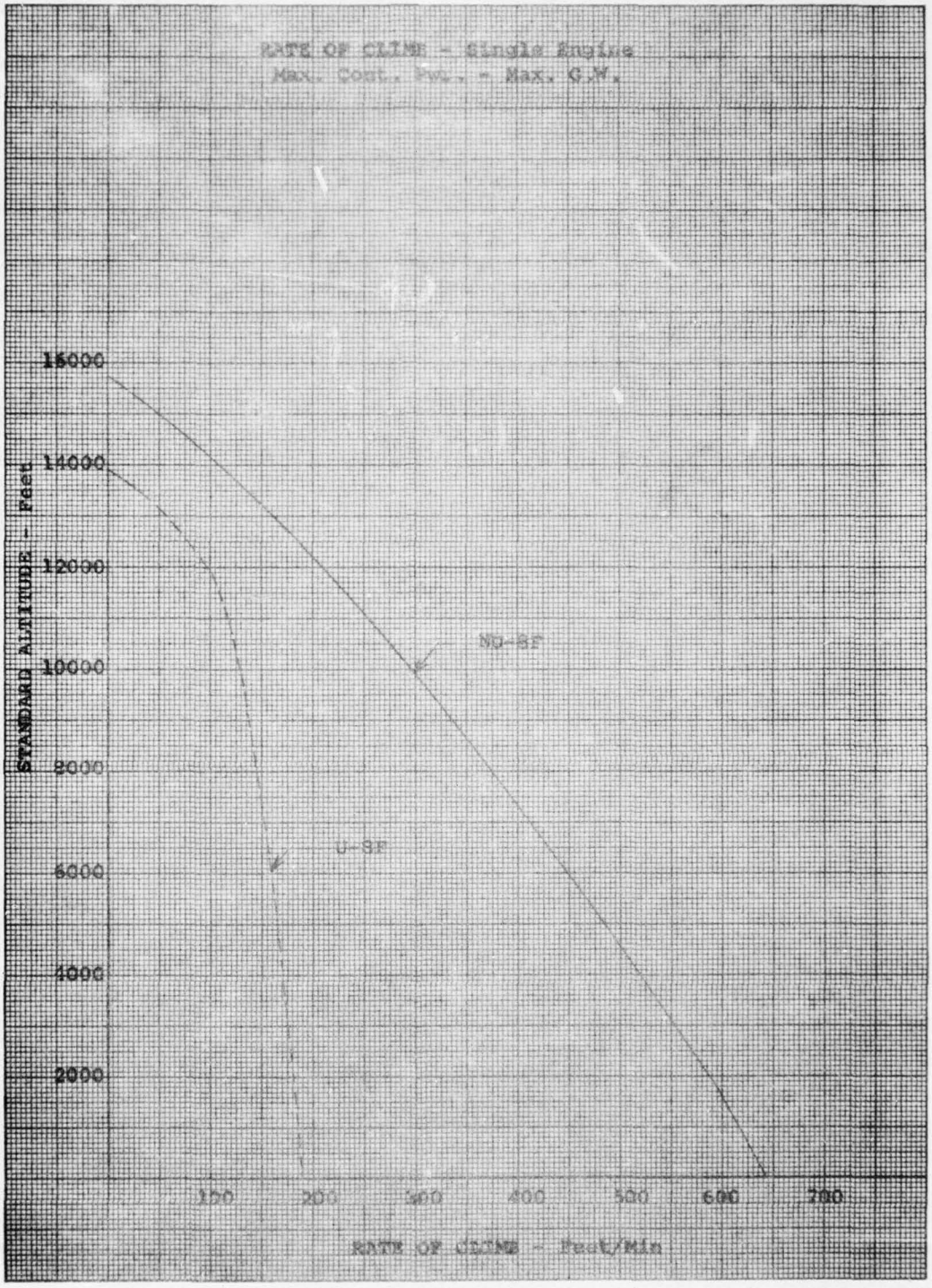


Figure 19

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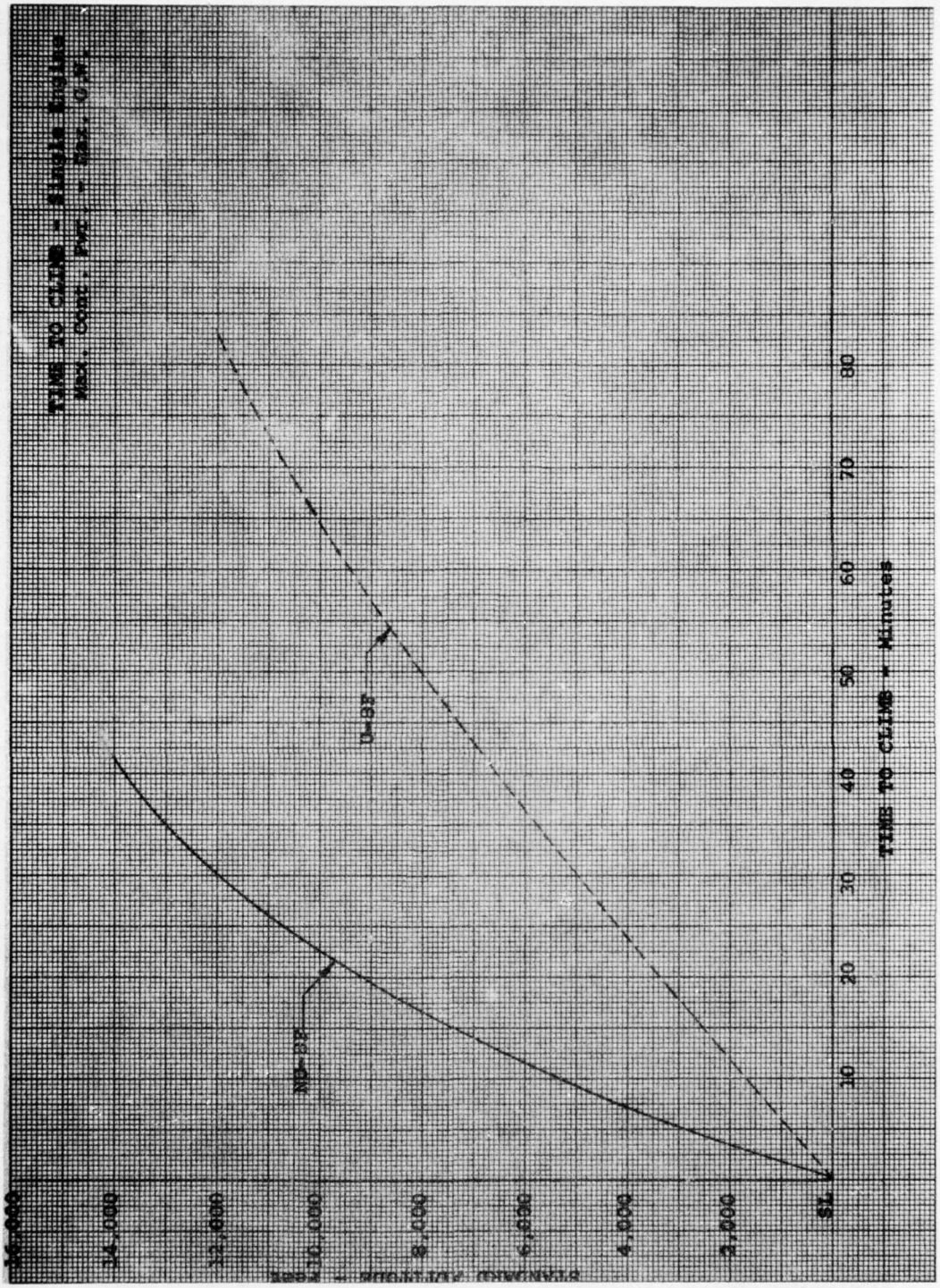


Figure 20

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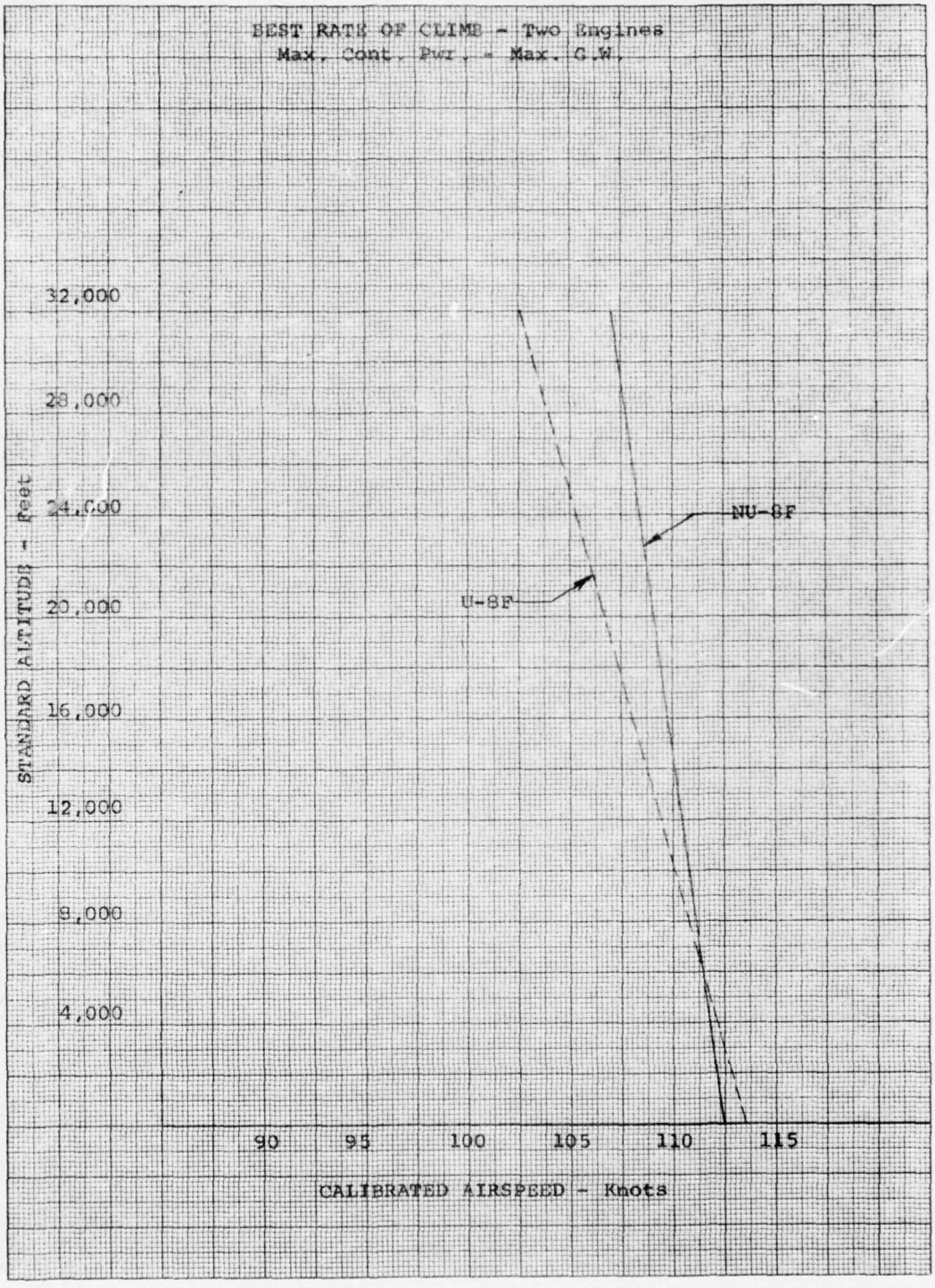


Figure 21

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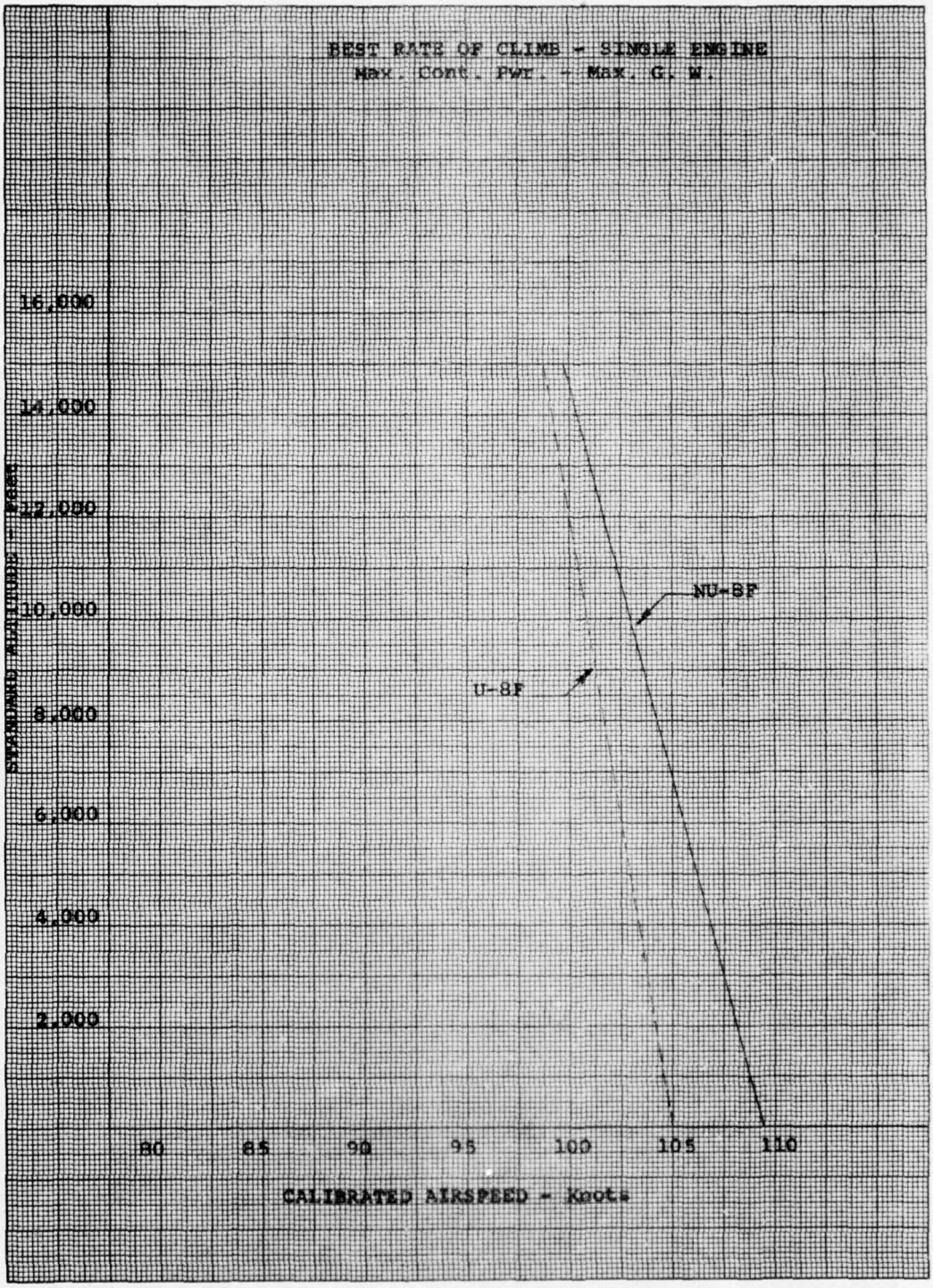


Figure 22

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2.8. CRUISE PERFORMANCE.

2.8.1. Objective.

To determine the cruise performance of the NU-8F Airplane by investigating:

a. Cruise, two engines - 10,000 feet.

b. Cruise, two engines - 15,000 feet.

c. Cruise, two engines - 20,000 feet.

d. Cruise, single engine - 10,000 feet.

2.8.2. Method.

2.8.2.1. Two-engine cruise performance was investigated by developing speed-versus-power plots at 10,000, 15,000, and 20,000 feet with the NU-8F Airplane in a clean configuration, at maximum forward center of gravity, and at maximum gross weight.

2.8.2.2. Single-engine cruise performance was investigated by developing a speed-versus-power plot at 10,000 feet with NU-8F Airplane in a clean configuration, the critical engine feathered, at maximum forward center of gravity, and at maximum gross weight.

2.8.3. Results.

See figures 23 through 28.

2.8.4. Analysis.

2.8.4.1. Fuel consumption for the PT6A-6 engine decreased with an increase in altitude with a consequent increase in range.

2.8.4.2. Maximum endurance at the altitudes tested was at that power setting producing a true airspeed (TAS) of approximately 180 knots.

2.8.4.3. At 65 percent of power in single-engine flight at 10,000 feet, the NU-8F Airplane could maintain an airspeed of approximately 138 knots TAS as compared to approximately 116 knots TAS in the U-8F at maximum continuous power.

2.8.4.4. A propeller setting of 1900 r.p.m. is recommended for normal cruise because of the low noise level and diminished wear on engine.

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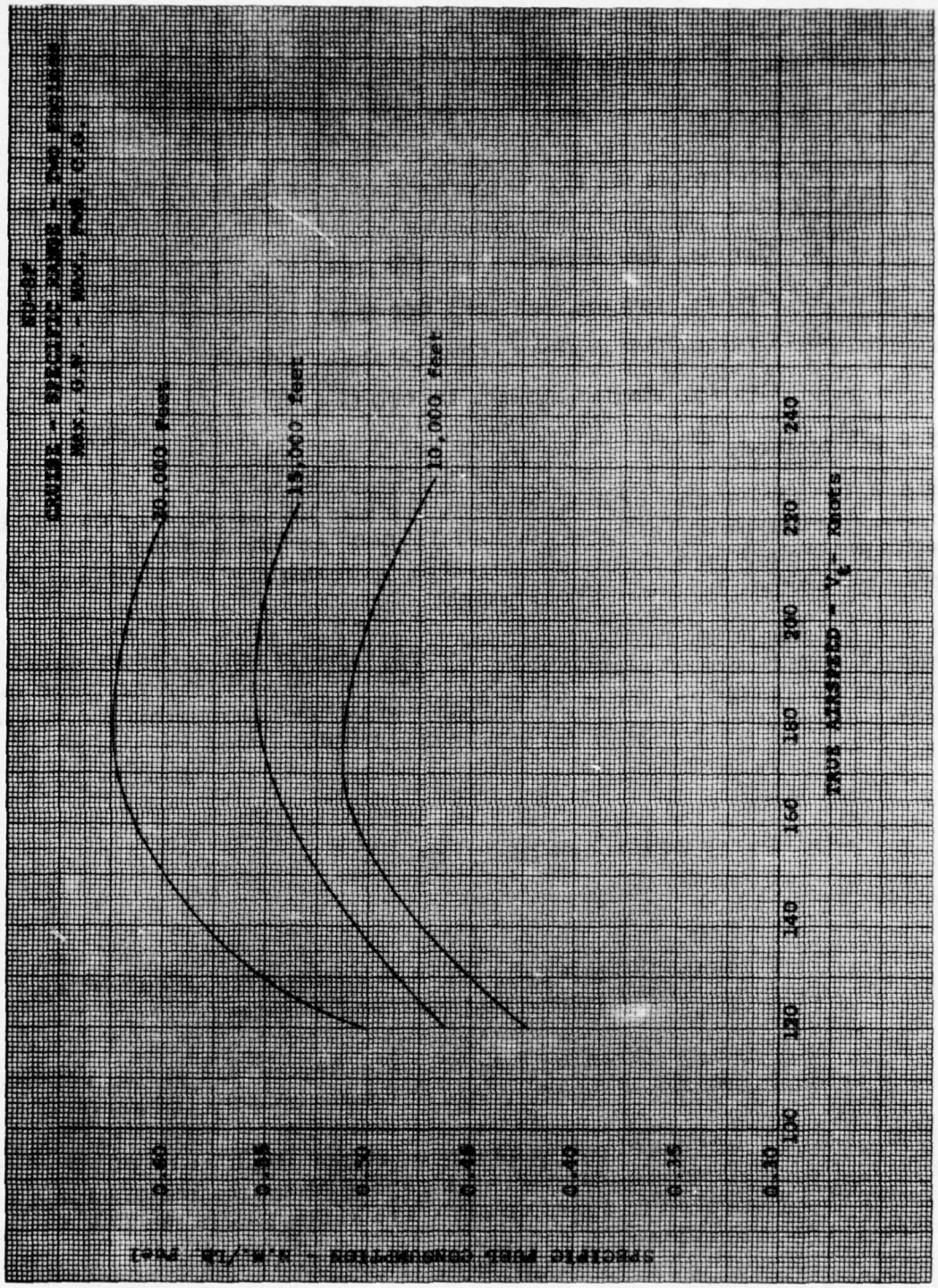


Figure 23

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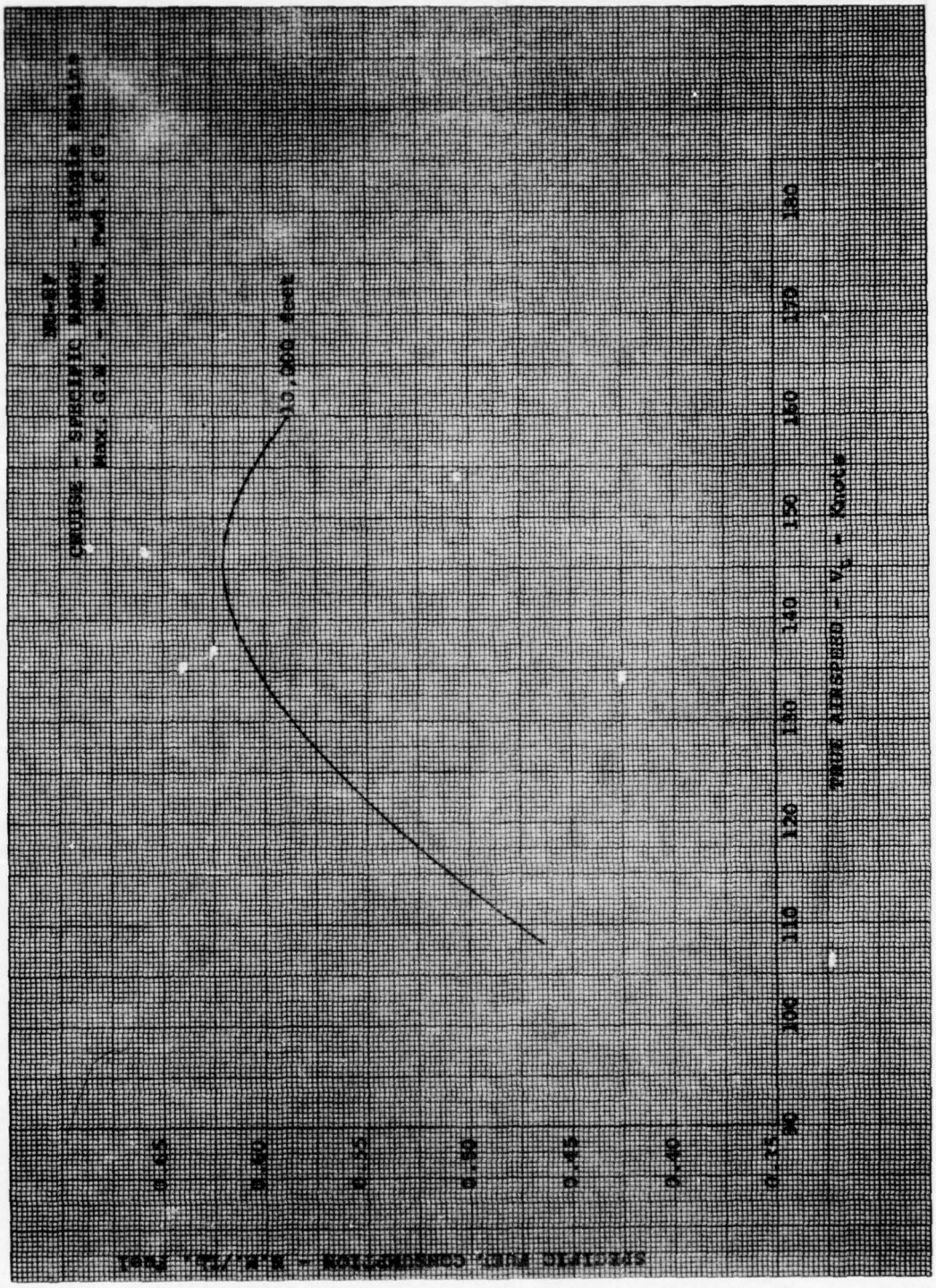


Figure 24

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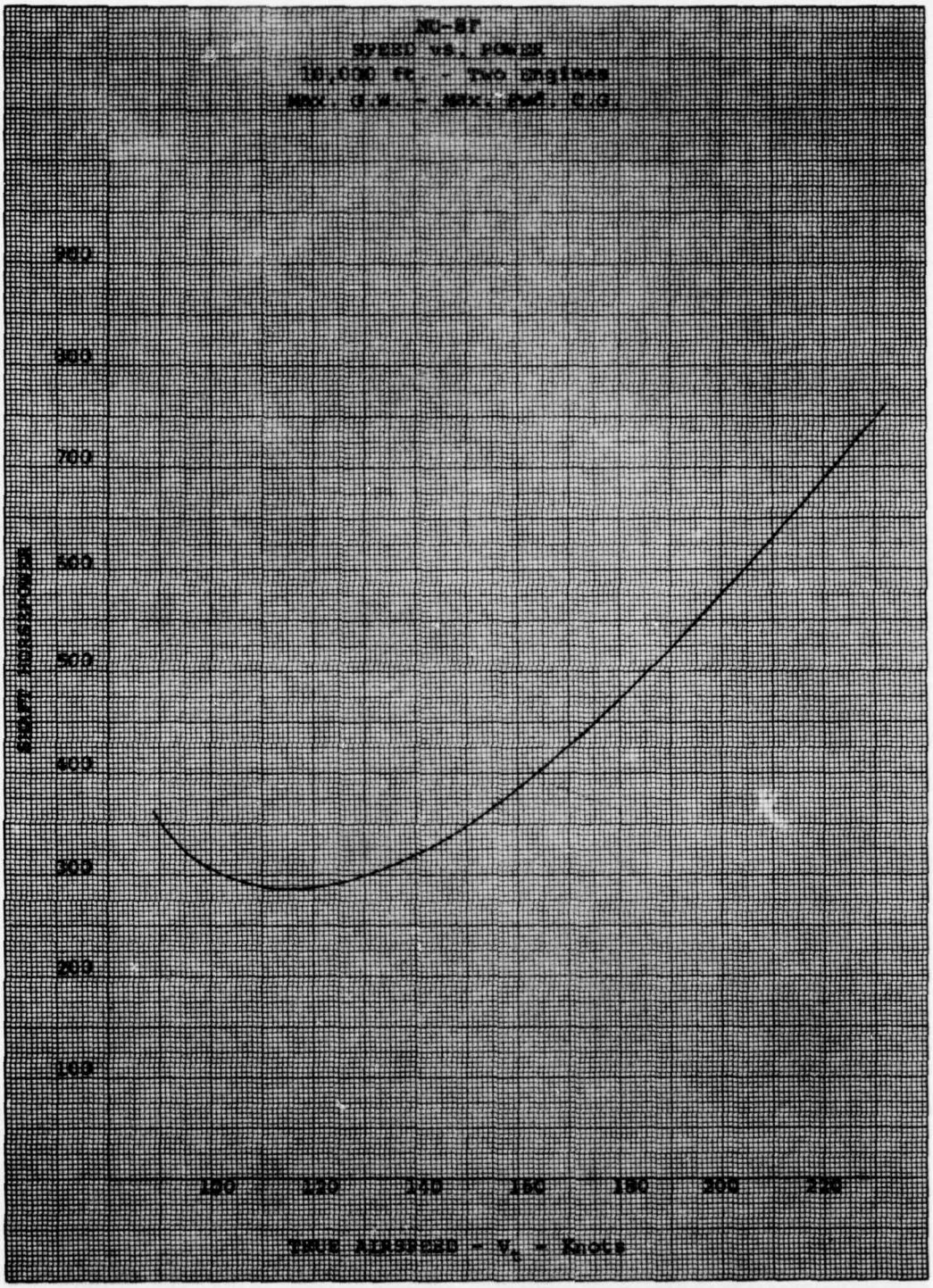


Figure 25

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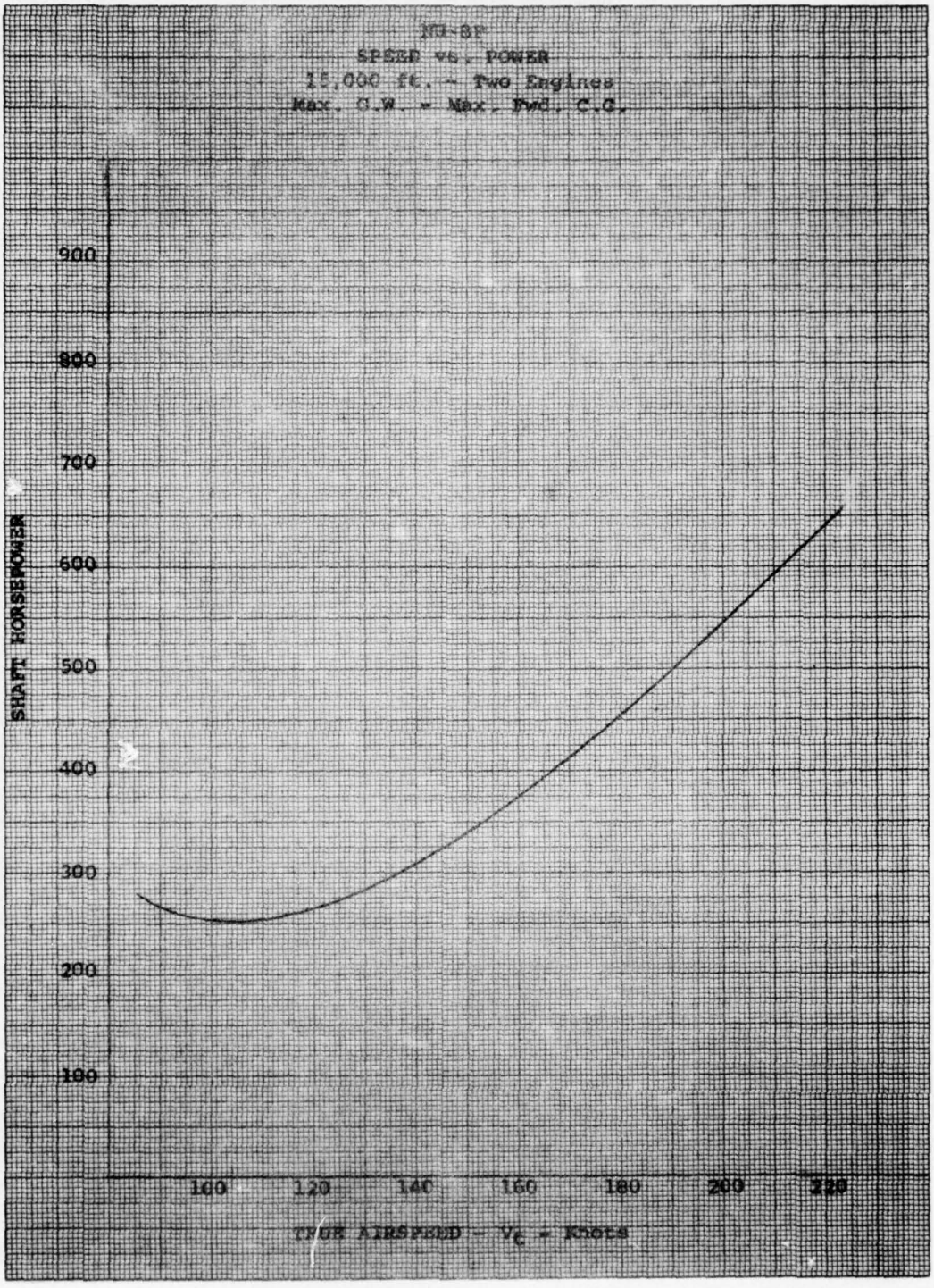


Figure 26

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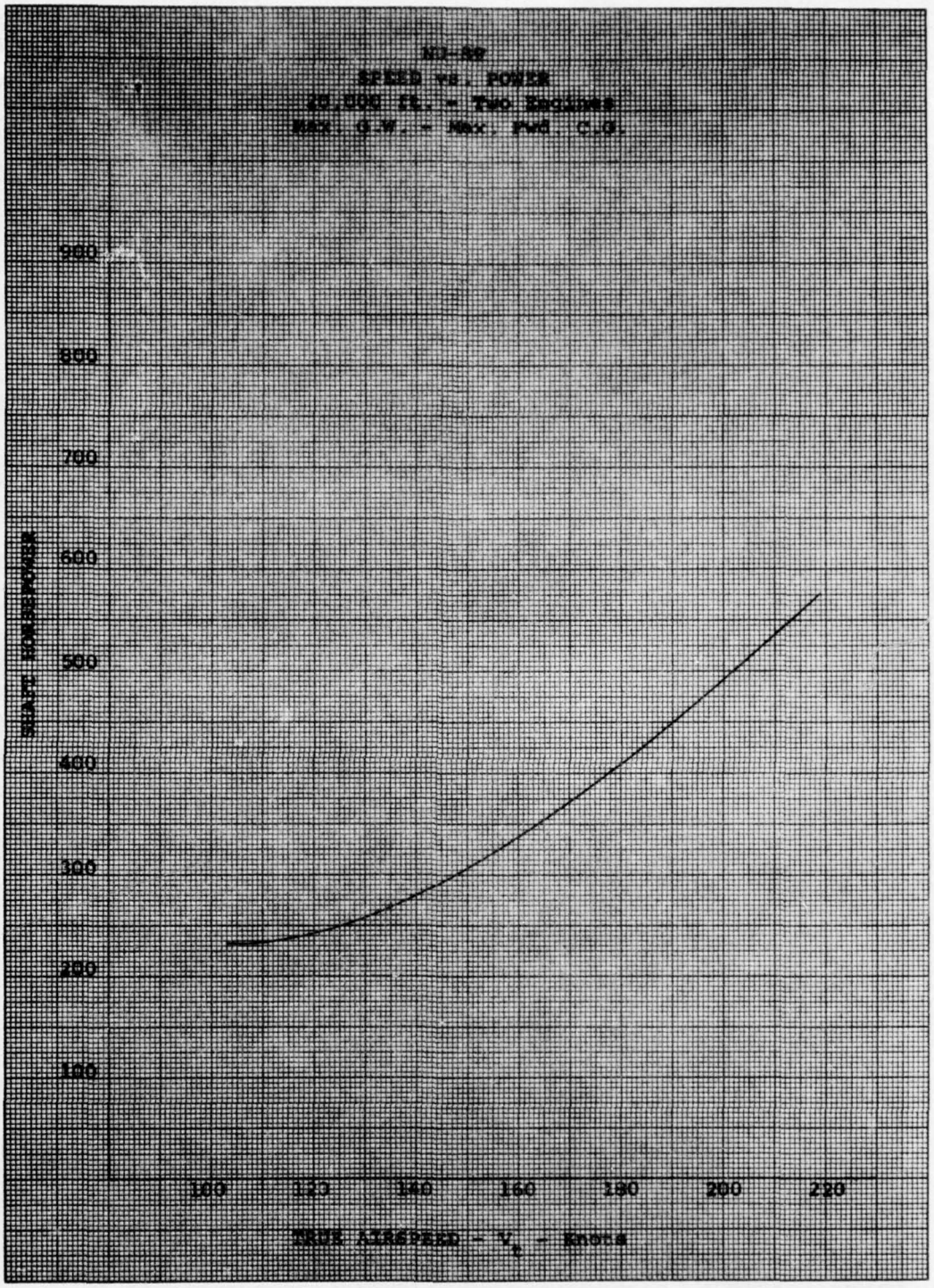


Figure 27

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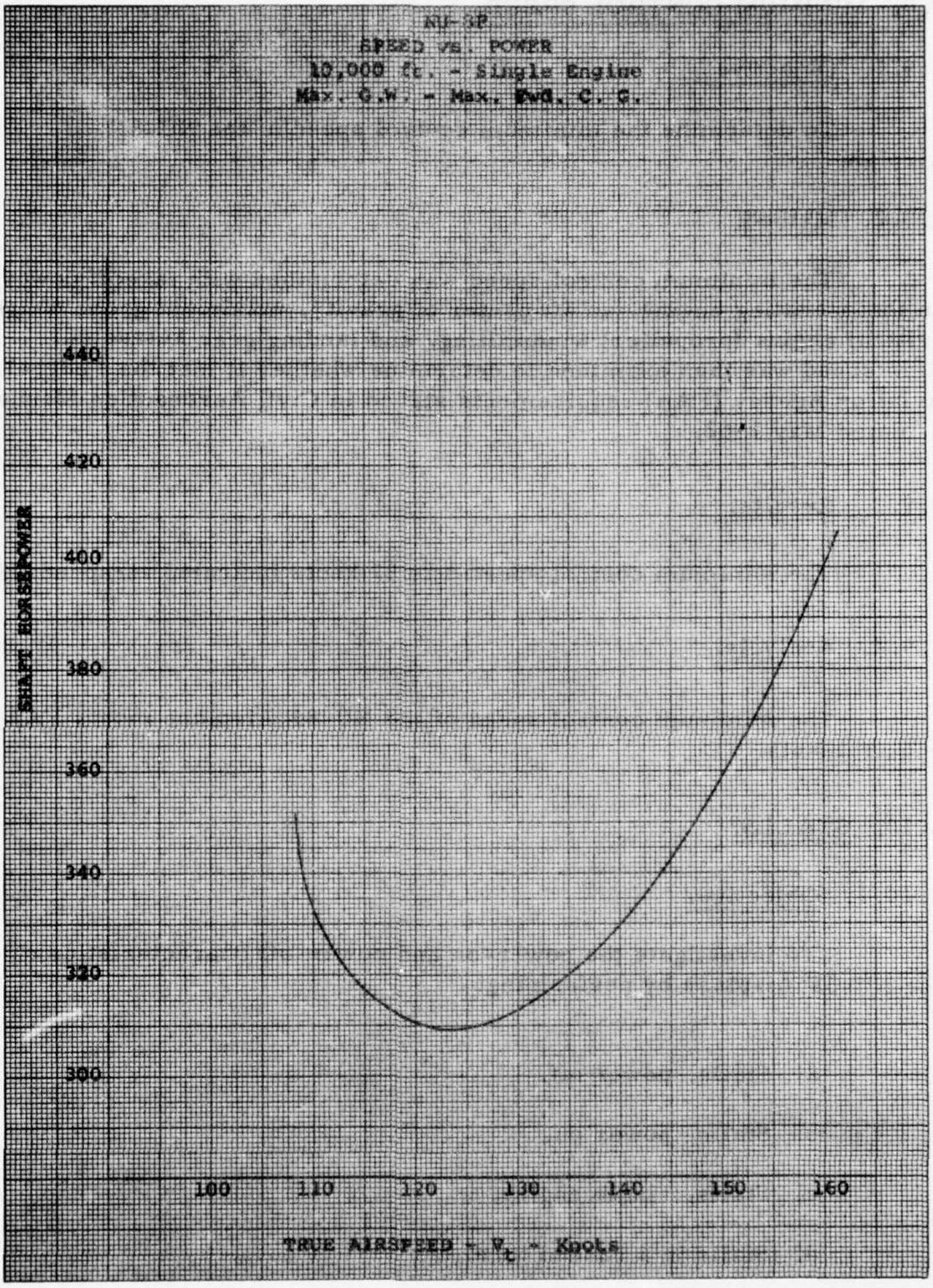


Figure 28

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2.9. MINIMUM CONTROL SPEED.

2.9.1. Objective.

To determine the minimum control speed of the NU-8F Airplane.

2.9.2. Method.

The minimum control speed was determined with takeoff power on the operating engine, an aft center of gravity, maximum gross weight, critical engine (propeller) windmilling, and landing gear retracted. This speed was then examined to determine whether it met the Federal Aviation Agency (FAA) requirements stated in Civil Aeronautics Manual 3, dated May 1962.

2.9.3. Results.

The minimum control speed was 87 knots indicated airspeed (IAS).

2.9.4. Analysis.

The minimum control speed of the NU-8F Airplane meets FAA requirements.

2.10. STALLS.

2.10.1. Objective.

To investigate the power-on and power-off characteristics of the NU-8F Airplane by performing:

a. Stalls, power off.

b. Stalls, power on.

c. Stalls, single engine.

d. Stalls in a banked turn.

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2.10.2. Method.

2.10.2.1. Stalls, Power Off.

Power-off stalls were performed at various increments of flap settings, at maximum forward and aft centers of gravity while at maximum gross weight.

2.10.2.2. Stalls, Power On.

Power-on stalls were performed with the engines at maximum continuous power, at maximum forward and maximum aft centers of gravity while at maximum gross weight.

2.10.2.3. Stalls, Single Engine.

Single-engine stalls were accomplished with the airplane in a clean configuration, critical engine inoperative, operating engine at 75-percent maximum continuous power, maximum forward and aft centers of gravity while at maximum gross weight.

2.10.2.4. Stalls in a Banked Turn.

Thirty-degree stalls were accomplished with the airplane in a clean configuration at maximum aft center of gravity, at maximum gross weight, and at a 75-percent maximum continuous power.

2.10.3. Results.

See figures 29 and 30.

2.10.4. Analysis.

2.10.4.1. Buffeting was easily discernible prior to each stall.

2.10.4.2. The airplane fell off to the left with each stall. Except for the 30-degree banked stall, the initial dropping of the nose at the beginning of the stall was at a slower rate during power-on stalls than during power-off stalls.

2.10.4.3. The 30-degree banked stall to the left or right produced a sudden jerk in the controls at the moment of stall followed by a quick roll to the left of approximately 20 degrees.

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INDICATED STALLING SPEEDS - KNOTS

LEVEL FLIGHT

Maximum Allowable Forward C. G.			Maximum Allowable Gross Weight - 8700 lb.		Gear Up
Item	Power	0% Flaps	30% Flaps	60% Flaps	100% Flaps
Buffet	On*	65			
Buffet	Off	83	75	75	66
Stall	On*	63			
Stall	Off	79	69	69	59

Maximum Allowable Aft C. G.			Maximum Allowable Gross Weight - 8700 lb.		Gear Up
Buffet	On*	65			
Buffet	Off	83	76	70	68
Stall	On*	63			
Stall	Off	78	71	65	65

30° Banked Stalls

Maximum Allowable Aft C. G.			Maximum Allowable Gross Weight - 8700 lb.	Gear Up
Buffet	On**	70		
Stall	On**	69		

Single-Engine Stalls

Maximum Allowable Forward C. G.			Maximum Allowable Gross Weight - 8700 lb.	Gear Up
Buffet	On**	79		
Stall	On**	78		

Maximum Allowable Aft C. G.			Maximum Allowable Gross Weight - 8700 lb.	Gear Up
Buffet	On**	78		
Stall	On**	76		

*Maximum continuous power.
**Seventy-five percent maximum continuous power.

Figure 29

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2.10.4.4. Comments of the FAA pertaining to power-on and power-off stalls in the landing configuration are included as follows:

"Noncompliance with CAR 3.120 exists in that excessive roll occurs when stalling with the airplane in the landing configuration and power on or off. We recommend the pilot be informed of this condition and advised to recover from stalls when the stall warning horn or stall buffet is encountered."

It should be noted, however, that with the wings level, the stall occurred at 55 to 60 knots IAS with adequate warning from the warning horn and buffeting long before the stall actually occurred. The manufacturer stated that this condition has been rectified in the pressurized NU-8F (King Air) to meet FAA requirements.

STALL ALTITUDE LOSS (FEET)

Two Engine, Maximum Allowable Gross Weight

Power		Flaps			
		0%	30%	60%	100%
Maximum aft c.g.	Off	450	520	510	475
Maximum fwd c.g.	Off	200	320	425	400
Maximum aft c.g.	On	400			
Maximum fwd c.g.	On	300			

Single Engine, Maximum Allowable Gross Weight

Maximum aft c.g.	On	500
Maximum fwd c.g.	On	475

Figure 30

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2.11. DESCENT PERFORMANCE.

2.11.1. Objective.

To determine the optimum descent speed of the NU-8F Airplane with both engines inoperative.

2.11.2. Method.

Sawtooth descents were performed with the aircraft at maximum gross weight, clean configuration, and the engines at zero thrust condition.

2.11.3. Results.

2.11.3.1. See figure 31.

2.11.3.2. During the sawtooth descents with the throttles at flight idle and with the propellers feathered but windmilling, a small amplitude vibration was observed at 110 knots IAS which increased in magnitude up to 130 knots. Above 130 knots, the vibration quickly dampened out. At 140 knots IAS, the vibration was no longer evident. This phenomenon was never encountered during single-engine flight.

2.11.4. Analysis.

For best glide distance, the optimum descent speed was determined to be 100 knots IAS.

2.12. TRIM CONTROL.

2.12.1. Objective.

To determine the adequacy of available trim control of the NU-8F Airplane.

2.12.2. Method.

The NU-8F Airplane was trimmed about all three axes during the mission profiles flown during the NU-8F Military Potential Test.

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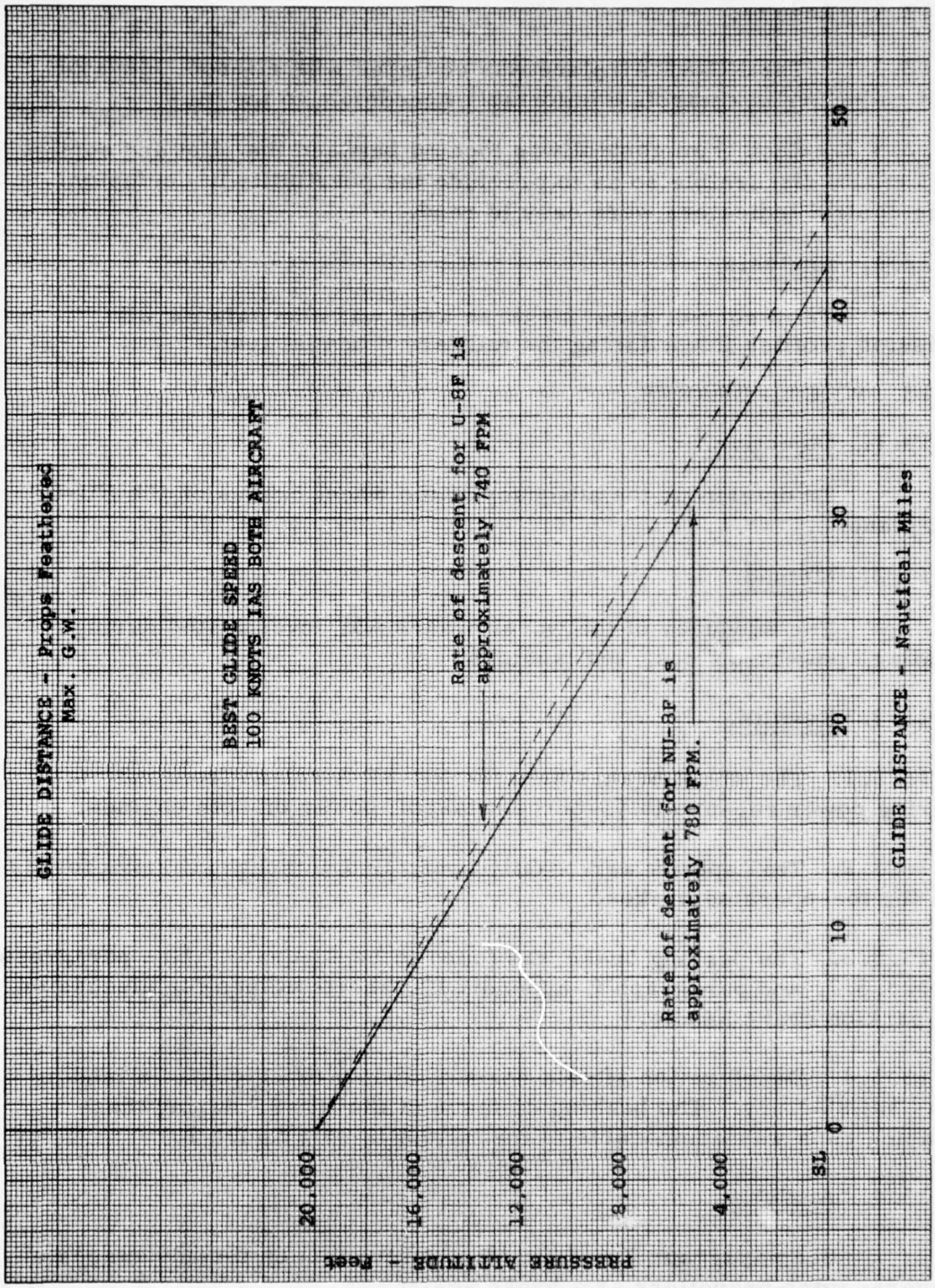


Figure 31

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2.12.3. Results.

2.12.3.1. The NU-8F Airplane was equipped with aileron, elevator, and rudder trim controls comfortably accessible to the pilot.

2.12.3.2. Each trim control was located between the pilot and copilot and easily discernible so as to preclude the possibility of confusion. The control indicators were easy to read.

2.12.4. Analysis.

Trim control about all three axes was adequate for all mission profiles flown during the military potential test.

2.13. WHEEL BRAKES.

2.13.1. Objective.

To determine the adequacy of the wheel brakes on the NU-8F Airplane.

2.13.2. Method.

The adequacy of the wheel brakes was investigated during taxiing, power run-ups, and landings.

2.13.3. Results.

2.13.3.1. The wheel brakes held the NU-8F Airplane from rolling during power run-ups to 95-percent takeoff power on both engines.

2.13.3.2. Taxi speeds were easily controlled without excessive forces on the toe-operated brakes.

2.13.3.3. The parking brake was found to be adequate. (See paragraph 2.1.3.3.7. and paragraph f, appendix III, shortcomings for discussion of parking brake handle.)

2.13.3.4. Deceleration after a normal landing or an obstacle landing was satisfactory. The braking distance of the NU-8F during these landing runs was comparable to that of the U-8F (figure 16).

2.13.4. Analysis.

See paragraph 2.6.4.2. for a discussion on the advantages of reverse pitch propellers as a brake assist.

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2.14. WEATHER CAPABILITY (ICING TEST).

2.14.1. Objective.

To determine the operational flight suitability of the turbine powered U-8F (NU-8F) Airplane in icing conditions by investigating:

a. Problems associated with engine air inlet icing.

b. Performance of the wing and empennage leading edge deicer boots.

c. Performance of the electro-thermal propeller deicers.

d. Performance of the electrically-heated windscreens.

e. Effect of icing on the pitot-static system.

2.14.2. Method.

2.14.2.1. During the period 20 March to 23 March 1964, the NU-8F Airplane was tested in artificially induced and natural icing flight environments. The artificially induced icing phase, consisting of two tests, was conducted in the vicinity of Dallas, Texas. Water, colored with yellow vegetable dye to improve visibility of ice accretions, was sprayed into a sub-zero (^{o}C.) atmosphere from a CV-2 "Caribou" Airplane. The NU-8F was then flown behind the CV-2 so that only one side of the airplane at a time was immersed in the spray. The NU-8F was flown at a distance behind the CV-2 which permitted the water spray to cool and turn into ice upon impact. The duration of the spray was 18 minutes on each flight. Color movies and 35 mm color photographs were taken from the rear of the CV-2 and from a T-28 Airplane whose pilot also acted as safety controller for the flight formation.

2.14.2.2. The second phase of this test was conducted in two flights in natural icing conditions within a 100-mile proximity of Minot Air Force Base, North Dakota. The temperatures in the clouds varied from minus 2^{o}C. to minus 12^{o}C. Light-to-moderate icing conditions were encountered.

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2.14.3. Results.

2.14.3.1. Icing Test Flight No. 1 -- Artificially Induced Icing Conditions.

2.14.3.1.1. This test was flown at a pressure altitude of 10,500 feet and an indicated airspeed (IAS) of approximately 130 knots. The left side of the airplane was immersed in the spray stream at an outside air temperature (OAT) which varied from minus 6°C. to minus 2°C. Prior to entering the spray, the propeller deicer switches, the windshield deicer switches, the pitot, heat switch, and the fuel continuous heat switch were placed in the ON position while the engine anti-ice switch was placed in the AUTO position. (The engine air inlets incorporate annular screens inside the nacelles aft of the compressor which are protected during flight in icing conditions by anti-ice fluid that automatically flows whenever an accretion of ice on the screens results in a sufficient pressure drop accross the screens to activate the system. This anti-ice fluid is carried from the two anti-ice discharge nozzles at the entrances to the air-intake scoops to the annular screens by the ram air entering the air scoops. Anti-ice fluid flow is indicated by two amber lights on the instrument panel that remain on during the flow.)

2.14.3.1.2. At the start of this test run and with 1/2 inch of ice on the leading edge of the left wing, flight control response was satisfactory. However, as ice built up to about 1 1/4 inches, flight control response deteriorated proportionately.

2.14.3.1.3. The left windshield was not kept in the spray all through this run. The torrential concentration of water from the spray necessitated the use of the wipers to clear the slush and maintain adequate forward visibility.

2.14.3.1.4. The pitot heater worked satisfactorily.

2.14.3.1.5. It was discovered in flight that prior to entering the icing spray, the engine anti-ice mechanism released anti-ice fluid at high airspeeds and high power settings with the engine anti-ice switch in the AUTO position. The engine anti-ice panel lights came on when fluid flowed, and the engine torquemeter readings increased as the fluid produced a higher air mass flow to the engines. The light for engine No. 1 first came on at a turbine compressor speed (N_1) of 84 percent and an IAS of 140 knots. The light for engine No. 2 came on at an N_1 of 93 percent and an IAS of 155 knots.

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2.14.3.1.6. Stalling speeds with a buildup of ice (one inch) on the left side of the airplane only are listed below:

Power-Off Stalls

Clean	98 knots IAS
Gear down	92 knots IAS
Gear down and full flaps	79 knots IAS

2.14.3.2. Icing Test Flight No. 2 -- Artificially Induced Icing Conditions.

2.14.3.2.1. This test was flown at a pressure altitude of 15,500 feet and an IAS of approximately 110 knots. (The CV-2 (Caribou) was not capable of a faster speed at this altitude.) The right side of the NU-8F was immersed in the spray stream at an outside air temperature which varied from minus 6°C. to minus 7°C. Prior to entering the spray, the same deicing switches were actuated in this test as in Test No. 1.

2.14.3.2.2. During this test run as ice built up on the right wing to about one inch, control response deteriorated proportionately. Never during this test, however, did the airplane run out of trim, left aileron travel, or right rudder travel.

2.14.3.2.3. The engine anti-ice indicators were observed during the climb to altitude. With the engine anti-ice switch in the AUTO position, the left engine anti-ice light came on at an N_1 of 84 percent and an IAS of 140 knots. The right engine anti-ice light came on at an N_1 of 93 percent and an IAS of 155 knots.

2.14.3.2.4. Stalling speeds with a buildup of ice (one inch) on the right side of the airplane only are listed below:

Power-Off Stalls

Clean	92 knots IAS
Gear down	92 knots IAS
Gear down and full flaps	79 knots IAS

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2.14.3.2.5. The right engine was shut down in flight. Flight was satisfactorily maintained at about 5000 feet with the power available on the left engine and approximately one inch of ice on the right wing.

2.14.3.2.6. An approach for a landing was made at a speed of 110 knots IAS with ice still on the right wing. No lack of control response was noticed. Landing was normal and touch-down was made at approximately 80 knots IAS.

2.14.3.2.7. After landing, the airplane was inspected. Although ice was still on the wing leading edge, there was no ice on either lip boots of the heated air-intake scoop or the ram-air heater. Ice was found inside the engine nacelles at the rear of the air-intake scoop beneath the annular air screen. A few small pieces of ice, approximately 1 1/4 inches in diameter, were observed on the annular air screens. Photography revealed that the air-intake-scoop lip boots were melting the ice only to have some of it run just aft of the lip boots and refreeze on the outside in small irregular shapes. It was not possible to photograph the inside of the air-intake scoop in flight.

2.14.3.3. Icing Test Flight No. 3 -- Natural Icing Conditions.

2.14.3.3.1. During flight in clear air enroute to the icing weather, the engine anti-ice switch was turned on and off several times to determine which power settings would cause the engine anti-ice lights to come on, thereby indicating a flow of anti-ice fluid. At a pressure altitude of 15,000 feet, an OAT of minus 7°C. and an N_1 compressor speed of 94 percent, the lights did not come on with the engine anti-ice switch in the AUTO position. Placing the switch in the MANUAL position caused a flow of anti-ice fluid as indicated by the lights coming on. Ten minutes after placing the switch back to the AUTO position with the N_1 at 94 percent, the lights started to blink. At an N_1 of 96 percent, the lights remained on. However, during a climb at 150 knots IAS to 17,000 feet pressure altitude, the lights did not come on. The N_1 speed was 98 percent on both engines during this climb. Three minutes after leveling off and establishing a cruise setting where the N_1 of both engines was now97 percent and the IAS was 170 knots, the left engine anti-ice light began blinking, indicating an intermittent flow of engine anti-ice fluid.

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2.14.3.3.2. Entry into light icing conditions was made at a pressure altitude of 6,000 feet, OAT of minus 11°C., N_1 speed of 83 percent, and an IAS of 158 knots. This power and airspeed condition was selected to preclude the premature flow of engine anti-ice fluid when the engine anti-ice switch was placed in the AUTO pisition. During this test, the deicing and anti-icing systems were placed in operation. All systems except the engine alcohol anti-ice system worked satisfactorily. As ice built up on the leading edges of the wing to approximately one inch, the airspeed decreased to approximately 150 knots IAS and then increased again to approximately 155 knots as the wing and empennage deicing boots removed the ice. Occasionally, ice would sling off the propellers against the nose of the airplane. Ice accumulated in small irregular formations outside and to the rear of the heated air-intake lip boots. (The inside of the air scoop was not visible from the cockpit.) No decrease in power was observed during any part of this test run while in icing conditions.

2.14.3.4. Icing Test Flight No. 4. -- Natural Icing Conditions.

2.14.3.4.1. This test flight began at Minot Air Force Base, North Dakota, where the NU-8F had been left outdoors for about 16 hours in snow conditions and freezing temperatures. The engines were started without an auxiliary power unit at an OAT of minus 12°C. Both engines started on the first attempt using the manufacturer's recommended normal starting procedures.

2.14.3.4.2. The airplane was flown in clouds at a pressure altitude of 7,000 feet and OAT of minus 3°C. in light-to-moderate icing conditions. The engine anti-ice lights were monitored to insure that the engine anti-ice system did not spray fluid at high power settings when not needed. The necessity of using low power settings of 83 percent N_1 resulted in an initial cruise speed of 145 knots IAS.

2.14.3.4.3. As rime ice built up on the leading edge of the wing and empennage from approximately 3/8 inch to 1/2 inch, the airspeed diminished to 130 knots IAS. Upon activating the wing and empennage deicer boots which removed the ice, the airspeed increased to 140 knots IAS. From the cockpit, it appeared that the engine air-intake-scoop lip boots were successful in melting the ice, only to have it refreeze just aft of the lips on the outside of the nacelles. Although the wing and empennage deicer boots operated satisfactorily throughout the test, ice remained on the wing tips, wing light, and horizontal stabilizer tips.

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Operation of the vertical stabilizer deicer boots was not visible from the cockpit or cabin; however, control response indicated ice removal.

2.14.3.4.4. Both windshields remained free of ice as long as the electrical heater elements were working. The right windshield heater was turned off for thirty minutes. This permitted a buildup of ice of approximately 3/4 inch. The right windshield heater element was then turned on, and required only twenty minutes to clear approximately 90 percent of the area covered by the heater. The remaining slushy 10 percent was cleared by the windshield wiper.

2.14.4. Analysis.

The icing tests showed that all deicing systems on the NU-8F worked satisfactorily except the engine alcohol anti-ice system. Although power loss did not occur during any of the test runs, it was necessary to conduct all test runs at reduced power settings to preclude the unnecessary discharge of anti-ice fluid when the switch was in the AUTO position. Since the initial entry speeds into the natural icing conditions were at approximately 150 knots IAS, the full capability of the NU-8F was not realized when encountering icing conditions. At the altitudes flown during the natural icing test runs (below 10,000 feet), the NU-8F should have been cruising initially at approximately 185 knots IAS. Operation of the engine alcohol anti-ice system in the automatic position was unsatisfactory. This is considered to be a deficiency. At pressure altitudes of 15,000 feet or more, this deficiency in the engine anti-ice system was manifested only at a very high power setting (94 to 98 percent N_1).

2.15. ADEQUACY OF AVIONIC EQUIPMENT.

2.15.1. Objective.

To determine the adequacy of the avionic equipment on the NU-8F Airplane for mission support suitability by evaluating:

a. The equipment presently installed.

b. Requirements for substitute or additional equipment.

c. Adequacy of inverters.

d. Adequacy of generators.

e. Panel arrangement of avionics.

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2.15.2. Method.

A qualitative analysis of the installed avionic equipment was made considering the mission support roles requiring airplanes of the NU-8F type. A quantitative analysis was then made to determine if the inverters and generators were of sufficient capacity to accommodate the electrical loads.

2.15.3. Results.

2.15.3.1. Installed equipment was generally identical to the U-8F equipment.

2.15.3.2. Location and operation of avionic equipment controls and displays were satisfactory except that the pilot's instrument panel did not conform to the Army standard "T" panel configuration. (See figure 32 for NU-8F panel arrangement and figure 33 for standard "T" panel.)

2.15.3.3. The copilot instrumentation and configuration were adequate.

2.15.3.4. Except as indicated below, maintenance of avionic equipment presented no unusual problems. No unusual skills, training, tools, or support equipment were required.

2.15.3.4.1. Marker beacon receiver failure occurred three times in 100 flight hours. Failure in this type marker beacon was attributed to an inherent problem of the receiver.

2.15.3.4.2. UHF squelch became inoperative on two occasions. Failures were due to unstable power from the airplane inverters.

2.15.3.4.3. The 250 v.a. nonstandard inverter failures constitute a deficiency, as both inverters failed in less than 300 flight hours. Standard inverters which normally function in excess of 1000 hours were required.

2.15.3.5. The installed generators were inadequate to supply power to minimum essential equipment under emergency conditions. (See Analysis, paragraph 2.15.4.4. for explanation.)

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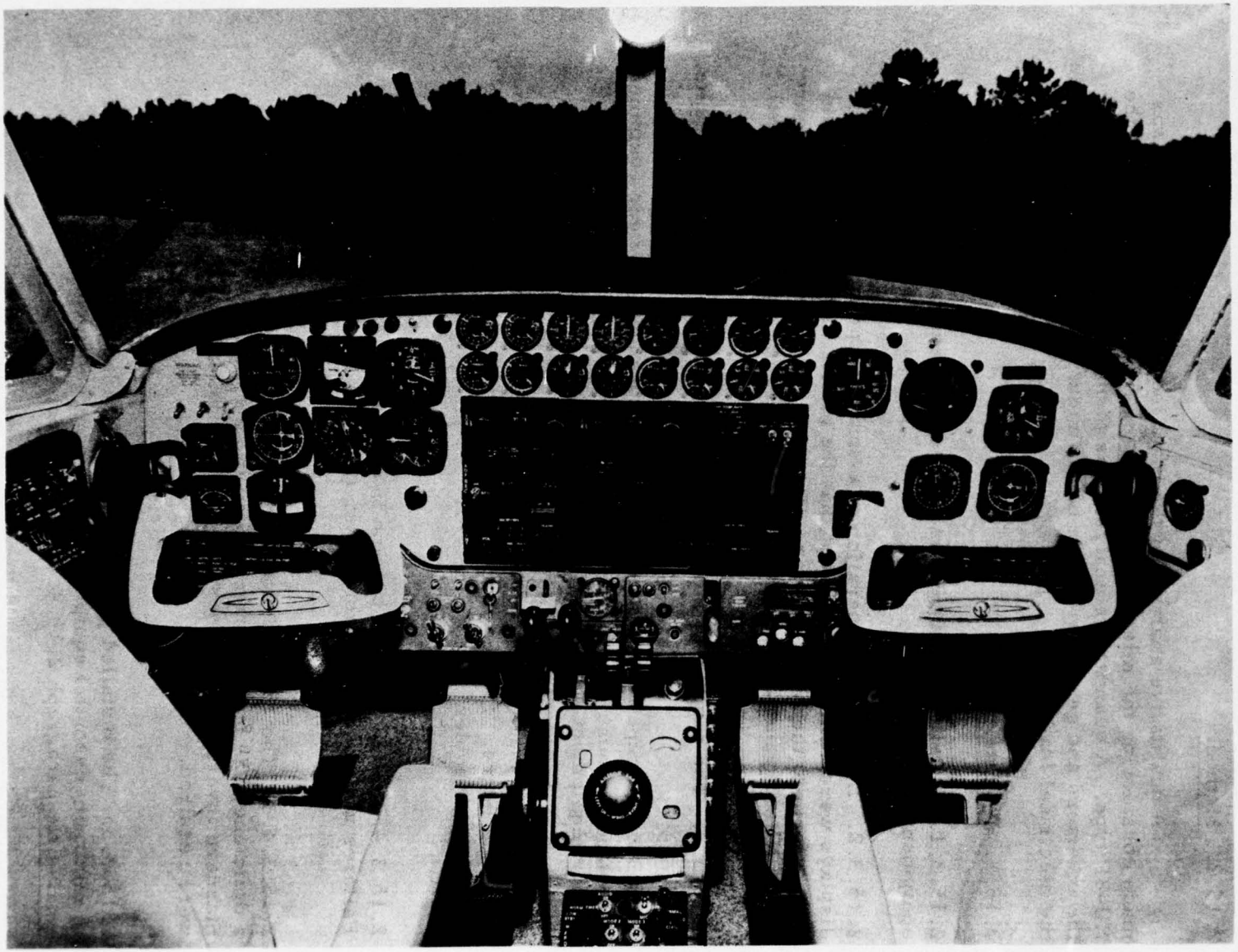
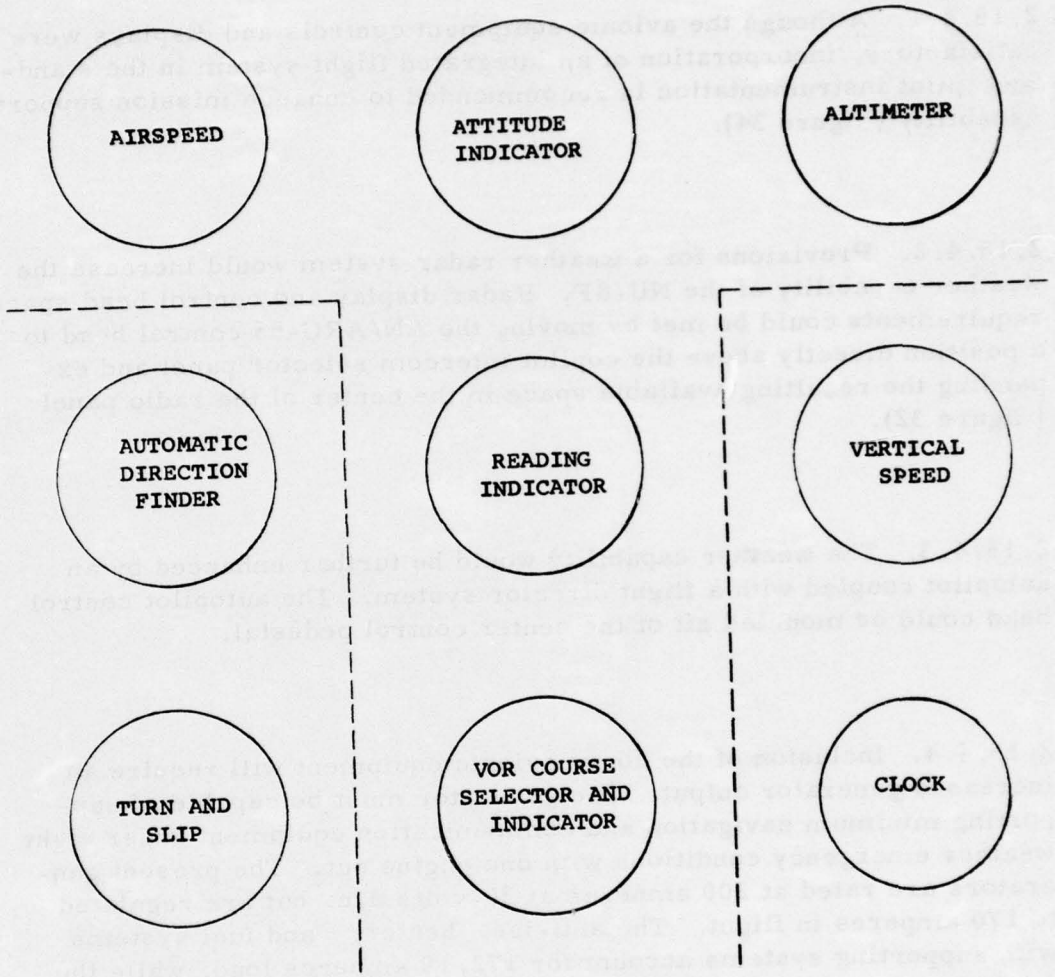


Figure 32. NU-8F cockpit and panel arrangement.

OPTIMUM PANEL ARRANGEMENT OF INSTRUMENTS
CURRENTLY STANDARD IN THE ARMY



(Dotted line indicates basic "T", not to be painted on panel.)

Figure 33

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2.15.4. Analysis.

2.15.4.1. Although the avionic equipment controls and displays were satisfactory, incorporation of an integrated flight system in the standard pilot instrumentation is recommended to enhance mission support capability (figure 34).

2.15.4.2. Provisions for a weather radar system would increase the weather capability of the NU-8F. Radar display and control head space requirements could be met by moving the AN/ARC-55 control head to a position directly above the copilot intercom selector panel and expanding the resulting available space in the center of the radio panel (figure 32).

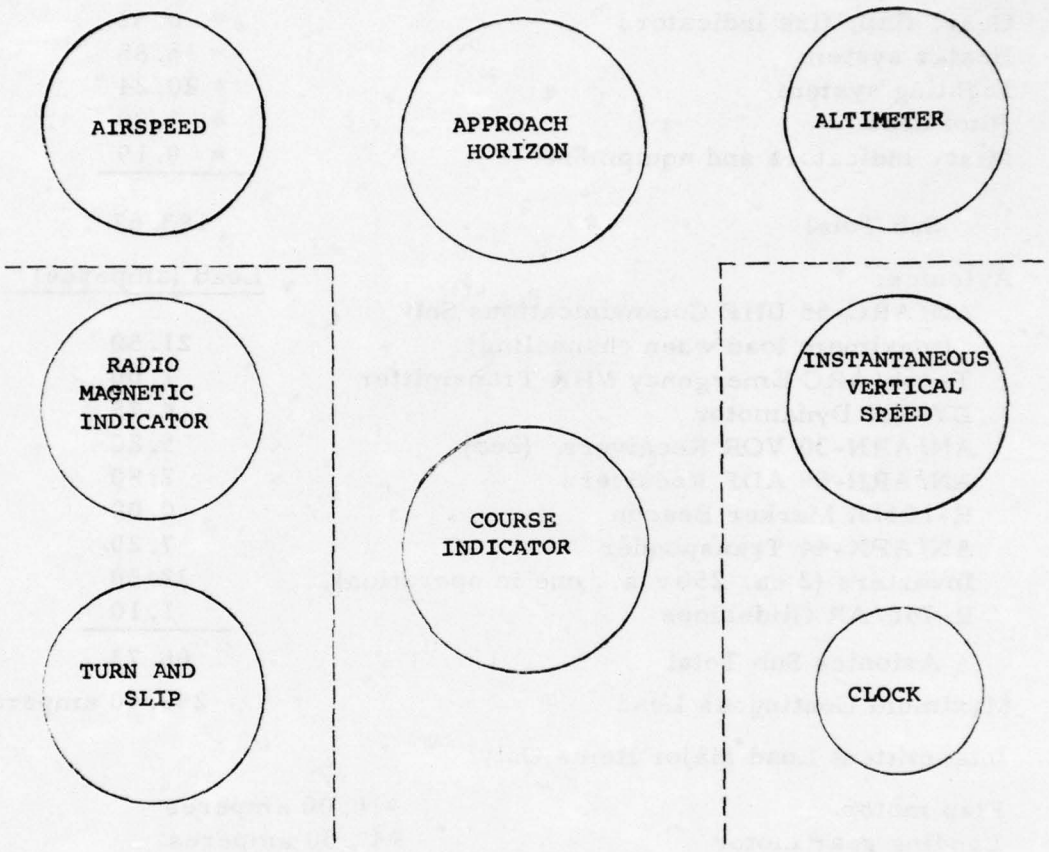
2.15.4.3. The weather capability would be further enhanced by an autopilot coupled with a flight director system. The autopilot control head could be mounted aft of the center control pedestal.

2.15.4.4. Inclusion of the above avionic equipment will require an increased generator output. One generator must be capable of supporting minimum navigation and communication equipment under night weather emergency conditions with one engine out. The present generators are rated at 200 amperes at 30-volts d.c. but are regulated to 170 amperes in flight. The anti-ice, heater, and fuel systems with supporting systems account for 172.19 amperes load, while the minimum navigational equipment and one inverter account for 48 amperes load for a total of 221.19 amperes. Intermittent loads will further overload the present generators (figure 35).

2.15.4.5. The avionic equipment recommended in paragraph 5, figure 35, must be judiciously installed to preclude aggravating or restricting some loading configurations such as the case of two pilots, full fuel and oil, and no passengers (figures 8 and 9).

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OPTIMUM PANEL ARRANGEMENT FOR INTEGRATED SYSTEMS



(Dotted line indicates basic "T", not to be painted on panel.)

Figure 34

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28-VOLT D. C. LOAD ANALYSIS - NU-8F

1. Continuous Load Equipment:	Load (amperes)
Anti-ice equipment	*107.81
Battery relays (reverse current relays)	* 2.50
Fuel system	* 23.46
Gear, flap, fire indicators	* 0.32
Heater system	* 16.85
Lighting system	* 20.24
Pitot heat	* 3.30
Misc. indicators and equipment	* 9.19
Sub Total	183.67

Avionics:	Load (amperes)
AN/ARC-55 UHF Communications Set (maximum load when channeling)	21.50
T-366/ARC Emergency VHR Transmitter	1.00
DY-107 Dynamotor	4.75
AN/ARN-30 VOR Receivers (2ea)	5.80
AN/ARN-59 ADF Receivers	2.80
R-1041A Marker Beacon	0.08
AN/APX-44 Transponder	7.20
Inverters (2 ea. 250 v.a., one in operation)	22.50
R-746/AR Glideslope	1.10
Avionics Sub Total	66.73
Maximum Continuous Load	250.40 amperes

2. Intermittent Load Major Items Only:

Flap motor	*16.00 amperes
Landing gear motor	*47.50 amperes
Landing lights	*17.86 amperes

3. Evaluation of adequacy of generator output was based on the capability of a single generator to supply power to minimum essential equipments under the most adverse conditions, i.e., night weather conditions on single engine:

*Manufacturer's Data

Figure 35

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a. Continuous load equipment less non-essential elements of lighting system (dome, anticollision and reading lights) 173.19 amperes

b. Avionics:

AN/ARC-55 (UHF)	21.50 amperes
Inverter	22.50 amperes
AN/ARN-30 (VOR)	2.90 amperes
Glideslope	1.10 amperes

c. Minimum essential load 221.19 amperes

Present 170 ampere, 28.75-volt d.c. generators are inadequate. (The generators are rated at 200 amperes at 30-volts d.c. but are regulated to 170 amperes in flight by over-current relays and 28.75-volt d.c. by carbon pile voltage regulators.) Recommend that 300-ampere, 30-volt d.c. brushless generators be installed. The weight increase of generators, brackets, wiring, and switches to sustain the increased load is approximately 35 pounds.

4. Optional Avionics Equipment:

Item	Net Increase in Weight	Power or Current
AN/ATN-158 Weather Radar	49.4 lb.	348 v.a.
FD-105C (Micro-Miniaturized)	16.7 lb.	1 amp d.c. 150 v.a.
AN/ASW-12(V) Automatic Flight Control System	40.3 lb.	9.9 amp d.c. 111 v.a.
HF Comm (ARC-102)	91.0 lb.	40 amp d.c.
DME	34.0 lb.	55 amp

Various combinations of the above options will necessarily require larger inverters than the present 250 v.a. inverters. Typical inverters are:

Capacity (v.a.)	Weight (lb.)	Peak Input Current (amperes)
250	16	22.5
750	28	52
1500	44	108

5. Recommend the following additional equipment be standard on NU-8F Airplane, in following priority:

a. AN/ATN-158 Weather Radar

b. FD-105C (Micro-Miniaturized) Integrated Flight System

c. AN/ASW-12(V) Automatic Flight Control System

Figure 35 (Cont'd)

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2.16. STABILITY AND CONTROL.

2.16.1. Objective.

To make a qualitative analysis of the stability and control of the NU-8F Airplane by evaluating the following characteristics:

a. Static longitudinal stability.

b. Dynamic longitudinal stability.

c. Static directional and lateral stability.

2.16.2. Method.

Static longitudinal, directional, and lateral stability, and dynamic longitudinal stability were evaluated qualitatively using FAA test methods specified in Civil Aeronautics Manual 3, May 1962 as changed.

2.16.3. Results.

2.16.3.1. Static longitudinal stability was positive. Resultant fore and aft stick forces encountered were estimated to be within the 40 pounds maximum prescribed by FAA.

2.16.3.2. Dynamic longitudinal stability was excellent. The oscillations encountered during this test were consistently "long term" (25 - 27 seconds). The airplane stabilized two knots below the initial trimmed speed.

2.16.3.3. Static directional and lateral stability were positive in all configurations tested. When released from the induced skid or sideslip condition, the airplane returned to its trimmed condition. During these tests, full rudder deflection failed to produce a reversal of rudder pressure (rudder lock).

2.16.4. Analysis.

Stability and control characteristics were adequate.

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2.17. ORGANIZATIONAL MAINTENANCE, SERVICE, AND GROUND-SUPPORT REQUIREMENTS.

2.17.1. Objective.

To determine the organizational maintenance, service, and ground-support requirements of the NU-8F Airplane by evaluating:

a. Petrol, oil, and lubricants (POL) and parts consumption.

b. Skills and man-hours required for organizational maintenance.

c. Adequacy of common tools and equipment.

d. Requirements for special tools and equipment.

2.17.2. Method.

2.17.2.1. Organizational maintenance, service, and ground-support requirements were determined through observations and accumulation of data during maintenance, service, and ground-support activities for the NU-8F Airplane. Two Army aircraft mechanics, MOS 671.20 and 672.20, with very limited experience on U-8F type aircraft were assigned to maintain the NU-8F for the test under the supervision of a maintenance officer. They were assisted by one airplane manufacturer's technical representative and one engine manufacturer's technical representative. The mechanics and maintenance officer attended a three-day maintenance familiarization course at the airplane manufacturer's plant.

2.17.2.2. Maintenance was performed in accordance with AR 750-6.

2.17.2.3. References used for this portion of the test were:

a. AR 750-6, Maintenance of Supplies and Equipment.

b. Manufacturer's Preliminary Pilot's Flight Operation Manual.

c. Manufacturer's Preliminary Maintenance Manual.

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d. Manufacturer's Maintenance Manual for the PT6A Turboprop Engine.

e. Manufacturer's Parts Catalog for PT6A Turboprop Engine.

f. Applicable technical manuals.

2.17.3. Results.

2.17.3.1. POL and Parts Consumption.

2.17.3.1.1. Actual fuel consumption was approximately the same as specified by the manufacturer. Fuel consumption was considerably higher than that of the U-8F; however, a considerably greater airspeed was derived. For actual fuel consumption, see figure 23.

2.17.3.1.2. No oil changes are required by manufacturer specifications during the life of the engine. Oil was added as needed. Oil consumption was one quart per 20 flying hours.

2.17.3.1.3. Of the 68 different parts replaced during the test, 40 were interchangeable with the U-8F. The remaining 28 parts were for the PT6A-6 engines.

2.17.3.2. Skills and Man-Hours Required for Organizational Maintenance.

2.17.3.2.1. The mechanics encountered no serious difficulty in performing maintenance of the airplane and felt that they could have maintained the airplane without factory technical representatives on site.

2.17.3.2.2. Maintenance man-hours on the airframe of the NU-8F compared favorably to those of the U-8F.

2.17.3.2.3. Engine maintenance man-hours were considerably less than those of the U-8F.

2.17.3.2.4. Avionic maintenance required less man-hours than that of the U-8F due to better accessibility of avionic equipment.

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2.17.3.2.5. The average time required to perform the routine maintenance inspections was as follows:

a. Daily inspection: 30 minutes.

b. Intermediate (25 hours) inspection: 4 hours.

c. Periodic (100 hours) inspection: 32 hours.

2.17.3.3. Adequacy of Common Tools and Equipment.

2.17.3.3.1. Army Aircraft General Mechanic Tool Set, FSN 5180-323-4692, and Army Aircraft Organizational Maintenance Tool Set, FSN 518-323-5037, were adequate for the performance of organizational maintenance except as stated in paragraph 2.17.3.4 below.

2.17.3.3.2. The ground-support equipment presently found in the Army inventory was adequate for the NU-8F Airplane.

2.17.3.4. Requirements for Special Tools and Equipment.

The NU-8F airframe was maintained with the same special tools provided for the U-8F. Special tools for maintaining the PT6A-6 engines were available. However, no maintenance requirements arose for their use.

2.17.3.5. Miscellaneous Comments.

See section 3, parts II and III, appendix II.

2.17.4. Analysis.

A tactical organization would be able to maintain the NU-8F using common tools, ordinary skills, and usual time available.

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2.18. COMPARISON OF NU-8F WITH U-8F.

2.18.1. Objective.

To compare the characteristics and performance of the NU-8F Airplane with the U-8F Airplane.

2.18.2. Method.

A comparison was made by extracting data from the NU-8F test results and comparing it with U-8F handbook data showing significant advantages and disadvantages.

2.18.3. Results.

COMPARISON OF NU-8F WITH U-8F

Item	Characteristic	NU-8F (Turboprop)	U-8F (Reciprocating Engine)
1.	Dimensions		
	a. Length	35 feet 4 1/2 inches	33 feet 3 1/2 inches
	b. Wing span	45 feet 10 1/2 inches	45 feet 10 1/2 inches
	c. Height	14 feet 8 inches	14 feet 2 1/2 inches
2.	Maximum allowable gross weight	8,700 lb.	7,700 lb.
3.	Basic weight	5,081 lb.	5,504 lb.
4.	Useful load (difference between maximum gross weight and basic weight)	3,619 lb.	2,196 lb.
5.	Payload (useful load less 200-pound pilot, full fuel, and oil)	1,045 lb.	592 lb.

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Item	Characteristic	NU-8F (Turboprop)	U-8F (Reciprocating Engine)
6.	Engine rating	500 s.hp.	340 s.hp.
7.	Engine time before overhaul	600 hours	2,000 hours
8.	Normal cruise speed		
	a. 10,000 ft.	220 knots True Airspeed (TAS)	170 knots TAS
	b. 15,000 ft.	220 knots TAS	170 knots TAS
	c. 20,000 ft.	220 knots TAS	170 knots TAS
9.	Maximum operating speed (airspeed indicator red line at all altitudes)	234 knots IAS	234 knots IAS
10.	Range (less 30 minutes fuel reserve and no wind at cruise speed shown in item 8 above)		
	a. 10,000 ft.	970 N.M.	880 N.M.
	b. 15,000 ft.	1,100 N.M.	920 N.M.
	c. 20,000 ft.	1,240 N.M.	980 N.M.
11.	Climbs, 2 engines at sea level	2,050 f.p.m.	1,304 f.p.m.
12.	Climbs, single engine at sea level	640 f.p.m.	184 f.p.m.

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Item	Characteristic	NU-8F (Turboprop)	U-8F (Reciprocating Engine)
13.	Service ceiling, 2 engines at maximum gross weight	28,400 ft.	28,000 ft.
14.	Service ceiling, single engine at maximum gross weight	14,000 ft.	12,000 ft.
15.	Normal takeoff distance at sea level over 50-foot barrier, no wind, maximum landing weight, 0^{o} flaps hard surface runway	1,918 ft.	2,855 ft.
16.	Normal landing distance at sea level, over 50-foot barrier, no wind, maximum landing weight, full flaps	3,292 ft.	2,572 ft.
17.	Fuel	JP-4, JP-5, Aviation Kerosene (JET A-1)	100/130 Aviation Gasoline
18.	Alternate fuels	JP-1, Aviation Gasoline Grades 80/87, 91/96, 100/130 (for 150 hours engine life only)	115/145 Aviation Gasoline
19.	Oils	Esso Aviation Turbo Oil 35, Esso Turbo Oil 35, Aeroshell 750, Wakefield Castrol 98	Grade 1065, Grade 3050 (SAE 20)

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Item	Characteristic	NU-8F (Turboprop)	U-8F (Reciprocating Engine)
20.	Oxygen endurance	Same for both airplanes; e.g., with the maximum number of persons aboard (6 occupants) the oxygen endurance is as follows: 10,000 feet - 2.5 hours 15,000 feet - 2.3 hours 20,000 feet - 2.1 hours	
21.	Safety features	a. Auxiliary tanks gravity feed to main tanks less 44 gallons/per wing	a. No gravity feed
		b. All tanks feed automatically during normal operation.	b. Fuel tanks are manually selected subject to fuel mismanagement.
		c. Main and standby fuel boost pumps operate automatically.	c. Main and auxiliary fuel pumps must be manually selected.
22.	Training requirement		
	a. Aviator	a. Easier to transition	a. N/A
	b. Mechanics	b. Simpler engine and systems; easier to teach	b. N/A
23.	Advantages and potential uses	a. Trainer for CV-7a	a. N/A
		b. Utility transport	b. Utility transport
		c. Limited cargo (heavier loads than U-8F)	c. Limited cargo

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Item	Characteristic	NU-8F (Turboprop)	U-8F (Reciprocating Engine)
24.	Advantages and potential uses	d. Greater variety of fuels can be used	d. Limited fuels for use
		e. Standardization of Army policy toward all turbine fleet	e. N/A
		f. Ease of fuel logistics (single turbine fuel - JP-4)	f. N/A
		g. Better two-engine and single-engine performance	g. N/A
		h. Higher cruise speeds	h. N/A
		i. Reduced noise levels	i. N/A
		j. Easier to start, operate, and shut-down.	j. N/A
		k. Easier to maintain	k. N/A

2.18.4. Analysis.

The NU-8F Airplane was found to be a significant improvement over the U-8F because of its greater payload, higher normal cruise speed, greater range, vastly better two-engine and single-engine performance, versatility in choice of fuels, safety features, and simplicity and ease for training aviators and mechanics.

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SECTION 3 - APPENDICES

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APPENDIX I

LIST OF REFERENCES

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APPENDIX I

LIST OF REFERENCES

1. Plan of Test, USATECOM Project No. 4-4-1005-01, "Military Potential Test of the NU-8F Airplane," US Army Aviation Test Board.

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5. USATECOM Regulation 705-2, 24 September 1963.

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11. Letter, US Army Aviation Human Research Unit, 20 May 1964, subject: "Human Factors Evaluation of Beechcraft Turbine Engine NU-8F Command/Liaison Aircraft."

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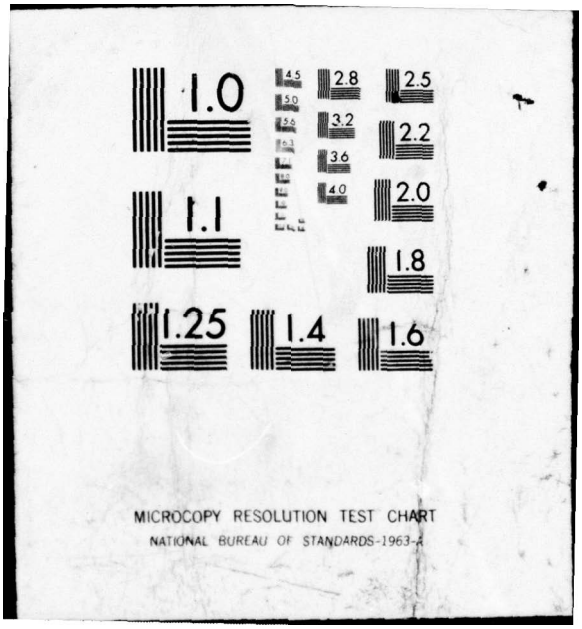
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APPENDIX II

TEST DATA

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PART I - Detailed Description of Materiel

PART II - Maintenance Test Data

PART III - Maintenance Items

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APPENDIX II

PART I

DETAILED DESCRIPTION OF MATERIEL

1. The NU-8F Airplane has the same fuselage as the U-8F except for a larger vertical stabilizer swept back 41 degrees and a ventral fin below the empennage for added stability and has two PT6A-6 free-turbine engines installed. The NU-8F has increased fuel capacity to 360 US gallons, increased gross weight to 8700 pounds, and increased braking capacity. The wing group has increased strength to provide for the higher gross weight of the airplane and greater thrust of the PT6A-6 engines.

2. The PT6A-6 engine is a free-turbine engine employing a three-stage axial, single-stage centrifugal compressor driven by a single-stage reaction turbine. Another single-stage reaction turbine, counter-rotating and facing with the first, drives the airplane propeller through reduction gears. Engine fuel is sprayed into the annular combustion chamber by fourteen fuel nozzles mounted in the outer periphery of the combustion chamber (gas generator case). An ignition unit and two coil igniter plugs are used to start combustion. The fuel flow control schedule is maintained by a hydro-pneumatic unit, which is regulated by a power control lever (throttle). All accessories are gear-driven from the main compressor shaft.

3. Each engine turns a hydraulically-controlled, constant-speed, three-bladed, full-feathering propeller. Propeller speed is maintained by a propeller governor at the r.p.m. selected by the pilot-controlled propeller lever.

4. The NU-8F has electrically-heated windshields, electro-thermal propeller deicers, electrically-heated deicer boots at the engine air inlets, pneumatic deicer boots on the leading edges of the wings and empennage, and an electrically-heated pitot tube. The pneumatic boots are inflated by engine bleed air. The engine air inlets incorporate screens which are protected during flight in icing conditions by spraying alcohol into the incoming airflow upstream of the screens. Alcohol pump operation is indicated by two amber lights on the instrument panel.

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PART II

MAINTENANCE TEST DATA

1. The NU-8F was accepted by the US Army Aviation Test Board on 13 March 1964 with 193:40 hours on the airframe and 43:50 hours on each engine. The following major discrepancies were noted:

a. Cracks at top of No. 1 and No. 2 engine air-intake scoop.

b. Copilot's RMI inoperative.

c. UHF radio weak.

d. No. 2 engine main boost pump inoperative.

2. No air-intake covers were provided for the airplane. To prevent foreign object damage, covers were locally designed and manufactured. These items have proven adequate.

3. The manufacturer's preliminary flight and maintenance manuals were not sufficiently comprehensive and did not conform to standard military manual format.

4. The seats are fully reclining. However, if seat backs are reclined too far back, the cam will disengage from the seat rail. The seat must then be removed to re-engage the cam. Recommend that a stop be installed to prevent disengagement of the cam.

5. There were very sharp edges on the corners of the ash trays which tore clothing and injured passengers' legs. The edges were filed during the test. Recommend that the ash trays be modified with rounded edges.

6. The right main boost pump required four hours for replacement. The access hole for replacement of this boost pump was too small. Recommend that the access hole to the right and left pumps be enlarged to approximately eight inches in diameter which would reduce the time for replacement of the pump by approximately three hours.

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7. The front top cowling fasteners have casket type locks which required a six-point socket wrench. Standard issue sockets have twelve points. Recommend that the casket type locks be modified to accommodate the standard issue twelve-point socket in order to eliminate a special tool.

8. The data plate on the landing gear struts read the same as that on the U-8F. However, because of the increased gross weight of this airplane, the nose gear strut must be inflated an additional two inches and the main gear struts inflated an additional 1 1/2 inches to prevent the struts from bottoming-out on landings. Recommend that the data plates be changed to read correctly for the NU-8F.

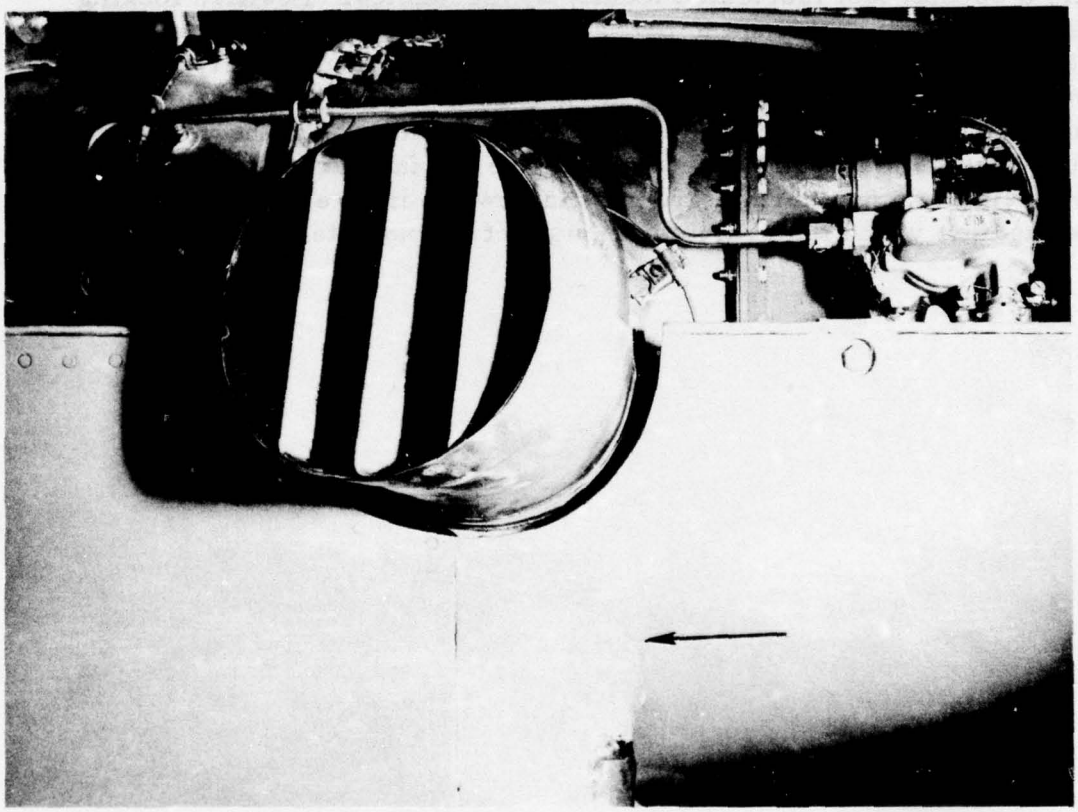


Figure 36. Engine cowl with cracks at engine scoop.

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9. The combustion chambers were changed on or about 4 May 1964 in accordance with a factory modification. The purpose was to reduce the amount of smoke from the exhaust stacks. The modification reduced the amount of smoke but the smoke accumulation that now forms on the wing and nacelle surfaces was extremely difficult to remove. Before the modification, the smoke could be easily wiped off with a soft cloth.

10. The cracks at the engine air-intake scoops (both sides of each engine and also inside the scoop) were due to improper bonding of the plastic filler material to the metal cowl (see figure 36). It is believed that this discrepancy is correctible by the manufacturer.

11. Access to the fuel strainer drain cock, which was recessed into the lower mid-section of the nacelle, was extremely difficult even with a special tool fabricated locally by mechanics. Positive locking was difficult, increasing the probability of fuel loss by leakage. With the fuel firewall valve closed, an improperly closed fuel strainer drain cock was not apparent during a routine draining of the fuel strainer sump. The drain cock should be more accessible. Furthermore, it must become standard procedure to leave the fuel firewall valve in the ON position during normal ground shutdown to insure a static head of fuel against which the drain cock must act to indicate no leaking.

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PART III

MAINTENANCE ITEMS

The following list was extracted from DA Form 2408-13, Aircraft Inspection and Maintenance Record, used for the NU-8F during the test.

Maintenance Item	Corrective Action	Man-Hours
1. Cracks at top of No. 2 engine air-intake scoop.	Temporarily repaired.	00:10
2. Cracks at top of No. 1 engine air-intake scoop.	Temporarily repaired.	00:10
3. Copilot's RMI inoperative.	Installed C-6H gyrosyn indicator.	00:30
4. Carpet in the way of copilot' foot mike button.	Removed foam rubber.	00:10
5. Throttles need synchronizing.	Throttles synchronized.	00:30
6. Propeller controls need synchronizing.	Propeller controls synchronized.	00:15
7. Holes in pilot's oxygen mask.	Replaced mask.	00:10
8. Holes in copilot's oxygen mask.	Replaced mask.	00:10
9. Copilot's oxygen tube line red flow spring missing.	Flow spring replaced.	00:10
10. Right engine main boost pump inoperative in flight.	New pump installed.	04:00

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Maintenance Item	Corrective Action	Man-Hours
11. Remove pilot's directional gyro and installed C-6H gyrosyn indicator.	Installed C-6H and replaced loose avionics.	06:00
12. UHF squelch inoperative.	Replaced RT-349 and checked system.	01:00
13. Right front passenger seat rack needs repairing.	Repaired.	00:30
14. No. 1 engine propeller governor needs adjusting.	Governor adjusted.	00:30
15. No. 2 engine propeller governor needs adjusting.	Governor adjusted.	00:30
16. Oil filter on No. 1 engine needs changing.	Filter changed.	00:15
17. Oil filter on No. 2 engine needs changing.	Filter changed.	00:15
18. Battery instrument check due.	Completed.	00:30
19. Ground wire broken on nose wheel.	Repaired ground wire.	00:30
20. No. 1 propeller seal leaking.	Gasket replaced on propeller governor.	00:15
21. Engine anti-ice fluid does not register below 1/4 full.	Gauge recalibrated.	00:30

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Maintenance Item	Corrective Action	Man-Hours
22. Engine anti-ice lights go on in auto-position.	None.	None.
23. Right lower cowling cracked at front top left corner.	Repaired.	00:15
24. Rivets pulling loose left lower cowling top left and right corners.	Repaired.	01:45
25. Right transfer pump inoperative.	Repaired.	00:20
26. Heater inoperative.	Repaired.	00:10
27. Deicer boot pressure exceeds red line at high power settings.	Valve adjusted.	00:15
28. Copilot's artificial horizon reads 1/2 bar left wing low.	Replaced artificial horizon.	02:00
29. Oxygen system leaking.	Outlets tightened.	00:05
30. Screw in top left wing panel marked LW 24 needs replacing.	Replaced screw.	00:05
31. Copilot's altimeter sticks.	Replaced altimeter.	01:00

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Maintenance Item	Corrective Action	Man-Hours
32. Right engine transfer pump inoperative in flight after 3 1/2 hours of flight.	Replaced pump.	01:30
33. Suction gauge reads high.	Readjusted.	00:30
34. R-1041A marker beacon inoperative.	Replaced R-1041A marker beacon.	00:30
35. Four bolts installed in wrong position at No. 2 fire detection mounts.	Repositioned bolts.	00:35
36. Pilot's compartment doors off tracks and need adjusting.	Adjusted and reglued sound proofing.	00:30
37. Brake pucks need changing.	Installed brake pucks.	00:35
38. Wheel bearings need packing.	Bearings packed.	00:30
39. Right wing aileron trim down 4 degrees.	Trim tab adjusted.	00:05
40. No. 1 propeller seal leaking.	Replaced damaged seal.	00:20
41. Heater insufficient on AUTO position.	Adjusted heater control.	00:20
42. No. 1 fuel flow gauge has slight fluctuation.	See entry No. 49.	

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Maintenance Item	Corrective Action	Man-Hours
43. Engine oil filters on No. 1 and No. 2 overdue change.	Replaced filters.	00:20
44. Lights out on copilot's flight instruments.	Replaced bulbs.	00:15
45. Right landing gear indicator shows gear up.	Landing gear greased and adjusted indicator.	00:30
46. No. 1 main boost pump inoperative.	Replaced pressure switch.	00:30
47. Right top cowling right front corner rivet pulling loose.	Rivet tightened.	00:10
48. Left propeller bent.	Replaced propeller and front engine section.	27:00
49. No. 1 engine fuel flow gauge has severe fluctuation at 80-percent power on ground run-up.	None.	None.
50. No. 2 engine fuel flow gauge has severe fluctuation at 80-percent to 100-percent power on ground run-up.	None.	None.
51. Right pressure regulator needs replacing.	Replaced.	01:30

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Maintenance Item	Corrective Action	Man-Hours
52. No. 1 turbine surges during extended ground operation at high power setting.	None.	None.
53. No. 2 turbine surges during extended ground operation at high power setting.	None.	None.
54. Copilot's altimeter needs adjustment to pilot's altimeter.	Altimeter adjusted.	00:10
55. Anti-ice gauge sticks.	Replaced.	02:00
56. Bracket broken on right main landing gear door left side.	Fabricated.	02:00
57. Fuel filters on No. 1 and No. 2 engines need replacing.	Replaced filters.	00:20
58. Bracket cracked on inboard and outboard landing gear door left-hand side.	Cracks stop drilled.	00:10
59. Bracket cracked on landing gear door outboard right-hand gear.	Crack stop drilled.	00:10

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Maintenance Item	Corrective Action	Man-Hours
60. No. 1 fuel indicator sometimes spins in flight.	None.	None.
61. UHF squelch inoperative.	Replaced RT-349 (UHF) and adjusted squelch.	00:30
62. Landing gear hung up twice in flight.	Removed graphite from actuator and regreased.	00:40
63. Change red line from 208 knots to 234 knots on airspeed indicators. Authority: FAA letter.	Marked red line at 234 knots, yellow from 208-234 knots, green from 80-208 knots.	01:00
64. Marker beacon inoperative.	Replaced marker beacon receiver.	00:10
65. Right altimeter light inoperative.	Replaced bulb.	00:02
66. Right fuel pressure switch inoperative.	Replaced switch.	00:30
67. No. 1 and No. 2 oil filter change due.	Replaced filters.	00:30
68. Airplane needs landing gear lubricated.	Landing gear lubricated.	00:20
69. Pin burned on Omni mount.	Replaced mount.	02:00
70. Landing gear warning horn signal erratic.	Tightened loose connection.	00:20

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Maintenance Item	Corrective Action	Man-Hours
71. Heater will not operate above 20,000 feet.	Replaced pressure switch on heater fuel.	01:00
72. Left engine idles at 60 percent N_1 during taxiing.	Adjusted fuel control.	00:30
73. Right fuel standby boost pump pressure control line needs capping.	Repaired and replaced control.	00:30
74. Left fire warning light inoperative on test.	Tightened connection.	00:30
75. Leak in oxygen system.	Outlets tightened.	00:05
76. Right engine accelerates 1 1/2 seconds faster than left engine.	Flight check ok after adjustment made.	00:30
77. Ground wire broken on nose wheel.	Replaced cable.	00:15
78. Throttles are not synchronized at mid-range of quadrant.	Flight check ok after adjustment made.	01:00
79. No. 1 torque gauge sticks.	Replaced.	01:00
80. Left wing inboard flap paint peeling off.	Spot painted.	00:10

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Maintenance Item	Corrective Action	Man-Hours
81. UHF squelch inoperative.	Adjusted sensitivity.	00:20
82. UHF squelch inoperative.	Adjusted squelch and side tone.	02:00
83. Master key switch loose.	Tightened switch.	01:00
84. No. 2 Omni radio intermittent.	Replaced receiver.	01:00
85. Main inverter intermittent.	Repaired and replaced inverter.	06:00
86. Right auxiliary fuel tank filler cap broken.	Painted cap.	00:10
87. Right auxiliary fuel tank filler cap needs painting.	Painted cap.	00:10
88. Cockpit compartment doors need spot painting.	Spot painted.	00:10
89. Left main landing gear tire worn.	Replaced tire.	00:30
90. Standby magnetic compass deviates 5 degrees with windscreen heater on.	None.	None.
91. Right main landing gear tire worn.	Replaced tire.	00:30
92. Brake pucks need changing.	Replaced pucks.	00:30

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Maintenance Item	Corrective Action	Man-Hours
93. Brackets need replacing on main landing gear doors.	Replaced brackets.	06:00
94. Several screws loose on step.	Tightened.	00:05
95. No. 1 fire warning light inoperative.	Repaired wire.	00:20
96. Oil filters due replacement.	Replaced.	00:30
97. No. 1 and No. 2 engine combustion chambers due change in accordance with factory modification.	Changed combustion chambers.	24:00
98. No. 1 and No. 2 engine fuel controls due change in accordance with factory modification.	Changed fuel controls.	04:00
99. Fuel nozzles not safetyed.	Safetyed.	02:00
100. Upholstery along seat tracks in floor loose.	Reglued upholstery.	00:20
101. Wrong type of fire extinguisher installed in aircraft.	Req. No. 15657-64.	None.
102. Periodic inspection due.	Completed.	32:00
103. No. 1 engine cowling removed for periodic inspection.	Reinstalled cowl.	00:15

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Maintenance Item	Corrective Action	Man-Hours
104. No. 2 engine cowling removed for periodic inspection.	Reinstalled cowl.	00:15
105. No. 1 engine propeller spinner removed for periodic inspection.	Reinstalled spinner.	00:15
106. No. 2 engine propeller spinner removed for periodic inspection.	Reinstalled spinner.	00:15
107. No. 1 and 2 propellers need servicing.	Serviced.	00:30
108. Inspection plates removed for periodic inspection.	Replaced.	02:00
109. Main landing gear track screw needs servicing.	Greased.	00:20
110. Passenger seats removed for periodic inspection.	Reinstalled.	00:20
111. Passenger seat belts removed for periodic inspection.	Reinstalled.	00:30
112. Cockpit seat belts and shoulder harness removed for periodic inspection.	Reinstalled.	00:15

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Maintenance Item	Corrective Action	Man-Hours
113. Copilot shoulder harness reel will not release.	Readjusted.	00:15
114. Aileron control cables tension low.	Adjusted tension.	02:00
115. Throttle linkage not equal.	Adjusted linkage.	00:10
116. Left fire warning light intermittent on test.	See entry No. 123.	None.
117. Right deicing pressure switch needs checking.	Pressure switch removed and moisture removed from switch.	02:30
118. Right deicing pressure needs adjusting.	Pressure switch adjusted.	00:10
119. No. 1 engine air-intake scoop cracked.	None.	None.
120. No. 2 engine air-intake scoop cracked.	None.	None.
121. No. 1 engine fuel flow gauge fluctuates approximately 50 lb/hr at medium-to-high torque settings at 2200 r.p.m. It also fluctuates in flight at medium-to-high torque settings at 1900 r.p.m.	None.	None.

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Maintenance Item	Corrective Action	Man-Hours
122. Landing gear warning horn came on during landing roll.	Replaced broken inboard micro switch right main gear.	00:30
123. Left fire warning light unreliable.	None.	None.
124. Key switch fell out.	Repaired and replaced switch.	04:30

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APPENDIX III

DEFICIENCIES AND SHORTCOMINGS

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APPENDIX III

DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES.

Deficiency	Suggested Corrective Action	Remarks
a. The fire-wall fuel valve switch and the main fuel boost pump switch are identical and adjacent to each other causing confusion to operate.	Place a guard cover over the fire-wall valve switch.	None.
b. The heater is inoperative above 20,000 feet.	Redesign the heater to function up to service ceiling.	None.
c. The oxygen pressure gauge is not readable from the cockpit.	Install a second pressure gauge adjacent to the deicer boot's pressure gauge.	None.
d. The limited oxygen supply restricts the duration of missions at high altitudes where the NU-8F is most efficient.	Pressurize the cabin.	None.
e. The capacity of the generators is inadequate to meet the minimum required electrical load under night weather conditions with one engine out.	Install 300-amp, 30-volt d.c. brushless generators.	None
f. The engine has intermittent small power fluctuations in flight and violent fluctuations at high power settings during power run-ups.	The manufacturer should determine and eliminate the cause.	None.

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Deficiency	Suggested Corrective Action	Remarks
g. Presently installed nonstandard inverters failed in less than 300 flight hours.	Install standard inverters with a life of at least 1000 hours.	None.
h. Excessive roll occurs when stalling with the airplane in the landing configuration with power on or off.	Install corrective stall strips on the leading edge of the wing.	This FAA observed deficiency has been corrected on the civilian production model (King Air), according to the manufacturer.
i. The engine alcohol anti-ice system, when operated in the automatic position, permits deicing fluid to flow when not required.	The manufacturer should determine and eliminate this deficiency.	None.

2. SHORTCOMINGS.

Shortcoming	Suggested Corrective Action	Remarks
a. Filling the auxiliary fuel tanks first will result in less than full fuel.	"FILL MAIN TANKS FIRST" should be stenciled adjacent to the auxiliary fuel filler cap.	None.
b. Both 6-volt and 28-volt light bulbs are used on instruments and gauges.	Standardize all instrument and gauge lights to 28 volts.	None.

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Shortcoming	Suggested Corrective Action	Remarks
c. All flight instruments except the pilot's RMI and artificial horizon are dimly lighted.	Increase the brightness of the bulbs.	None
d. The pilot's flight instruments were not arranged in accordance with the Army standard "T" panel.	Rearrange the pilot's flight instruments to conform to the Army standard "T" panel.	None.
e. The fuel flow meters and fuel tank gauges are not calibrated in the same units.	Calibrate the fuel tank gauges in pounds of fuel.	None.
f. The pilot's vent-air handle and parking brake handle are too close and identical in appearance and feel.	Redesign the brake handle with a different shape and color the handle red.	None.
g. Two OAT gauges, installed at different locations, read differently.	Eliminate the overhead OAT gauge and increase the scale size of the installed gauge.	None.
h. The marking "fuel" beneath the propeller overspeed governor test switch served no purpose.	Delete this mark from future models.	None.
i. The access cover to the oxygen bottle cannot be readily opened and closed.	Hinge the cover at its bottom and substitute a winged Dzus fastening for the screw fastening.	None.

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Shortcoming	Suggested Corrective Action	Remarks
k. The APU receptacle cover is located in the path of the exhaust gases of No. 2 engine.	Relocate the receptacle and install a spring-loaded hinged-type cover that will close unaided after withdrawal of the APU cover and will not open against the slip-stream.	None.
l. Residual thrust of propellers prolongs the landing ground roll.	Install reverse pitch propellers.	None.
m. The access holes to main boost pumps are too small.	Enlarge access holes to approximately eight inches in diameter.	None.
n. The cowl casket locks require use of a nonstandard 6-point socket wrench.	Modify locks to fit a standard 12-point socket wrench.	None.
o. The landing gear data plates show the wrong strut inflation information.	Install correct data plates.	None
p. The manufacturer's operator's manual and maintenance manuals provided do not conform to standard Army format.	No action recommended at this time because the NU-8F is a one-of-a-kind test bed.	None.
q. The cam at the passenger seat back can disengage from the seat rail if the seat is reclined too far.	Install a cam stop to prevent disengagement of the cam.	None.

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3. Corrected Deficiencies/Shortcomings.

Deficiency/Shortcoming	Corrective Action	Remarks
a. The oil pressure gauges were improperly marked.	Re-marked gauges.	None.
b. Oil temperature gauges were improperly marked.	Re-marked gauges.	None.
c. The standby magnetic compass deviates with the windshield heater on.	Warning placard was placed above the compass.	None.
d. No standby magnetic compass card holder for disposable correction card is installed.	Installed a correction card holder.	None.
e. Ash trays have sharp edges.	Edges were rounded.	None.

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APPENDIX IV

COMMENTS FROM FEDERAL AVIATION AGENCY AND PARTICIPATING AGENCIES

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PART I - Federal Aviation Agency Comments

PART II - US Army Aviation Research Unit Human Factors Evaluation of NU-8F Command/Liaison Aircraft

PART III - US Army Aeromedical Research Unit Noise Level Survey of NU-8F Aircraft

PART IV - US Army Board for Aviation Accident Research Evaluation of NU-8F Aircraft and Recommended Changes

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Part I

Federal Aviation Agency
Control Region
4825 Troost Avenue
Kansas City, Missouri 61110

Mar 10, 1964

Commanding Officer CE-210
U. S. Army Transportation Research Command
Ft. Eustis, Virginia

Attention: Contracting Officer

Dear Sir:

The purpose of this letter is to complete the FAA portion of the "Beech NU 8F Memorandum of Understanding between the Department of the Army and the FAA" dated August 22, 1963.

Enclosed is a letter (Reference 903-51) dated 3/5/64 from the Designated Manufacturers Certification Representative at Beech Aircraft Corporation to the FAA certifying that the Model NU 8F airplane complies with the applicable airworthiness requirements listed in the Memorandum of Understanding with certain deviations. In accordance with the Memorandum of Understanding the FAA has conducted a routine verification program as outlined in FS P 8110.1. We have confined our evaluation and comments to types of operations which we expect would normally be encountered by this type of aircraft in Civil Aviation. Our comments on these deviations and any operational restrictions which should be imposed are as follows:

1. CAR 3.700c - Rear position lights

We agree that this is not a hazard to the safe operation of the airplane and no operational restriction is necessary.

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2. CAR 3.361 - Main landing gear wheels

The use of non TSO wheels which have been approved by the military for a heavier aircraft does not appear to present a hazard to the safe operation of the airplane, particularily in view of the operational experience that has been accumulated on the NU-8F aircraft by the contractor.

3. CAR 3.756 through 3.761 - Instrument markings

Presentation of markings in terms of standard military instrument limitations is not considered to present a hazard to the safe operation of the airplane.

4. CAR 3.449c (Special Conditions) - Electric driven fuel pumps

Failure of the electrical system buss, which is considered remote, could under extreme operating conditions and a combination of events, cause simultaneous engine malfunctioning or complete loss of power from both engines. This consequence is due to (a) dependence of the two electrical fuel pumps (main and standby) for each engine on the one electrical buss for power, and (b) the possibility of hazardous qualities of fuel vapor forming at the engine driven fuel pump inlet with the electrical pumps not operating. Fuel vapor formation depends on the type fuel used, airplane altitude, fuel temperature, and fuel pressure at the engine fuel pump inlet. Flight tests conducted by Beech have demonstrated capability of the airplane and engines to operate to an altitude of 26,000 feet using JP-4 fuel with the electric fuel pumps "OFF" without serious effects on engine operation. Fuel temperature at the time of the tests is not known. Forthcoming hot fuel tests by Beech in the Model 65-90 will determine any corrective measures necessary before hot weather airplane operations commence.

Our conclusions are that this noncompliance with CAR 3.449c (Special Conditions) will not likely create unsafe airplane and engine operations if fuel system components are maintained to minimize fuel pressure drops resulting from blocked fuel strainer, filters, or other parts, and the approved placards and operating instructions in the Airplane Flight Manual regarding emergency procedures for the electrical system are observed.

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5. CAR 3.438 - Hot fuel system tests

We are in agreement with Beech that the fuel system does not include features conducive to vapor locking under normal operating conditions. Since the results of hot fuel tests will be completed on the Beech Model 65-90 by April 1, we do not believe that an operational restriction need be imposed for the interim period. Should the results of the Beech tests indicate problem areas we would recommend correction of the system prior to operation in high temperature conditions.

6. CAR 3.415 (a) (Special Conditions) - Engine inlet vibration characteristics

Our review of data presented by Beech (UACL Report No. 364 dated November 6, 1963) shows that the engine will operate satisfactorily vibrationwise under extreme conditions of air pressure distortion at the compressor air inlet. Further, design analyses indicate that the NU-8F engine air inlet system will, under all normal airplane and engine operating conditions, supply air to the engine compressor inlet with a distortion pattern considerably less severe than the level substantiated by the engine manufacturer. We feel this background justifies operation of the airplane at this time without engine vibration restrictions. Beech proposes to complete the inlet distortion tests on the Model 65-90 by April 1, 1964, so that the Army operation of the airplane prior to this date should not accumulate total times in excess of those accumulated by Beech Aircraft Corporation. If revisions are necessary as shown by the Model 65-90 tests they should be incorporated in the NU-8F.

7. CAR 3.611a (Special Conditions) - Entrance of flammable fluids in the engine intake

We believe that airworthiness of the aircraft can be assured by inspection of the oil return lines and the combustor drains on the daily pre-flight inspection of the aircraft.

8. CAR 3.120 - Stall characteristics

Noncompliance with CAR 3.120 exists in that excessive roll occurs when stalling with the airplane in the landing configuration and power on or off. We recommend the pilot be informed on this condition and advised to recover from stalls when the stall warning horn or stall buffet is encountered.

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9. CAR 1.100 - Identification marking

This exception to the CAR was made to comply with military contractural requirements and no unairworthiness exists. The following items are applicable and are not covered by the Beech letter. Where reference is made to the Flight Operations Manual, Beech Part 130390 dated 3-1-64 is applicable.

10. CAR 3.85 - Balked landing climb

Balked landing climb data is not included in the Flight Operation Manual. The airplane has been demonstrated to comply with the balked landing requirements of CAR 3.85 (c).

11. CAR 3.735 - Operations limitation and information

Stall speeds are omitted from the Flight Operation Manual. This information should be included in the manual.

Engine re-starts have not been conducted at altitudes above 15,000 feet. This information should also be included in the Flight Operation Manual.

12. CAR 3.737 - Limitations

No limitations (red line or indices) are shown on torque pressure indicators. Pilots should be informed of the torque pressure build up during takeoff, and power should be monitored closely to assure torque limits are not exceeded.

The applicable Special Conditions to the NU 8F have been revised from those shown in the Memorandum of Understanding. The current Special Conditions upon which this certification is made are listed in Beech Aircraft Corporation letter 903-51. Copies of these can be furnished to the Army if desired.

Sincerely yours,

/s/John A. Carran
/t/JOHN A. CARRAN
Engineering & Manufacturing Branch
Flight Standards Division

Enclosures

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FEDERAL AVIATION AGENCY
CENTRAL REGION
4825 Troost Avenue
Kansas City, Missouri 61110

Mar 26, 1964

IN REPLY
REFER TO CE-212-VR

Commanding Officer
U.S. Army Transportation Research Command
Ft. Eustis, Virginia

Attention: Contracting Officer

Dear Sir:

The purpose of this letter is to supplement our letter to you dated March 10, 1964 which enumerated twelve items where the Beech NU8F aircraft deviated from the civil certification basis established for the aircraft.

Add item thirteen to our letter of March 10, 1964 as follows:

13. CAR 3.757 - Airspeed Indicator

The airspeed indicator may be marked per present CAR 3.757 instead of per the special condition which deleted the yellow arc and established the red radial at .8 V_D/M_D (208 knots). V_D for this aircraft is 300 mph (260 knots). Present CAR 3.757 would require a red radial line at .9V_D (270 mph, 234 knots), a yellow arc extending from this point to Vcruise (240 mph, 208 knots) and a green arc from V_C to V_{S1}.

We do not feel that marking the indicator in this manner constitutes a hazard providing the operator is aware that all operation in the yellow range must be with caution.

A copy of this letter is being forwarded to the Beech Aircraft Corporation for their information.

Sincerely yours,

/s/W.H. Harris
/t/John A. Carran, Chief
Engineering & Manufacturing Branch
Flight Standards Division

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PART II

U.S. ARMY AVIATION HUMAN RESEARCH UNIT
U.S. Continental Army Command
Post Office Box 428
Fort Rucker, Alabama

A Field Unit of
The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
Operating Under Contract With
The Department of the Army
HUMRRO

Telephone:
Fort Rucker 4101

20 May 1964

Major Harold Silver
U.S. Army Aviation Test Board
Fort Rucker, Alabama

Subject: Human Factors Evaluation of Beechcraft turbine engine NU-8F Command/Liaison aircraft

Dear Major Silver:

In connection with the military potential test you are conducting, I wish to submit the enclosed Human Factors Evaluation report on the Beechcraft NU-8F Command/Liaison aircraft.

Very truly yours,

/s/H. Alton Boyd, Jr.
/t/H. ALTON BOYD, JR.
Research Associate

HABjr/nsb

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US ARMY AVIATION HUMAN RESEARCH UNIT
FORT RUCKER, ALABAMA

19 May 1964

Human Factors Evaluation of Beechcraft NU-8F Command/Liaison Aircraft

1. Summary

1.1. The human factors design of the Beechcraft NU-8F Command/Liaison aircraft was found to be adequate for mission accomplishment. However, steps should be taken to alleviate the shortcomings listed under paragraph 2.

2. Detailed Considerations

2.1. The location of the APU plug causes the crewmen who operate in its area to be subject to burns by hot exhaust gases from the right engine unless the engine is not operating or its propeller is feathered. It should be relocated to avoid this operating hazard.

2.2. The cover of the APU plug may be opened only by a screwdriver type tool. To speed up and facilitate its operation, it should be fastened by a push-to-unlatch type fastener which may be activated by a crewman's finger.

2.3. No provision is made for a step or walkway on the wings to check the gas tanks. The tanks' relative inaccessibility will probably increase the incidence of failure to perform this important preflight procedure. Also, checking the oil dipstick is somewhat difficult due to its height and location on top of the engine. Hinging the cowling on both sides may alleviate this difficulty somewhat, especially for a short man. Cognizance is taken of the stowable, fly-away ladder designed to be used for these checks, but it is not felt that this is an efficient means of facilitating the preflight procedures. Provision should be made to increase the probability that the tanks are checked by reducing the difficulty and complexity of the procedure.

2.4. Access to the fuel strainer sump is extremely difficult, even with the special tool made locally by mechanics. Its positive locking is difficult--increasing the probability of fuel loss by leakage in flight. If, when it is checked, the fire wall valve is closed, the fact that the fuel strainer sump is not securely locked would not be apparent by leakage. It should be made more accessible.

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2.5. The location of the fuel gauges on the pilot's left wall panel produces some parallax when viewing the gauges from a normal head position.

2.6. The fuel flow meter is calibrated in pounds per hour but the fuel tank gauges are marked "1/4--1/2--3/4" (portions of a tank). To facilitate fuel management, fuel gauge markings should be marked in pounds.

2.7. On the left main panel, the vent air handle and parking brake handle are within approximately 6 inches of each other with one directly above the other. In addition, they are identical in appearance and feel. The position of one should be changed or its handle shape change significantly.

2.8. The engine fire warning lights are so high on the instrument panel that a pilot of more than six feet in height may miss a warning, having it obscured by the overhanging glare shield at the top of the panel. Larger lights or lower placement of the warning lights on the panel would be desirable.

2.9. Some instrument lights are 6 volt and others 24 volt. They should all be the same if possible to reduce logistical and maintenance complexity.

2.10. The standby magnetic compass reads erroneously as long as the electric windshield heater is turned on. This should be corrected or the standby compass should have a cautionary label.

2.11. The firewall fuel valve switches and fuel boost valve switches are adjacent and identical. Their confusion in flight could result in shutting off the fuel to an engine. The switches should be separated by more distance, having significantly different shapes, or different methods of activation.

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Part III

Technical Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-TO 9 June 1964

SUBJECT: Noise Level Survey of NU-8F Aircraft

TO: NU-8F Project Officer
Aircraft Test Division
United States Army Aviation Test Board
ATTN: Major Harold Silver
Fort Rucker, Alabama 36362

1. The noise levels reported herein were measured with a General Radio Octave Band Noise Analyzer, Type 1558-A. When used with a GR type 1560-P3 Microphone the analyzer indicates directly the sound pressure level in any of its 12 bands, for levels between 44 and 150 db (Re 0.0002 dyne/cm^2). Prior to utilization the analyzer was calibrated electrically and acoustically. Calibration was accomplished with a General Radio Sound Level Calibrator (Model 1552B) and transistor oscillator (Model 1307-A). A 25-foot extension cable (Type 1560-P73) was used during the majority of the measurements. (A 7db correction factor was added to all readings obtained with the extension cable.)

2. The internal measurements were made at normal head level positions, centerline cockpit and each of the four passenger seats. External measurements were completed with the microphone placed approximately 50 inches above the ground. Since both sides of the aircraft were basically the same, measurements were recorded around the left side at 50 foot distance.

3. Raw data for the NU-8F and U-8F is presented in Tables 1 and 2 respectively. Graphic illustrations of the data are presented in Figures 1-2 for comparison purposes.

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4. Internal Noise Environment: The overall noise levels in the cockpit and passenger seats of the NU-8F during take-off and cruise conditions are significantly less than the U-8F, particularly in the low frequency ranges below 1200 cps. This is especially important because our standard headsets and APH-5 ear muffs offer greater protection against high frequency noise components. These levels still exceed the 90 db criteria established by The Surgeon General, U. S. Army to facilitate speech communication and prevent temporary hearing loss for non-protected ears. Until a more liberal damage-risk criteria is approved and published, it is recommended that all occupants wear ear protection during extended flight profiles.

5. External Noise Environment: The reader will note a substantial reduction in sound pressure levels between the NU-8F and U-8F at 50' distance during ground power check conditions. This is not surprising since low frequency noise components are propagated through any medium more easily and with less loss of intensity. (See USAARU Report 63-1 for a thorough explanation of reciprocating and gas turbine noise characteristics.) There is no clear advantage for the NU-8F during prop check conditions because the propeller is the dominating noise generator during this experimental condition. (You will note that the turbine engine has more intense noise in front quadrants and the reciprocating engine in the rear quadrant.) Unfortunately, there are no published damage-risk criteria for near-field external noise environments. The primary consideration is a reduction of external noise to increase the effectiveness of the aircraft during combat operations. This can only be achieved by reducing the noise generated by the propeller during tactical operations.

6. The NU-8F is a definite product improvement as far as internal noise characteristics are concerned. A more positive position on external noise cannot be accomplished until further research has been completed.

References:

1. Air Force Regulation 160-3, "Hazardous Noise Exposure," 29 October 1956.

2. Beranek, L. L., ed., "Noise Reduction," New York, McGraw-Hill, 1960.

3. Harris, C.M., ed., "Handbook of Noise Control," New York, McGraw-Hill, 1957.

4. Harris, J. "An Evaluation of Ear Defender Devices," U.S. Naval Medical Research Laboratory, New London, Conn., V. 14, No. 11, 15 December 1955.

5. Hatfield, J.L., and Gasaway, D.C., "Noise Problems Associated with the Operation of Army Aircraft," USAARU Report 63-1, June 1963.

6. Military Specification. "Acoustical Noise Level in Aircraft, General Specification for," MIL-A-8806 (ASG), Department of Defense, 25 October 1956.

7. TB MED 251, "Noise and Conservation of Hearing," Department of the Army Technical Bulletin, 11 May 1956.

/s/Jimmy L. Hatfield
/t/ JIMMY L. HATFIELD
Major, MSC
Psychologist

4 Incl
1. Table 1 (dupe)
2. Table 2 (dupe)
3. Figure 1 (dupe)
4. Figure 2 (dupe)

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Incl 1

IV-16

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TABLE I

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS

DATA COLLECTION SHEET

Type Aircraft NU-8F

Analyzed by °Major Hatfield

Date 4 June 1964

		18.75	37.5	75	150	300	600	1200	2400	4800	9600	
INTERNAL	C	37.5	75	150	300	600	1200	2400	4800	9600	----	C
Take-off N_1 95%, 2200 RPM torque 1175, TIT 960°												
Centerline cockpit	109	90	87	97	103	96	89	79	69	67		104
Normal Cruise 2,000' N_1 92%, 1900 rpm, Torque 1000, TIT 830°, 200KIAS												
Centerline cockpit	104	93	89	102	95	89	86	84	80	69		104
Centerline seat 3	105	83	91	104	91	85	83	78	71	66		106
Centerline seat 4	106	83	91	105	95	86	84	78	69	66		105
Centerline seat 5	105	82	89	104	96	86	82	73	64	58		105
Centerline seat 6	105	81	88	104	97	85	83	75	67	59		105
EXTERNAL												
Power Check N_1 86% 1900 RPM, Torque 720, TIT 780°												
50' - 0°	110	78	92	100	107	102	104	98	94	84		110
45°	111	86	92	103	106	103	104	97	93	83		111
90°	108	85	85	96	104	101	104	97	91	93		107
135°	115	83	95	106	102	107	109	108	92	82		116
Prop Check N_1 87% 1750 RPM, Torque 780, TIT 780												
50' - 0°	111	78	91	101	104	106	104	96	89	82		109
45°	109	85	90	101	102	106	99	97	92	89		110
90°	108	86	91	100	96	99	102	102	88	83		107
135°	110	77	94	105	103	106	102	102	86	80		111

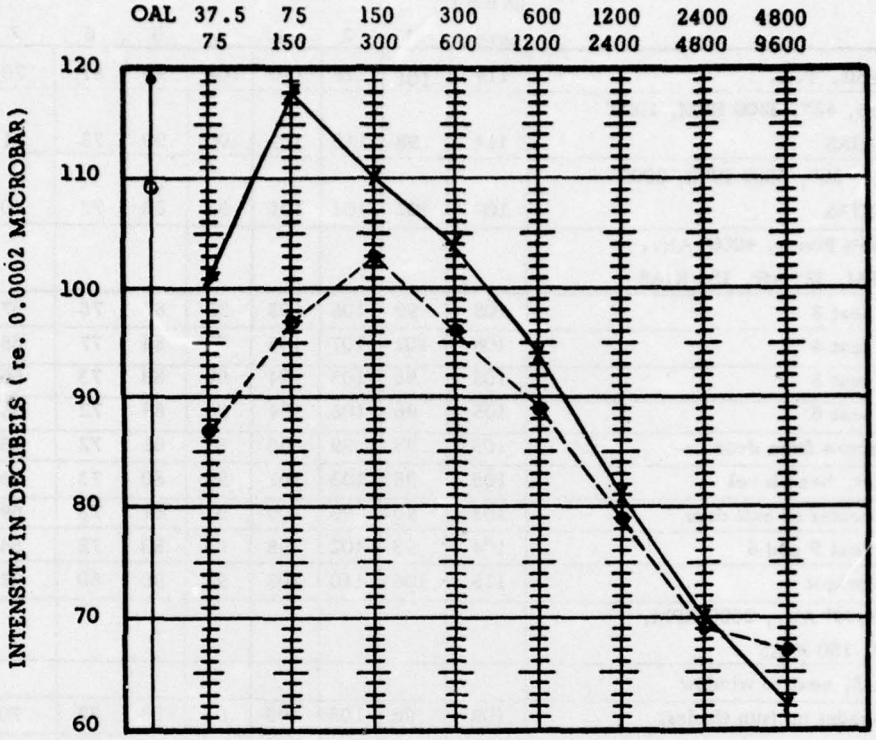
	Overall Level	Octave Bands 1	2	3	4	5	6	7	8
CL cockpit, T.O.	119	101	118	110	104	94	81	70	62
Climb, 42", 3200 RPM, 1000' 155 KIAS	114	98	115	109	100	90	78	71	69
Level, 30", 3000 RPM, 2000' 160 KIAS	109	101	108	101	93	85	77	70	66
NRC, 65% Power, 4000' Alt., 2600 RPM, 32" MP, 155 KIAS									
CL, seat 3	108	99	106	103	92	87	76	67	58
CL, seat 4	108	101	107	105	92	84	77	68	60
CL, seat 5	108	98	103	104	90	83	73	66	58
CL, seat 6	105	96	102	104	90	83	72	66	57
CL across from door	103	98	99	96	88	81	72	65	54
Toilet, head level	106	98	103	101	90	80	73	66	54
12" center of exit door	103	90	95	100	91	81	73	69	56
CL, seat 5 and 6	104	93	102	98	93	83	72	64	56
CL cockpit	115	106	110	103	97	90	80	72	66
NRC, 3000' Alt., 2600 RPM, 32" MP, 150 KIAS									
Seat 3, next to window									
Shades up (sun shades)	109	96	103	106	93	88	77	70	62
Shades down	109	98	100	107	95	88	76	70	59
Shades down, cockpit door cl.	109	97	99	108	94	89	77	70	60
CL near floor of rear cargo area	108	100	108	102	93	83	78	72	56
R-ear, copilot	116	103	112	112	99	84	78	72	67
External Measurements Power Check									
0^{o}, 3000 rpm	112	95	107	109	104	104	99	92	81
45^{o}, 30" manifold pressure	115	96	107	113	107	105	99	91	81
90^{o}	115	99	110	113	97	90	83	88	78
135^{o}	115	100	107	113	109	106	98	92	81
Prop Check									
0^{o}, 2100 rpm	106	90	106	102	96	94	87	80	72
45^{o}, 18" manifold pressure	108	91	104	106	97	94	90	80	72
90^{o}	113	92	108	112	97	98	93	76	67
135^{o}	110	95	104	108	99	95	86	82	70

TABLE 2

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CENTERLINE COCKPIT DURING TAKE-OFF

FREQUENCY BY OCTAVE-BANDS



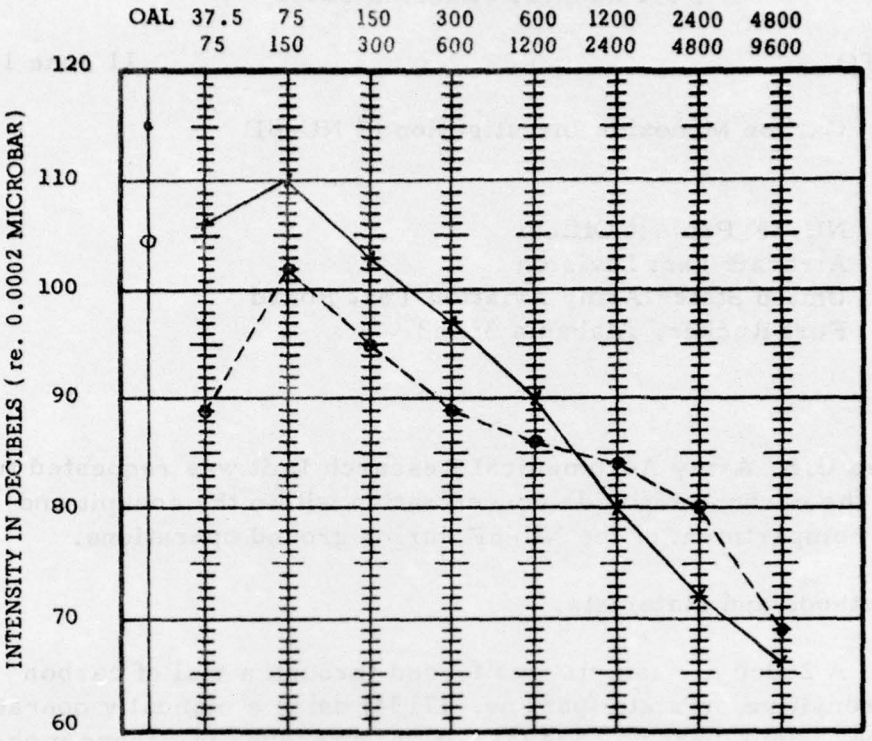
Legend:
• U-8F
o NU-8F
OAL - Overall noise level

FIGURE 1

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CENTERLINE COCKPIT DURING NORMAL CRUISE

FREQUENCY BY OCTAVE-BANDS



Legend:
- U-8F
- NU-8F

OAL - Overall noise level

FIGURE 2

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Technical Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-TO 11 June 1964

SUBJECT: Carbon Monoxide Investigation of NU-8F

TO: NU-8F Project Officer
Aircraft Test Division
United States Army Aviation Test Board
Fort Rucker, Alabama 36362

1. The U.S. Army Aeromedical Research Unit was requested to determine the carbon monoxide concentration within the cockpit and passenger compartment of the NU-8F during ground operations.

2. Methods and Materials.

a. A 250cc air sample was forced through a vial of carbon monoxide sensitive crystals (part no. 47134) using a manually operated "piston type" pump (part no. 83498). In the presence of carbon monoxide, the normally pale yellow indicating crystals turn green. The concentration of carbon monoxide is determined by comparing the color of the exposed vial to a standard color chart (part no. 994200). Sensitivity of the indicating crystals is .001 to 0.1% carbon monoxide.

b. Samples were collected during the following conditions:

(1) Taxiing.

(2) Ground idle, propellers feathered, heater blower on, aircraft positioned cross wind.

c. Equipment used:

(1) Mine Safety Applicant Company, Universal Testing Kit Model 2 with carbon monoxide detectors.

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3. Positions and Locations.

a. Centerline cockpit.

b. Centerline cabin at seat number three.

4. Results and conclusions. No carbon monoxide was detected in the air samples taken at ground idle or while taxiing.

/s/William C. Thrasher
/t/ WILLIAM C. THRASHER
1/Lt. MSC
Psychology Assistant

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Part IV

HEADQUARTERS
DEPARTMENT OF THE ARMY
Office of the Assistant Chief of Staff for Force Development
Board for Aviation Accident Research
Fort Rucker, Alabama

BAAR-I 13 July 1964

SUBJECT: Evaluation of NU8F Aircraft and Recommended Changes

TO: President
U.S. Army Aviation Test Board
ATTN: Major Silver
Fort Rucker, Alabama

1. During the month of April, coordination was effected between the Aviation Test Board project officer for the NU8F and Major Jack O. Ray, USABAAR. Considerable ground discussion and orientation as well as a one-hour flight was accomplished during this time. Numerous small deficiencies were noted and agreed upon; however, since these recommended changes are included in the Aviation Board report, no mention will be made here.

2. USABAAR considers that if the NU8F is purchased for use in the Army, two major modifications must be accomplished to allow the aircraft to be acceptable. These modifications would greatly improve the operational capability of the aircraft and are as follows:

a. Reversible propeller: The additional cost of equipping this aricraft with reversible propellers is very nominal in consideration of the overall cost price. To operate this aircraft under ideal conditions, i.e. improved fields with dry, hard landing surfaces, excessive braking is required in order to stop in less than 2000-2500 feet. This, of course, is caused by the flight idle position still giving forward thrust after touchdown.

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BAAR-I 13 July 1964
SUBJECT: Evaluation of NU8F Aircraft and Recommended Changes

(1) Experience has shown that even aircraft with STOL characteristics such as the CV-2, when operating on airfields, both improved and unimproved, required a reverse capability if the surface is wet or ice covered.

(2) A modification of the CV-2 was proposed and adopted, which, no doubt, cost considerably more money than it would have had it been required originally on all production models. Not only is the cost figure a consideration but the loss of time on the aircraft and reduced operational capability of the units while the aircraft are being modified.

b. Pressurized cabin: Since the aircraft is equipped with turbine engines, it has a most efficient cruising altitude of approximately 16,000 feet. Flying the aircraft at altitudes it was designed for allows for more efficient operation, better speeds, and a much improved weather penetration capability. With the maximum number of persons aboard, cruising at an optimum altitude, the present oxygen system would not permit enough range in hours to make the aircraft a worthwhile addition to the inventory.

3. *It has been most enjoyable to participate in this program and* if USABAAR can be of further assistance on the evaluation of the NU8F or other aircraft, we would be pleased to assist.

/s/William D. C. Jones, Lt Col
/t/ROBERT M. HAMILTON
Colonel Infantry
Director USABAAR

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APPENDIX V

COORDINATION

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APPENDIX V

COORDINATION

The following participating agencies reviewed the final report:

US Army Board for Aviation Accident Research (USABAAR)

US Army Aeromedical Research Unit (USAARU)

US Army Aviation Human Research Unit (USAAHUMRU)

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APPENDIX VI

DISTRIBUTION LIST

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APPENDIX VI

DISTRIBUTION

USATECOM PROJECT NO. 4-4-1005-01

Addresses	Final Report
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CG, US Army Mobility Command ATTN: AMSMO-RDT Centerline, Michigan	2
CG, US Army Transportation Research and Engineering Command ATTN: SMOFE-AAE Fort Eustis, Virginia	2
CG, US Army Aviation Materiel Command ATTN: SMDSM-EP St. Louis, Missouri	1

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AD _____ Accession No. _____

US Army Aviation Test Board, Fort Rucker, Alabama. Report of USATECOM Project No. 4-4-1005-01, Military Potential Test of NU-8F Airplane, 9 October 1964, DA Project No. 1X141809D179, 160 pp., 38 illus. For Official Use Only. The US Army Aviation Test Board (USAAVNTBD) conducted the Military Potential Test of the NU-8F Airplane in the vicinities of Fort Rucker, Alabama, and Minot, North Dakota, during the period 16 March 1964 to 3 June 1964. The USAAVNTBD was responsible for the execution of the test and submission of the report. Inputs were received from participating agencies. A total of 9 deficiencies and 16 shortcomings was found during the test. Five deficiencies/shortcomings were corrected during the test. It was concluded that when the deficiencies are corrected, the NU-8F will be more suitable for Army use than the U-8F, that correction of the shortcomings will enhance the suitability of the NU-8F, and that environmental testing and a 1000-hour logistical evaluation of the airplane with the PT6A-6 engines are required to determine the engine suitability for Army use. It was recommended that the NU-8F be considered more suitable for Army use than the U-8F after correction of the deficiencies, that the shortcomings be corrected as economically feasible, and that the NU-8F with the PT6A-6 engines undergo environmental testing and a 1000-hour logistical evaluation after correction of the deficiencies.

AD _____ Accession No. _____

US Army Aviation Test Board, Fort Rucker, Alabama. Report of USATECOM Project No. 4-4-1005-01, Military Potential Test of NU-8F Airplane, 9 October 1964, DA Project No. 1X141809D179, 160 pp., 38 illus. For Official Use Only. The US Army Aviation Test Board (USAAVNTBD) conducted the Military Potential Test of the NU-8F Airplane in the vicinities of Fort Rucker, Alabama, and Minot, North Dakota, during the period 16 March 1964 to 3 June 1964. The USAAVNTBD was responsible for the execution of the test and submission of the report. Inputs were received from participating agencies. A total of 9 deficiencies and 16 shortcomings was found during the test. Five deficiencies/shortcomings were corrected during the test. It was concluded that when the deficiencies are corrected, the NU-8F will be more suitable for Army use than the U-8F, that correction of the shortcomings will enhance the suitability of the NU-8F, and that environmental testing and a 1000-hour logistical evaluation of the airplane with the PT6A-6 engines are required to determine the engine suitability for Army use. It was recommended that the NU-8F be considered more suitable for Army use than the U-8F after correction of the deficiencies, that the shortcomings be corrected as economically feasible, and that the NU-8F with the PT6A-6 engines undergo environmental testing and a 1000-hour logistical evaluation after correction of the deficiencies.

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