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UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

11 17 APR 1959

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ATBG-DT-AVN-959

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SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
(Modified YH-41) Helicopter

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TO: Commanding General
United States Continental Army Command
Fort Monroe, Virginia
ATTN: ATDEV

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1. AUTHORITY. Letter, ATDEV-6 452.1, Headquarters, USCONARC, 17 March 1959, subject: "Check Test of the Modified YH-41 Helicopter."

2. PURPOSE. To conduct a check test ^{was conducted} to determine whether engineering features incorporated in the CH-1C (modified YH-41) Helicopter offer significant advantages which should be considered for incorporation in future Army helicopters.

3. SCOPE. The CH-1C Helicopter, a commercial version of the modified YH-41, was flown by personnel of the US Army Aviation Board, US Army Aviation School, and US Army Transportation Aircraft Test and Support Activity in the vicinity of Fort Rucker, Alabama. The aircraft was flown for 57 hours during a three-week period. During the test period, emphasis was placed upon flight and performance characteristics, manufacturer's corrections of the deficiencies noted in this Board's report of service test of the YH-41 Helicopter (Project Nr AVN 3057), and the arrangement of the instruments. Maintenance was performed by the manufacturer.

4. GENERAL INFORMATION.

a. Background.

(1) The YH-41 Helicopter is the military equivalent of the commercial CH-1B. This helicopter has been under development by Cessna since 1952 and has progressed through three CAA-certificated configurations since the inception of the Cessna program. This aircraft was originally proposed to the Army as a high-performance, two-place helicopter. As development continued, a decision was made by Cessna to utilize the available cabin space and performance to provide seats for two additional passengers.

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ATBG-DT AVN 959

SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
(Modified YH-41) Helicopter

(2) Ten of these aircraft were procured as an off-the-shelf, CAA-certificated, commercial helicopter. No mock-up inspection was conducted to provide alterations to make the YH-41 suitable for Army use. During the Contract Technical Compliance Inspection, many recommendations for alterations were submitted that would have improved the suitability of the helicopter. These were not accepted by the Technical Compliance Committee Board because the procurement was limited to a service test quantity, and contractual compliance was completely met by the aircraft's being CAA-certificated.

(3) The YH-41 was service tested by the US Army Aviation Board at Fort Rucker, Alabama, in 1958; and upon completion of tests, this Board recommended that the YH-41 Helicopter be considered unsuitable for Army use at that time. Major deficiencies found were: instability of the helicopter, particularly in turbulent conditions; inaccessibility for maintenance and inspection; frequent and recurrent engine malfunctions in the idle r. p. m. range; and inability of the helicopter to utilize fully its seating capacity and lifting capacity because of the low gross weight certification. It was recommended that the aircraft be re-evaluated by the US Army Aviation Board if the manufacturer accomplished a significant improvement in the deficiency areas indicated. The manufacturer indicated an immediate interest in correcting these deficiencies by initiating an intensive engineering development program aimed at making the helicopter more suitable for military use. One of the test aircraft was bailed back to the manufacturer to help support the program.

b. Description of Materiel.

(1) The CH-1C Helicopter was configured as a three-place instrument trainer. It is a single-engine helicopter with a single main rotor of all-metal bonded construction and an all-metal antitorque tail rotor. The main-rotor blades are attached to the rotor hub by means of the Cessna-designed "blade attaching angle" which allows for blade pitch change without the use of antifricition bearings. Dual controls are provided in a side-by-side arrangement for pilot and copilot. The helicopter has one seat located behind the pilot. The landing gear is of the skid type. The engine is mounted forward of the main-rotor drive. A Continental FS0-526-A, six-cylinder, horizontally opposed engine, equipped with a gear-driven cooling fan incorporating a centrifugal-type slip clutch and a single-stage, gear-driven supercharger, powers the helicopter. The engine delivers 270 horsepower up to its critical altitude of 7900 feet. The cyclic trim mechanism consists of lateral and longitudinal trim springs which are self-centering and electrically actuated by a button switch on the cyclic control stick. A directional trim knob is located near the right front door post which permits trimming the forces in the antitorque

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ATBG-DT AVN 959

SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
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pedals to zero. Electrical energy is supplied by a 24-volt, direct-current system, powered by a 50-ampere rated automotive-type generator.

(2) Installed equipment includes a heating, ventilating, and defrosting system; ARC Type 210 Receiver-Transmitter, AN/ARN-30A VOR Receiver; Wilcox 702 Marker Beacon Receiver, Wilcox 700 Glideslope Receiver; Lear ARCON; and an ARC Type 21 ADF. The instrument panel has been enlarged and instruments have been provided to permit IFR flight.

(3) The CAA-certificated maximum gross weight is 3000 pounds. The empty weight of the aircraft received was 2298 pounds with full oil and trapped fuel. Fuel capacity was 90 gallons of which 87.3 gallons were usable.

5. TESTS.

a. Flight.

(1) Stability. During service test of the YH-41, instability was noted, particularly under gusty conditions. During this test, special attention was given to this problem.

(a) Lateral Stability. The manufacturer has made two modifications to the cyclic control system.

1. The YH-41 had a tendency to roll sharply to the left when power was reduced suddenly; therefore, this would require a lateral trim change (full cyclic displacement). In the CH-1C this was compensated for and the lateral trim change was automatic without moving the cyclic stick.

2. To compensate for the instability in the roll axis in turbulent air, the manufacturer installed a mechanical gyro system. The gyroscope mechanically operated the lateral cyclic control system through the helicopter's boost system. This resulted in improved stability.

(b) Longitudinal Stability. Longitudinal stability was improved by replacing the swept-back tapered stabilizer with a larger rectangular stabilizer which was connected to the collective pitch stick instead of the cyclic stick.

(c) Directional Stability. The directional stability was improved by redesigning the tail rotor. In addition, a yaw trim was provided.

ATBG-DT AVN 959

SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
(Modified YH-41) Helicopter

(d) Autorotations. The YH-41 had a tendency to pitch down and roll to the left following a power failure. Rapid rotor decay was also a major problem. All of these autorotational characteristics were improved by the following modifications:

1. Collective pitch system was redesigned.
2. Collective pitch stop limits were changed.
3. Automatic lateral power trim was installed.

a. Night Flying. The helicopter was flown at night with special attention being given to the adequacy of lighting and flight instruments and the effect of reflection and glare. The following were noted:

- (1) Instruments were difficult to read because of instrument panel vibration.
- (2) The instrument and landing lights were adequate except that no provisions were made for adjusting the landing light.
- (3) The reflection of the rotating beacon light from the cabin inclosure was objectionable but did not seriously impair visibility.
- (4) The reflection and glare of the position lights seriously impaired visibility.
- (5) Flame-damping was not provided although the manufacturer states that flame-damping is provided on a YH-41 bailed to them.

b. Suitability as an Instrument Trainer. Flights under simulated and actual instrument conditions were conducted in conjunction with the Army Aviation School to determine if the CH-1C Helicopter could be used as an Army instrument trainer. The following were noted:

- (1) A high-frequency vibration and a vertical vibration were very noticeable. These vibrations resulted in an excessive instrument panel vibration and a high rate of pilot fatigue.
- (2) The omni course selector was difficult to adjust and read because of the instrument panel vibration.
- (3) Lack of antitorque pedal adjustment resulted in a high rate of pilot fatigue particularly when flying under simulated instrument conditions. If a pilot adjusted his seat to be able to control the cyclic

ATBG-DT AVN 959

SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
(Modified YH-41) Helicopter

comfortably throughout its full fore and aft range, he was too close to his antitorque pedals; conversely, if he adjusted his seat to be able to control the antitorque pedals comfortably, he was too far from the cyclic stick when it was displaced forward for cruising flight.

(4) Although the flight instruments were not arranged in accordance with the Boards proposal for an optimum panel arrangement, the instrument panel was generally adequate.

c. Maintenance.

(1) The engine malfunctions experienced during service test in the idle r. p. m. range were corrected by the installation of a double idle stop which kept the flight idle r. p. m. out of idle adjustment sensitive range and eliminated failure during acceleration.

(2) The inaccessibility for maintenance and inspection of the airframe noted during the service test was corrected and was considered satisfactory. No improvement on engine accessibility or engine component accessibility was evident.

d. Deficiencies Noted in the CH-1C Which Were Not Reported in the Service Test.

(1) Cyclic Displacement. The position of the cyclic, when the helicopter was at a hover, was to the right and rear. During transition from a hover to forward flight the cyclic had to be displaced forward until it was almost against the forward stop. The consensus of pilots was that this was objectionable.

(2) Vibrations.

(a) A high-frequency vibration was noted which was most pronounced in the antitorque pedals.

(b) The aircraft had a very pronounced vertical vibration which was noted throughout the test period. The manufacturer stated that this vibration was caused by the main rotor blades being out of track.

(c) The above-mentioned vibrations resulted in excessive instrument panel vibration and a higher rate of pilot fatigue.

6. DISCUSSION. The aircraft was CAA certificated for a maximum gross weight of 3,000 pounds although the manufacturer has increased the gross weight to 3,100 pounds. The weight of the CH-1C (full fuel and oil) was

ATBG-DT AVN 959

SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
(Modified YH-41) Helicopter

2,822 pounds. This permitted a crew weight of only 178 pounds. This limitation did not permit full utilization of the seating capacity of the aircraft. If the aircraft were CAA certificated for a maximum gross weight of 3,100 pounds, a useful load of only 278 pounds would be permitted. Adequate power is available to permit operation of the aircraft at maximum gross weights in excess of 3100 pounds. It will be noted from the data below that with full fuel the helicopter cannot be flown with pilot and copilot or be used for an instrument trainer without exceeding a maximum gross weight of 3100 pounds.

Max. gross weight (CAA certificated)-----	3,000 lb.
Basic weight (plus full oil)-----	2,298 lb.
Fuel (max. endurance 3.95 hrs at 75 knots A/S)-----	524 lb.
One pilot (parachute and Jeppesen case)-----	225 lb.
Gross weight (one pilot)-----	3,047 lb.
Gross weight (instructor and student)-----	3,247 lb.
Gross weight (instructor and two students)-----	3,447 lb.

7. CONCLUSIONS.

a. Most of the major deficiencies noted in Project Nr AVN 3057 have been corrected or compensated for.

b. The engineering features incorporated in the CH-1C (modified YH-41) Helicopter as reflected in its characteristics and performance do not warrant further Army interest.

8. RECOMMENDATION. It is recommended that no further consideration be given to the CH-1C (modified YH-41) Helicopter for Army use.

9. COORDINATION. This report has been coordinated with the US Army Aviation School.

10. REFERENCES.

a. Letter, ATBG-DG 452.1, US Army Aviation Board, 15 June 1957, subject: "Requirement for YH-41 Type Aircraft," with one indorsement.

ATBG-DT AVN 959

SUBJECT: Report of Test, Project Nr AVN 959, Check Test of the CH-1C
(Modified YH-41) Helicopter

b. Test Report AVN 3057, US Army Aviation Board, March 1958,
subject: "Service Test of the YH-41 Helicopter."

c. Cessna Helicopter Proposal, undated, subject: "Development
of Combined Exhaust Muffler-Flame Damper for Helicopters."

d. Engineering Development Program, Cessna Aircraft Corporation,
15 August 1958, subject: "YH-41."

O Glenn Goodland Col

for JACK L. MARINELLI
Colonel, Artillery
President