

Reproduced by

DOCUMENT SERVICE CENTER

ARMED SERVICES TECHNICAL INFORMATION AGENCY

U. S. BUILDING, DAYTON, 2, OHIO

REEL-C 7090

A.T.I. 200500

"NOTICE: When Government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the U.S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto."

UNCLASSIFIED

Reproduced

FROM

LOW CONTRAST COPY.

ORIGINAL DOCUMENTS

MAY BE OBTAINED ON

LOAN

FROM

ARMED SERVICES TECHNICAL INFORMATION AGENCY

DOCUMENT SERVICE CENTER

U.B. BUILDING, DAYTON, 2, OHIO

REPORT 1732

LATEST REVISION

HELICOPTER
DIVISION

of

OFFICIAL FILE COPY
PROPELLER LABORATORY
Office of Record

MCDONNELL *Aircraft Corporation*

ST. LOUIS 3, MISSOURI

PROGRESS REPORT NO. 45

MONTH OF MAY 1950

RAM JET HELICOPTER ROTOR DEVELOPMENT

SUBMITTED UNDER AF33(038)-9845

MODEL XH-20

PREPARED BY *A. C. Ballauer*
A. C. Ballauer

APPROVED BY *H. H. Harkamp*
H. H. Harkamp

DATE PREPARED

APPROVED BY

NO. OF SHEETS

APPROVED BY

*Enclosure (1)
Ref: 2143-701-1587*

DATE 15 June 1950

REVISED _____

REVISED _____

McDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE AREPORT 1732

MODEL _____

CONTENTS

1. ROTOR DEVELOPMENT
 - 1.1 General
 - 1.2 20 Foot Diameter Rotor
 - 1.3 27 Foot Diameter Rotor

2. RAM JET DEVELOPMENT
 - 2.1 Blocked Inlet Ram Jet
 - 2.2 High Speed Ram Jet
 - 2.3 Contamination Tests

3. WORK PROGRAM FOR JUNE
 - 3.1 Autorotation Tests and Studies
 - 3.2 High Speed Rotor
 - 3.3 Ram Jet Development

4. HELICOPTER TEST DATA

5. FIGURES

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 1REPORT 1732

MODEL _____

1. ROTOR DEVELOPMENT

1.1 General.- During May the 20 foot diameter rotor with 10 inch chord blades was reinstalled in the No. 1 XH20 helicopter and prepared for autorotation flight tests. Part of the preparation consisted of installation and test of a new swivelling rudder. Figure 1 shows the rudder on the ship in flight. In addition to the usual hinge axis the new rudder has an axis normal to the hinge axis which allows the rudder to float in the rotor wash so that the rudder hinge proper is always normal to the airflow. Preliminary flight tests indicate that rudder control was somewhat improved and it is believed that further work with this arrangement will provide satisfactory control in most flight regimes. Design of the 27 foot diameter rotor was continued and drawings were released for machining the blade spars.

1.2 20 Foot Diameter Rotor.- The blade torsion tests described in Progress Report 44 were conducted on the whirl stand and only total blade torsion was measured by means of a strain gauge link installed between the pitch change arm and the rotor hub. It is impractical therefore, at this time, to put the information in form such that the individual effects of centrifugal force, e.g. location and aerodynamic effects on the engine can be shown. The statement relative to the reason for the actual torsion moments obtained in the test was based purely on qualitative reasoning in that the ram jet c.g. has remained

DATE 15 June 1950**MCDONNELL** *Aircraft Corporation*PAGE 2

REVISED _____

REPORT 1752

ST. LOUIS 3, MISSOURI

REVISED _____

MODEL _____

fixed with respect to the blade spar while the blade c.g. and c.p. have moved aft with each increase in solidity. Upon completion of the improved 27 foot rotor attempts will be made to measure torsion at various stations along the blade.

1.3 27 Foot Diameter Rotor.- Blade design for this rotor is complete except for such details as may come up during the process of assembly. After further discussion with NARMECO it was decided to eliminate the use of aluminum foil as a filler for the trailing edge in as much as this feature would require considerable experimentation and would appreciably delay delivery of the assembled blades. Therefore, the present construction of the blades is similar to the arrangement shown on the original drawings, the skin and channel being assembled to the spar by means of the Metlbond adhesive, as shown in MAC drawing J1-0117. An attempt will be made to secure a bond between the skin stiffeners and the channel so as to better transfer the air loads to the spar.

1.4 Autorotation Tests and Studies.- During May the studies of the effect of various parameters on autorotation performance were completed and they will be submitted in the form of MAC Engineering Report No. 1691. Data from the actual tow tests are being studied for comparison with the theoretical data. As stated in Progress Report No. 44 the final results will be reported upon completion of tow tests of the 18 foot diameter, 8.22 inch chord rotor and ram jets Nos. 26 and 27 with reduced exit area. It is anticipated that early

DATE 15 June 1950

REVISED _____

REVISED _____

McDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 3REPORT 1732

MODEL _____

in June autorotation flight tests will be made using the 20 foot diameter, 10 inch chord rotor and ram jets of the lowest drag coefficient available at that time.

2. RAM JET DEVELOPMENT

- 2.1 Blocked Inlet Ram Jet.- No further whirl tests of the blocked inlet ram jets were made in May, however, it is planned to flight test these units in June during the autorotation flight tests.
- 2.2 High Speed Ram Jet.- Work on the high speed ram jet continued along the line of tests of improved diffuser and flame holder designs. No whirl stand operation of the engines has been conducted to date.
- 2.3 Contamination Tests.- Throughout May temperature surveys were made of the rotor wake with the ram jets mounted so as to direct the jet wake down, up, outboard and inboard with respect to the chord plane and original centerline of the ram jet. All runs were made at as near 5° blade pitch angle as possible and as near the same tip speed as possible. Since the attitude of the ram jet was changed by means of an adapter fitting it was not possible to determine the effect of the ram jet attitude on drag and jet performance. Some configurations required additional power supplied by the air turbine in order to maintain the desired test RPM. The tests, therefore, gave indications only of how to reduce contamination and did not evaluate any actual thrust loss or gain due to the ram jet attitude. The data accumulated is still being studied, but it appears from preliminary review the jet should be directed down with respect to the rotor plane and some-

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 4REPORT 1732

MODEL _____

what inboard. In the tests it appeared that deflecting the jet inboard was as effective as deflecting it down, from the viewpoint of ram jet inlet temperatures but the pure inboard deflection resulted in high blade temperatures. The combination decided upon will have a 7° downward component with respect to the blade chord and a 4° degree inward component with respect to the tangent line to the blade radius. A set of ram jets will be altered so as to give this direction to the exit jet and will be tested on the whirl stand for more complete determination of all performance factors.

3. WORK PROGRAM FOR JUNE

- 3.1 Autorotation Tests and Studies During June.- No tow tests of the ram jet rotor are contemplated in as much as the 18 foot diameter rotor is still being used on the whirl stand for contamination tests. Flight autorotation tests will be attempted during June using the 20 foot diameter rotor on the No. 1 XE-20.
- 3.2 High Speed Rotor Design.- Drawings for the fabrication of the high speed rotor will be released in June and it is expected that parts will be completed in time for delivery to NARMCO for assembly by July 1. NARMCO has promised completion of the assembly with satisfactory bonds by August 1.
- 3.3 Ram Jet Development.- Ram jet development will continue along the line of minimizing or eliminating effects caused by contamination. It is anticipated that late in June results of the contamination tests will be analyzed completely and new ram jets will be constructed

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 5

REPORT 1732

MODEL _____

in accordance with these findings.

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 8REPORT 1732

MODEL _____

J1 HELICOPTER TEST DATA

DATE: 18 May 1950 **OPERATOR:** C. Wood

TEST STAND: # 1

ROTOR: 20 Foot diameter with 10 inch chord and #26 and #27 jets.

PURPOSE: The purpose of this test was to check the operation of the swivel rudder J1-3325.

TEST SET-UP: The flyable test-stand was equipped with the new rudder J1-3325.

REMARKS: A flight was made at approximately 4:30 p.m. for 2 minutes. Fair directional control was possible, but on occasion the rudder would tend to stay against the upper stop. In this position very little directional control was obtained. Test stand was not able to hover with #26 and #27 jets.

Flight time for test: 2 minutes
Running time for test: 6 minutes

Total flight time to date 23 Hours, 9 Minutes
Total running time to date 107 Hours, 39 Minutes

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 7REPORT 1732

MODEL _____

J1 HELICOPTER TEST DATA

DATE: 25 May 1950 **OPERATOR:** C. Wood
E. Toney

TEST STAND: #1

ROTOR: 20 foot diameter with 10 inch chord and #26 and #27 jets.

PURPOSE: The purpose of this test was to again check the operation of the new rudder and to attempt to improve the operation of #26 and #27 jets.

TEST SET-UP: The test stand was equipped with the new swivel rudder J1-3325. A new sensitive altimeter was installed on the instrument panel for use in autorotation tests.

REMARKS: Three flights of 2 minutes each were made on the ramp. The test stand would not hover because more jet thrust was required for the 10 inch chord blades.

The rudder directional control was fair; however, it would on occasion tend to stay against the upper stop. In this position the directional control was poor.

The test stand was tied down and several adjustments of the metering needle valves were made. Some improvement of the jet thrust was obtained by setting the needle valves to 7/8 turn open each.

The rotor seemed to shake considerably.

Flight time for test: 6 Minutes
Running time for test: 35 Minutes

Total flight time to date: 23 Hours, 15 minutes
Total running time to date: 108 Hours, 14 minutes

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 8REPORT 1732

MODEL _____

J1 HELICOPTER TEST DATA

DATE: 29 May 1950

OPERATOR: G. Wood

TEST STAND: # 1

ROTOR: 20 Foot diameter with 10 inch chord

PURPOSE: The purpose of this test was to fly the test stand with the swivel type rudder and to check the performance of the #26 and #27 jets.

TEST SET-UP: In order to reduce the vibration the trailing edges of the 10 inch chord blades were straightened.

REMARKS: The flight test indicated that the vibration of the rotor was very much reduced. The test stand would not hover; however, stabilised forward flight was possible.

The directional control of the rudder was good in forward flight. However, in turning and hovering the rudder sometimes stayed against the upper stop. In this position the directional control was very poor.

Flight time for test: - 10 Minutes

Running time for test: - 20 Minutes

Total flight time to date: - 23 Hours, 25 Minutes

Total running time to date: - 108 Hours, 34 Minutes

DATE 15 June 1950

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 9

REVISED _____

REPORT 1732

REVISED _____

MODEL _____

J1 HELICOPTER TEST DATA

DATE: 2 May 1950 OPERATOR: C. Wood
 TEST STAND: # 2
 ROTOR: 20 Foot diameter with 10 inch chord and jets #26 and #27.
 PURPOSE: The purpose of this test was to obtain autorotation data on the towing rig for angles of attack of 20°, 30°, and 40°.

TEST SET-UP: Test stand #2 was mounted on the towing rig with the thrust beam installed. The oscillograph, etc., was mounted on the towing truck.

REMARKS: At angles of attack of 20, 30, and 40° approximately 6 thrust traces were made for each of the following pitch settings: 4°, 2°, and 0°. A total of approximately 100 traces were made. See text for evaluation of data.

Running time for test: - 1 Hour
 Total flight time to date: - 2 Hours, 58 Minutes

Total running time to date: - 20 Hours, 30 Minutes

DATE 15 June 1950

REVISED _____

REVISED _____

MCDONNELL *Aircraft Corporation*
ST. LOUIS 3, MISSOURI

PAGE 10REPORT 1732

MODEL _____

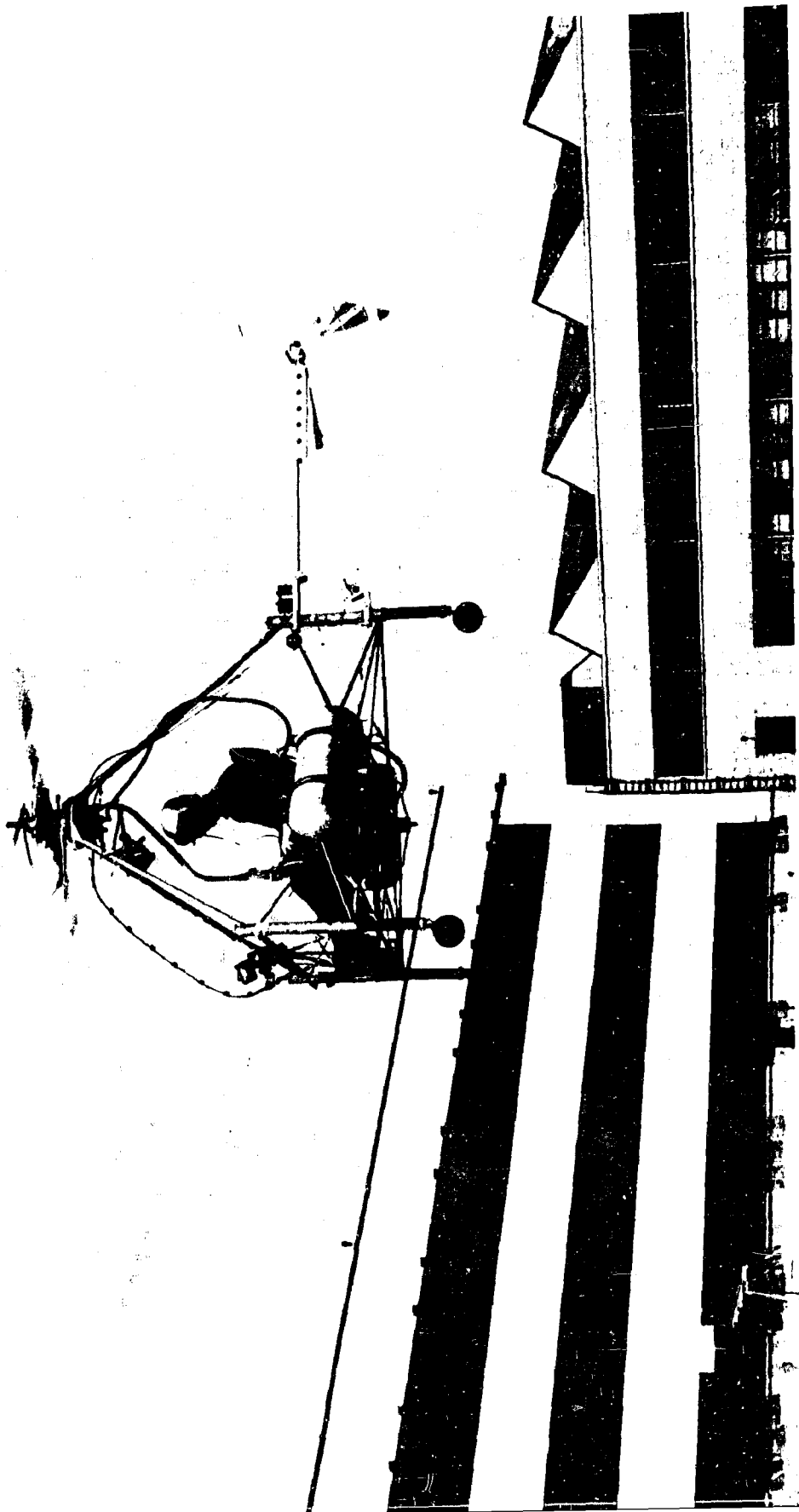
J1 HELICOPTER TEST DATA

DATE: 4 May 1950 OPERATOR: C. Wood
 TEST STAND: #2
 ROTOR: 20 Foot diameter with 10 inch chord and #26 and #27 jets.
 PURPOSE: The purpose of this test was to obtain autorotation data on the towing rig for an angle of attack of 50°.

TEST SET-UP: Same as 2 May.

REMARKS: Approximately a total of 40 traces were made at an angle of attack of 50° at pitch settings 14°, 22°, and 0°. There was a cross wind of approximately 10-15 mph. See text for evaluation of data.

Running time for test: 20 Minutes
 Total flight time to date: 2 Hours, 58 Minutes
 Total Running time to date: 20 Hours, 50 Minutes



NEGATIVE DJH-18097

FIGURE 1.- FLIGHT TEST OF SWIVELING RUDDER

K O P A R

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

ATI- 200 500 *

403111

P 1/3

McDonnell Aircraft Corp., St. Louis, Mo.
RAM JET HELICOPTER ROTOR DEVELOPMENT,
by A.C. Ballauer. Progress rept. no. 45, Month of
May 50. 15 June 50, 11p incl illus. Rept. 1732. USAF
Contr. No. AF 33(038)-9845

1. Helicopter rotors, Jet
 2. Engines, Ramjet
 3. H-20
- I. Ballauer, A.C.
II. USAF Contr. No.
AF-33(038)-9845

(Not abstracted)

~~AD-A800 040~~



* Jet Helicopters
→ Rotors
Ramjet Engines

DIVISION: Aircraft & Flight Equipment (1)
SECTION: Rotating-Wing Aircraft (9)
DIVISION: Propulsion Systems (27)
SECTION: Gas Turbine & Jet (2)
DISTRIBUTION: Copies obtainable from A' -DSC

When this card has served its purpose, it may
be destroyed in accordance with AFR 205-1, Army
Reg. 380-5 or OPNAV Inst. 551-1.
ARMED SERVICES TECHNICAL INFORMATION AGENCY
DOCUMENT SERVICE CENTER

NTIS, Auth: AFWAL ITS, 7 Jul 81