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NOISE SURVEY HU-1A HELICOPTER
WITH MODIFIED EXHAUST SYSTEM

Task 9R38-01-017-54
Contract DA 44-177-TC-562

July 1961

prepared by:

VERTOL DIVISION
THE BOEING COMPANY
Morton, Pennsylvania
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HEADQUARTERS
U. S. ARMY TRANSPORTATION RESEARCH COMMAND
TRANSPORTATION CORPS
Fort Eustis, Virginia

TREC-ADS 9R38-01-017-54

SUBJECT: Noise Survey HU-1A Helicopter with Modified Exhaust System

TO: See Distribution List

1. During the course of aircraft research or development programs, modifications are occasionally made which may affect the noise level of the aircraft.

2. A research program was recently conducted which resulted in a modified engine exhaust system for HU-1A helicopter number 9-1632. The purpose of the following report is to present a comparison of noise output of this helicopter with that of a similar helicopter in standard configuration.

3. The conclusions made by the contractor are concurred in by this Command.

4. This report is a supplement to TREC Technical Report 61-72 and is the first report of a continuing program to maintain up-to-date information on the internal and external noise levels of current and future Army aircraft. Additional reports of this type will be submitted as the data become available.

FOR THE COMMANDER:

Approved by:

Everette Forehand
Project Engineer

Earl A. Wirth
CWO-4 USA
Adjutant
Task 9136-01-017-54

Contract DA 44-177-TC-562

July 1961

NOISE SURVEY HU-1A HELICOPTER
WITH MODIFIED EXHAUST SYSTEM

REPORT 247

Prepared By
VERTOL DIVISION
THE BOEING COMPANY
MORTON, PENNSYLVANIA

FOR
U. S. ARMY TRANSPORTATION RESEARCH COMMAND
FORT EUSTIS, VIRGINIA
This report was prepared by the Dynamics Department of Vertol Division of The Boeing Company, under Contract DA44-177-TC-562, Project 9R38-01-017-52, Amendment 4. It was funded by U. S. Army Transportation Research Command, and was under the technical cognizance of Mr. J. Everette Forehand, USA TRECOM, Ft. Eustis, Virginia.

Sound level tests were conducted at Hayes Aircraft Corporation, Birmingham, Alabama. Aircraft Project Engineer was Mr. J. Davenport. Mr. C. Shakespeare of Vertol supervised field measurements.
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MODEL HU-1A

CONCLUSIONS

Noise levels of Army HU-1A helicopters 9-1632 (equipped with a modified exhaust system) and 58-2080 (standard configuration) were recorded under similar operating and ambient conditions and are, therefore, directly comparable. Some difference exists in the 200 ft directivity patterns of the aircraft in hover, along with an increase in high frequency noise in take-off and landing. The latter may be due to various pilot techniques in achieving the requirements of Test 2. Except for these, however, sound pressure levels of the aircraft, under similar operating conditions, are considered the same. Other differences lie within the envelope of repeatability.

It is, therefore, concluded that the modified exhaust system of HU-1A No. 9-1632 does not significantly affect the acoustic characteristics of the aircraft.
INTRODUCTION

A noise level survey of an Army HU-1A helicopter with a modified exhaust system (Ser. 9-1632) was made in conformance with tests and procedures reported in Reference 1. Data have been presented in a manner similar to Reference 1 and a comparison is made with HU-1A (Ser. 58-2080) noise levels reported therein.

The aircraft and operating conditions were similar, so that sound levels of the two aircraft may be directly compared. Gross weight, engine torque, gas generator rpm and rotor rpm have been compared and found to be similar in each instance.
DISCUSSION

Figure 1 is an illustration of HU-1A S/N 9-1632. Measurement equipment is shown installed in the aircraft in Figure 2.

Sound levels of the HU-1A in hover are shown in Figure 4. A noticeable difference exists in the directivity pattern in the high frequencies (1200 - 2400 cps, 2400 - 4800 cps and 4800 - 10,000 cps octave bands) on the port side of the aircraft. The remaining differences, however, are not of real significance, and are felt to lie in the range of repeatability.

Take-off and landing noise is shown in Figure 6. No large differences are noted between aircraft except in the high frequency (2400 - 4800 cps and 4800 - 10,000 cps) bands where HU-1A Serial 9-1632 shows an increase (about 10 db) at locations 1 and 2.

Noise levels of the aircraft in flyby are plotted in Figures 8, 9 and 10. Again, no significant difference is noted.

Internal sound levels are plotted in Figures 12, 13 and 14. While sound pressure levels inside aircraft 9-1632 are less than aircraft 58-2080, this may be due to a difference in interior configurations of the aircraft. Aircraft 58-2080 contained an auxiliary, range-extension fuel tank which considerably altered the internal acoustics of the aircraft. As a result, sound levels inside the two aircraft are not directly comparable. Comparison plots of the two aircraft are presented for hover and overhead flyby conditions in Figures 18, 19 and 20, respectively. Each spectrum level in Figure 18 represents an average value of three locations. This was done so that no one point would indicate a false trend. Note that the aft locations for 9-1632 have a somewhat higher SPL. Finally, overhead flyby comparisons do not indicate any significant trend, although at the 500 ft. altitudes, 9-1632 does have a lower SPL.

Figures 15, 16 and 17 are narrow band (continuous spectrum) charts which are directly comparable with those appearing in Reference 1.

Figure 21 is a comparison of fundamental frequencies and harmonics for each identifiable noise source at position 23, Test 1.
BIBLIOGRAPHY


APPENDIX I

ILLUSTRATIONS
FIGURE 1

HU-1A HELICOPTER
S/N 91632

FIGURE 2

SOUND LEVEL RECORDING EQUIPMENT
MEASUREMENT LOCATIONS - TEST 1

FIGURE 3

- 7 -
VARIATION OF SOUND PRESSURE LEVEL AT 200 FT. RADIUS

ENGINE SPEED 6400 rpm  ROTOR SPEED 320 rpm  MAP ___ in. Hg

KEY
Symbol  Octave Band - CPS
A  20-75
B  75-150
C  150-300
D  300-600
E  600-1200
F  1200-2400
G  2400-4800
H  4800-10 KC

NOTE: Broken lines are for clarity only.

Figure 4

- 8 -
Figure 5 - Microphone Locations Test 2
MAXIMUM SOUND PRESSURE LEVELS DURING TAKEOFF AND/OR LANDING

**Takeoff**

**Landing**

- Frequency Band - Cycles per second
- Sound Pressure Level in Band - Decibels re 0.0002 dyn/cm²

Figure 6

- Runway
- 100 ft
MEASUREMENT LOCATIONS - TEST 3

FIGURE 7

- 11 -
MAXIMUM EXTERNAL SOUND PRESSURE LEVELS MEASURED AT GROUND STATION

A/C-TEST

HU-IA-3

DISTANCES

0'
100'
200'
500'

FREQUENCY BAND ~ CYCLES PER SECOND

ALTITUDE = 25'

ALTITUDE = 50'

SOUND PRESSURE LEVEL IN BAND ~ DECIBELS RE 0.0002 DYN/CMS

20  2  150  150  100  4800  4800

20  2  150  150  100  4800  4800

Figure 8
MAXIMUM EXTERNAL SOUND PRESSURE LEVELS MEASURED AT GROUND STATION

A/C-TEST HU-IA-3

DISTANCES
0' - A/C
100' -
200' -
500' -

ALTITUDE

DISTANCE (MICROPHONE)

Figure 9

- 13 -
Maximum External Sound Pressure Levels Measured at Ground Station

A/C - Test

HU-IA-3

Distance

DISTANCES

0'
100'
200'
500'

Frequency Band - Cycles per Second

Sound Pressure Level in Band - Decibels re 0.0002 dynes/cm²

Figure 10
APPROXIMATE MICROPHONE POSITIONS USED FOR VARIOUS NOISE MEASUREMENTS INSIDE AIRCRAFT

FIGURE 11
- 15 -
CABIN - INBOARD LOCATIONS

CABIN - OUTBOARD LOCATIONS

Figure 13
- 17 -
VARIABLE LOCATIONS - WINDOWS OPEN

Figure 14
- 18 -
HU-IA REQUEST SPECTRUM
POSITION 7 PILOT'S EAR LEVEL

FIGURE 15
Figure 16: HU-IA Noise Spectrum

Position 19 Cabin

Sound Pressure Level - (dB re 0.0002 dyn/cm²)

Frequency (CPS)

20
COMPARISON OF
EXTERNAL SOUND PRESSURE LEVELS
AT 200 FT. RADIUS

FORWARD LOCATIONS - 17 27 24
S/N 58-2080
S/N 9-1632

STRB. LOCATIONS - 18 19 20
S/N 58-2080
S/N 9-1632

AFT LOCATIONS - 21 22 23
S/N 58-2080
S/N 9-1632

PORT LOCATIONS - 24 25 28
S/N 58-2080
S/N 9-1632

DECIBELS RE 0.0002 DYNE/CM²

SOUND PRESSURE LEVEL IN BAND

FREQUENCY BAND CYCLES PER SECOND

FIGURE 18
COMPARISON OF OVERHEAD FLYBYS

Measurement Location Directly Under Aircraft

S/N 58-2080  S/N 9-1632

ALTITUDE 25 FT.

SOUND PRESSURE LEVEL IN BAND - DECIBELS REL 0.0002 DYN/CM²

FREQUENCY BAND - CYCLES PER SECOND

ALTITUDE 50 FT.

SOUND PRESSURE LEVEL IN BAND - DECIBELS REL 0.0002 DYN/CM²

FREQUENCY BAND - CYCLES PER SECOND

FIGURE 19

- 23 -
COMPARISON OF OVERHEAD FLYBYS

Measurement Location Directly Under Aircraft

S/N 58-2080  S/N 9-1632

ALITUDE

100 FT.

FREQUENCY BAND - CYCLES PER SECOND

SOUND PRESSURE LEVEL IN BAND - DB REL 0.0002 DYNES/CM^2

ALTITUDE

500 FT.

FREQUENCY BAND - CYCLES PER SECOND

FIGURE 20
IDENTIFICATION OF NOISE SOURCES

HU-1A

EXTERNAL POSITION 23

S/N 58-2080

S/N 9-1632

S/N 58-2080

S/N 9-1632

FIGURE 21
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## OCTAVE-BAND ANALYSIS SHEET

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Contract DA 44-177-TC-562 (Amend. 4)

Unclassified Report

Internal and external noise levels measured during typical operations of an Army type HU-IA helicopter, Serial No. 9-1632 are presented. A comparison of sound levels is made with HU-IA Serial No. 58-2080. The sound pressure levels of the two aircraft during similar operating conditions are found to be essentially the same.

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