AMRL-TR-75-50
VOLUME 51

USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

VOLUME 51
HH-53C IN-FLIGHT CREW NOISE

OCTOBER 1975

AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio 45433

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

NOTICES

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the 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.

Please do not request copies of this report from Aerospace Medical Research Laboratory. Additional copies may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Federal Government agencies and their contractors registered with Defense Documentation Center should direct requests for copies of this report to:

Defense Documentation Center
Cameron Station
Alexandria, Virginia 22314

TECHNICAL REVIEW AND APPROVAL

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

HENNING E. VON GIERKE
Director
Biodynamics and Bionics Division
Aerospace Medical Research Laboratory

AIR FORCE - 6 JULY 76 - 100

(4) [illegible]

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: AMRL-TR-75-50 Vol 51 (14)	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK: Volume 51, HH-53C In-flight Crew Noise (6)	5. TYPE OF REPORT & PERIOD COVERED: Volume 51 of a series
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): Justus F. Rose, Jr., Col, USAF Nick A. Farinacci, Capt, USAF, BSC	8. CONTRACT OR GRANT NUMBER(s): (17) 723104
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Aerospace Medical Research Laboratory Aerospace Medical Division, Air Force Systems Command, Wright-Patterson AFB, OH 45433	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (16) 62202F 1AF-7231-04-18
11. CONTROLLING OFFICE NAME AND ADDRESS: Same as above (11)	12. REPORT DATE: Oct 1975
	13. NUMBER OF PAGES: 15 (12) 15P.
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (19) Justus F. Rose Jr., Henry J. Mohlman, Nick A. Farinacci, David J. Eiermann, John N. Cole,	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Noise
Noise Environments
Bioenvironmental Noise
In-flight Crew Noise
HH-53C Helicopter

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The HH-53C is a USAF heavy assault transport helicopter used to search, locate, and recover combat aircrew members, personnel, and/or vital aerospace hardware. This report provides measured data defining the bioacoustic environments at flight crew locations inside this helicopter during normal flight operations. Data are reported for 15 locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level,

OVER

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

009 850

perceived noise level, and limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol 1: Organization, Content and Application", AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 72310418, Measurement of Noise and Vibration Environments of Air Force Operations. Col Justus F. Rose, Jr. conducted the field measurements and performed the data analysis; Capt Nick Farinacci prepared this report.

The authors acknowledge the efforts of Mr. John N. Cole who established the data analysis requirements and assisted in the preparation of this report, and Mr. Henry Mohlman and Mr. David Eilerman of the University of Dayton who assisted in the mechanics of data processing.

Table of Contents

List of Tables

INTRODUCTION

The HH-53C is a USAF heavy assault transport helicopter used to search, locate, and recover combat aircrew members, personnel, and/or vital aerospace hardware. This helicopter, which is manufactured by the United Aircraft Corporation, Sikorsky Aircraft Division, is powered by two T64-GE-7 turboshaft engines rated at 3,925 shp at 13,600 rpm maximum power. The engines drive both a six-blade, fully-articulated, 22 m diameter main rotor, and a conventional four-blade 4.9 m diameter tail rotor. The engines are manufactured by the General Electric Company, Aircraft Engine Group, Military Engine Division.

This volume provides measured data defining the bioacoustic environments produced inside this helicopter. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the HH-53C helicopter.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and aerospace ground equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, aerospace ground equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. *Refer to Volume 1* (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., in-flight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; Autovon 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

---

1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application,* AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a standard-configured HH-53C helicopter during typical speed, altitude, and flight maneuver conditions. This helicopter had full factory insulation as compared with those helicopters flown in SEA from which the insulation was removed. These levels describe the standard HH-53C environments, but may not be representative of those levels encountered if the helicopter has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made at various flight crew locations. Table 1 lists the measurement locations and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A.

The microphone position was at ear level external to headgear in a region 0.2-0.3 meters from the head when an individual was present. At unoccupied locations, measurements were made at ear level throughout a volume where the head would normally be located. In both cases the microphone was randomly moved throughout a spherical volume approximately 0.3 meters in diameter and the resultant samples analyzed using a 4- or 8-second integration time to obtain a power-averaged level that effectively smooths out short-duration fluctuations and best describes the exposure.

Although the presence of a crew member at a measurement location affects the resultant sound field, the magnitude of such effects is generally small and not significant in determining exposure limits or voice communication capabilities. Consequently, no distinction is made in this report between occupied and unoccupied measurement locations.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the HH-53C helicopter at the 15 specified locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These variety of measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1

MEASUREMENT LOCATIONS AND TEST CONDITIONS

HH-53C, Eglin AFB, 11 May 1971
Serial # 69-5789

LOCATION	*POSITION*	*HEIGHT ABOVE DECK*
1	Between Pilot and Copilot	Seated Head Level
2	Station 162 — Flight Engineers Station	Seated Head Level
3	Station 212, Centerline (1st row of Windows)	1.5 Meters
4	Station 212, Left Side	Seated Head Level
5	Station 222 Centerline	1.5 Meters
6	Station 302, Right Side	Seated Head Level
7	Station 312, Centerline (2nd row of Windows)	1.5 Meters
8	Station 312, Left Side	Seated Head Level

TABLE 1 (Continued)

MEASUREMENT LOCATIONS AND TEST CONDITIONS

HH-53C, Eglin AFB, 11 May 1971
Serial # 69-5789

LOCATION	*POSITION*	*HEIGHT ABOVE DECK*
9	Station 342, Centerline (Directly under gear box)	1.5 Meters
10	Station 412, Centerline (3rd row of Windows)	1.5 Meters
11	Station 412, Left Side	Seated Head Level
12	Station 500, Centerline (forward edge of ramp)	1.5 Meters
13	Station 500, Left Side	1.5 Meters
14	Just inside rescue door, Right Side	1.5 Meters
15	Gunners Station on ramp	1.5 Meters

CONDITION	*DESCRIPTION*
A	Internal APU running, ramp down, crew entrance door open.
B	Ground Idle — ramp up, crew entrance door closed.

	#1 Engine		#2 Engine
Torque	10%		10%
Ng	65%		65%
T5	450°C		450°C
Rotor RPM		50%	
Fuel Flow	250#/hr		250#/hr

C — Taxi Power — ramp up, crew entrance door closed.

	#1 Engine		#2 Engine
Torque	15%		15%
Ng	80%		80%
T5	475°C		475°C
Rotor RPM		100%	
Fuel Flow	300#/hr		300#/hr

D — Lift off/climb — ramp up, crew entrance door closed.

	#1 Engine		#2 Engine
Torque	80%		80%
Ng	90%		90%
T5	500°C		500°C
Rotor RPM		100%	
Fuel Flow	1200#/hr		1200#/hr

E — Cruise — 1500' PA, 138 KIAS — ramp up.

	#1 Engine		#2 Engine
Torque	55%		55%
Ng	91%		91%
Tg	560°C		560°C
Rotor RPM		100%	
Fuel Flow	1000#/hr		1000#/hr

F — Same as E — ramp down.

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB) 1/3 OCTAVE BAND

NOISE SOURCE/SUBJECT: HH-53C HELICOPTER INFLIGHT NOISE LEVELS

OPERATION:

IDENTIFICATION: OMEGA 3.2 TEST 71-010-001 RUN 01

17 JAN 75

FREQ (HZ)	LOCATION/CONDITION 1/B	1/C	1/E	2/A	2/B	3/E	4/E	5/A	6/B	6/C
25	92	94	104	67	80	107	102	65	86	91
31.5	89	93	102	68	79	107	104	64	88	87
40	93	98	101	68	77	106	105	63	95	90
50	97	98	104	72	73	108	112	62	99	98
63	89	92	97	80	77	100	108	71	91	91
80	87	92	94	90	85	96	99	80	88	88
100	90	95	93	81	80	98	99	75	92	92
125	87	89	95	86	84	97	98	82	91	88
160	89	89	96	89	84	99	99	85	91	89
200	89	90	96	85	82	95	96	77	88	87
250	90	86	94	85	82	95	97	78	88	86
315	87	85	93	90	84	94	95	81	88	85
400	86	84	92	88	83	94	93	79	89	91
500	90	86	94	92	88	95	93	86	92	92
630	86	83	92	94	88	94	92	83	90	91
800	83	80	91	87	82	92	91	79	88	88
1000	82	79	89	84	80	90	90	77	85	85
1250	84	81	90	87	77	94	93	74	91	88
1600	81	79	89	79	77	91	90	73	89	85
2000	81	79	88	80	80	88	88	73	83	83
2500	80	79	86	79	77	89	88	69	88	91
3150	78	78	84	77	76	87	87	71	87	85
4000	78	79	83	78	78	87	87	72	83	85
5000	77	76	81	78	80	85	85	70	83	85
6300	78	76	80	78	78	85	85	67	83	81
8000	78	77	85	82	81	91	91	79	84	82
10000	74	74	80	74	78	85	85	67	81	79
12500	75	74	79	74	77	84	84	68	83	81
16000	76	76	82	76	78	87	88	76	84	83
OVERALL	103	104	111	100	96	114	115	93	105	104

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: 2 MEASUREU SOUND PRESSURE LEVEL (DB) 1/3 OCTAVE BAND

IDENTIFICATION:
OMEGA 3.2
TEST 71-010-001
RUN 02
17 JAN 75
PAGE F2

NOISE SOURCE/SUBJECT:
HH-53C HELICOPTER
INFLIGHT NOISE LEVELS

OPERATION:

FREQ (HZ)	LOCATION/CONDITION 6/D	7/E	8/E	9/E	10/E	11/E	12/E	13/E	14/E	15/F
25	98	102	102	100	99	99	100	102	102	109
31.5	96	99	100	100	103	103	98	100	102	108
40	98	103	104	104	104	103	103	105	105	111
50	101	111	109	105	113	115	114	111	107	111
63	94	100	105	99	102	106	102	103	107	102
80	90	94	100	96	94	104	97	103	102	100
100	91	93	104	98	98	102	104	107	102	104
125	91	93	99	94	94	101	99	104	103	98
160	91	95	97	97	95	102	100	103	102	101
200	90	93	94	92	94	96	97	97	100	98
250	90	92	94	92	93	97	95	100	99	97
315	90	91	90	92	93	97	95	99	99	98
400	91	91	92	93	92	94	95	98	99	98
500	94	93	94	98	93	93	94	94	101	97
630	90	91	91	92	91	90	92	89	100	96
800	89	90	89	90	89	89	91	88	98	95
1000	87	88	89	89	88	88	88	87	98	94
1250	99	96	96	100	95	95	93	93	98	95
1600	95	92	92	93	91	90	88	88	97	92
2000	88	88	89	88	88	87	84	83	97	91
2500	94	91	93	95	91	89	87	86	96	89
3150	90	89	90	89	88	86	84	82	94	87
4000	87	86	87	89	85	84	81	79	96	87
5000	84	85	85	87	83	82	80	78	94	84
6300	81	84	84	84	83	81	79	77	95	84
8000	87	90	88	86	86	83	82	80	101	85
10000	82	85	84	83	83	82	79	77	95	83
12500	82	86	84	83	83	82	79	78	95	85
16000	85	89	86	86	86	85	82	80	98	87
OVERALL	108	113	114	111	114	117	115	115	115	117

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB)
OCTAVE BAND

NOISE SOURCE/SUBJECT:
HH-53C HELICOPTER
INFLIGHT NOISE LEVELS

OPERATION:

IDENTIFICATION:
OMEGA 3.2
TEST 71-010-001
RUN G1

17 JAN 75

PAGE J1

FREQ (HZ)	LOCATION/CONDITION 1/B	1/C	1/E	2/A	2/B	3/E	4/E	5/A	6/B	6/C
31.5	96	100	107	72	84	112	108	69	96	94
63	98	100	105	90	86	109	114	81	100	99
125	93	97	99	91	88	103	103	87	96	95
250	93	92	99	92	88	99	101	84	92	91
500	92	89	97	96	91	99	97	88	95	96
1000	88	85	94	91	85	97	96	82	93	92
2000	85	84	92	84	83	94	93	77	92	92
4000	82	82	88	82	83	91	91	76	90	90
8000	82	81	87	84	84	93	93	79	88	85
16000	78	78	84	78	81	89	89	76	86	85
OVERALL	103	104	111	100	96	114	115	93	105	104

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB) OCTAVE BAND

NOISE SOURCE/SUBJECT:
HH-53C HELICOPTER
INFLIGHT NOISE LEVELS

OPERATION:

IDENTIFICATION:
OMEGA 3.2
TEST 71-010-001
RUN 02
17 JAN 75
PAGE J2

FREQ (HZ)	LOCATION/CONDITION 6/D	7/E	8/E	9/E	10/E	11/E	12/E	13/E	14/E	15/F
31.5	102	106	107	106	107	107	105	107	108	114
63	102	111	111	106	113	115	114	112	110	112
125	96	98	105	101	101	106	106	110	107	106
250	95	97	98	97	98	101	100	104	104	102
500	97	96	97	100	97	97	99	100	105	102
1000	99	98	97	101	96	97	96	95	103	99
2000	97	95	96	98	95	94	92	91	101	95
4000	92	92	93	93	90	89	87	85	99	91
8000	89	92	90	89	89	87	85	83	102	89
16000	86	90	88	88	88	87	83	82	99	89
OVERALL	108	113	114	111	114	117	115	115	115	117

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

NOISE SOURCE/SUBJECT: HH-53C HELICOPTER INFLIGHT NOISE LEVELS

OPERATION:

IDENTIFICATION: OMEGA 3.2 TEST 71-010-001 RUN 01

27 APR 76

PAGE H1

	LOCATION/CONDITION									
	1/B	1/C	1/E	2/A	2/B	3/E	4/E	5/A	6/B	6/C
HAZARD/PROTECTION										
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR										
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR										
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)										
NO PROTECTION										
OASLC	102	103	109	100	96	112	114	92	104	103
OASLA	94	92	100	97	92	102	102	89	99	99
T	85	120	30	50	120	21	21	202	36	36
HGU-2A/P HELMET WITH H-154										
OASLA*	86	85	92	86	82	94	94	79	88	87
T	339	404	120	339	679	85	85	960	240	285
HGU-2A/P HELMET WITH H-154(A)										
OASLA*	82	81	88	82	77	89	91	74	83	82
T	679	807	240	679	960	202	143	960	571	679
HGU-2A/P HELMET WITH CUSTOM LINER										
OASLA*	90	88	96	93	88	98	97	85	93	93
T	170	240	60	101	240	42	50	404	101	101
V-51R EAR PLUGS										
OASLA*	71	69	77	73	68	79	79	65	74	74
T	960	960	960	960	960	960	960	960	960	960
H-157 IN-FLIGHT COMMUNICATION UNIT										
OASLA*	78	79	84	78	73	86	88	70	80	79
T	960	960	480	960	960	339	240	960	960	960
COMMUNICATION										
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)										
PSIL	88	86	95	90	86	97	96	82	93	93
ANNOYANCE										
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)										
TONE CORRECTION (C IN DB)										
PNLT	109	108	114	111	106	118	118	103	114	116
C	1	1	1	2	1	1	1	2	1	2

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

IDENTIFICATION:
OMEGA 3.2
TEST 71-010-001
RUN 02

27 APR 75

PAGE H2

NOISE SOURCE/SUBJECT:
HH-53C HELICOPTER
INFLIGHT NOISE LEVELS

OPERATION:

	LOCATION/CONDITION									
	6/D	7/E	8/E	9/E	10/E	11/E	12/E	13/E	14/E	15/F
HAZARD/PROTECTION										
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR										
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR										
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)										
NO PROTECTION										
OASLC	107	112	112	110	113	116	114	115	114	115
OASLA	104	102	103	105	101	102	101	102	109	104
T	15	21	18	13	25	21	25	21	6	15
HGU-2A/P HELMET WITH H-154										
OASLA*	89	92	93	92	92	96	94	98	99	96
T	202	120	101	120	120	60	85	42	36	60
HGU-2A/P HELMET WITH H-154(A)										
OASLA*	85	87	89	88	89	92	91	94	94	92
T	404	285	202	240	202	120	143	85	85	120
HGU-2A/P HELMET WITH CUSTOM LINER										
OASLA*	97	97	97	99	96	98	98	100	103	100
T	50	50	50	36	60	42	42	30	18	30
V-51R EAR PLUGS										
OASLA*	77	78	78	79	78	80	79	81	84	81
T	960	960	960	960	960	960	960	807	480	807
H-157 IN-FLIGHT COMMUNICATION UNIT										
OASLA*	82	85	88	85	86	90	89	91	91	89
T	679	404	240	404	339	170	202	143	143	202
COMMUNICATION										
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)										
PSIL	98	97	97	99	96	96	95	95	103	99
ANNOYANCE										
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)										
TONE CORRECTION (C IN DB)										
PNLT	119	119	120	121	118	120	118	119	124	119
C	3	2	2	3	2	2	1	2	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1976 — 657-030/817