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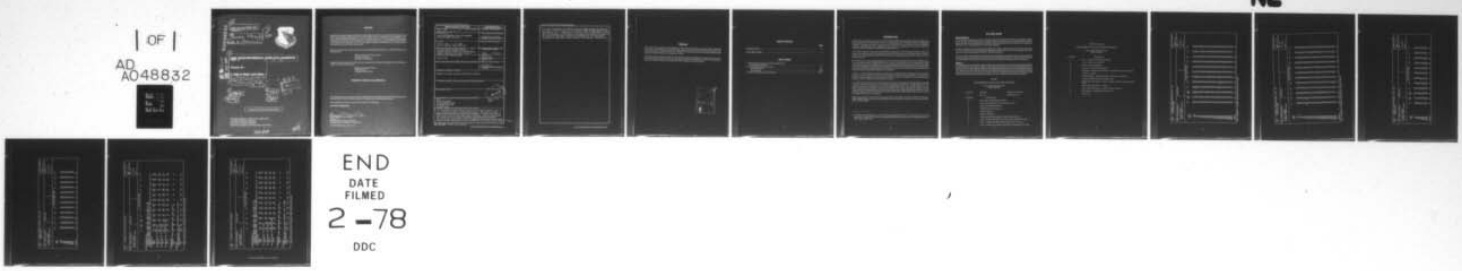

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FOR THE COMMANDER

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

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

The F-104D is a USAF two-seat version of the F-104C aircraft for use as both a supersonic fighter and operational trainer. This report provides measured data defining the bioacoustic environments at flight crew locations inside this aircraft during normal flight operations. Data are reported for one location 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, perceived noise level, and limiting times

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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 F-104D is a USAF two-seat version of the F-104C aircraft for use as both a supersonic fighter and operational trainer. This aircraft, which is manufactured by the Lockheed Aircraft Corporation, Lockheed California Company, is powered by one J79-GE-7A turbojet engine rated at 15,800 lbs maximum take-off thrust with afterburner. The engine is manufactured by the General Electric Company, Aircraft Engine Group, Military Engine Division.

This volume provides measured data defining the bioacoustic environments produced inside this aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the F-104D aircraft.

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.

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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 F-104D aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard F-104D environments, but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made at one flight crew location. Table 1 lists the measurement location 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 was randomly moved external to the headgear in a region 0.2-0.3 meter from the head 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.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the F-104D aircraft at the specified location. 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 measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1

MEASUREMENT LOCATION AND TEST CONDITIONS

F-104D, Eglin AFB, 26 Jul 1971
Serial # 57-1323

LOCATION	*POSITION*	*HEIGHT ABOVE DECK*
1	Rear Seat	Seated Head Level

CONDITION	*DESCRIPTION*
A	Ground power unit operating, canopy open.
B	Engine start, ground power unit operating, canopy open.
C	Idle power, 65% RPM, canopy open.
D	80% RPM flap check, canopy open.
E	Taxiing, canopy open.
F	Takeoff — afterburner.
G	Initial acceleration, gear and flaps up, pressurization valve open.
H	Climb — 400 KIAS, 100% RPM, .7M, 10.0M PA, pressurization valve open.
I	Cruise — 320 KIAS, 90% RPM, 15.0M PA, pressurization valve open.
J	Cruise — military power, 350 KIAS, .7M, 16.0M PA, pressurization valve closed.

TABLE 1 (Continued)

MEASUREMENT LOCATION AND TEST CONDITIONS

F-104D, Eglin AFB, 26 Jul 1971
Serial # 57-1323

CONDITION	*DESCRIPTION*
K	Cruise — 370 KIAS, .81M, 93% RPM, 23.0M PA.
L	Cruise — military power, 23.0M PA.
M	Cruise — afterburner, 23.0M PA.
N	Decelerate — speed brakes out, 23.0M PA.
P	Penetration — 300 KIAS, 84% RPM, 20.0M PA ↘, takeoff flap setting, speed brakes out.
Q	Same as P — 7.0M PA.
R	GCA final approach — 200 KIAS, 92% RPM, 1.5M PA, gear and *flaps down.*
S	240 KIAS, 90% RPM, 2.7M PA, takeoff flap setting.
T	VFR overhead traffic pattern — initial — 300 KIAS, 90% RPM, 1.7M PA, takeoff flap setting.
U	VFR overhead traffic pattern — pitchout.
V	VFR overhead traffic pattern — downwind, gear and flaps down.
W	Final approach — 94% RPM, gear and flaps down.
X	Landing roll.

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

IDENTIFICATION:
OMEGA 3.2
TEST 71-014-054
RUN 01
03 JAN 75
PAGE F1

NOISE SOURCE/SUBJECT:
F-104D AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

FREQ (HZ)	LOCATION/CONDITION 1/A	1/B MIN	1/B MAX	1/C	1/D	1/E	1/F	1/G	1/H	1/I	1/J	1/K
25	65	85	88	89	85	86	85	84	75	74	74	73
31.5	68	92	100	101	90	95	92	89	80	78	84	79
40	73	95	104	105	94	100	94	94	85	83	88	85
50	82	92	96	95	93	93	88	87	79	78	83	79
63	81	88	87	84	89	89	88	80	75	74	79	75
80	71	82	85	84	87	85	97	84	79	81	77	76
100	93	93	89	87	93	91	96	85	81	82	82	79
125	92	92	89	89	98	93	96	85	82	81	91	82
160	82	84	82	82	91	88	85	79	75	74	75	71
200	80	83	82	82	87	87	85	82	80	77	78	74
250	84	89	86	86	89	93	88	82	80	79	73	72
315	80	89	88	88	92	92	88	82	80	79	75	73
400	79	91	88	89	93	104	85	84	83	82	78	79
500	73	87	94	94	89	95	89	89	90	86	86	78
630	73	86	99	98	91	95	87	87	85	85	80	79
800	68	87	87	87	92	89	85	88	87	85	82	81
1000	70	92	90	90	94	93	91	92	91	89	84	82
1250	70	93	91	91	94	94	88	93	92	90	82	80
1600	71	96	101	103	94	97	84	93	93	92	81	80
2000	75	94	98	100	102	100	87	95	95	93	82	83
2500	70	92	95	96	100	99	84	95	96	92	82	83
3150	69	95	91	92	99	98	80	97	97	95	82	82
4000	84	95	92	93	99	96	83	100	100	98	83	83
5000	68	94	90	90	97	95	86	99	99	96	85	78
6300	70	93	89	90	97	95	78	99	99	97	78	76
8000	66	96	89	90	96	94	75	97	98	95	76	73
10000	64	97	86	87	93	90	70	94	94	92	74	70
12500	63	90	83	84	91	88	68	92	93	89	72	70
16000	60	95	82	83	89	86	66	95	99	91	71	68
OVERALL	97	107	109	110	110	110	104	108	108	105	97	94

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

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

IDENTIFICATION:
OMEGA 3.2
TEST 71-014-054
RUN 02

03 JAN 75

PAGE F2

NOISE SOURCE/SUBJECT:
F-104D AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

FREQ (HZ)	LOCATION/CONDITION 1/L	1/M	1/N	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X
25	79	83	80	71	75	79	77	78	79	74	79	80
31.5	84	86	86	77	79	84	82	82	84	81	85	86
40	85	89	91	85	86	88	84	84	83	84	90	92
50	79	88	86	80	78	84	82	82	82	84	86	86
63	76	85	80	75	74	80	79	78	79	80	82	88
80	78	80	81	78	76	84	80	77	79	82	81	98
100	98	97	90	87	91	85	86	84	85	86	85	96
125	107	108	97	84	82	85	87	86	86	84	87	96
160	82	84	82	75	71	75	72	73	72	75	76	87
200	76	77	76	71	73	80	77	76	76	77	77	83
250	76	78	77	72	73	79	76	77	78	79	80	84
315	74	77	84	74	75	79	76	77	79	79	80	81
400	77	79	83	79	76	81	78	81	83	83	83	79
500	85	84	91	76	76	78	76	79	77	82	83	81
630	78	80	92	77	76	82	80	82	81	84	88	86
800	81	83	90	79	79	82	81	81	81	82	86	77
1000	84	85	88	79	78	82	79	82	80	79	81	78
1250	80	83	86	79	76	79	77	79	78	78	81	79
1600	81	82	88	77	75	76	75	78	77	76	80	79
2000	83	84	89	79	78	80	77	80	79	76	80	82
2500	82	84	89	79	74	77	75	77	77	77	79	82
3150	81	83	89	79	73	75	74	75	75	73	77	81
4000	83	83	87	80	80	84	81	82	85	78	81	84
5000	85	86	83	74	70	76	73	75	75	72	77	85
6300	76	78	79	72	71	73	71	72	73	74	75	83
8000	73	75	77	71	68	70	69	70	70	70	72	79
10000	70	71	75	68	65	67	66	68	68	67	69	73
12500	70	71	73	68	65	66	65	67	67	69	70	69
16000	69	70	72	67	63	64	64	66	65	66	68	65
OVERALL	108	109	102	93	94	96	94	94	95	95	97	103

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

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

IDENTIFICATION:
OMEGA 3.2
TEST 71-014-054
RUN 01
03 JAN 75
PAGE J1

NOISE SOURCE/SUBJECT:
F-104D AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

FREQ (HZ)	LOCATION/CONDITION 1/A	1/B MIN	1/B MAX	1/C	1/D	1/E	1/F	1/G	1/H	1/I	1/J	1/K
31.5	74	97	106	107	96	101	97	95	87	85	90	86
63	85	93	97	96	95	95	98	89	83	83	85	82
125	96	96	92	91	100	96	99	89	85	85	92	84
250	86	93	91	90	94	96	92	86	85	83	80	78
500	81	93	100	100	96	105	92	92	91	89	87	83
1000	74	96	94	95	98	97	93	96	95	93	88	86
2000	77	99	103	105	105	103	90	99	99	97	86	87
4000	84	99	96	96	103	101	88	104	104	101	88	86
8000	72	100	93	94	100	98	80	102	102	100	81	78
16000	65	96	86	86	93	90	70	97	100	93	75	72
OVERALL	97	107	109	110	110	110	104	108	108	105	97	94

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

IDENTIFICATION:
OMEGA 3.2
TEST 71-014-054
RUN 02

03 JAN 75

PAGE J2

NOISE SOURCE/SUBJECT:
F-104D AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

FREQ (HZ)	LOCATION/CONDITION 1/L	1/M	1/N	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X
31.5	88	91	92	85	87	90	86	87	87	86	91	93
63	83	90	88	83	81	88	85	84	85	87	88	99
125	107	108	98	89	92	88	89	88	89	88	89	99
250	80	82	85	77	78	84	81	81	82	83	84	87
500	86	86	95	82	81	85	83	85	85	88	90	88
1000	87	88	93	84	82	86	84	86	85	85	88	83
2000	87	88	93	83	81	82	81	83	83	81	84	86
4000	88	89	91	83	81	85	82	83	86	80	83	89
8000	78	80	82	75	73	75	74	75	75	76	77	85
16000	72	73	76	70	67	68	67	69	69	71	72	70
OVERALL	108	109	102	93	94	96	94	94	95	95	97	103

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

IDENTIFICATION:
OMEGA 3.2
TEST 71-014-054
RUN 01
28 APR 76
PAGE H1

NOISE SOURCE/SUBJECT:
F-104D AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

	LOCATION/CONDITION											
	1/A	1/B MIN	1/B MAX	1/C	1/D	1/E	1/F	1/G	1/H	1/I	1/J	1/K
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	97	106	108	109	109	109	104	107	106	104	96	93
OASLA	88	106	106	108	109	108	97	108	108	105	94	92
T	240	11	11	8	6	8	50	8	8	13	85	120
HGU-2A/P HELMET WITH H-154												
OASLA*	81	93	89	90	93	95	87	93	95	91	80	76
T	807	101	202	170	101	71	285	101	71	143	960	960
HGU-2A/P HELMET WITH H-154(A)												
OASLA*	77	83	84	85	86	89	83	80	80	77	74	71
T	960	571	480	404	339	202	571	960	960	960	960	960
HGU-2A/P HELMET WITH CUSTOM LINER												
OASLA*	82	95	98	99	97	100	92	94	93	91	86	84
T	679	71	42	36	50	30	120	85	101	143	339	480
COMMUNICATION												
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)												
PSIL	77	96	99	100	100	102	92	96	95	93	87	85
ANNOYANCE												
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)												
TONE CORRECTION (C IN DB)												
PNLT	109	120	122	123	124	123	113	123	123	119	110	107
C	5	1	3	3	2	2	2	1	2	0	2	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: 3 MEASURES OF HUMAN NOISE EXPOSURE	IDENTIFICATION: OMEGA 3.2 TEST 71-014-054 RUN 02 03 JAN 75 PAGE H2
NOISE SOURCE/SUBJECT: F-104D AIRCRAFT INFLIGHT NOISE LEVELS	OPERATION:

	LOCATION/CONDITION											
	1/L	1/M	1/N	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X
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	108	102	93	94	95	93	94	94	94	96	103
OASLA	95	96	99	89	88	91	89	90	91	90	93	94
T	71	60	36	202	240	143	202	170	143	170	101	85
HGU-2A/P HELMET WITH H-154												
OASLA*	91	92	85	76	76	78	77	77	78	78	80	85
T	143	120	404	960	960	960	960	960	960	960	960	404
HGU-2A/P HELMET WITH H-154(A)												
OASLA*	85	86	81	71	72	74	72	73	73	74	76	81
T	404	339	807	960	960	960	960	960	960	960	960	807
HGU-2A/P HELMET WITH CUSTOM LINER												
OASLA*	92	93	93	82	81	85	83	84	84	85	88	87
T	120	101	101	679	807	404	571	480	480	404	240	285
COMMUNICATION												
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)												
PSIL	87	88	94	83	81	84	82	85	84	85	87	85
ANNOYANCE												
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)												
TONE CORRECTION (C IN DB)												
PNLT	114	115	115	105	106	109	106	107	110	105	107	112
C	3	3	2	1	3	3	3	2	3	2	1	2

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

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