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Volume 146



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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK
Volume 146
F-16B In-Flight Crew Noise

AUGUST 1979

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AEROSPACE MEDICAL DIVISION
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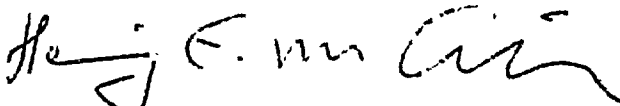
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FOR THE COMMANDER



HENNING E. VON GIERKE

Director

Biodynamics and Bioengineering Division
Aerospace Medical Research Laboratory

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The F-16B is a two-seated light-weight fighter. This report provides measured data defining the bioacoustic environments at the pilot's location inside this aircraft for 31 flight conditions. Data are reported for two 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		

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interference level, 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, Volume 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.



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PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723108, Crew Safety In Operational Noise Environments.

The author acknowledges the efforts of Mr. John N. Cole who established the data analysis requirements, Mr. Henry Mohlman and Mr. Fred Lampley of the University of Dayton who assisted in the mechanics of data processing and Mrs. Norma Peachey who typed this report and prepared it for publication.

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INTRODUCTION

The F-16B is a USAF light-weight fighter manufactured by the General Dynamics Corporation. This aircraft is powered by one F-100-PW-200(3) turbofan engine rated at 25,000 lbs. maximum takeoff thrust with afterburner. The engine is manufactured by the United Aircraft Corporation, Pratt & Whitney 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-16B 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 ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support 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 F-16B aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard F-16B 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 inside the cockpit at the pilot's 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, etc.

The microphone was attached to the pilot's helmet by means of a lightweight boom. This arrangement enabled adjustment of the microphone close to the ear level at a distance of 0.1 meter with its diaphragm parallel and facing away from the helmet's surface. In the analysis, microphone corrections for random incidence were applied to the overall systems response. The recorded samples were analyzed using a four or eight second integration time to obtain a power-averaged level which 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-16B aircraft at the specified location. This table includes the overall, $\frac{1}{3}$ 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 LOCATIONS AND TEST CONDITIONS
F-16B, Edwards AFB CA, 12 June 1979

<i>Location</i>	<i>Position</i>	<i>Height Above Deck</i>
1	Pilot Front Seat	Seated Head Level
2	Copilot Back Seat	Seated Head Level

<i>Condition</i>	<i>Description</i>
Front Seat	
A	Ground run up - engine speed 75% N ECS Source - OFF (Canopy closed)
B	Ground run up - engine speed 75% N ECS Air Source - Norm Temp. control - comfortable Auto position Defog - Full AFT position
C	Ground run up - engine speed 75% N ECS Air Source - Norm Temp. control - Manual warm position short of thermostat cycling Defog - Full AFT position
D	Normal MIL Power takeoff FCR - STBY Air Source - Norm Temp. control - comfortable Auto Defog - Full AFT position
E	MIL Power climb to 5000'
F	Cruise at 5000' - Speed 488 KIAS - .8M
G	Cruise at 5000' - Speed 488 KIAS - .8M Defog - MAX Defog
H	Cruise at 5000' - Speed 488 KIAS - .8M Temp. control - Comfortable Manual Defog - Full AFT position
I	Cruise at 5000' - Speed 488 KIAS - .8M Temp control - Manual warm (short of thermostat cycling) Defog - Full AFT position

Condition
Front Seat

Description

J	MIL Power climb 5000' - 30000' Speed 488 KIAS - .8M to 304 KIAS - .8M Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
K	Cruise at 30000' Speed 304 KIAS - .8M Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
L	Descent from 30000' to 25000' Speed 304 KIAS - .8M - 338 KIAS - .8M Idle Power, S/B out Air Source - Norm Temp. control - comfortable Auto Defog - MAX Defog
M	Cruise at 25000' Speed 338 KIAS - .8M Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
N	Descent from 25000' to 20000' Speed 338 KIAS' - .8M - 373 KIAS - .8M Idle Power, S/B out Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
O	Cruise at 20000' Speed 373 KIAS - .8M Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
P	Cruise at 20000' Speed 373 KIAS - .8M Air Source - OFF

Condition
Front Seat

Description

Q	Descent from 20000' to 5000' Idle Power - S/B out Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
R	Cruise at 5000' Speed 488 KIAS - .8M Air Source - Norm Temp. control - Manual Defog - Full FWD position
S	MIL Power climb to 5000' to 40000' Speed 0.8M Temp. control - Auto (mid) Defog - MAX
T	Hi-speed run 40000' - .8M to 1.12M Air Source - Norm Temp. control - Auto (mid) Defog - MAX
U	Descent from 40000' to 20000' Idle Power - S/B out
V	Air combat maneuvering (20000') Air Source - Norm Temp. control - comfortable Auto Defog - Full AFT position
W	Descent 20000' to 10000' Idle Power - S/B out Air Source - Norm Temp. control - comfortable Auto Defog - Norm
X	Hi-speed run 1000' - .8M to 1.12M Air Source - Norm Temp. control - comfortable Auto Defog - Full AFT position
Y	Descent 10000' to 5000' Speed 448 - .8M to 488 KIAS - .8M Air Source - Norm Temp. control - comfortable Auto Defog - MAX

<i>Condition</i>	<i>Description</i>
Z	Landing and roll out Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
Back Seat	
A	Ground run up - engine speed Idle Air Source - Norm Temp. control - comfortable Auto
B	Normal MIL Power takeoff Air Source - Norm Temp. control - comfortable Auto
C	Cruise at 7500' - speed 250 KIAS Air Source - Norm Temp. control - comfortable Auto
D	Descent from 14000' to 5000' Idle Power - S/B out Air Source - Norm Temp. control - comfortable Auto
E	Normal landing traffic pattern

[illegible]

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (03)											
2											
1/3 OCTAVE BAND											
IDENTIFICATION:											
OMEGA 3.2											
TEST AK-079-001											
NOISE SOURCE/SUBJECT: OPERATION:											
F-15B AIRCRAFT											
IN-FLIGHT CREW NOISE											
23 JUL 79											
PAGE F2											
LOCATION/CONDITION											
FREQ (HZ)											
1/0	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X	1/Y	1/Z
25	71	76	75	78	66	65	80	75	81	82	77
31.5	72	72	76	77	66	64	81	76	79	81	76
40	83	82	92	89	76	78	90	99	87	91	89
50	76	74	85	86	70	76	80	92	79	87	86
63	73	72	79	81	66	72	75	78	77	82	82
80	84	85	91	93	78	79	87	92	90	92	89
100	90	94	97	95	81	88	88	96	92	100	91
125	86	87	90	91	79	82	85	89	89	93	89
160	87	88	87	92	91	81	88	88	95	92	85
200	90	91	88	94	82	84	90	92	93	93	89
250	90	90	90	95	90	82	94	92	95	95	88
315	88	88	89	94	81	81	91	92	94	94	88
400	89	89	90	95	81	81	89	89	93	92	89
500	92	91	92	97	85	84	92	92	96	94	90
630	93	92	92	98	84	84	92	91	97	95	93
800	92	89	88	96	82	81	91	88	96	92	93
1000	88	86	86	96	80	81	88	87	94	89	91
1250	91	85	87	95	81	84	85	84	92	87	93
1600	89	83	86	95	79	82	83	82	89	84	94
2000	88	82	85	94	79	82	81	80	88	82	94
2500	86	81	82	92	76	79	79	77	86	79	92
3150	86	80	82	93	76	79	77	77	86	80	92
4000	88	78	83	95	78	82	77	78	85	80	94
5000	87	80	82	94	75	80	75	75	83	79	94
6300	87	76	82	94	76	79	78	77	85	77	95
8000	84	74	79	91	73	75	77	82	80	74	91
10000	83	73	78	89	72	74	77	76	79	71	98
12500	80	70	74	84	70	70	73	75	74	68	85
OVERALL	102	101	103	109	96	96	102	102	106	105	105

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:	
2	1/3 OCTAVE BAND		
NOISE SOURCE/SUBJECT:	OPERATION:		
F-16B AIRCRAFT	()		OMEGA 3.2
IN-FLIGHT CREW NOISE	()		TEST AK-079-001
	()		RUN 03
	()		23 JUL 79
	()		PAGE F3
LOCATION/CONDITION			
FREQ (HZ)	2/A	2/B	2/C
25	69	82	71
31.5	76	88	76
40	91	97	87
50	81	93	88
63	76	88	80
80	76	89	84
100	86	93	89
125	83	90	88
160	78	87	86
200	81	93	95
315	76	90	91
400	79	88	91
500	81	93	93
630	84	96	91
800	81	96	88
1000	78	91	85
1250	79	88	84
1600	76	88	86
2000	80	87	89
2500	76	86	86
3150	81	82	84
4000	78	82	85
5000	73	79	87
6300	74	80	81
8000	69	77	79
10000	65	75	78
12500	59	70	76
OVERALL	95	105	103

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:													
3		OCTAVE BAND													
NOISE SOURCE/SUBJECT:		OPERATIONS:													
F-16B AIRCRAFT		(													
IN-FLIGHT CREW NOISE		(													
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TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:											
3													
OCTAVE BAND													
NOISE SOURCE/SUBJECT:		OPERATION:											
F-16B AIRCRAFT													
IN-FLIGHT CREW NOISE													
		LOCATION/CONDITION											
FREQ (HZ)		1/O	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X	1/Y	1/Z
31.5		84	83	92	88	90	77	76	90	89	88	92	89
63		85	86	92	92	92	79	81	88	93	90	93	91
125		93	96	98	101	97	92	90	92	98	97	101	94
250		94	94	94	102	99	91	87	97	96	99	99	93
500		96	95	96	101	100	88	88	96	95	100	98	96
1000		95	91	92	101	98	86	87	93	91	99	95	97
2000		93	87	89	98	98	83	86	86	85	93	87	98
4000		92	84	87	98	98	81	85	81	81	89	84	98
8000		89	79	85	96	97	78	82	82	84	87	79	97
OVERALL		102	101	103	109	107	96	96	102	102	106	105	105

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:	
3	OCTAVE BAND		
NOISE SOURCE/SUBJECT:		OMEGA 3.2	
F-16B AIRCRAFT		TEST AK-079-301	
IN-FLIGHT CREW NOISE		RUN 83	
		23 JUL 79	
		PAGE J3	

TABLE: MEASURES OF HUMAN NOISE EXPOSURE														IDENTIFICATION:
NOISE SOURCE/SUBJECT:														
OPERATIONS:														
F-16B AIRCRAFT														OMEGA 3.2
IN-FLIGHT CREW NOISE														TEST AK-079-081
														RUN 01
														23 JUL 79
														PAGE M1
LOCATION/CONDITION														
1/A	1/B	1/C	1/D	1/E	1/F	1/G	1/H	1/I	1/J	1/K	1/L	1/M	1/N	1/O
HAZARD/PROTECTION														
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR														
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR														
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)														
NO PROTECTION														
OASLC	97	105	103	105	104	107	109	111	112	108	160	98	100	101
OASLA	92	100	98	101	100	104	109	106	110	108	98	95	97	97
T	120	30	42	25	30	15	6	11	5	0	42	71	50	50
HGU-2A/P HELMET WITH H-154														
OASLA*	83	92	90	92	92	94	95	98	99	94	85	83	86	86
T	571	120	170	120	126	85	71	42	36	85	404	571	339	339
HGU-2A/P HELMET WITH H-154(A)														
OASLA*	79	88	86	88	88	91	89	94	96	88	81	79	81	82
T	960	240	339	240	240	143	202	85	60	240	807	960	807	679
HGU-2A/P HELMET WITH CUSTOM LINER														
OASLA*	88	97	95	98	97	100	100	103	105	99	92	89	92	92
T	240	50	71	42	50	30	30	18	13	36	120	202	120	128
COMMUNICATION														
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)														
PSIL	86	95	93	94	95	98	101	100	104	100	92	89	92	92
ANNOYANCE														
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNOB)														
TONE CORRECTION (C IN DB)														
PNLT	106	112	110	113	113	117	124	119	122	122	112	110	112	112
C	1	0	0	1	2	1	1	1	1	0	1	1	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE												IDENTIFICATION:
4												
NOISE SOURCE/SUBJECT:												OMFGA 3.2
OPERATION:												TEST AK-079-001
F-16B AIRCRAFT												RUN 12
IN-FLIGHT CREW NOISE												23 JUL 79
												PAGE H2
LOCATION/CONDITION												
1/O	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X	1/Y	1/Z	
HAZARD/PROTECTION												
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR												
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR												
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)												
NO PROTECTION												
OASLC	132	161	103	108	137	96	95	101	102	105	105	105
OASLA	100	97	98	106	105	92	93	97	97	103	99	104
T	30	50	42	11	13	120	161	50	50	18	36	15
HGU-2A/P HELMET WITH H-154												
OASLA*	86	67	89	95	93	84	81	89	39	92	91	90
T	240	285	240	71	101	460	807	202	232	121	143	176
HGU-2A/P HELMET WITH H-154(A)												
OASLA*	83	83	84	96	89	80	76	85	85	68	87	87
T	571	571	480	170	243	960	960	404	434	240	285	571
HGU-2A/P HELMET WITH CUSTOM LINER												
OASLA*	94	93	93	100	98	88	87	94	33	93	96	96
T	85	101	101	30	42	240	285	85	101	42	60	60
COMMUNICATION												
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)												
PSIL	95	91	92	100	99	66	87	92	91	97	93	97
ANNOYANCE												
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PND3)												
TONE CORRECTION (C IN DB)												
PNLT	114	110	112	121	120	117	108	110	110	115	113	118
C	1	1	1	1	1	2	1	1	1	1	1	0
* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.												

TABLE: MEASURES OF HUMAN NOISE EXPOSURE				IDENTIFICATION:			
4				OMEGA 3.2			
NOISE SOURCE/SUBJECT:				TEST AK-079-001			
F-16B AIRCRAFT				RUN 03			
IN-FLIGHT CREW NOISE				23 JUL 79			
				PAGE M3			
				LOCATION/CONDITION			
				4/A	2/B	2/C	2/E
HAZARD/PROTECTION							
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR							
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR							
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)							
NO PROTECTION							
OASLC	94	104	102	103	102		
OASLA	90	101	99	90	98		
T	170	25	36	42	42		
HGU-2A/P HELMET WITH H-154							
OASLA*	78	89	91	91	89		
T	960	202	170	170	202		
HGU-2A/P HELMET WITH H-154(A)							
OASLA*	74	85	85	86	85		
T	960	404	404	339	404		
HGU-2A/P HELMET WITH CUSTOM LINER							
OASLA*	84	96	93	94	93		
T	480	60	101	85	101		
COMMUNICATION							
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)							
PSIL	84	96	93	93	92		
ANNOYANCE							
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)							
TONE CORRECTION (C IN DB)							
PNLT	106	113	114	112	117		
C	1	1	1	1	3		

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.